Fluid-enhanced crystallization to generate high-S apatite of silicic magmas: Evidence from Pinatubo and other calc-alkaline systems

MARTIN J. STRECK1*, ASHLEY VAN HOOSE1, CINDY BRODERICK2 AND FLEURICE PARAT3
1Department of Geology, Portland State Univ., Portland, OR 97207, USA (*correspondence: streckm@pdx.edu)
2Department of Mineralogy, Univ. of Geneva, Geneva 1205, Switzerland (Cindy.Broderick@unige.ch)
3Géosciences Montpellier, Univ. Montpellier 2, Montpellier cedex 5, France (Fleurice.Parat@gm.univ-montp2.fr)

We consider high-S apatites to be apatites with \( \geq 0.7 \) wt.% \( \text{SO}_3 \). High-S apatites of magmas with rhyolitic melt are of particular interest because experimental data suggest that such apatites are ‘over enriched’ in S relative to equilibrium crystal-melt partitioning processes. In Pinatubo dacite, 29% of all investigated apatites (N=69) include high-S concentrations. Conversely, the dominant apatite populations of silicic oxidized magmas are medium- (0.3-0.6 wt.% \( \text{SO}_3 \)) and low-S (\(<0.3 \) wt.% \( \text{SO}_3 \)) apatites (also at Pinatubo), which are consistent with crystallization from melt at or below S saturation at various temperatures.

Explanations for high-S apatites range from inheritance (from mafic magmas or country rock) to S exchange between apatite and anhydrite as a consequence of close petrographic association of both phases in systems containing anhydrite (e.g. at Pinatubo). The compositional fingerprint (e.g. REE, Sr) ties high-S apatites to the same melt environment as the dominant populations, and thus makes inheritance unlikely. Finding low-S apatite inclusions in anhydrite in conjunction with the lack of consistent rimward enrichment of S of anhydrite-hosted apatites, argues against S exchange between these two phases.

To generate high-S apatite, we envision a process that we call ‘fluid-enhanced crystallization,’ whereby the high-S signal is controlled by the presence of a S-rich fluid adjacent to a growing apatite while other compositional characteristics are mostly controlled by the silicate melt. This process would be consistent with observed reverse S zonation towards the rim, small scale and strong changes in S content within single grains, occurrence of low- to high-S apatites as inclusions together in single host minerals, and compositional similarity among low- to high-S apatites. At Pinatubo the existence of such S-rich fluid is corroborated by S isotopes of anhydrite as well as growth features of anhydrite. A suitable source for S-rich fluids would be fluids derived from degassing underplated mafic magmas.

Post-collisional magmatism during Variscan orogeny: The Furcatura pluton (Danubian domain, Romanian Southern Carpathians)

C. STREMTAN1, J. RYAN1, V. ATUDOREI2 AND I. CHERATA3
1Dept. of Geology, University of South Florida, Tampa, US (cstremta@mail.usf.edu)
2Dept. of Earth and Planetary Sciences, University of New Mexico, Albuquerque, US
3Dept. of Geology, ‘Babes-Bolyai’ University, Cluj-Napoca, Romania

Exploratory geochronological data indicate that the Furcatura pluton (312 ±2.8 Ma) was emplaced during the Hercynian orogeny. This late stage magmatism is essentially granitic/granodioritic, lacking associated basic rocks. Furcatura pluton (FP) is remarkably heterogeneous, showing wide ranges for most of the petrographical and geochemical parameters. The metaluminous to slightly peraluminous (average A/CNK of 1.04) granitoids are high-K (\( \text{K}_2\text{O}/\text{Na}_2\text{O} \) of 0.51-1.63) calc-alkaline, while some samples have shoshonitic affinity (maximum \( \text{K}_2\text{O} \) of 5.61). They lack significant Eu anomalies (average Eu/Eu* of 0.94) and have subparallel REE patterns, with \( \delta^{18}\text{O} \) values of the quartz separates, ranging from 7.37 to 11.5%, with the highest values measured in the late magmatic aplitic veins. In conventional discrimination diagrams, as well as reflected by their trace elemental compositions, FP granitoids show both I- and S-type granite features. Geochemical evidence suggests the pluton was derived from a heterogeneous, primarily (lower?) crustal source, with subordinate additions of mantle-derived melts (e.g. low Nb/U and Ce/Pb). However, based on available data, contributions from a previously subduction-enriched mantle component can not be completely ruled out. Therefore, the FP granitoids may provide clues for deciphering the processes involved in the production of post-collisional magmas.