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Constraining Halogen Budgets in Continental Arcs at the Whole-Rock Scale

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Halogens (F, Cl, Br, I) are primary components of volcanic gas emissions and play an essential role in continental arc magmatic environments due to their solubility in fluids that generate metallic ore deposits. Despite their ubiquity, the behavior and budget of halogens in continental arc environments are poorly constrained. We investigated the plutonic and volcanic halogen budgets in intermediate-to-felsic igneous rocks (56–77 wt% SiO_2) from the Sierra Nevada (California) - a Mesozoic continental arc where plutonic and volcanic outcrops can be correlated via their geographic, compositional, and geochronologic framework.

We measured the halogen concentrations of bulk rock powders and their leachates via ion chromatography (F, Cl) and ICP-MS (Br, I). Halogen concentrations in our rock powders range between 107–727 µg/g F, 13–316 µg/g Cl, 2–323 ng/g Br, and 1–69 ng/g I. In contrast, leachates yielded 3–4 orders of magnitude less Cl and F, one order of magnitude less I, and similar amounts of Br compared to their corresponding bulk rocks. Preliminary data show no significant differences between volcanic and plutonic samples, suggesting that halogen concentrations in these rocks are insensitive to shallow fractionation. Although F and I exhibit no correlation with major element compositions, Cl and Br display negative trends with increasing SiO_2 and K_2O, and positive trends with increasing Fe_2O_{3T}, MnO, MgO, CaO, and TiO_2, suggesting mafic minerals as important hosts of structurally bound halogens. Overall, Sierran plutonic rocks display low halogen contents (max. F, Cl = 727, 315 µg/g), consistent with biotite- and apatite-bearing granitoids reported in [1].

This work suggests that halogens do not preferentially enrich in shallow plutonic or volcanic portions of a continental arc system and that mafic mineral phases likely serve as primary reservoirs of these elements in intermediate-to-felsic igneous rocks. These hypotheses will be further investigated in future work through in-situ analysis of halogen concentrations in crystals.

[1] Teiber, Marks, Wenzel, Siebel, Altherr & Markl (2014), Chemical Geology, vol. 374–375, pp. 92–109, doi: 10.1016/j.chemgeo.2014.03.006.