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Textural and mineral-chemical evidence for magmatic sulfides within Devonian oxidized I-type granitoids, New Brunswick, Canada: implications for fertility of associated porphyry Cu-Mo-Au systems

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Magmatic sulfides are the main storage for chalcophile metals within crystallizing subvolcanic felsic magmas as they have high partition coefficients. In addition to melt composition, pressure, temperature, redox, and sulfur abundance are the fundamental factors in sulfide-sulfate saturation [1]. If oxygen fugacity remains constant, sulfur solubility will decrease with decreasing T and increasing P. Sulfides predominate in crystallizing felsic melts under reduced conditions, i.e. were fO_2 is at or below Quartz-Fayalite-Magnetite (QFM) buffer, whereas sulfate prevails under oxidizing conditions (fO_2 above QFM+2) [1]. In hydrous felsic magmas, oxygen fugacity and melt composition control the redox behavior of sulfur, with H_2S as the dominant reduced sulfur species when fO_2 is below QFM+1 [2], but when fO_2 is above QFM+1, the main possible S-bearing species are SO_2 [3].

Magmatic sulfide saturation and dissolution plays a considerable role in controlling the metals in arc-related magmatic systems. Some subduction-related, oxidized I-type granitoid magmas in New Brunswick (NB) show reduced features (ilmenite series), because of emplacement of magma into graphite-bearing metasedimentary rocks. In fact, when the magma includes SO_2 more than 250 ppm and fO_2 is buffered by SO_2-H_2S, the magma forms oxidized-type granites with 0.2 to 1.5 modal percent magnetite [4]. In I-type oxidized granitoid intrusions of NB, the reaction processes of resorption, oxidation, and decomposition of early magmatic sulfide minerals with exsolving hydrothermal fluids evidently cause enrichment of various ore materials; earlier LA-ICPMS analysis of magmatic pyrrhotite, pyrite, and chalcopyrite in some reduced NB granitoids shows significant abundances of these metals. Magmatic sulfides in these oxidized I-type granitoids examined using μ-XRF-EDS appear enriched with chalcophile metals (i.e. Au, Cu, Bi, Zn, Ag, Co, Ni) like reduced NB granitoids systems. Oxidation of magmatic sulfides to magnetite releases metals and S to exsolving volatiles; this study further examines the saturation and distribution of metals between preserved magmatic sulfides and how they relate to the fertility of these porphyry systems.

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