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Chalcophile element geochemistry of the Baima layered intrusion, Emeishan Large Igneous Province, SW China: implications for sulfur saturation history and genetic relationship with high-Ti basalts

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Unlike the Bushveld complex, in which economic Fe-Ti oxide layers commonly occur in the upper section of these layered intrusions [1], the Permian Baima mafic layered intrusion, which is believed to be related to the S-undersaturated Emeishan high-Ti basalts, hosts a giant Fe-Ti oxide deposit in the lower or middle parts of the intrusion [2, 3, 4].

Uniformly high Cu/Pd (1.9×10^6 - 6.1×10^4) and low Pd/Zr (<0.1) indicate that the Baima parental magma experienced prior sulfide segregation. Mantle-liked $\delta^{34}S$ values and low S/Se values indicate negligible external sulfur addition. Primitive mantle-normalized PGE patterns of the Baima rocks indicate that their parental magmas were initially S-undersaturate, and experienced significant fractionation of silicate minerals before reaching sulfide saturation. MELTS modeling indicates that the parental magmas were generated by ~60% fractional crystallization of olivine, pyroxene, and chromite from a high-Ti picritic magma at a deep crustal levels (5 kbar) [4]. Hence, we suggest that S saturation and sulfide liquid immiscibility in the deep crust resulted from relatively high S concentration in the residual magma, which was triggered by advanced fractional crystallization of silicate minerals.

Strong positive correlations between IPGE and PPGE and between PGE and V, Cr, and S suggest that magmatic sulfide is the dominant mineral controlling the distribution of PGE in the Baima intrusion. A positive correlation between S and Cr, FeO_T+TiO_2, and V, together with MELTS calculations, indicate that the parental magma of the Baima intrusion reached a second stage of S saturation in the shallower Baima magma chamber, which was likely triggered by decreasing Fe^{2+} accompanying magnetite precipitation.

Primitive mantle-normalized PGE patterns for Baima intrusion rocks display similar trends to high-Ti basalts inside the Panxi area [5, 6, 7], suggesting that they are comagmatic, and following a similar differentiation trend. However, the lavas erupted before they reached sulfide saturation. The more evolved nature of high-Ti basalts outside the Panxi area [7, 8] indicate that they experienced more extensive pre-eruption fractional crystallization. Further fractional crystallization process led these lavas show more PGE fractionated feature.

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