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Titanite major and trace element compositions as petrogenetic and metallogenic indicators of Mo ore deposits: Examples from four granite plutons in the southern Yidun arc, SW China

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Abstract

Major, minor, and trace element abundances in titanite crystals from four granitic plutons in southern Yidun arc, SW China, have been determined using electron microprobe and laser ablation-inductively coupled plasma-mass spectrometry. The selected plutons are the Cretaceous Xiuwacu (CXWC) pluton, with quartz vein-type Mo mineralization (economic-Mo), the Tongchanggou (TCG) pluton, with porphyry-type Mo mineralization (economic-Mo), the Triassic Pulang (PL) pluton, with porphyry-type Cu mineralization (subeconomic-Mo), and the Triassic Xiuwacu (TXWC) pluton, without any Mo mineralization (Mo-barren). Our study reveals that the chemical compositions of titanite crystals from these plutons such as REE, Sr, Ga, δEu, δCe, Fe_2O_3/Al_2O_3, halogens, and Mo can be used to track magma compositions, oxidation states, metal fertility, and crystallization history. The data from this study also show that titanite crystals from these plutons with different potential of Mo mineralization have similar Mo contents and exhibit an irregular variation between Mo and Sr abundances (indicating non-Mo enrichment in the residual melt during the progressive crystallization) for some Mo-mineralized plutons. Our new observations support the recent hypothesis that high initial Mo contents in magma and the enrichment of Mo in residual melts formed by fractional crystallization are not the only requirements to form a granite-related Mo ore deposit. Efficient extraction of the residual melts, possibly facilitated by high concentrations of magmatic F is also critical to the ore formation. Evidence for high-F concentration in felsic magma, which facilitates melt and fluid separation and economic Mo mineralization during magma evolution, may be traced by the presence of F-rich titanite crystals in the two Mo-mineralized granite plutons (CXWC and TCG). These new findings from this study confirm that titanite is indeed a good petrogenetic and metallogenic indicator. However, in light of the limited contribution of metal fertility to Mo mineralization, we suggest that titanite Mo concentrations should be used along with other crucial proxies, such as titanite F contents and Fe_2O_3/Al_2O_3 ratios to better evaluate the Mo-mineralized potential of granites.

Keywords: Titanite, LA-ICP-MS, REE, oxidation state, magma composition, Mo mineralization, ore genesis; From Magmas to Ore Deposits