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Contrasting magma compositions between Cu and Au mineralized granodiorite intrusions in the Tongling ore district in South China using apatite chemical composition and Sr-Nd isotopes

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Abstract

Identifying magma fertility is an important task in ore genesis research. In this paper, we use apatite chemistry and Sr-Nd isotopes for such a study. The apatite crystals are from four Cretaceous coeval granodiorite intrusions with different styles of hydrothermal mineralization in the Tongling ore district, South China. The selected intrusions are Hucun, Dongguashan, and Xinwuli, which host both porphyry and skarn Cu deposits, and the Chaoshan, which hosts a skarn Au deposit. The abundances of apatite major and trace elements, such as Mn, V, Ce, S, F, Cl, and Cu, together with the whole-rock compositions, are used to decipher the oxidation states, volatile compositions, and Cu fertility of the parental magmas. The apatite Sr-Nd isotope compositions are used as tracers for the magma sources. The results show that: (1) the parental magma of the Au-mineralized intrusion is less oxidized and has higher S-Cl contents than those of the Cu-mineralized intrusions, and (2) the proportion of mantle-derived melt is much higher in the former than in the latter. The results also reveal that the Cu-mineralized intrusions have highly variable apatite Cu-Cl-S compositions. Specifically, the Xinwuli intrusion has much higher Cu but lower Cl-S contents in apatite than the other two intrusions, indicating that a Cu-rich magma is not universally required for the formation of hydrothermal Cu deposits. This study demonstrates that apatite is a robust petrogenetic and metallogenic indicator for porphyry and skarn-type Cu-Au ore deposits.

Keywords: Apatite, magma oxidation state, Sr-Nd isotopes, LA-ICP-MS, Cu and Au mineralization; High-Grade Metamorphism, Crustal Melting and Granite Magmas