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Magma oxygen fugacity and volatile components control the Miocene high-Sr/Y granitoids forming either Cu or W mineralization in the Gangdese metallogenic region, Xizang, China

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Abstract

Porphyry copper deposits are usually associated with high-Sr/Y granitoids. The Miocene Gangdese porphyry copper belt in southern Tibet is also associated with high-Sr/Y granitoids, forming wolframite deposits. Why some coeval high-Sr/Y granitoids formed Cu deposits (Cu-granitoids) while others formed W deposits (W-granites) remains unclear. We address this issue by studying magma sources and properties, analyzing magmatic zircons, biotites, and apatites in these granites, and combining this information with previously published bulk-rock and zircon isotopic data. In situ chemical analyses of magmatic zircon, biotite, and apatite show that the properties of the magmas that produced the Cu-granitoids and W-granites were significantly different. Zircon ΔFMQ values of the W-granites were much lower than those of the Cu-granitoids, suggesting a more reduced magma for W deposits. Water content of the W-granites (7–9 wt%) seems to be lower than that of the Cu-granitoids (10–12 wt%). This is suggested by the low-zircon Ce/Nd and (Ce/Nd)/Y ratios and high-Dy/Yb ratios in the W-granites. Biotite and apatite from the W-granites generally have lower Cl contents than those from most Cu-granitoids. Moreover, the SO_3 concentration in apatite from the W-granites is also lower than that of the Cu-granitoids. These data agree with the genetic environment suggested by previously published isotopic data. Bulk-rock Sr-Nd and zircon Hf isotopes indicate that the Cu-granitoids were mainly sourced from juvenile lower crust. In contrast, the source of W-granites was contaminated with the old Lhasa terrane basement. Our results highlight the role of magma oxygen fugacity and volatile components in controlling metal variations in high-Sr/Y granitoids. Combinations of magmatic zircon ΔFMQ and Ce/Nd, (Ce/Nd)/Y and Dy/Yb ratios, and apatite and biotite SO_3 and Cl contents can be used to discriminate W-granites from Cu-granitoids in the Gangdese metallogenic region, and hence granitoids potentially hosting W vs. Cu ore deposits.

Keywords: High-Sr/Y granitoids, porphyry copper deposit, W-related granites, magma oxygen fugacity, volatile components, Gangdese metallogenic region