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Compositional variations of coeval magmatic sulfide deposits in the Kalatongke area, western China: Implications for the further exploration

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A significant magmatic Ni-Cu sulfide deposit cluster occurs in the Southern Chinese Altai Orogenic Belt, western China. The most important deposits are associated with the mafic units of the Y1, Y2, Y3 and Y9 mafic-intermediate complexes. The on-going exploration campaign has also been found sulfide mineralization in the G21 intrusion. The zircon U-Pb age of this intrusions indicates that only the younger intrusions (~281 – ~287 Ma) contain significant sulfide mineralization. In contrast, the older intrusions, such as Y5 (~320 Ma) that occurs ~200 m north of the Y3 intrusion is not economically valuable. New and existing petrological and geochemical data show that there are some important similarities and differences between these coeval deposits. The host lithologies change from olivine-bearing rocks for the Y1-Y2-Y9 deposits to olivine-free rocks such as norite for the Y3 deposit and leucogabbro for the G21 deposit. The olivine Fo contents of the Y1 deposit are up to 82 mol%, which are slightly higher than those of the Y2 deposit (up to 81 mol%) and the Y9 deposit (up to 79 mol%). The average plagioclase An contents of the olivine-bearing Y1-Y2-Y9 deposits are higher than those of the olivine-free Y3-G21 deposits. Among the three deposits (Y1, Y2 and Y3) that occur closely along the same structural lineament, the Ni/Cu ratios of bulk sulfides decrease from the olivine-bearing deposits (Y1 and Y2) to the olivine-free Y3 deposit (Y3). The PGE tenors of these deposits (Y1, Y2 and Y3) and the nearby coeval deposits (Y9 and G21) are extremely low, indicating that their parental magmas are severely depleted in PGEs. The variations of PGE tenors within a single deposit as well as among the different deposits are mainly due to variable R factors.

The host rocks of these deposits are all characterized by elevated initial 87Sr/86Sr ratios from 0.7045 to 0.7047, positive εNd values from 4.95 to 6.86, positive εHf values of zircon from 9 to 16, and elevated $\delta^{18}O$ values of zircon from 6.15 to 6.7 ‰. The isotope data indicate that the parental magmas for these deposits experienced up to ~15 wt % crustal contamination. The δ34S values of the sulfide minerals from these deposits are from -3.1 ‰ to 0.4 ‰, with a peak at -2.2 ‰, indicating the involvement of crustal sulfur. The isotope data and mineral chemistry together indicate that both olivine fractional crystallization and addition of crustal sulfur played a role in triggering sulfide saturation in the parental magmas for these deposits. Based on higher Ni/Cu ratios of sulfide mineralization in the olivine-bearing intrusions (Y1, Y2, Y9) than in the coeval olivine-free intrusions (Y3, G21), we recommend that Ni exploration in the region focus on the olivine-bearing intrusions that were emplaced in the Early Permian.