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S-C-O isotopic constraints on the ore-bearing fluids of the Tongchang copper deposit at Yimeng, central Yunnan

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The Tongchang carbonate-hosted copper deposit is located between the NS Yimen fault and the Luzhijiang fault in the Kangdian area, central Yunnan. Sedimentary and hydrothermal vein mineralization coexist in the Luoxue Formation of the early-middle Proterozoic Kunyang Group. This paper aims to determine the ore-forming fluid source of the two different types of copper deposits utilizing S-C-O isotopes from a new dimension. Ore microscopy shows that the mineralalogy includes bornite, chalcopyrite, and pyrite in the sedimentary type deposit and chalcopyrite and pyrite in the hydrothermal vein type deposit. In the sedimentary type deposit, the values of $\delta^{34}S_{CDT}$ analyses of bornite, chalcopyrite and pyrite minerals vary between -12.1 ‰ and +12.3 ‰, which implies biological reduction of sulfate in the sea water. The results of $\delta^{13}C_{PDB}$ and $\delta^{18}O_{SMOW}$ of the dolomite stratum range from -3.7 ‰ to 1.4 ‰ and from 16.7 ‰ to 21.7 ‰, respectively, which are consistent with Precambrian marine carbonate. The C and O isotopic values of dolomite are fairly consistent suggesting small changes in the depositional environment. These possibly indicate that the ore-bearing fluid entered the marine carbonate during diagenesis. For the hydrothermal vein type deposit, $\delta^{34}S_{CDT}$ of chalcopyrite and pyrite minerals vary from -4.6 ‰ to 9.5 ‰, with most of them close to 0 ‰. This suggests a magmatic hydrothermal source for the fluid, with the deviating values maybe contaminated by the carbonate during the copper deposition. The $\delta^{13}C_{PDB}$ and $\delta^{18}O_{SMOW}$ of calcites range from -3.7 ‰ to -0.1 ‰ and from 11.9 ‰ to 17.0 ‰, respectively. The calculated $\delta^{13}C_{PDB}$ and $\delta^{18}O_{SMOW}$ of the fluid are between -6.24‰ and -0.35‰ and between – 3.1 ‰ and 6.0 ‰, respectively, which overlap the range of magmatic water. This evidence suggests the vein calcite was sourced from the original magma and not from leached stratum carbonate. The ore-bearing magmatic hydrothermal fluid rose and gradually gathered in shallow, favorable structural positions. When the temperature decreased appropriately, the copper mineralized from the low salinity and reducing fluid.

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