Deciphering Fluid Origins in the Paleozoic Iron Oxide-Cu-Au (IOCG) Deposits, NW China: Constraints from Noble Gases and Halogens

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Represented by the Laoshankou, Qiaoxiahala, and Heijianshan deposits, the northern margin of East Junggar and the Yamansu belt of East Tianshan are two important potential belts for Paleozoic iron oxide-Cu-Au (IOCG) mineralization in NW China. All IOCG deposits in these two regions formed in a basin inversion setting (dying back-arc basin) and show significant two-stage mineralization, i.e., Fe-oxide and chalcopyrite(-gold). In this study, we used halogen (Cl, Br, and I) and noble gases (Ar, Kr, and Xe) from fluid inclusions of quartz and epidote as reliable tracers to track the fluid sources and evolution of these deposits. The results (in mole ratios) obtained by a MAP 215-50 noble gas mass spectrometer through an UHV extraction line at the Noble Gas Laboratory at the Australian National University (ANU) and showed that three different fluid end members are mainly involved in the mineralization processes of these Paleozoic IOCG deposits: (1) a magmatic-hydrothermal fluid, with I/Cl, Br/Cl, and $^{40}Ar/^{36}Ar$ ratios of 16.3×10^{-6} to 18.0×10^{-6}, 1.03×10^{-3} to 1.06×10^{-3}, and 352 to 437, respectively; (2) surface-derived bittern brine derived from seawater evaporation, with highest Br/Cl ratios of 1.53×10^{-3} to 1.80×10^{-3} and I/Cl and $^{40}Ar/^{36}Ar$ ratios of 77.1×10^{-6} to 87.7×10^{-6} and 672 to 883, respectively; and (3) basin brine or formation water modified by organic-rich strata through water-rock reaction, with highest I/Cl ratios of 477×10^{-6} to $26{,}301\times10^{-6}$, low Br/Cl ratios of 0.39×10^{-3} to 1.28×10^{-3}, and $^{40}Ar/^{36}Ar$ ratios of 288 to 510, respectively. The obvious multi-stage mineralization and involvement of Ca-rich hypersaline non-magmatic brines with variable origins in the Paleozoic iron oxide-Cu-Au deposits in the Central Asian Orogenic Belt (CAOB) resemble the characteristics of other IOCG type deposits in the world. These findings further suggest that non-magmatic fluids dominate the formation of IOCG deposits in the basin inversion setting.