

Pyrite in-situ S–Fe isotope constraints on the ore-forming sources and mineralization processes of gold and polymetallic deposits in the Liaodong Peninsula, North China Craton

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Plenty of gold and polymetallic deposits are widespread in the eastern part of the North China Craton. They are associated with mafic to felsic dikes and hosted by Precambrian basement or Mesozoic granitoids. However, the sources of gold and other metals in the ore fluids remain controversial. Here we present in-situ S and Fe isotopes and trace element contents of pyrites from various gold and Pb–Zn–(Ag) deposits in the Liaodong Peninsula, China. Pyrites from quartz vein-type gold deposit hosted by Mesozoic granites in the Wulong deposit have relatively homogeneous magmatic-like S isotopes ($\delta^{34}\text{S}$ values of 0.9‰ to 2.5‰) and Co/Ni ratios, indicating derivation of sulfur and, by inference, of ore fluids/materials most likely from Mesozoic magmas. In contrast, pyrites from gold and Pb–Zn–(Ag) deposits in the Qingchengzi orefield hosted by Precambrian basement have high and variable $\delta^{34}\text{S}$ values (9.7‰ to 12.7‰ for Wandigou altered rock-type gold deposit and 4.7‰ to 8.5‰ for Xiquegou Pb–Zn deposit and Zhenzigou Pb–Zn–Ag deposit), identical to those of host rocks, indicating the important contributions of gold and other metals from wall rocks to the ore deposits. Pyrites from the various deposits have variable $\delta^{56}\text{Fe}$ values of 0.08‰ to 0.63‰ for the Pb–Zn–Ag deposit, –0.58‰ to 1.23‰ for the altered rock-type gold deposit, and –0.68‰ to 0.77‰ for the quartz vein-type gold deposit, indicating distinct mineralization processes. Rapid precipitation of pyrites (with negative $\delta^{56}\text{Fe}$ values) in the alteration rock and subsequent deposition of pyrites (with positive $\delta^{56}\text{Fe}$ values) from the residual fluids in an Fe-open hydrothermal system during intensive ore-forming fluid-wall rock interaction account for the Pb–Zn–Ag mineralization, while weak fluid-rock interaction and pyrites precipitation from a Fe-closed hydrothermal system contribute to gold mineralization. Our observations provide a robust Fe–S isotope evidence for the contribution of various sources and metallogenic processes for distinct gold and polymetallic deposits.