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Genesis of the Early Cretaceous Tudui–Shawang gold deposit, Jiaodong Peninsula, North China Craton: Evidences from H-O-He-Ar-S-Pb isotopic compositions

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A new gold metallogenic belt has recently been identified in which contains reserves of > 120 tonnes Au along the northeastern margin of the Jiaolai Basin, Jiaodong Province. Nevertheless, the origin of these deposits are currently under vigorous debate. Among these deposits, the Tudui–Shawang gold deposit is a particular fault-hosted sulfide-rich gold deposit, with three mineralization stages, i.e., quartz-coarse-grained pyrite mineralization, quartz-polymetallic sulfide mineralization, and quartz-calcite mineralization. Here, we present records of which combined systematic H–O–He–Ar–S–Pb isotopic data of this deposit. The $\delta^{18}O_{H2O}$ values of quartz in ore stages 1 and 2 range from +3.4‰ to +6.3‰ and +2.3‰ to +4.5‰, whereas the δD_{SMOW} from −93‰ to −86‰ and −97‰ to −83‰. Both suggest that the ore-forming fluids are derived from magmatic sources, followed by mixing with meteoric water. The measured $^{3}He/^{4}He$ ($^{40}Ar/^{36}Ar$) of hydrothermal fluids in pyrites are 1.53 to 3.21 R_a (732 to 1783) for stage 1, and 0.38 to 2.58 R_a (360 to 1544) for stage 2. The linear correlation between He and Ar isotopes is the result of a combination between mantle components and crustal fluid. The estimated ^{3}He/heat ratios range from 0.13 to 2.55 × 10^{-12} cm^3 STP J^{-1}, reflecting the heat source is actually high $^{3}He/^{4}He$ fluids originating from mantle. The pyrite $\delta^{34}S$ from stage 1 and 2 vary from 5.6 to 10.1‰ with an average of 8.2‰. Lead isotopic compositions of pyrites ($^{206}Pb/^{204}Pb$ = 17.102 to 18.248; $^{207}Pb/^{204}Pb$ = 15.435 to 15.590; $^{208}Pb/^{204}Pb$ = 37.659 to 38.691) show a consistent origin as mafic dikes. We, therefore, propose deep-seated, most likely mafic dike magmatic and mantle-derived sources for gold ore formation. In comparison with other Jiaodong gold deposits, both of them exhibit similar geochemical signatures and thus consistent geodynamic setting, which are considered to associate with the subduction of the Paleo-Pacific Plate and the destruction of the North China Craton during the Early Cretaceous.

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