

# Fluid Inclusion and Noble Gas Studies of the Dongping Gold Deposit, Hebei Province, China: A Mantle Connection for Mineralization?

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## Abstract

The Dongping gold deposit (>100 t Au) occurs about 200 km inboard of the northern margin of the North China craton. The deposit is mainly hosted by syenite of a middle Paleozoic alkalic intrusive complex that was emplaced into Late Archean basement rocks. Both groups of rocks are intruded by Late Jurassic to Early Cretaceous crustal-melt granite dikes and stocks, some within a few kilometers of the deposit. The gold ores were deposited during this latter magmatic period at about 150 Ma, a time that was characterized by widespread regional north-south compression that formed the east-west-trending Yanshan deformational belt. The ores include both the telluride mineral-bearing, low sulfide quartz veins and the highly K-feldspar-altered syenite, with most of the resource concentrated in two orebodies (1 and 70).

Fluid inclusion microthermometry indicates heterogeneous trapping of low-salinity (e.g., 5–7 wt % NaCl equiv) fluids that varied from a few to 60 mole percent nonaqueous volatile species. Laser Raman spectroscopy confirms that the vapor phase in these inclusions is dominated by CO<sub>2</sub> but may be comprised of as much as 9 mole percent H<sub>2</sub>S and 20 mole percent N<sub>2</sub>; methane concentrations in the vapor phase are consistently <1 mole percent. The variable phase ratios are consistent with fluid immiscibility during ore formation. Fluid inclusion trapping conditions are estimated to be 250° to 375°C and 0.6 to 1.0 kbar. Helium isotope studies of fluid inclusions in ore-stage pyrites indicate <sup>3</sup>He/<sup>4</sup>He ratios of 2.1 to 5.2 Ra (Ra = 1.4 × 10<sup>-6</sup> for air) for orebody 1 and 0.3 to 0.8 Ra for orebody 70. The former data suggest that at least 26 to 65 percent mantle helium occurs in the fluids that deposited the veins in orebody 1. The lower values for orebody 70, which is characterized by a more disseminated style of gold mineralization, are interpreted to reflect an increased interaction of ore fluids with surrounding crustal rocks, which may have contributed additional <sup>4</sup>He to the fluids.

A mantle source for at least some of the components of the gold-forming fluid is consistent with upwelling of hot asthenosphere and erosion of as much as 100 to 150 km of cool Archean lithosphere beneath the craton during this time. The Dongping deposit is located along the 100-km-wide north-south gravity lineament, which marks the western border of the thinned crust. As both regional metamorphism of Mesoproterozoic and younger cover rocks, and widespread granite magmatism, also occurred at ca. 150 Ma, it is unclear as to whether one or both of these also contributed fluid and/or metals to the hydrothermal system. Importantly, these new data suggest that economically significant gold deposits of similar mineral style and fluid composition, which are scattered along the margins of the craton, may all be products of a fluid originally partly sourced within the mantle.

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