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The metal source of gold deposits in the Yangshan gold belt, West Qinling, China: In situ LA-ICP-MS analysis and sulfur isotope of sulfides

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The Yangshan gold belt, located in the West Qinling region, is one of the largest gold reserves in China. The gold belt is comprised of six gold deposits, and Anba is the largest one with more than 280 t gold resource. The gold deposits are strictly controlled by the E-W-trending Anchanghe - Guangyinba fault and Getiaowan – Caopingliang composite anticline. The granitic dikes in the gold belt intruded at ~220 Ma and predate the gold mineralization.

The mineralization is dominated by widespread disseminated style, with lesser quartz vein and veinlet styles. The syn-metamorphic pyrite (Py_0) has framboidal or colloform texture and is disseminated in the metasedimentary host rocks. The hydrothermal mineralization stages are divided into early ore stage (Py_1-quartz), main ore stage (Py_2-Apy_2–quartz-sericite) and late ore stage (Py_3-Apy_3–stibnite–calcite-quartz). As indicated by the trace elements in sulfides and the observations by HRTEM and AFM, the gold is mainly hosted in main ore stage pyrite and arsenopyrite as solid solution or lattice-bound gold, while during the late ore stage, gold is released from the structures of pyrite and arsenopyrite to form free gold under slightly lower temperature and/or pressure conditions.

EPMA and LA-ICP-MS analyses reveal that different generations of sulfides have characteristic elemental patterns, which can be used as a proxy for the distinct hydrothermal events. The Py_0 in the greenschist facies strata and now locally overgrown by Py_1 and Py_2 have high contents of gold and related trace elements, which would provide an obvious source for gold in deposits of the Yangshan gold belt, where such pyrite was metamorphosed at depth below presently exposed levels.

The syn-metamorphic Py_0 in phyllite and metasandstone has $\delta^{34}S$ values ranging from -29 ‰ to +12.5 ‰, which is similar to those in sedimentary rocks. In addition, the Py_0 in marble has similar $\delta^{34}S$ values (15.3 ‰ ~ 17.5 ‰) to those of contemporaneous seawater. The $\delta^{34}S$ values of hydrothermal pyrite from the gold deposits of the Yangshan gold belt have a narrow range of -2.1 ‰ to +1.2 ‰. The $\delta^{34}S$ values of main ore-stage arsenopyrite range from -4.2‰ to +3.0‰ and the $\delta^{34}S$ values of stibnite range from -6.6‰ to -4.5 ‰. Some of the values are lower than the minimum $\delta^{34}S$ value of granitic rocks, but within the $\delta^{34}S$ value ranges of metamorphic and sedimentary rocks, and also within the range of orogenic gold deposits.

In conclusion, the gold in the deposits of Yangshan gold belt is mainly from the early Py_0 in the metasedimentary host rocks. Combined with the $\delta^{18}O$ values (15.9 ‰ ~ 21.5 ‰) of quartz from gold-bearing veins, the abundant CO_2 (7.3 ~ 21.5 mol %) present in the fluid inclusions of ore-stage quartz, and homogenization temperature (271.3 ~ 288.3 ℃) of the late ore stage quartz surrounded by stibnite, with low salinity of 2.22 ~ 4.79 wt % NaCl, the gold deposits in the Yangshan gold belt are best defined as orogenic gold deposits.