

Magmatic Fingerprints and Timing of Gold Mineralization at the Yangshan Deposit, West Qinling: Rb-Sr Geochronology and Pyrite Geochemistry

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The Yangshan gold deposit in the West Qinling orogenic belt, one of China's largest, hosts disseminated gold in metasedimentary rocks and minor native gold-bearing quartz veins, yet its genetic relationship to magmatism remains contentious. We present new in-situ muscovite Rb-Sr geochronology, trace element mapping, and sulfur isotope analyses of pyrite from mineralized granite porphyry dikes and gold-bearing quartz veins to constrain the timing and source of gold mineralization.

Hydrothermal muscovite intergrown with native gold in quartz veins yields a robust Rb-Sr isochron age of 210.1 ± 5.6 Ma (MSWD = 1.2), coeval with nearby granitic dike emplacement (210–213 Ma). LA-ICP-MS trace element mapping of zoned pyrite reveals two discrete gold enrichment stages: an early phase associated with Co-Cu-As-Ni, followed by a later stage enriched in Bi-Co-Ni-Pb-Cu-Sb, indicating episodic fluid pulses rather than continuous mineralization. In-situ sulfur isotope analyses of gold-bearing pyrite show restricted $\delta^{34}\text{S}$ values ranging from -1.43‰ to 2.86‰ (mean 0.43‰), consistent with a magmatic sulfur source, though minor sedimentary contamination is indicated by subtle isotopic variations across growth zones.

Integration of spatial relationships, precise geochronology, and trace element-isotope systematics demonstrates that mineralization is contemporaneous with Late Triassic magmatism, and ore-forming fluids were predominantly magmatically derived. These findings challenge previous models invoking metamorphic fluids alone and establish the Yangshan deposit as a magmatic-hydrothermal system linked to post-collisional extension. This study highlights the critical role of in-situ analytical techniques in resolving genetic controversies and provides a new exploration framework for orogenic belt gold deposits.