In-situ trace elements and S-Pb isotopic analyses of pyrite: implications for ore-forming processes in the Qiyugou gold deposit, China

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Qiyugou gold deposit is one of the most important gold deposits in the Xiaoqinling–Xiong'ershan gold mineralization province. This deposit is hosted in Archean Taihua Supergroup rocks and occurs as breccia pipes. In this study, we performed a detailed in-situ analysis of trace elements and sulfur and lead isotopes in pyrite from different ore stages, in order to reveal the gold distribution and precipitation mechanisms of this deposit.

Pyrite is a major constituent of hydrothermal mineralization and is also the most abundant sulfide mineral in the Qiyugou gold depsoit. Pyrite formed in different stages of hydrothermal deposits can be served as an excellent record of the ore-forming processes. Four mineralization stages are distinguished including K-feldspar-quartz-pyrite stage (I), gold-pyrite-quartz stage (II), gold-quartz-polymetallic sulfides stage (III), and quartz-carbonate stage (IV). Three types of pyrite are recognized: an early medium- to coarse-grained pyrite (Py1) in the potassic alteration zone from stage Ⅰ, a medium-grained pyrite (Py2) with abundant fractures from stage Ⅱ, and a fine-grained pyrite (Py3) filled in the fractures of early pyrites from stage Ⅲ. The visible native gold grains occur as small inclusions and fractures within Py2 and Py3. LA-ICP-MS analysis reveals the presence of invisible gold in pyrite. The highest Au concentrations are found in Py3, which correlate with higher Bi and Te concentrations, whereas Py1 contains negligible to lowest Au concentrations.

In-situ LA-MC-ICP-MS lead isotope analyses indicate that the sulfides have similar $^{206}Pb/^{204}Pb$, $^{207}Pb/^{204}Pb$, and $^{208}Pb/^{204}Pb$ ratios to the granite porphyry in the district, indicative of similar lead sources. In-situ LA-MC-ICP-MS sulfur isotope analyses of pyrite show a large $\delta^{34}S$ range but increasing trend from −18.1 to −1.5 per mil from Py1 and Py2 to Py3, which may suggest a decreasing in temperature and oxygen fugacity from early to late stages, which may also lead to Au precipitation from the hydrothermal fluids.