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Textures and in-situ chemical and isotopic analyses of pyrite, Huijiabao Trend, Youjiang Basin, China: Implications for paragenesis and source of S

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Many Carlin-like Au deposits occur within the late Paleozoic and Triassic Youjiang Basin of SW China. The Huijiabao Trend in Guizhou Province contains over 300 tons (10.6 Moz) of Au at an average grade of 7–18 g/t. Petrographic and SEM studies of pyrite in barren host rocks and high grade ore bodies led to the recognition of four stages of pyrite. Py1 consists of fine-grained framboidal crystals in black mudstone. Py2 is comprised of coarser grained euhedral–subhedral clusters that are spatially related to organic matter. Py3 is coarse grained, euhedral, and occurs as overgrowths on Py1 and Py2. Py3's porous texture, inclusion of randomly oriented detrital minerals, and association with quartz recrystallization suggest it was deformed during late Triassic orogenesis with Py1 and Py2. Py4 generally occurs as rims on Py1–Py3 and is intergrown with arsenopyrite.

Sensitive high resolution ion microprobe (SHRIMP) $d^{34}S$ analyses of each pyrite type and arsenopyrite show that Py1 is related to Py2 and that Py3 is related to Py4 and arsenopyrite. The S isotope compositions of Py1 (-7.5 to 5.9‰) and Py2 (−5.3 to 7.9‰) are bimodal, which suggests that H_2S was generated by biogenic sulphate reduction in sulfate limited systems during diagenesis. The compositions of Py3 (−2.6 to 1.5‰), Py4 (−1.2 to 1.5‰), and arsenopyrite (−0.8 to 0.9‰) are homogeneous and have an intermediate range of values near 0‰ that suggest H_2S was derived either from average pyrite (0.2‰) in sedimentary rocks or from a concealed magmatic source. Laser ablation–inductively coupled plasma–mass spectrometer (LA–ICP–MS) trace element analyses support different origins and show that Py3 and Py4 are ore related. The *w*(Co)/*w*(Ni) and *w*(S)/*w*(Se) ratios of Py1 and Py2 are consistent with formation during sedimentation or diagenesis, whereas the ratios of Py3, Py4, and arsenopyrite are consistent with a hydrothermal origin. The concentrations of Au in Py1 (0.23–2.5 ppm) and Py2 (0.06–12 ppm) show that little Au was added during sedimentation or diagenesis. The concentrations of Au in hydrothermal Py3 (1.1–110 ppm) and Py4 (0.34–810 ppm) indicate that most of the Au was introduced during hydrothermal fluid flow. The Au contents of arsenopyrite (0.09–0.52 ppm) and late realgar suggest they formed from Au depleted fluids. The Au/As ratios of Py1 and Py2 are typical of diagenetic pyrite whereas Py3 and Py4 have ratios that approach those of ore stage pyrite in Nevada Carlin-type deposits. The fracturing of Py3 suggests that ore fluid movement was associated with deformation.

Published isochron ages on arsenopyrite (Re-Os ~200 Ma) and calcite-realgar veinlets (Sm-Nd ~135 Ma) in the Huijiabao trend are older than mafic dikes (84 Ma) exposed ~20 km to the east. If the 200 and 135 Ma ages are valid, H_2S and Au may be derived from a sedimentary source because simultaneous igneous intrusions have not been found. If these ages are invalid and the gold deposits are actually late Cretaceous in age, H_2S and Au may be derived from a magmatic source.