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Deposition of Au-rich rims of pyrite from a Carlin-type Au deposit

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The ubiquitous hydrothermal zoned rims of disseminated pyrite host most of the gold (Au) in Carlin-type Au deposits. Although Au occurrence within these rims is well examined, few studies have focused on the mechanisms for rim formation. We present detailed textural and *in-situ* elemental and sulfur isotopic data for zoned pyrite rims from the Shuiyindong Carlin-type Au deposit, China. Two types of pyrite rims were identified: concentrically zoned rims that co-exist with arsenopyrite and show gradational interfaces with cores of fine-grained (~150 μm) pyrite (type-1); and finely zoned rims that overgrow porous cores of coarse-grained (~400 μm) pyrite (type-2). Laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS) analyses reveal that both types of pyrite rim are enriched in Au, As, and Cu, but are depleted in Ni and Pb relative to the cores. The type-1 pyrite rims have much higher Au and As than the type-2 rims. Secondary ion mass spectrometry (SIMS) sulfur isotopic analyses show that the pyrite rims and cores of each type have consistent sulfur isotopic compositions, with mean $\delta^{34}S$ values of 2.4‰ for type-1 and 3.0‰ for type-2.

These results show that the rims and cores of type-1 pyrite might be precipitated from a pulse of fluid influx, whereas the type-2 pyrite rims may have formed during the interaction between ore fluids and pre-existing hydrothermal pyrite cores. The narrow $\delta^{34}S$ range of these two types of pyrite indicates that they were precipitated from similar ore fluids. However, local fluid-pyrite interaction could have altered the Au budget and sulfur isotopic compositions of ore fluids, leading to the lower Au content and slightly higher $\delta^{34}S$ values of type-2 rims than type-1 rims. The consistent sulfur isotopes of pyrite rims and cores indicate that changing fluid redox was not the primary cause for rim formation. Rather, other factors such as destabilization of Au-S complexes (via sulfidation), increasing pH (via decarbonization), and rapid growth rate could have promoted the effective incorporation of Au into the thin pyrite rims.