Anomalous Compositions of Pyrite Associated with the Uranium Mineralization in the McArthur River Deposit, Athabasca Basin, Saskatchewan

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Abstract

The McArthur River uranium deposit is the largest high grade uranium deposit in the world. The deposit occurs along the P2 reverse fault near the unconformity between the crystalline basement rocks and the Athabasca sandstones. Pyrite is abundant in the basement rocks, especially in graphitic metapelites. The overlying sedimentary rocks contain very minor amounts of pyrite along fractures near the unconformity. Samples were collected from metapelites (n=12), pegmatites (n=4) and from sandstones (n=3) along the P2 structure. Among them, one is a high-grade ore from Zone B and another ~12m below this ore. Both contain pyrite with uraninite inclusions. For comparison, samples far from the ore were also collected such as pelites ~3.0 km W of the McArthur River mine. Pyrite in these samples forms fine-disseminations (<0.05mm), euhedral cubes (<10 mm), isolated grains in clay and monominerallic veinlets and films along late fractures (1-2 mm in width).

Pyrite shows a large range in $\delta^{34}S$; from -30 to +20 ‰ (median=8 ‰, n=10) for disseminated/ euhedral grains in pelites, and from +5 to +40 ‰ (median=10 ‰, n=12) in late fractures in pelites. Although the spread is large the median values are similar. The values close to mineralization (< 100 m) are in a more restricted range from 0 to +15‰ (median=9 ‰, n=19) which are close the median values for all pyrite. Values for pyrite in the ore have an even more restricted range from -1 to + 3‰ (median=1.5‰, n=4). The evidence suggests that the S in the uraniferous fluids was well mixed and that the fluid to rock ratios were high.

Pyrite in samples far from the uranium mineralization has near the stoichiometric composition, whereas pyrite grains from ore show large compositional variations in a thin section. Some grains show compositional zoning with Ni (<0. 72 %), Co (<0.1 %), and As (< 2.5 wt%). Contents of As are inversely correlated with those of S, indicating that As is forming AsS dianion in pyrite. It has been known that the uranium ore contains considerable As, but no As mineral has been found. This study suggests that pyrite is the most likely host of As. Intragrain compositional variation of pyrite suggests little recrystallization, if any, after its crystallization.