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Fluid History of Zambian Copper Deposits Based on Metal Zonation in Pyrite

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This study was aimed at determining the textural and chemical zonation in pyrite from the black shale Copper Orebody Member at the Nkana deposit and the footwall Mindola Clastics in the Konkola deposit. Pyrite in fifteen black shale samples from Nkana and eighteen footwall sandstones from Konkola were mapped in detail by LA-ICPMS to determine the timing of the various metals in the ore system. The resulting pyrite maps demonstrate that the original sedimentary pyrites appear to be low in Co, Ni, Cu, and As. The first fluid phase appears to be rich in Co and As, shown by the penetration of Co and As into the structure of early pyrite. Copper mineralization follows the Co-As phase, but only penetrates pyrite or diffuses into pyrite around the pyrite rims. The Cu fluid phase is accompanied by minor Pb, Zn, Ag, and Bi, which penetrate the rims, internal fractures, and grain boundaries of the pyrite. Significant conclusions are 1) the sequence of fluid events was a Co-As fluid first, followed by a Cu-rich fluid with traces of Pb, Zn, Ag, and Bi to follow; 2) the Cu-sulfides did not replace pre-existing pyrite, indicating that sulfur for the copper minerals was most likely sourced from anhydrite beds and nodules in the sedimentary rocks; 3) Cu and Ag contents of pyrite are not a reliable indicator of proximity to ore; 4) cobalt-alteration of pyrite appears to increase in intensity when approaching the copper ore zones; and 5) poorly developed Pb and Bi rims and grain boundary alteration up to 100 ppm is present on all pyrites investigated whether proximal or distal to ore. Thanks to Mawson Croaker and Nicky Polington, who originally collected the legacy samples used in this study.