

Distribution and Partitioning of Trace Elements During Hydrothermal Sulfidation of Magnetite by Pyrite, KCD Gold Deposit, DRC

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Magnetite plays a crucial role during the sulfidation process within iron-rich host rocks like banded iron formation (BIF). During this process, fluid-mineral interaction between magnetite and H₂S-rich hydrothermal fluids results in precipitation of pyrite, which can be auriferous. Research on the partitioning behavior of trace elements during this process is notably scarce. This study investigated ten samples ranging from unaltered to strongly altered BIF units in the Karagba-Chauffer-Durba (KCD) gold deposit. We employed detailed micro-analytical LA-ICP-MS analysis on pyrite-magnetite pairs along with whole-rock geochemistry to evaluate the distribution and partition coefficients of various elements, including Au, As, Ag, Cu, Co, Ni, Mo, Pb, Sb, S, Cd, Hg, Se, Gd, Zn, Mn, Cr, V, and Ti. Petrographic assessments revealed alteration assemblages characterized by Fe-carbonate, sericite, quartz, pyrite, chlorite, and magnetite, accompanied by major and trace element changes. The decrease in SiO₂ content from unaltered to altered samples suggests desilicification during carbonate-pyrite alteration, with the formation of secondary magnetite, under near-neutral to acidic conditions. Mineral trace elements such as V, Co, Ni, Zn, Ga, Ge, and Cr displayed distinct behavior during alteration. Vanadium, primarily occurring as V⁵⁺ at high oxygen fugacity and V³⁺/V⁴⁺ at low oxygen fugacity, exhibited sensitivity to reducing conditions, influencing its solubility and mobility in magnetite. Co and Zn, considered compatible elements in pyrite, showed depletion in magnetite, indicating sequestration in pyrite. Ni showed variability between unaltered and altered BIFs, highlighting the influence of alteration on its distribution. Ga, Ge, and Cr remained relatively immobile during alteration, suggesting their compatibility with magnetite and potential as tracers of magnetite origin. Furthermore, the Co/Ni ratios in magnetite and pyrite served as proxies for assessing hydrothermal versus metamorphic minerals. This study contributes to understanding the trace element evolution during sulfidation hydrothermal alteration and partitioning of trace elements in both magnetite and pyrite.