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Trace and REE signatures of chalcopyrite from Malanjkhand copper deposit, Madhya Pradesh, India.

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Chalcopyrite is the most important ore of copper, and it contains significant amounts of precious and critical metals such as Ag, Au, Co, Se, and Te, etc., which can be recovered as a by-product during copper smelting [1]. Understanding the trace elemental chemistry of chalcopyrite is important for better metal recovery, improving economic viability, and gaining insights into ore formation processes to improve exploration strategies. In this study, we aim to determine the distribution and range of concentration of trace elements in chalcopyrite and evaluate their significance in understanding the physical-chemical conditions during the formation of the Malanjkhand copper deposit, Madhya Pradesh, India. Chalcopyrite crystals collected from seven different quartz veins hosted by granitoids were analyzed using Inductively Coupled Plasma Mass Spectrometry (ICP-MS). Results show that the concentrations of Ni, Zn, Pb, Co, and Mn were above 100 ppm, while Ga, As, Se, Ag, Bi, Cd, Th, In, Sn, Te, and U were 1 to 10 ppm. Very low concentrations of less than 0.3 ppm of Au, Tl, and Hg were determined. Zinc shows a striking positive correlation with Te, Se, Hg, and Cd, which suggests a complex coupled substitution mechanism during their incorporation to maintain the charge balance in the chalcopyrite crystal lattice. All the chalcopyrite grains plot near the Ni apex of the ternary discrimination diagram of Se-Ni-Cd, indicating magmatic sources [2]. The REE concentration (ΣREE) of all the samples is relatively low, ~4.8 to 33 ppm. Chondrite-normalized patterns show a prominent negative Eu anomaly with relatively LREE-elevated concentrations over HREE. Eu/Eu* values of all the samples are varying from 0.39 to 0.96. The negative anomaly of Eu may be due to chalcopyrite precipitation under reducing conditions, or early fractionation in plagioclase, or its higher compatibility in magmatic hydrothermal fluids with high Cl concentration.

[1] George, et al. (2018), *Mineralogical Magazine, 82,* 59-88.

[2] Duran et al. (2019). *Journal of Geochemical Exploration*, *196*, 105-130.