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Apatite geochemistry from the Eloise iron sulphide copper-gold deposit, Cloncurry District, Australia: Insights into fluid evolution

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The processes involved in the formation of iron oxide copper gold (IOCG) and iron sulphide copper-gold (ISCG) deposits, and associated fluids remain highly debated. In recent years, mineral chemistry of accessory phases (e.g., apatite) has become an increasingly important tool to decipher these fluids and processes. Recent studies have shown that, other than Cu, Au and Fe, these deposits can be enriched in other critical elements such as rare earth elements (REE) and U[1]. Although, as the concentration of REE between different deposits varies significantly, understanding the processes and fluids responsible for their enrichment becomes an important step in understanding their role as a resource.

Eloise is an ISCG deposit in the Eastern Mount Isa Province, northwest Queensland, Australia. Previous studies of apatite from Eloise have reported distinct light rare earth element (LREE) depletion[1]. A combination of petrography and petrochronology of apatite, along with major and trace element chemistry of biotite and amphibole has been carried out to understand the processes controlling such a variation.

Based on petrography and mineral chemistry we identify 5 different alteration stages at the Eloise ISCG deposit: 1) Na-Ca and Ca-Fe alteration, 2) Fe-K alteration, 3) Cu-Fe sulphide brecciation, 4) Post mineralization alteration and 5) Silicification. While the apatite present in early Na-Ca and Ca-Fe alteration are primary, apatites in all the subsequent alteration are a result of metasomatism of primary apatite. U-Pb geochronology of apatite reveal that alteration occurred from ca. 1555-1530 Ma, followed by silicification associated with local D3 metamorphism[2] at ca. 1526 Ma. Based on mineral chemistry, varying roles of ligands (primarily, F^-, Cl^- and CO_3^{2-}) have been observed in deposition, mobilization and redistribution of REE. We present a comprehensive model of the REE mobilisation history at Eloise.

References

[1] Chandler et al., 2021 report for Geological Survey of Queensland, Australia.

[2] Baker, 1996 PhD thesis, James Cook University, Australia.