Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.14451

Fluid assisted alteration of Apatite from Beldih, West Bengal, Eastern India: Evidences of REE Mobilization

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Apatite [$Ca_5(PO_4)_3(OH, F, Cl)$], is a common accessory phase in most rocks that favors exchange of elements (due to similar ionic radii of Ca: 1.12Å with various Rare Earth Elements; REEs: 1.16Å) into the mineral both during cationic substitution and fluid-assisted alterations, which eventually converts the mineral into a potential sink of trace elements (REEs, Sr, Th, and U) [1][2]. The substitution of elements into the structure of apatite is a function of physico-chemical conditions and consequently can act as a geochemical proxy pertinent to the geochemical ambiance of the formation of the mineral [3]. Accordingly, in this study an apatite mine (Beldih; South Purulia Shear Zone, SPSZ) is selected to appraise the formation of associated REEs using petrographic and geochemical evolution of apatite.

Petrographic and geochemical studies confirm the presence of two types of texturally and geochemically constrained apatite (i.e., Ap1 and Ap2) in the samples. The grains representing Ap1 are pristine, while Ap2 grains are found as epitaxial overgrowth surrounding Ap1, indicating influx of a later fluid that had altered Ap1 and precipitated Ap2 by coupled dissolution-precipitation process. REE-bearing phases (monazite, allanite, and baddeleyite) in Beldih are found as inclusions within apatite and at the rims of Ap1, suggesting possible precipitation of REE-bearing phase during the fluid event, in which the grain boundaries provided the potential pathways for fluid infiltration. Further, geochemical distribution of elements in Ap1, Ap2 and REE-bearing phases indicate that the later fluid is associated with alkali metasomatism (K and Na), which corroborates with [4]. Accordingly, this study demonstrates fluid assisted alteration of apatite and micron-scale mobilization of REEs from apatite by coupled dissolution-precipitation process during a later alkali metasomatism (K and Na), has regionally affected SPSZ. This study also highlights that geochemical behaviour of apatite can provide robust information about the evolution and manifestation of REEs.

Keywords: Beldih, Apatite, Fluid infiltration, Dissolution-precipitation, REEs.

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