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Fluid-mediated LREE mineralization by alteration of allanite and zircon in A-type Jharsuguda granites, India

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The A-type granites of Jharsuguda at the western margin of the Singhbhum craton in India host several Nb-, Ta-, and Be-bearing pegmatites. Detailed SEM and electron-microprobe analysis reveal potential LREE-carbonate mineralization through the occurrence of predominantly bastnäsite-(La) and bastnäsite-(Ce) and rarely bastnäsite-(Nd), parisite, synchysite-(Ce) and thorian synchysite-(Ce) in these granites. Both F- and OH-dominant members are present. A few of the bastnäsite-(Ce) show very high content of ThO_2 (up to 14.6 wt.%), and the concentration of ThO_2 in the thorian synchysite-(Ce) varies from 4.8 to 13.1 wt.%. LREE-carbonates replace primary allanite and zircon, forming pseudomorphs varying in size from 40 μm to 500 μm. These pseudomorphs generally have two zones: an inner zone of LREE carbonate, which is surrounded by a zone enriched in Si, Al, and Fe containing very low concentrations of REEs and Ca. Signatures of oscillatory zoning and inclusions of residual zircon are sometimes observed in these pseudomorphs. Rare cerite-(Ce) with 68.7 wt.% Ce_2O_3, which is higher than in any so far reported cerite, is also encountered. The elevated Ce_2O_3 concentration, the positive Ce-anomaly in its REE pattern, and the association with kaolinite suggest that cerite was formed by hydrothermal alteration of cerianite. Minor alteration of zircons is observed in the granites. While the fresh zircons are devoid of inclusions, the altered ones contain numerous mineral inclusions, including that of monazite. Altered zircons are sometimes associated with LREE-bearing carbonates. The compositional data indicate the replacement of primary minerals by a halogen, phosphate, and carbon-bearing fluid.