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Fluid-mediated alteration of zircons to fergusonite-(Y) in A-type granites and pegmatite from the Jharsuguda district, India

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The A-type granites of Jharsuguda at the boundary between the Singhbhum Craton and Rengali Province have rare earth potential. Two populations of zircon are present. One of them represents the unaltered zircons of magmatic origin, as evidenced by the presence of oscillatory zoning and Th/U ratios > 0.7. The other population consists of the altered equivalents of these primary zircons. These zircons have Th/U ratios < 0.1, suggesting their metamorphic origin. Occasionally, single grains of zircon containing both altered and unaltered domains are also encountered. The unaltered zircons comprise a very small proportion. The altered zircons appear dark in CL images and are characterized by low EPMA totals with non-formulae elements like Al, P, Ca, Fe, Y, and REEs. Numerous mineral inclusions, including those of U- Th-bearing ones, are typical of these altered zircons. Xenotime inclusions are typical of altered zircons with xenotime overgrowths in the granites. Rare Nb-rich inclusions are also present in these altered zircons. In both the granites and pegmatite, fluid-mediated alteration resulted in fergusonite-(Y) and other Nb-Ta-REE oxides in the cracks and fractures. Pseudomorphs of fergusonite-(Y), Nb-Ta-REE oxides, and allanite are also formed by replacing earlier zircon grains. The size of these fergusonite grains ranges from a few micrometers in granite to up to 500 micrometers in pegmatites. The LA-ICPMS U-Pb dating zircons yield a primary age of 2.95 Ga and metamorphism ages of 2.80 Ga and 2.45 Ga. Selected fergusonite-(Y) grains from the pegmatite suggest a 2.1 Ga U-Th-Pb EPMA age for these fergusonites. Rims of some zircon grains in both granites and pegmatite also yield an age of 2.1–2.2 Ga. The age data suggest that the Jharsuguda granites and pegmatite underwent at least three metamorphic/tectonothermal events, during the last of which fergusonites are formed by the remobilization of REEs and HFSEs, probably in the presence of complexing ligands like F^- and $PO4^-$, as confirmed by EPMA X-ray element maps of altered zircons.