
Apatite Replacement and Rare Earth Mobilization, Fractionation, and Fixation During Weathering

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Abstract: During an electron microscope study of the weathering of granite from southern New South Wales, Australia, an assemblage of minerals including florencite and rhabdophane was discovered replacing apatite. Light rare earth elements released from allanite early in weathering apparently combined with P released by leaching of primary apatite to form secondary phases exhibiting a range of morphologies and compositions. Chondrite normalized fractionation patterns $La > Nd > Sm > Ce$; $La > Ce > Nd \geq Sm$ and $La = Sm = Nd > Ce$ were identified. The rare earth elements were present in very small crystals and aggregates of secondary minerals ($< 10 \mu m$) and coexisted with clays and secondary Fe-Ti oxides. The weathered granite was enriched about 6 to 10 times in all rare earth elements except Ce relative to fresh granite if the abundances were corrected for apparent enrichment due to reduction in density. The rare earth elements were probably derived from higher in the weathering profile, possibly by destruction of florencite and rhabdophane in very intensively weathered rock. Ce remained relatively immobile during weathering, probably due to its oxidation to Ce^{4+} .

Key Words: Apatite • Florencite • Granite • Phosphorus • Rare earth elements • Rhabdophane • Scanning electron microscopy • Weathering

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