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Weathering of ilmenite from granite and chlorite schist in the Georgia Piedmont

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ABSTRACT

Ilmenite grains from weathering profiles developed on granite and ultramafic chlorite schist in the Georgia Piedmont were studied for evidence of morphological and chemical alteration. Ilmenite-rich concentrates from the fine sand (90–150 μm) component were studied to test the assumption that there is no difference between ilmenite in the parent rock and that in colluvium delivered to primary drainage systems.

Ilmenite grains in the granite profile are rounded to subhedral, and commonly contain hematite exsolution blebs. Dissolution pits are observed along the boundaries of the exsolution blebs, with goethite occurring as an alteration product. Ilmenite grains in the schist profile occur as fractured anhedral grains with uncommon lamellae of rutile. Grain fractures are filled with goethite and hematite, particularly in the B-horizon. Ilmenite from the granite profile is Mn rich (7–15 mol% $MnTiO_3$), whereas ilmenite from the schist profile contains only 1–2 mol% $MnTiO_3$ and up to 8 mol% $MgTiO_3$. Two populations of grains develop in both profiles. Grains with abundant exsolution blebs and fractures alter through a proposed two-step reaction mechanism. It is proposed that ilmenite first undergoes a solid-state transformation to pseudorutile via an anodic oxidation mechanism. Oxidized Fe and Mn diffuse from the structure and precipitate as goethite and MnO_2. Pseudorutile is ephemeral and undergoes incongruent dissolution to form anatase, hematite, and goethite. The second population of grains experienced only slight oxidation and dissolution on grain surfaces, and they persist through the weathering profile. The Fe^{2+} content of competent ilmenite grains is somewhat lower in the C-horizon, compared with grains in the host rock. In horizons above the C-horizon, the Fe^{2+} contents of the ilmenite are similar to those in the host rock.

This study shows that using ilmenite minor-element chemistry as a tracer for sediment provenance is a valid technique, however, textural features of ilmenite in colluvium may be distinct from those in the parent rock. Also, the production of secondary phases, such as anatase, goethite, and hematite, in soil profiles results in part from the alteration of ilmenite.