Geochemical and mineralogical studies on the weathering of granitic rocks

by

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ABSTRACT

Chemical, mineralogical, and autoradiographic techniques have been applied to the study of five weathering profiles developed on granitic rocks. Two profiles from the Tishomingo granite, Oklahoma, two profiles from the Mount Scott granite, Oklahoma, and a single profile from the Elberton granodiorite, Georgia, were investigated.

The relative mineral stabilities in the three granites under investigation generally follow the expected sequence: plagioclase feldspar, biotite, potassium feldspar, quartz, from least to most stable respectively. This relative stability sequence is consistently observed regardless of climatic and/or local physiochemical variations. Kaolinite is the predominant clay mineral present in the Elberton profile from Georgia. Illite and kaolinite are both present as major constituents in the four Oklahoma profiles.

The largest physical and chemical changes occur in the transition from the C-horizon (weathered rock) to the B-horizon (soil). Mineralogy is the predominant factor controlling the relative mobility of calcium, sodium, potassium, rubidium, and thorium during weathering. Calcium and sodium are concentrated in the plagioclase feldspars and mafic minerals and are released and mobilized during the early stages of weathering. Potassium and rubidium are concentrated in the relatively stable orthoclase feldspars and thorium in the resistate minerals. These three elements are mobilized only in the intermediate and final stages of weathering. Lithium, copper, and zinc are generally enriched in the soil portion of the weathered mantle as a result of absorption surface exchange with clay minerals.

Stability diagrams indicate that the natural surface waters of east-central Georgia are in equilibrium with kaolinite, the major clay mineral present in the soils. In contrast, the surface waters of southern Oklahoma are in equilibrium with kaolinite and montmorillonite, but not illite which is a major constituent of the Oklahoma soils. Combined field and theoretical evidence indicates that the Georgia soils have reached maturity and are probably the result of extensive weathering early in the post-glacial period. The Oklahoma soils are very immature and are presently undergoing active alteration.

Preliminary experimental studies indicate that the initial stages of mineral leaching closely approximate a zero-order reaction. After several hours of dissolution in distilled water, rims of hydrous aluminum silicate apparently form on minerals undergoing leaching and become the rate limiting factor. The formation of alteration rims occurs in both open and closed systems and is not an equilibrium process.