Incipient Weathering of Granite-Gneiss and Soil Development in Southwestern Nigeria

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Abstract

The effects of intensive leaching of granite-gneiss by the tropical rainfall, acidified carbonated water and simple aliphatic (citric) and aromatic (salycyclic) organic acids at the onset of rock weathering were investigated by simulated weathering for 10 weeks. The results indicated that at the initial stage of weathering of granite-gneiss under humid tropical condition with particular reference to southwestern Nigeria, more Mg and Ca were leached from the medium grained granite-gneiss than the coarse textured equivalent. In terms of relative ease with which the different elements were leached, Na~Mg~K>Ca>SiO_2, while Fe and Al concentrations in the leachates were below the detection limit (0.001 mg/kg). The presence of mostly acidic parent rock with low content of basic cations in an area of acidic rain (rain water *p*H 5.14 - 6.45), high rainfall (>1300 mm/yr) with greater than 0.8 PET and high soil temperature (27-31 ^{0}C at 50 cm soil depth) are factors considered to enhance hydrolytic weathering in the region. The hydrolytic weathering plus the climatic, geologic and physical setting of the region appear to predispose the rocks to ferrallitic pedogenesis.

Introduction

Weathering precedes soil formation and it is a continuing process during soil development. Weathering relates to the chemical and physical disintegration and decomposition of rock and minerals contained in them (Buol *et al.*, 1980). Progressive fragmentation of the initial rock and plasmification of the component weatherable minerals (Eswaran, 1997), otherwise termed arenisation (Millot, 1970), is one of the most important initial stages of weathering of granites. In the humid tropics, intensive weathering is associated mainly with pronounced leaching, and the principal factors commonly suggested to encourage rapid leaching are high and acidic precipitation, year round high soil temperature, mineralogical composition of the parent material and the contributions of organic acids.

The role of simple organic acids in mineral weathering has been demonstrated in laboratory experiments in which the acids caused accelerated mineral dissolution and selective release of some elements (Henin & Pedro, 1965; Boyle *et al.*, 1974;Manley and& Evans, 1986). It was suggested that water soluble, low molecular weight organic acids entering the soil as microbial metabolites or plant exudates from living or dead cells, together with microbial oxidation products of humic substances or lignin polymers are the likely organic compounds involved (Manley & Evans, 1986). The concentrations of such acids in soils are generally in the range of 10^{-3} to 10^{-5} *M*.

It was observed that six (Boyle *et al.*, 1974) and 16 (Manley & Evans, 1986) organic acids extracted greater percentages of Fe, Mg and Al than inorganic acids of similar strength. These workers, however, based their studies on single minerals, yet weathering and soil formation are complex processes involving simultaneous distintegration, decomposition and transformation of a variety of minerals within the rock-saprolite soil sequence (Eswaran, 1979; Buol