Analytical Transmission Electron Microscope Studies of Plagioclase, Muscovite, and K-Feldspar Weathering

Jillian F. Banfield[1] and Richard A. Eggleton

Department of Geology, Australian National University P.O. Box 4, Canberra, A.C.T. 2601, Australia

[1] Present address: Department of Earth and Planetary Sciences, The Johns Hopkins University, Baltimore, Maryland 21218.

Abstract: Analytical and high-resolution transmission electron microscopy of weathered plagioclase and K-feldspar provided microtextural and chemical data that suggest a sequential formation of weathering products. An alteration layer < 1 µm thick on feldspar surfaces had short-range order and was termed protocrystalline. Relative to the parent feldspars the protocrystalline layer was depleted in Ca, Na, K, and Si and significantly enriched in Fe. On plagioclase, the protoerystalline material was replaced by Ca-Fe-K-smectite, another protocrystalline material, and spherical halloysite. Abundant tubular halloysite on the corroded surface apparently formed by reprecipitation of components released by plagioclase dissolution. The K-feldspar was markedly more resistant to weathering than the plagioclase.

Recrystallization of the patchily developed protocrystalline rind produced Fe-bearing, aluminous smecrite, which was ultimately replaced by spherical halloysite and laths of kaolinite. Muscovite laths within plagioclase crystals were converted initially to illite by loss of K, then to randomly interstratified illite/smectite, and then to smectite that contained Mg, little K and Fe, and was more aluminous and contained less Ca than the smectite that originally replaced the plagioclase. Smectite was replaced epitactically by kaolinite. Kaolinite was the stable weathering product of the feldspars and muscovite in the profiles. It probably formed in equilibrium with a solution whose composition was no longer controlled by the microenvironment within the feldspar, but approached that of meteoric water.

Key Words: Analytical electron microscopy • High-resolution transmission electron microscopy • Illite • Kaolinite • K-feldspar • Muscovite • Noncrystalline intermediate • Plagioclase • Smectite • Weathering

Clays and Clay Minerals; February 1990 v. 38; no. 1; p. 77-89; DOI: 10.1346/CCMN.1990.0380111