Mineralogical Transformation of Bioweathered Granitic Biotite, Studied by HRTEM: Evidence for a New Pathway in Lichen Activity

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Abstract: The question of whether clay minerals can be biogenically transformed as a result of lichen activity at the lichen-rock interface remains unresolved. We applied several microscopical and analytical techniques—scanning electron microscopy-back-scattered electron (SEM-BSE), energy dispersive spectroscopy (EDS) and high-resolution transmission electron microscopy (HRTEM)—in an attempt to address this issue. Unaffected granitic biotite and bioweathered material from the granitic biotite and *Parmelia conspersa* lichen thalli interface were examined using HRTEM after ultrathin sectioning. The *n*-alkylammonium treatment of ultrathin sections was carried out in order to study the biogenous mineralogical transformation of the biotite. Microsamples proceeding from unaffected biotite zones demonstrated homogenous 10-Å *d(001)*-value biotite phase. HRTEM images of lattice fringes of samples taken from the lichen-biotite contact zone reveal large areas of both unexpanded (10-Å) and randomly and $R = 3$ distributed expanded (from 14- to 30-Å) layers of phyllosilicates identified as interstratified biotite-vermiculite. Results of artificial biotite weathering (replacement of K by Ca ion) also revealed the biotite-vermiculite phase formation, indicating that K release in biotite is one of the mechanisms responsible for interstratified mineral phase formation. Two parallel processes, physical exfoliation of biotite and interlayer ionic exchange of K and subsequent vermiculite formation, are the mechanisms for biotite bioweathering induced by lichens.

Key Words: Back-scattered Electrons • Biotite • Bioweathering • Granite • High-Resolution Transmission Electron Microscopy (HRTEM) • Lattice-Fringe Images • Lichens • Vermiculite

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