Domain Segregation in Ni-Fe-Mg-Smectites

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Abstract: The first stage of lateritic weathering of pyroxenes in the Niquelandia area, Brazil, leads either to Fe-rich products or to a phyllosilicate clay. In relatively unfractured parent rock the phyllosilicate clay contains Ni-rich smectites, the atomic ratio of Ni: octahedral cations ranging from 0.3 to 0.5. These smectites were studied by polarized light microscopy, X-ray powder diffraction (XRD), transmission electron microscopy, and electron microprobe, and infrared, optical absorption, Mössbauer, and extended X-ray absorption fine-structure (EXAFS) spectroscopy. The chemical composition of the smectite is constant on the optical microscope scale even to the smallest analyzed particles (3000 Å in diameter and about 75 Å thick). From XRD data the mineral is principally a swelling, trioctahedral smectite; however, some kerolite-pimelite-like layers are present, and a weak 06,33 reflection indicates the presence of a small amount of a dioctahedral phase. Mössbauer results show that all Fe cations are Fe^{3+} in octahedral sites. The structural formula of the smectite is: $(Ca_{0.01}\ K_{0.05})(Al_{0.17}Fe_{0.5}Mg_{0.48}Ni_{1.47}Cr_{0.02})(Si_{3.92}Al_{0.08})O_{10}(OH)_2$ The results obtained from all the above methods suggest that in the smectites Ni, and, perhaps, a small amount of Mg are clustered in pimelite-like domains (or layers), whereas Fe and some Al are clustered in nontronite-like domains (or layers). Most selected-area electron diffraction patterns exhibit continuous or punctuated (*hk*) rings, indicating that particles contain several stacked layers. The patterns of some thin particles, however, suggest dioctahedral layers having trans-octahedral vacancies, such as in the Garfield, Washington, nontronite. Thus, the Ni-Fe-Mg-smectite, which seemingly is homogeneous, actually consists of mixed trioctahedral and dioctahedral layers or domains.

Key Words: Chemical composition • Laterite • Mössbauer spectroscopy • Nickel • Nontronite • Pimelite • Smectite • Transmission electron microscopy

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