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Diagenetic formation of interlayer-deficient fluorophlogopite as a clay mineral in Early Cambrian phosphorite (Lesser Himalaya, India): The trioctahedral analog of illite

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Abstract

The occurrence of a trioctahedral analog of illite, the dioctahedral interlayer-deficient K-mica, has long been debated. Due to the inherent difficulties of determining structure and chemical composition of the extremely fine-grained material, earlier descriptions based on separated material are equivocal. Here we describe low-temperature (diagenetic) formation of fluorophlogopite, which is interlayer-deficient and therefore analogous to illite, using high-resolution in situ methods (transmission electron microscopy, TEM, with preparation by focused ion beam milling, combined with wavelength-dispersive analysis by field-emission gun electron microprobe). The average composition is $K_{0.5}Mg_{2.8}V_{0.01}Fe_{0.005}[Si_{3.15}Al_{0.85}O_{10}(OH)_{0.65}F_{1.35}]$, including minor amounts of NH_4 for charge compensation as determined by electron energy loss spectroscopy. The K-deficient Mg-mica occurs in layer packages of ~10 layers, and no indications for interlayering with other sheet silicate layers such as chlorite or vermiculite could be identified with TEM. X-ray powder diffraction patterns of separated material confirm the absence of smectite components.

The mineral was identified in phosphorites from the lowermost Cambrian Tal Group, Mussoori Syncline, Lesser Himalayas, India. The rocks are alternating phosphatic mudstones and phosphatic dolostones, at times interbedded with phosphate-poor carbonate layers, which are rich in organic matter. Sedimentary fluorophlogopite occurs in both rock types and in two textural associations; one in vesicles filled with amorphic organic matter, the other as reaction rims around illite, which contains up to 5 wt% V_2O_3 in its rims. Textural arguments favor an early diagenetic formation of both, V-bearing illite and fluorophlogopite, closely associated with organic matter and linked to dolomitization. The high-F content stabilizes phlogopite to low temperatures. Our findings confirm that the stability field of fluorophlogopite extends from magmatic to metamorphic and sedimentary conditions.

Keywords: Sediment petrology, mineral, fluorophlogopite stability, organic matter, dolomitization