Far-Infrared Study of the Interlayer Torsional-Vibrational Mode of Mixed-Layer Illite/Smectites

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Abstract: Investigation of mixed-layer illite/smectites with far-infrared (FIR) spectroscopy indicates the presence of torsional mode absorption bands associated with interlayer fixed-K sites. By contrast, hydrated montmorillonitic interlayer cation sites are transparent in the far IR. The presence or absence of bands for interlayer cation sites appears to be related to both the magnitude and site of negative layer charge within the 2:1 layer structure. The bimodal nature of illite/smectite spectra leads to the suggestion that two different fixed-K environments occur within illite/smectite structures. These two environments are controlled by the composition of the octahedral sheet. The torsional modes at 112 and 89 cm^{-1} represent fixed-K sites influenced, respectively, by an Al-rich, high-charge dioctahedral layer and a heterogeneous Al-Fe-Mg-bearing, low-charge layer. A general trend of increasing absorption of the 112 cm^{-1} band, relative to the 89 cm^{-1} band, is observed in a typical diagenetic illite/smectite sequence of Miocene shales from the Gulf of Mexico sedimentary basin. The absorbance strength of both torsional bands is also seen to increase with increasing degree of illitization and the amount of fixed potassium in the illite/smectite. These observations are consistent with the concept of shales undergoing illitization during burial diagenesis by both the collapse of high-charge smectite layers to form illite layers (i.e., transformation) and the formation of new high-charge (-0.9) illite layers at the expense of smectite layers (i.e., dissolution/neoformation).

Key Words: Burial diagenesis • Far-infrared • Illite/smectite • Miocene shale • Terrebonne Parish • Louisiana • X-ray diffraction

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