Interlamellar Adsorption of Carbon Dioxide by Smectites

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Abstract: The adsorption of CO_2 at low temperature ($\sim -70\ ^\circ$ C) on thin films of homoionic smectites was studied by X-ray diffraction and by i.r. absorption. An increase in the d_{001} spacings of these clay films upon adsorption of CO_2 was observed. In addition, a dichroic effect was readily discernible by comparing the i.r. spectra at two different orientations of the smectite films; i.e. with the film normal and tilted 35 $^\circ$ with respect to the i.r. beam. The CO_2 stretching vibration at 2350 cm^{-1} was used for the i.r. study. These observations conclusively show that CO_2 intercalates the smectite structure rather than being adsorbed only in pores between clay tactoids—the limiting process proposed by other investigators.

Adsorption isotherm data from earlier surface area studies are re-examined here through application of the Dubinin equation. Again, intercalation is demonstrated by convergence of the plotted experimental data for smectites containing large monovalent interlayer cations toward a pore volume that is near the calculated theoretical value for a monolayer of intercalated CO_2.

Scanning electron photomicrographs of Li- and Cs- smectites provide additional evidence that aggregation differences are not responsible for the large observed difference in BET surface areas obtained for these smectites with CO_2 as the adsorbate. At low magnification, visual differences in macro-aggregates are apparent, but at high magnification no significant differences are observed in the micro-structure of individual aggregates where the major amount of gas adsorption really occurs.

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