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Characterization of nitrogen adsorption isotherms of thermally-treated organoclays using multifractal analysis

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Nitrogen adsorption isotherms of soils have been reported to exhibit multifractal behavior. In the present work, multifractal analysis is used to characterize changes in N_2 adsorption isotherms of organoclays prepared with different cations and exposed to various thermal treatments. Wyoming bentonite was exchanged with benzyltrimethylammonium (BTMA-clay), tetraethylammonium (TEA-clay), and hexadecyltrimethylammonium exchanged at 41 and 90% of the cation exchange capacity of the clay (HDTMA41- and HDTMA90-clay). The resulting organoclays were exposed to temperatures ranging from 25 to 420ºC during two hours, freeze-dried, and N_2 adsorption isotherms were measured at 77ºK. The obtained isotherms showed multifractal behavior, and parameters derived from Rényi and singularity spectra varied with changes in the organic cation and the treatment temperature. The type of cation was the dominant factor responsible for changes in spectra, and significant interactions were observed between type of cation and temperature for several parameters. Significant correlations were found between organic carbon content and multifractal parameters, indicating a relation between changes in N_2 sorption sites and thermal transformations of the organic cations. Significant correlations were also found between some multifractal parameters and the heterogeneity exponent of a Freundlich model fitted to nitrobenzene isotherms measured in the organoclays, suggesting that multifractal analysis of N_2 adsorption isotherms could be useful to analyze the heterogeneity of sorption sites when sorption determinations yield a limited amount of data.