Geophysical Research Abstracts
Vol. 12, EGU2010-8586, 2010
EGU General Assembly 2010

Multifractal characteristics of Nitrogen adsorption isotherms from tropical soils

Eva Vidal Vázquez and Jorge Paz Ferreiro
Soil Science. Universidade da Coruña. Coruña, Spain (jpaz@udc.es, 34 981167065)

One of the primary methods used to characterize a wide range of porous materials, including soils, are gas adsorption isotherms. An adsorption isotherm is a function relating the amount of adsorbed gas or vapour to the respective equilibrium pressure, during pressure increase at constant temperature. Adsorption data allow easily estimates of specific surface area and also can provide a characterization of pore surface heterogeneity. Most of the properties and the reactivity of soil colloids are influenced by their specific surface area and by parameters describing the surface heterogeneity. For a restricted scale range, linearity between applied pressure and volume of adsorbate holds, which is the basis for current estimations of specific surface area. However, adsorption isotherms contain also non-linear segments of pressure versus volume so that evidence of multifractal scale has been demonstrated. The aim of this study was to analyze the multifractal behaviour of nitrogen adsorption isotherms from a set of tropical soils. Samples were collected form 54 horizons belonging to 19 soil profiles in the state of Minas Gerais, Brazil. The most frequent soil type was Oxisol, according to the Soil Survey Staff, equivalent to Latossolo in the Brazilian soil classification system. Nitrogen adsorption isotherms at standard 77 K were measured using a Thermo Finnigan Sorptomatic 1990 gas sorption analyzer (Thermo Scientific, Waltham, MA). From the raw data a distributions of mass along a support was obtained to perform multifractal analysis. The probability distribution was constructed by dividing the values of the measure in a given segment by the sum of the measure in the whole scale range. The box-counting method was employed to perform multifractal analysis. All the analyzed N_2 adsorption isotherms behave like a multifractal system. The singularity spectra, f(α), showed asymmetric concave down parabolic shapes, with a greater tendency toward the left side, where moments q >0. The width of the f(α) spectra ranged from 1.167 to 2.741 for individual isotherms. Therefore, shape and width of the singularity spectra suggest a high heterogeneity in the local scaling indices of the measure. The mass exponent function, τ(q), and the generalized dimension, Dq, also corroborate this pattern. The capacity dimension, D_0, was not significantly different from 1.000, but the entropy dimension, D_1, showed a wide range of values, from 0.317 to 0.749, as did the correlation dimension, D_2, which oscillates between 0.157 and 0.675. In accordance with this parameter (D_0- D_2) ranged from 0.325 to 0.843. The value of D_1 is also a good index of the degree of heterogeneity of a measure. The closer the D_1 value to the capacity dimension, the more homogeneous is the distribution of the measure, whereas a D_1 value close to zero is associated to clustering , so that most of the measure concentrates in a small size domain of the study scale. Because of the wide range of values obtained for D_1, D_2 and (D_0 – D_2), these multifractal parameters provide a good characterization of N_2 adsorption isotherms and they appear to be appropriate to discriminate different soil types and soil horizons.

Acknowledgement: This work was supported by Spanish Ministry of Education (Project PHB2009-0094-PC) and Spanish Ministry of Science and Innovation (Project CGL2009-13700-C02).