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Multiscale description of mercury intrusion curves from an Oxisol and the residual saprolite left after deep profile excavation

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Oxisols are highly weathered soils with a thick profile that are found primarily in the intertropical regions of the world. Brazilian Oxisols are characterized by 1:1 low activity clays a weak macrostructure and a strong micro-granular structure, which results in very stable aggregates (pseudosand) at the $<$1mm scale. The most important feature of mercury porosimetry curves from Oxisols is a bimodal pore size distribution. Pores smaller than 0.2 μm correspond to card-house-type assemblages of rigid kaolinite-gibbsite associations, whereas pores larger than 0.2 μm are mainly associated to the microaggregate fabric. We used de multifractal approach to compare pore-size distributions measured by intrusion porosimetry on the top layers of an Oxisol under native vegetation and the saprolite left after heavy soil disturbance by deep profile excavation. The study site was locates in Selviria-MS (Brazil), 51º 22´ W longitude, 20º 22´ S latitude and 327 m a.s.l. Long-term mean yearly precipitation is about 1370 mm and mean temperature 23.5 ºC. The undisturbed soil was an Oxisol developed over clay sediments. The clay mineralogy consisted mainly of kaolinite and gibbsite. During the 1960's a 5 to 8 m deep layer of the natural soil profile was removed for earthworks purposes due to the building of a large dam on the Parana River. The disturbed area sampled for this work was left after soil and subsoil decapitation in 1969. Excavation resulted in an abandoned unproductive area, whose top layer consisted of saprolitic materials. Samples from saprolite at the disturbed area, and from soil under native vegetation ("cerrado") at a nearly stand were collected in 2005. The sampling depths were 0.00 to 0.05 m and 0.05 to 0.10 m and five replications were taken per depth and treatment. Mercury intrusion was performed with a porosimeter (Thermoquest-Pascal, Milan, Italy), enabling pore-size study for pores with equivalent diameters ranging from approximately 150-100 μm, down to 0.005 μm, respectively. Values for the surface tension of mercury and its contact angle of 0.484 Nm^{-1} and 130º, respectively, were used, together with the Young-Laplace equation and assuming cylindrical pores in the calculations. The volume of pores $<$2 μm in diameter showed not significant differences between the Oxisol and the saprolite left after soil disturbance. In contrast the 0.2-100 μm porosity was significantly higher in the saprolite. Multifractal analysis was performed using the box-counting algorithm. Multifractal models described reasonably well the scaling properties of the pore size distributions of the Oxisol and the saprolite material. Several multifractal parameters showed no significant differences between the Oxisol and the residual saprolite. For example, the mean values of the entropy dimension, D_1, were 0.90 in both cases, with a range between 0.79 and 0.87 for the Oxisol and from 0.73 to 0.88 for the saprolite. However the correlation dimension, D_2, was significantly higher for the saprolite than for the Oxisol. The multifractal approach appears to be a useful tool for analyzing the underlying mechanisms in pore size distribution similitude or differences between contrasting soil horizons.

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