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Combining Image Processing and $H_2^{18}O$ displacement experiments to study water movement through Andosols

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The macro-porosity and morphometry of the soil's pore network are important factors affecting water and solute transport behaviour. The transfer of contaminants to water resources is of particular importance in the Valle de Bravo watershed, an important water supply for the Mexico City conurbation. This watershed is composed mainly of Andosols with unique mineralogical and physical characteristics. To study the soil structure and porosity and their effects on water tracer transport parameters we propose a new methodology using 2/3-D image analysis techniques combined with a $H_2^{18}O$ displacement experiments. The latter were conducted through intact soil core sampled at three depths of an Andosol profile. The soil structure and pore characteristics were determined by image analysis on thin sections extracted from each column once the displacement experiment completed. The total 2D macro-porosity varied from 80% of the total section area in the topsoil to around 60% in the subsoil. Tubular pores were the most abundant in the soil profile. They were replaced by packing pores in the topsoil region due to ploughing. Water transport in the intact subsoil columns was always in physical non-equilibrium, revealing the existence of preferential flow pathways. In the topsoil, one column out of three showed no preferential flow, likely the result of soil ploughing thus more homogenised pore connections. Image analysis of the thin sections of this topsoil sample exhibited a higher connectivity index. Overall our methodology offers a 2D quantitative characterisation of the macro-porous network (e.g. beyond 50 [U+F06D]m resolution) and the determination of water transport parameters on the same intact soil samples. 3D characterisation of soil porosity using X-ray computed tomography (CT) gave a better picture of pore connectivity but at a coarser spatial resolution and at higher cost.