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Physically pertinent equations giving soil pore-size distribution from granulosity.

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Pore-size distribution (PSD) of a soil or any unconsolidated rock is required to predict water content at various water potentials in various scientific fields (hydrogeology, global climate forescast, slope stability. . .) such as in their operational applications (agriculture, water supply and pollution prevention, mining activities. . .). Direct measurements of pore-size distribution are costly and demanding, thus many pedotransfer functions (PTF) have been defined to evaluate PSD from other cheaper data: mainly grain-size distribution and organic carbon content, often also bulk density, sometimes mineralogy, root density... The analytical form of those pedotransfer functions are hardly ever based on a physical model. Some authors use linear, affine, quadratic, non-linear equations. However, all authors implicitly use the following assumption: the relations issued from measurements on some samples can be applied to any other samples of similar material, and thus, the material has a homogeneous structure. We demonstrate that this only homogeneity hypothesis leads to a physical model that is only consistent with one analytical form, rarely used for pedotransfer functions. The poral volume of a given pore range size must be linearly linked to the volumes of solid constituents of the corresponding sizes whose primary arrangement or secondary arrangement or surface roughness and infolding create. Then, firstly, all volume ratios must be established with the same reference volume (total solid volume for example) and, secondly, these ratios are linked by a linear equation. Equivalently, all ratios can be expressed in terms of mass ratios, each divided by the corresponding density, respectively mineral density for grains or organic mater density for organic constituents or water density for poral volumes. The bulk density can be used as a multiplying factor to translate a quantity referring to total solid mass into a quantity referring to the whole soil volume (including porosity), but the bulk density should not be used as an additive term in the equation.

The use of this analytical form will improve PTF accuracy, enable its interpretations in terms of soil structure and enhance its predictive efficiency. The linear coefficients of such pedotransfer function have a physical meaning, they give primary arrangement or secondary arrangement or surface irregularity contribution. Their value for each mineralogy, climate, soil depth, biosphere, issued from studies of various authors could be summarized in tables, available for users.