Physical properties in European volcanic soils: a synthesis and recent developments

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Introduction

In advanced stages of soil formation on volcanic ash, when more clay is formed, the combination of high surface area and variable charge causes strong soil aggregation, and very large porosity, water retention capacity and shrinkage (e.g. Nanzyo et al. 1993, Poulenard et al. 2002, 2003). Despite previous works, physical properties of Andosols have not been fully explored and explained.

Maeda and Soma (1985), Warkentin et al. (1988), Mizota and van Reeuwijk (1993), Nanzyo et al. (1993), Pinheiro et al. (2001) and Poulenard et al. (2003) pointed out that, besides allophanes, organic colloids also influence bulk density and soil water retention. However, the interpretation by these authors are constituent-based and not physical-based. On another hand, most of the published results on hydraulic properties are related to the water retention at 1500 kPa and sometimes at 33 kPa (see the review Nanzyo et al. 1993). Rare are the published results on the effect on pedogenesis or/and land use the entire retention curve or on hydraulic conductivity as a function of soil saturation (Warkentin and Maeda 1980, Basile and De Mascellis 1999, Poulenard et al. 2003, Fernandez et al. 2004) or on the hydraulic conductivity and solute dispersivity (Katou et al. 1996, Basile and De Mascellis 1999, Fontes et al. 2004) Aggregation in many Andosols (WRB 2001) is also so strong that they fail to disperse completely when dispersion agents are used that are successful in other soils (e.g. Nanzyo et al. 1993, Mizota and van Reeuwijk 1993). Research in the areas of hydraulic properties, solute transport, aggregation and clay dispersion is therefore still required.

Finally, relationships between properties at different scales, such as organo-mineral clay, physico-chemical properties, elementary aggregates and physical macro-properties (water retention, water and solute transport, soil hydrophobicity, aggregate stability, shrinkage etc.) are still unclear. Some expected relationships will be reported in the present synthesis, which is based both on studies by the authors and co-workers in the frame of the COST-622 Action (Bartoli and Burtin, Basile et al., Buurman and