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Advance in soil clay minerals characterisation: direct x-ray diffraction profile fitting method

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It is widely accepted that the quality of soils largely depends on their clay mineralogy. However, because the identification of soil clay species is difficult, the mineralogical differences between horizons are hardly interpreted and often not enough significant to determine the actual mechanisms by which clays control the soil properties. The difficulty mainly arises from the complexity of soil clay minerals which are often poorly ordered and interstratified. The direct profile fitting method has been developed for diagenetic clays. It has been applied for the first time to soil samples in this work. Its principle is to calculate a theoretical $(00l)$ reflection set which mimics the experimental XRD patterns obtained from oriented preparations in the air-dried (AD) and ethylene glycol solvated (EG) states. The calculated XRD patterns take into account the experimental diffractometer parameters and the crystallographic characteristics of the different interstratified clay phases. When achieved, the fit provides a semi-quantification of the different clay minerals involved in the calculation.

The studied soil is a tilled Luvisol overlying loess deposits (France). The < 2 μm fraction extracted from the five horizons (L1, L2, E, BT, BT/M) is constantly composed of illite, smectite, randomly interstratified illite/smectite (60/40), chlorite/smectite (50/50) and two kaolinite (particle) populations of different crystallinity. Only the smectite content varies along the soil profile. These results indicate that leaching process is the main pedogenic factor which controls the repartition of the clay minerals in the profile. In addition, the carbon content of the < 2 μm fraction is closely related the variation of the smectite amount. This militates for a control of the carbon storage dynamics by smectites in the deep horizons. The present work shows that direct XRD profile fitting method is a powerful tool which allows to evidence tiny, but primordial,

variations of clay mineralogy in soils.