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Soil profiles' development and differentiation as revealed by their magnetic signal

Neli Jordanova and Diana Jordanova
NIGGG - BAS, Sofia, Bulgaria (vanedi@geophys.bas.bg)

Soil profiles' development is a major theme in soil science research, as far as it gives basic information on soil genesis and classification. The use of soil magnetic properties as indicators for physical and geochemical conditions during pedogenesis received great attention during the last decade mainly in relation to paleoclimate reconstructions. However, tracking the observed general relationships with respect to degree of soil differentiation would lead to capitalization of this knowledge and its further utilization as pedogenic indicator. Here we present an overview of the observed relationships and depth variations of magnetic characteristics along ten soil profiles of Chernozems, Luvisols and Planosols from Bulgaria. Depending on the general soil group considered, different relationships between depth distribution of the relative amount of superparamagnetic (SP), single domain (SD) and larger pseudo single domain (PSD) to multi domain (MD) ferrimagnetic fractions are revealed. The profiles of the soil group with pronounced accumulation of organic matter in the mineral topsoil (Chernozems and Phaeozems) a systematic shift in the relative maxima of SP- and SD- like concentration proxies is observed with the increase of profile differentiation. In contrast, the group of soils with clay-enriched subsoil horizon (e.g. Luvisols) shows different evolution of the depth distribution of the grain-size proxy parameters. The increase of profile's degradation leads to a decrease in the amount of the SP fraction and a split in its maxima into two depth intervals related to the eluvial and illuvial horizons respectively. Along with this tendency, the maximum of the SD fraction moves to progressively deeper levels of the illuvial horizon. The third soil group of the Planosols is characterized by specific re-distribution of the iron oxides, caused by the oscillating oxidation – reduction fluctuations within the profile. The diagnostic eluvial and illuvial soil horizons are enriched with stable SD magnetite-like fraction, likely originating from ferrihydrite transformations under repeating oxidative – reductive conditions. The major magnetic phase in illuvial horizons is hematite, while in eluvial and C-horizons magnetite dominates. These different trends in the evolution of mineralogy and magnetic grain size fractions along the depth of the various soil groups are useful indicators of the soil chemistry, as well as the dynamics of the main soil forming processes.