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The role of fulctuating redox conditions in the morphological development of a meadow soil

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Ever changing redox potential (Eh) in periodically water saturated soils can result various special morphological characteristics also reflected in soil coil colour and, in mineralogical attributions. The most abundant redox sensitive minerals of hydromorphic soils are those containing iron and manganese, due to the different solubility in the function of their oxidation state. Based on Eh-pH diagrams of iron compounds (Lemos et al. 2007, Takeno 2005) Fe(II)/Fe(III) transition in soils can also be induced by Eh or pH oscilllations. Our aim was to find correlations between the effects of changing Eh and pH conditions and the quantitative and qualitative characteristics of pedogenic iron oxide-hydroxide minerals and soil organic matter (SOM).
This study focuses on the morphological and mineralogical investigation of a sandy meadow soil (calcic Gleysol, ferric, loamic) located in a swampy area in Central Hungary. Eh and pH were measured in 20, 40 and 100 cm depths by field monitoring station during the vegetation period. Mineralogical characteristics were studied by X-ray powder diffraction and selective dissolution methods (determining amorphous and crystalline Fe content). Morphological and chemical study of iron and carbonate concretions were carried out by electron microprobe. Total iron content was determined by X-ray fluorescence spectroscopy, and, particle size distribution by laser diffraction. Total soil organic carbon (SOC) and nitrogen content were measured by non-dispersive infrared spectroscopy. Humic substances were qualified by UV-Vis spectrometry, based on specific spectral absorbance (E4/E6).
Fluctuating Eh and pH conditions can be detected in the function of depth, in connection with seasonal changes of the groundwater level. The frequence of redox oscillations around the boundary of Fe(II)/Fe(III) is moderated in the topsoil, while reaches a maximum in 30-50 cm depth. The abundance of iron compounds is strongly affected by the intensity of redox fluctuations and vegetation patterns, as well. Close by plant roots, iron compounds of different oxidation states can be found associated. In the permanently water saturated subsoil (100 cm) Eh fluctuations do not affect iron solubility. Different dynamics of Eh fluctuations have driven to the characteristic accumulation of SOM, iron oxide-hydroxides and calcite in different depths of the soil profile. SOM accumulation has taken place resulting high values of SOC also even in the depth of 50-60 cm. The high proportion of C/N and E4/E6 values reflect advanced humification. Quantity and quality of humic subtances seem to correlate also with iron distribution.
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