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Changes of the magnetic parameters induced by heating in chernozem soils samples

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The magnetic behavior of the three loess samples (MD-14, K10-17, CG-13) and one topsoil sample (MD-1) from the chernozem soil profiles were investigated during heating up to 700^{o}C. Two of loess samples MD-14 and K10-17 contain similar amounts of the total iron (Fe$_t$) 1.17% and 0.95%, respectively, dithionite-extractable iron (Fe$_d$) that form iron oxides (31.88% and 31.73% of the Fe$_t$), and oxalate iron (Fe$_o$) that form the poorly crystalline fraction of the total Fe oxides (8.78% and 8.14% of the Fe$_t$). The low temperature susceptibility changes curve (κ(T)$_{LT}$) show that paramagnetic minerals prevail and poorly crystallized oxidized magnetite is slightly marked as a Vervey transition (Vt) at –160^{o}C in both samples. During heating of the MD-14 sample up to 600^{o}C, only slight decrees of susceptibility between 340 and 405^{o}C is observed on the high temperature susceptibility changes curve (κ(T)$_{HT}$), accompanied by the rise of the temperature of the Vt up to about –145^{o}C. No significant changes of the histeresis parameters are observed. The improvement of the magnetite crystallization was also observed in the topsoil sample MD-1, where the susceptibility fall up to 410^{o}C was preceded by the slight rise between 200 and 260^{o}C. Sample K10-17 presents sharp increase of susceptibility between 290 and 315^{o}C accompanied by the decrees of the Hcr and Hc and rise of the Mr and Ms. Starting from the 330^{o}C susceptibility decrees gradually up to about 580^{o}C. Above 290^{o}C creation of the magnetic fraction of the superparamagnetic-grain size is observed on the κ(T)$_{LT}$. Similar magnetic behavior occurred in the CG-13 sample, with considerable susceptibility increase between 300 and 350^{o}C. Very significant contribution of the crystalline Fe oxides (Fe$_d$ 75.48% of Fe$_t$ in amount of 1.59%) suggests the involvement of this fraction into the alteration process. Character of magnetic changes support lepidocrocite transformation through the intermediate superparamagnetic maghemite into the hematite. The goethite transformation into hematite with intermediate magnetite formation is also considered.

Above 600^{o}C in both MD-14 and K10-17 samples strongly magnetic fraction appeared in result of the transformation of the Fe-rich clay minerals, giving the rise of Mr and Ms together with the fall of Hcr and Hc and extremely high increase of susceptibility of cooling κ(T)$_{HT}$ curves. The high superparamanetic contribution is deduced from the κ(T)$_{LT}$ upward trend.

For the topsoil sample – the only in the set with the considerable presence of organic matter (Corg is 4.25%) the increase of susceptibility between 400 and 500^{o}C is observed. This points to the formation of the new ferrimagnetic mineral in the aftermath of the thermo-induced decomposition of organic matter. It is followed by the significant increase of all histeresis parameters up to 650^{o}C. In such temperatures the contribution of SP magnetite becomes significant. Heating from 650 to 700^{o}C leads to coarser SD texture expressed as the increase of Mrs/Ms ratio and decrease of Hcr/Hs ratio). Simultaneously, the growth of Hcr and Hc together with the fall of Mrs and Ms point at the mineralogical transformations of ferrimagnetic fraction to antyferromagnetic one.

Results show that the character of the magnetic transformations during heating point to the role of the iron-hydroxides, clay minerals and organic matter content. Further mineralogical studies are required in order to discover the complex character of transformations that take place in natural samples in elevated temperatures.

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