# Magnetism of soils applied for estimation of erosion at morphologically diverse area

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**Abstract:** Pedogenic magnetic enhancement in soils leads to establishment of typical variations of magnetic parameters along depth profiles. In areas, heavily affected by erosion, this pattern is disturbed due to removal of the uppermost soil layers. Tillage operation seriously enhance soil degradation, as far as soil particles are easily removed by water and wind. In agricultural land, the morphology (slope gradient) is the main controlling factor for soil redistribution over a slope.

A detailed field study on small test site of agricultural land situated in loess region in Southern Moravia (Czech Republic), followed by laboratory analyses, has been carried out in order to test the applicability of magnetic methods in soil erosion estimation. Haplic Chernozem is an original dominant soil unit in the wider area, nowadays progressively transformed into different soil units along with intensive soil erosion. An extremely diversified soil cover structure resulted from the erosion. The site was characterized by a flat upper part (slope 0-0.5°) while the middle part, formed by a substantive side valley, is steeper (up to 15°). The side valley represented a major line of concentrated runoff emptying into a colluvial fan (Zádorová et al 2011). Field measurements of magnetic susceptibility were carried out on regular grid, resulting in 101 data points. Bulk soil material for laboratory investigation was gathered from all grid points. Mass specific magnetic susceptibility $\chi$ and its frequency dependence $k_{FD}$ was used to estimate the significance of SP ferrimagnetic particles of pedogenic origin in top soil horizons. Thermomagnetic analyses, hysteresis measurement and scanning electron microscopy were used in order to determine dominant ferrimagnetic carriers in top-soil and sub-soil layers.

Strong correlation was found between the volume magnetic susceptibility (field measurement) and mass specific magnetic susceptibility measured in the laboratory (Kapicka et al 2013). Values of organic carbon content and magnetic susceptibly are spatially distributed depending on terrain position. Higher values of magnetic susceptibly and organic carbon content were measured at the flat upper part (where the original top horizon remained). The lowest values of organic carbon content and magnetic susceptibly were obtained on the steep valley sides. Here the original topsoil was eroded and mixed by tillage with the soil substrate (loess). High values of both

properties were measured also at colluvial fan (where soil eroded from the top horizon at upper parts was accumulated). Regression analysis showed positive correlation between the organic carbon content and volume magnetic susceptibility ($R^2$= 0.89).

The soil profile that was unaffected by erosion was investigated in detail. The vertical distribution of magnetic susceptibility along this ”virgin” profile was measured in laboratory on the samples from layers along the whole profile with 2-cm spacing. The undisturbed profile shows several soil horizons. Horizons Ac and A show a slight increase in magnetic susceptibility up to a depth of about 70 cm. Horizon A/Ck is characterized by a decrease in susceptibility, and the underlying C horizon (h > 103 cm) has a very low value of magnetic susceptibility. The differences between the values of susceptibility in the undisturbed soil profile and the magnetic signal after uniform mixing the soil material as a result of tillage and erosion are fundamental for the estimation of soil loss in the studied test field. Using the uneroded profile from the studied locality as a basis for examining the changes in cultivated soils, tillage homogenization model (Royall 2001) can be applied to predict changes in the surface soil magnetism with progressive soil erosion. The model is very well applicable at the studied site.

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**Keywords:** soils, magnetic parameters, soil erosion modelling

**References :**

Royall, D. (2001). Use of mineral magnetic measurements to investigate soil erosion and sediment delivery in small agricultural catchment in limestone terrain. *Catena, 46, 15-34.*

Kapicka, A., Dlouha, S., Grison, H., Jaksik, O., Kodesova, R., Petrovsky, E. Magnetism of soils applied for estimation of erosion at an agricultural land. *Geophys Res Abstr Vol. 15, EGU2013 -4774, 2013*

Zádorová, T., Penížek,V., Šefrna, L., Rohošková, M., Borůvka, L. (2011): Spatial delineation of organic carbon-rich Colluvial soils in Chernozem regions by Terrain analysis and fuzzy classification. *Catena, 85 (1), 22–33.*