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Linking soil organic carbon and field measurements of magnetic susceptibility as a proxy of soil quality in arable soils

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Soil magnetic susceptibility (MS) is a rapid and cost-effective technique that has been applied in environmental studies for monitoring soil pollution by heavy metals and soil redistribution and to infer soil forming processes. Few studies involved magnetic research in arable soils and limited information is available about the use of field magnetic susceptibility measurements to study the link between soil organic carbon (SOC), magnetic susceptibility and soil movement. To this purpose development of methodological approaches in environmental magnetism less time-consuming than measurements in the laboratory are needed.

This study was conducted to i) test the repeatability and reliability of field magnetic susceptibility compared to laboratory measurements; ii) evaluate the use of field magnetic measurements as a proxy of soil quality and iii) evaluate the use of field magnetic measurements to infer soil redistribution at field scale in unpolluted arable soils with low concentration of magnetic minerals.

Magnetic susceptibility was measured on a 10 m grid (n=156) using a Bartington MS2 meter. Field measurements of MS (κ) were carried with a MS2D loop and laboratory measurements of mass-specific magnetic susceptibility at low frequency (χlf) were performed using a MS2B sensor in topsoil (5 cm). We also established eroding and depositional sites by the 137Cs technique to be linked with MS and SOC.

The study field (1.6 ha) in the NE of Spain has been cultivated for winter cereals. Soils are developed on quaternary sediments. The mass-specific susceptibility in the topsoils (χlf) ranged from 11 to 44 $\times$ 10$-$8 m3 kg^{-1} (mean=25 $\times$ 10$-$8 m3 kg^{-1}) and the volume magnetic susceptibility (κ) from 13 to 64 $\times$ 10$-$5 SI (mean=28 $\times$ 10$-$5 SI). SOC ranged from 0.29 to 1.88% (mean=1.02%). Pearson correlation coefficient between χlf and κ was r= 0.87 (p<0.01) indicated that surface and laboratory MS measurements from different methodological procedures are well correlated and can be comparable and effective for mapping purposes. A close relationship was found between the finer soil particles, SOC and ferrimagnetic minerals.

Based on 137Cs inventories, at eroding sampling points soils were slightly weakly ferromagnetic (κ=27 $\times$ 10$-$5 SI), and had a mean of SOC content of 0.98% compared to depositional sites (κ=30 $\times$ 10$-$5 SI) where mean SOC was 1.07%. The results showed that soil redistribution is a relevant factor for the variation of MS and SOC. The measurements of field MS have the potential to provide detailed information that can be important for assessing soil quality. This work improves the knowledge on the spatial variability of MS, SOC and soil redistribution (137Cs) in arable soils with low magnetic signal for mapping soil degradation.