

## The GEMAS European background data set for magnetic susceptibility in agricultural soil

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**Abstract:** The GEMAS (Geochemical mapping of agricultural soils) project, a cooperation project between EuroGeoSurveys and Eurometaux, provides unified soil quality data for Europe. Samples of arable soil were taken during 2008 at an average density of 1 site/2500 km, covering the member states of the European Union (except Malta and Romania) and several neighbouring countries (e.g., Norway, Serbia, Ukraine). The GEMAS project produces REACH (Registration, Evaluation and Authorisation of CHemicals - EC, 2006) consistent soil geochemistry data at the continental scale, which makes the data set also optimally apt to provide the first continental scale overview of magnetic susceptibility in European soil. Samples from the upper 20 cm were taken in large agricultural fields (Ap-sample). After air drying and sieving to <2 mm, weight specific magnetic susceptibility  $k$  was measured using a Sapphire Instruments SI2B bridge with dynamic background correction.  $k$  quantifies the magnetic response to a small change of the external magnetic field.  $k$  is typically high in samples with a high concentration of iron oxides (magnetite, maghemite, haematite), iron hydroxides (goethite, limonite), or iron sulphides (pyrrhotite, greigite), and low for soil with high carbonate or silica content. While the median value in Ap soil is  $0.207 \times 10^{-6} \text{ m}^3/\text{kg}$ ,  $k$  varies over 4 orders of magnitude and allows for a clear classification. Its spatial distribution shows a broad distinct low over the sandy sediments of the last glaciation in central northern Europe, which consist primarily of quartz ( $\text{SiO}_2$ ) with very little amounts of iron and iron oxides. Other broad minima in  $k$

are also related to sedimentary basins. Localised, consistently positive,  $k$  anomalies occur near young volcanism, or old basalts exposed on the surface. Also iron ore provinces or mineralizations, e.g. the Iberian Pyrite Belt, are associated with high  $k$ . Elevated  $k$  values due to precipitation and subsequent weathering are found in Mediterranean chromic luvisols (terra rossa). On the European scale a unique signal of anthropogenic enhancement of  $k$  in Ap soil cannot be distinguished. All major features of the  $k$  distribution can be related to geology. Thereby, the GEMAS data set of magnetic susceptibility provides a continent wide reference of the natural background of  $k$  in Ap soil. It can be used to define the geological background variability for national and local studies, where this knowledge is needed to distinguish between anthropogenic and geogenic sources of observed  $k$  anomalies.

**Keywords:** Magnetic susceptibility, agricultural soil, geochemistry, environmental magnetism