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The role of geology and soil type on the evaluation of anthropogenic contribution to the topsoil magnetic susceptibility

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The application of magnetic methods for mapping the degree of anthropogenic pollution of soils is significantly obscured in areas with high background magnetic signal coming from the geology. The role of soil type in pollution studies is not considered very often, supposing that the anthropogenic enhancement is much higher than any differences arising from the different soil types. The latter is true for areas, very strongly affected by industries which are known as sources connected with significant emission of highly magnetic particles along with other pollutants (e.g. power plants, metallurgical industries, etc.). However, in order to reveal the picture of moderate degree of pollution, the soil factor should also be taken into account. Moreover, it is worth doing it, as far as the most damaged areas are obvious even by simple observation, while potentially in danger places are not always obvious. Considering the frequency-dependent susceptibility as a single judgment for the origin of the magnetic enhancement (pedogenic or anhropogenic) does not work in areas with strongly magnetic bedrocks and areas with very contrasting soil cover.

The above mentioned problems are addressed in our study which covers two regions in Eastern Bulgaria: Varna-Devnja and Burgas. The first area is characterized by low magnetic background signal, determined by the widespread limestones. The second area is situated southward and the geology is much more complex, represented by volcanic rocks and volcanoclastic sediments. The soil cover in both regions is represented by three main soil types: Chernozems, Planosols and Smolnitza. These soil types are very distinct and the corresponding differences in their magnetic pedogenic enhancement have to be taken into account. Field susceptibility mapping was carried

out in a regular grid with step of 4km and soil samples from the upper 20cm were taken for laboratory analyses. The area covers about 4400 km2 with 280 sampling points. The major industrial pollutants in Varna-Devnja region are concentrated in the so-called Devnja industrial complex, which comprises power plant, two plants for sodium production, two plants for polymers and fertilizers. The main pollution sources around Burgas are oil refinery, Cu- and Fe-mining and the corresponding metallurgical plants.

The constructed maps of the field magnetic susceptibility measurements reveal two obvious features: the area around Varna-Devnja characterized by low background signal from the geology shows maxima well corresponding to the known point pollution sources, but also is connected to the presence of Planosols. In the southern region (around Burgas) the main features observed on the field susceptibility map are linked to the geology. The range of magnetic susceptibility variations is very wide – between 10 and 2600 x 10^{-5} SI. Areas close to the main industries do not show even local maxima due to the strong influence of the bedrocks. Thus, both areas under investigation need careful evaluation of the roles of geology and soil type, in order to extract the signal coming from anthropogenic pollution.

Extended laboratory magnetic studies (hysteresis measurements, thermomagnetic analysis, pARM, SIRM, etc.) have been carried out for rock-magnetic characterization of soils, which allowed to construct the maps of the hysteresis parameters Hc, Hcr, Ms, Mrs and the ratios Mrs/Ms and Hcr/Hc and to draw conclusions about the contribution of different magnetic components. Several methods using the magnetic data are applied to correct for the effect of geology and soil type and will be discussed in the presentation.