Description for the general public

Almost all urban and industrial dust emitted from different sources to the atmosphere and finally deposited on the soil surface contain particles with magnetic properties. In the scientific literature they are called "technogenic magnetic particles" (TMPs). These particles are iron minerals (mainly oxide) formed during high-temperature processes, from various iron forms initially present in raw materials, additives or fuel used by different branches of industry. Due to their magnetic properties even a small amount of the TMPs present in soil can be detected using simple magnetic measurements (e.g. magnetic susceptibility). As that TMPs are carriers of many potentially toxic elements (PTEs) therefore, the measured magnetic susceptibility values often are used as the indicator of the soil pollution. The reason for choosing the research topic were promising results of the preliminary study performed on a small number of samples of urban and industrial dust showing that with appropriate choice of magnetic parameters, soil samples containing TMPs derived from different pollution sources are located in separate areas of the diagrams. It suggests that TMPs have certain characteristic parameters, distinguishing them depending on their origin. This is connected with their slightly different mineralogical composition and internal structure, that are the result of different formation conditions. The aim of the project is detailed magnetic characterization of soils containing TMPs as well as magnetic concentrates separated from these soils. Soil samples will be collected in areas of long-lasting anthropopression, from specific (still operating or historical) pollution sources as: iron and nickel smelters, iron foundry, glassworks, coking and cement plants, dumps of industrial wastes and big railway junctions. As a result of this project it is expected to find differences in magnetic characteristics between TMPs and iron minerals naturally occurring in soils as well as the differences between magnetic properties of TMPs derived from different branches of industry. Important is also to answer the question, whether it is possible to identify the origin of the TMPs found in soil, in respect to the pollution source, based on the combination of magnetic parameters. If these assumptions will be validated during the research, it will be possible in the future to determine the most important sources of soil pollution, in the area of study, on the base of the characteristic of magnetic particles found in the soil. It is very important especially in case of historical pollution.

The innovative aspect of this project is also combination of in-situ measurements of magnetic susceptibility and chemical analyses, carried out directly in the field on the area of identified magnetic anomaly. This allows to determine the kind of chemical soil pollution without the need of time-consuming and costly laboratory analyses. The magnetic susceptibility measurements will be done by using MS2 Bartington magnetic susceptibility meter equipped with MS2D loop sensor, together with chemical measurements done by using portable XRF equipment, purchased in the frame of this project. In areas of so precisely determined magnetic and geochemical anomalies topsoil cores will be sampled. The cores will be transported to the laboratory, where the vertical distribution of magnetic susceptibility and the content of potentially toxic elements in the soil profile will be measured. On the basis of these preliminary studies, the layers of the highest concentration of TMPs will be determined and soil material from these horizons will be subjected to further analysis and used for separation of magnetic fraction. The study will be consist of:

- analyses of changes of magnetic properties in the range of temperature between -195 do 700°C,
- identification of iron compounds and they internal structure by using Mössbauer spectroscopy, supported by optical microscopy and SEM technique
- more advanced measurements of magnetic properties including magnetic hysteresis parameters commonly used in environmental magnetic studies for identification of magnetic mixtures.

The final stage of the study will be chemical sequential extraction of trace metals carried out on magnetic and non-magnetic fractions that allows to specify the nature of physical and chemical binding between PTEs and TMPs. These studies will give new knowledge on the role of TMPs in the transport of pollutants and the capabilities and limitations of the application of soil magnetometry for soil pollution study in relation to specific pollution sources.