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Thermomagnetic identification of manganese and iron minerals present in soils and industrial dusts

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Many industries (e.g. metallurgy, power, cement, and coking plants) constitute a sources of industrial dusts containing technogenic magnetic particles (TMP). TMP are mostly iron oxides with ferrimagnetic or antiferromagnetic properties, therefore their presence in dusts, soils and sediments can be easily detected by magnetic susceptibility measurements. TMP, thanks their specific mineral and magnetic properties, and well developed specific surface area, are characterized by a chemical affinity for some elements like heavy metals.
The main objective of this study was identification of manganese and iron (hydro)oxides occurring in industrial dusts and soils being under their deposition for long time period. In principle, Mn and Fe (hydro)oxides present in these samples originate from high-temperature technological processes.
Soils samples (collected from different soil horizons) taken from surroundings of power station, iron/steel and non-ferrous plants as well as metallurgical dusts and fly ashes from power stations were subjected to investigation. During the studies temperature dependent magnetic susceptibility measurements and X-ray powder diffraction analyses were applied.
Thermomagnetic analyses (K-T) revealed differences between samples from particular industries, however an inflexion at 450-500°C of all curves was observed indicating a probable occurrence of maghemite- or titanomagnetite-like phases. The curves of TMP emitted by power plants have inflection at 580 °C indicating that magnetite was the main magnetic phase. In case of TMP originated from non-ferrous metal smelting additional curve deflection at 130 and 210 °C occurred relating to intermediate titanomagnetite or iron sulfides. X-ray diffraction proved the occurrence of magnetite and maghemite in almost all samples, especially connected with power industry and iron/steel metallurgy. Mineral analysis revealed that kind of industrial process influenced on the dominating mineral forms found in polluted soils and specific industrial dusts. Fly ashes were composed mainly of anhydrite (2-46%), quartz (18-33%), muscovite (0-8%), feldspar (0-8%) and hematite (2-8%), while different spinels (19-53%), hematite (0-38%), wüstite (0-40%) and additives of calcite, halite, sylvine and graphite are the components of metallurgical dusts. Dusts from non-ferrous metal smelting contain Pb and Zn minerals: zincite (1-95%), lanarkite (0-45%), gordaite (0-10%), challacoloite and sphalerite. Additionally, some rare minerals were found in these dusts, such as: anglesite, sphalerite, galena, metasideronatrite and in soil, coronadite.

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