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Magnetic properties of fly ash and its relevance for soil pollution mapping

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Fly-ash of industrial origin contains significant portion of Fe-oxides, magnetite (Fe3O4), and/or maghemite (γ-Fe2O3)[1]. They occurred as a result of mineralogical transformations of iron bearing source minerals during high temperature technological processes (e.g. fossil fuel combustion, metal ore processing, cement and ceramic production, etc.). Such ferrimagnetic minerals were observed both in fly-ashes falling directly on the soil surface and in suspended dust (PM 10), which can be transported over great distances, causing pollution of the natural environment [2]. Magnetic properties of industrially derived ferrimagnets are different from those of natural origin. In terms of morphology, they are typically of spherical shape, often with rough surface and with Fe-oxides sintered on Al-Si phase. Their typical size varies between about 2 and 50 μm and from magnetic point of view multi-domain (MD) structures prevail[3]. These particles can be detected with very high sensitivity and can serve as tracers of industrial pollutants in soil layers.
In this contribution we will show typical magnetic characteristics of fly-ashes from coal combustion and the application of magnetic method to assess contamination of soils due to fly-ash deposition in regional scale. Increased values of concentration-dependent parameter (magnetic susceptibility) were clearly identified in the top-soil layers. Thermomagnetic analyses and SEM observation indicate that the accumulated anthropogenic ferrimagnetics dominate these layers. Magnetic enhancement is limited to depths of 4-7 cm below the soil surface, usually in F-H or top of Ah soil horizons. Significant magnetic parameters (e.g. Curie temperature Tc) and SEM results of contaminated topsoils are comparable with magnetic parameters of fly-ashes, collected by high-volume samplers at the same localities.
Magnetic monitoring of pollution has several advantages. It is fast and, contrary to stationary monitoring stations, allows data acquisition at large number of sites, enabling thus better delineation of areas with different amount of deposited dust. Areas with higher imissions can be thus better targeted for sampling for more detailed and standardized chemical analyses.

References:
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