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Grain-size dependence of the magnetic properties of street dusts from Warsaw, Poland

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In recent years, in connection with a substantial development of transportation in urban areas, vehicular traffic increased its importance as source of pollution and consequent cause of health problems in urban environments. In fact, it is well established that the concentration and size of pollution related particulate matter (PM) are important factors affecting human health.

The aim of this study is to identify the variations of the magnetic properties and of the chemical composition of different granulometric fractions from street dusts collected at four locations in Warsaw: the city center, a suburb, a tramline and a big crossroad.

Dust samples were mechanically sieved and classified using the laboratory shaker with a standard sieve set (0.5 mm, 0.25 mm, 0.1 mm and 0.071 mm).

Data show a distribution of magnetic susceptibility (χ) in the wide range of 80–370 $\times$ 10^{-8} m^3kg^{-1}. Comparison of magnetic parameters shows that the street dust contains the pollution characteristics for air and soil. The samples were characterized by uniform magnetic mineralogy, typical for fine-grained magnetite, in a grain size range between pseudo-single-domain and fine multi-domain, with a small contribution from ultrafine superparamagnetic particles ($\sim$2-3.5 %). The street dust contains, as usual for the urban areas, spherical magnetic particles produced by fossil fuel combustion processes and mixture of irregular angular iron-oxides grains containing other elements.

The magnetic susceptibility and hysteresis properties of the dusts have been analyzed in detail; the temperature variation of the saturation of remanent magnetization and of the magnetic susceptibility revealed that the main magnetic mineral, for all the fractions, is almost stoichiometric magnetite, with the finest fractions (d=0.1 mm, 0.071 mm and d$<$0.071 mm) additionally containing magnetic minerals with a Curie temperature above 700 ˚C.

First Order Reversal Curves diagrams of selected samples generally pointed out a significant viscous component of magnetization, arguably carried by multidomain/superparamagnetic magnetic particles.

The magnetic properties of the street dusts are influenced by their grain-size; the magnetic susceptibility of the finest fraction (d $<$0.071 mm) is about 2 times higher than the coarsest fraction (d$>$0.5 mm) for all the locations and, concerning the hysteresis properties, the coarsest fractions (0.5 and 0.25 mm) have the highest values of coercivity.

The study of the magnetic properties of the street dusts can offer a significant contribution to their characterization, with interesting implications on the definition of their environmental impact.