Geophysical Research Abstracts
Vol. 14, EGU2012-3411-3, 2012
EGU General Assembly 2012
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Environmental pollution at Linfen and its change - magnetic monitoring of leaves and soil

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Linfen city (Shanxi Province, China) is one of the world's most polluted city due to coal mining, refineries and other industries. During recent years the local government took enormous efforts to improve the environmental standard. In this study, we are testing the efficiency of magnetic susceptibility (MS) measurements for the assessment of this pollution "hot spot" where the environmental issues dictate the questions and up turning methodical obstacles have to be mastered. In particular we are testing to which extent the combination of MS results from soil and dust-loaded tree leaves allow to discriminate in between historical and present pollution. MS signals in the large abandoned industrial area and in new industrial areas are strongly enhanced with surface soil mass-specific MS (χ) between (232-3126)$\times$10-8m3kg-1, while in the agricultural areas they range from (88-179)$\times$10-8m3kg-1. Temperature dependence of MS identifies magnetite as the major magnetic phase in all topsoil samples; additionally a variable content of a harder coercive phase indicated by S-ratios of 0.82-0.99. Low χfd% (<5%) and hysteresis properties show that magnetite particles occur in PSD+MD domain state. In contrast to soil samples which accumulate pollutants over a long time span, dust-loaded tree leaf samples reflect the current air spread of pollution. Leaf samples were taken from the wider Linfen city area at intervals of about 2 km. Values of χ (normalized to the mass of the dried leaf) range from (2.2-501.1)$\times$10-8m3kg-1 with a median of 23.16$\times$10-8m3kg-1, and gradually decrease with distance from pollution sources. Rock magnetic parameters again identify a dominance of PSD+MD low-coercivity magnetite. Strong enhancement of MS occurs in the new urban industrial area and in the southern part of city, which is also controlled by the prevailing wind direction and the typical basin topography. XRF results show an enrichment of heavy metals for topsoils and leaves, which were outlined as highly polluted by MS mapping. Concentrations of Fe, Cu, Zn, Pb are clearly higher at the old and new industrial areas compared to the agricultural non-industrial area. Other heavy metals not arising from anthropogenic sources, such as Ti, were similar at all study areas. The distribution of heavy metals and MS values at high and low polluted sites indicates that the extra magnetic particles accumulated in the industrial areas were neither inherited from soil parent materials nor from pedogenic processes, but originated from anthropogenic activities.