SOIL POLLUTION ASSESSMENT USING MAGNETIC METHODS IN TRUSKAVETS (LVIV REGION, UKRAINE)

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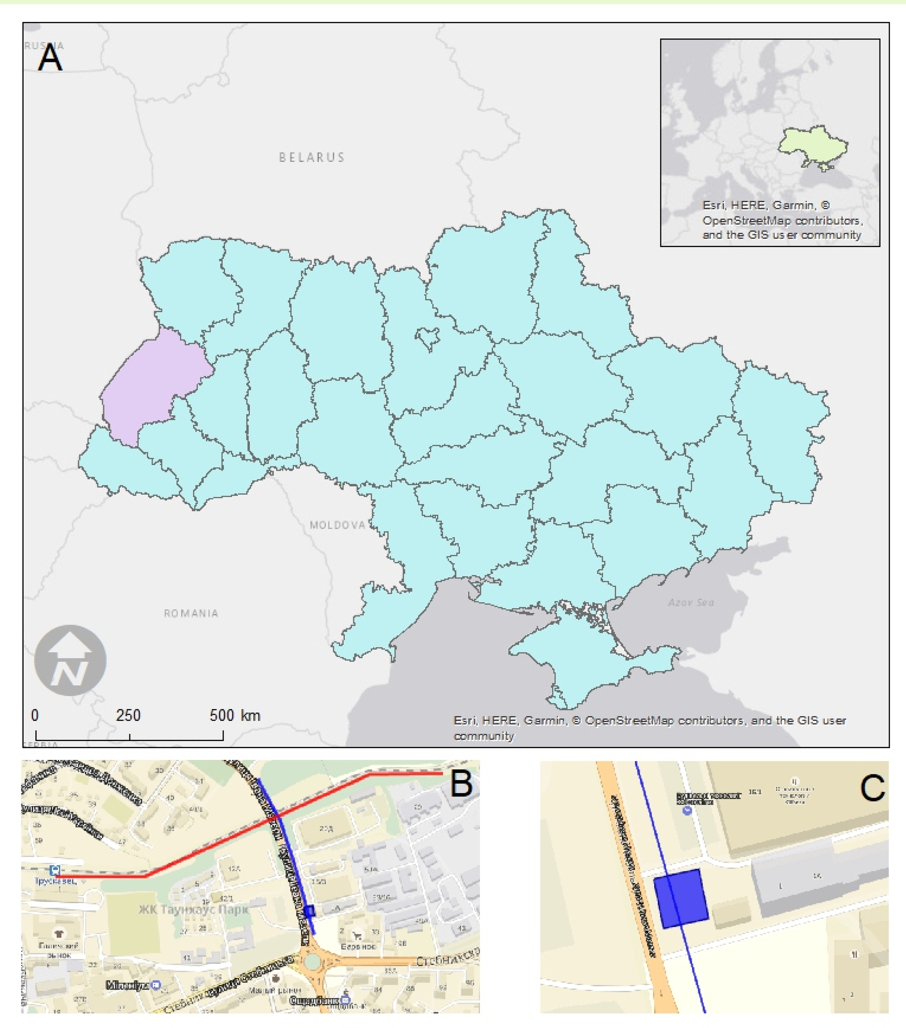
INTRODUCTION

United Nations (UN) sustainable development goals (SDGs) require for 2030 the implementation of important environmental sustainability measures (Tóth et al., 2018). Several SDGs are directly or indirectly connected with soil health and their capacity to supply ecosystem services in quality and quantity. Soil pollution causes adverse effects on soil ES and human health. Magnetic susceptibility (MS) measurements and magnetic mineralogy analyses are a cost-effective tool to quantify soil properties. The distribution of ferrimagnetic minerals in soils can be used to assess soil status (Jakšík et al., 2016) and as an alternative method to the traditional geochemical analyses (Liu et al., 2016).

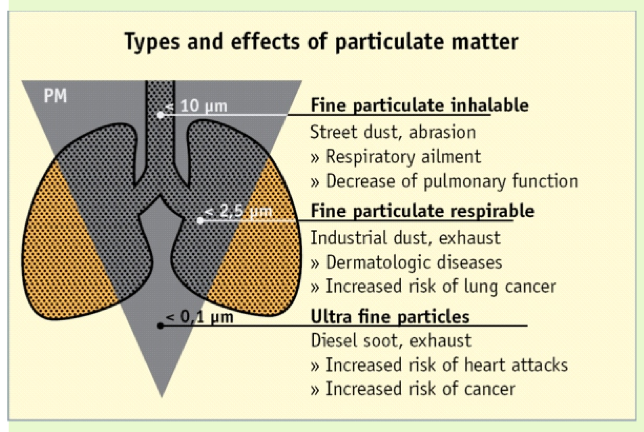
The aim of the present study is to apply MS to assess soil degradation and pollution in urbanized and non-urbanized areas of Truskavets (Lviv region, Ukraine).

SITE AND OBJECTS DESCRIPTION

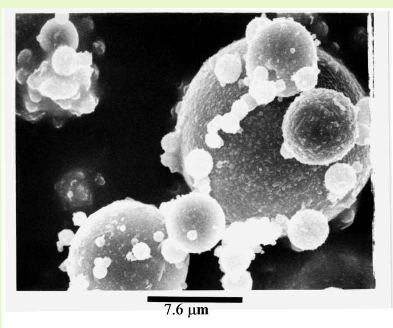
The peri-urban area of Truskavets is a part of the Drohobych-Borislav agglomeration. The natural soils are gleysols and phaeozems. 100 topsoil samples were sampled in urbanized sites, 20 in non-urbanized areas, and 55 in grid observation.



Study site

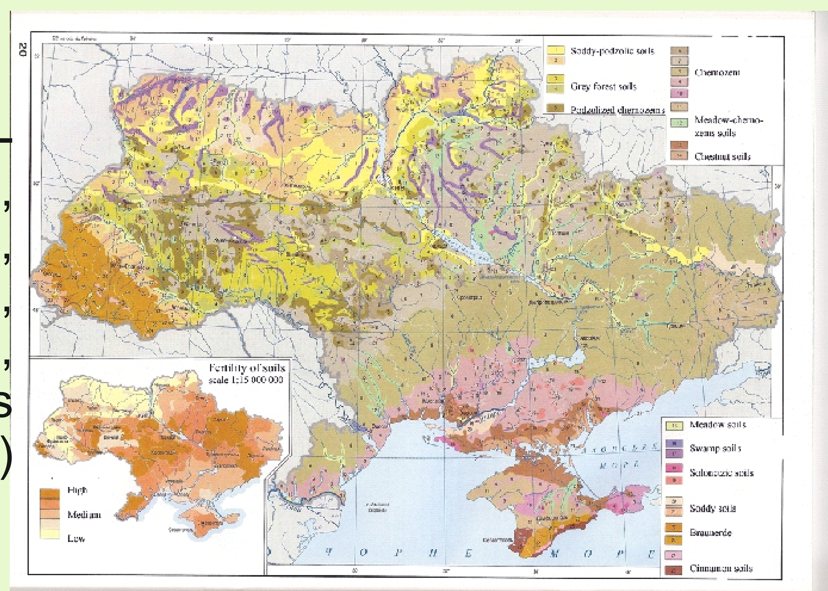


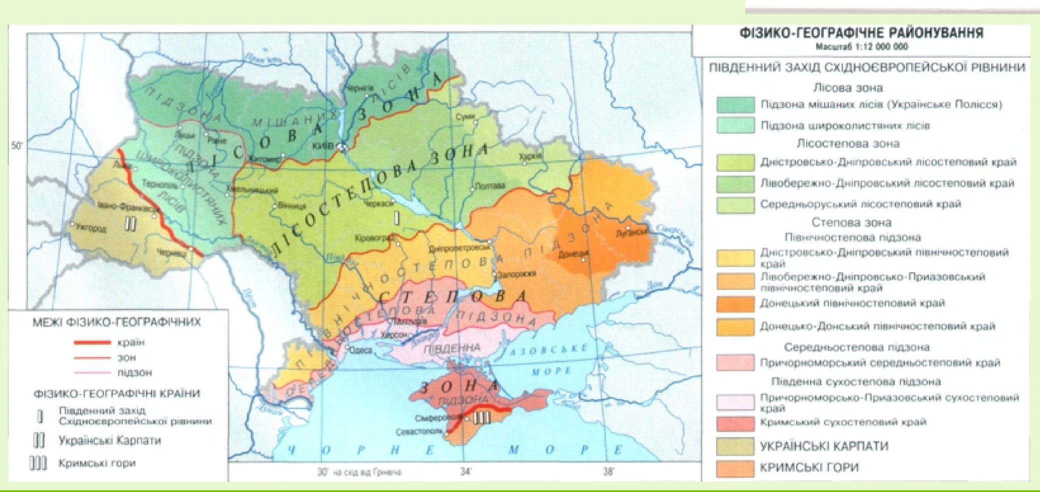
Particulate matter: PM10, PM2.5, PM0.1



Fly ash spherules, picture by Simo Spassov

Soil types: Albeluvisols (Soddy-podsolic), Phaeozems (Gray forest), Kastanozems (Chestnut), Chernozems (Leached, Typical, Ordinary, Southern, Meadow), Gleysols (Bog soils), Cambisols (Brawn and Mountains soils)





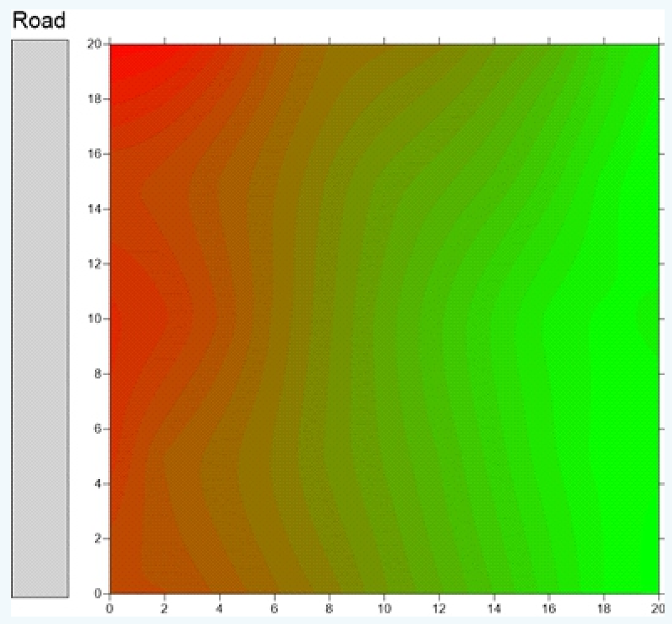
The main soil-climatic zones of Ukraine

RESULTS OF MAGNETIC MEASUREMENTS

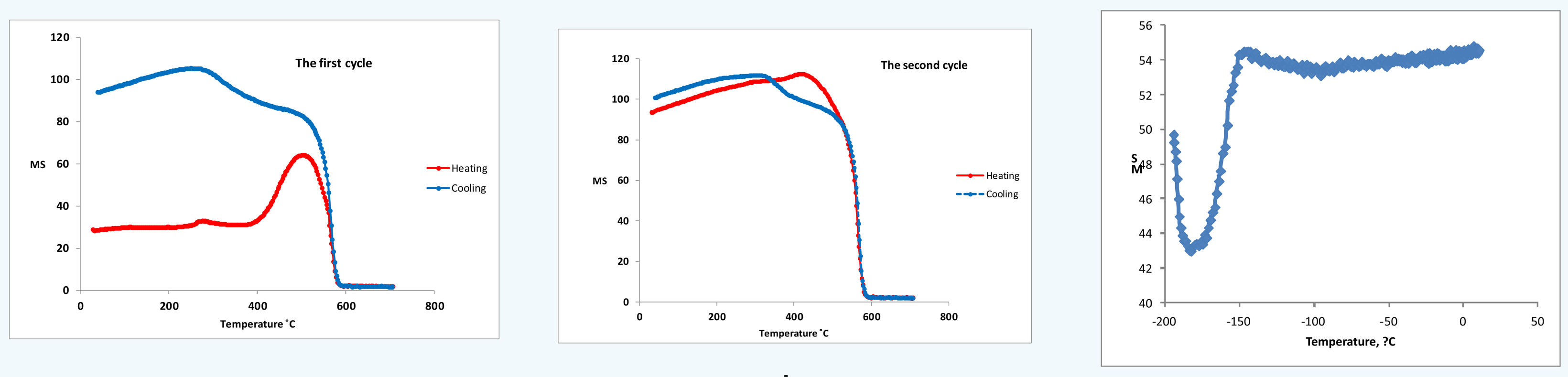
The results showed that the magnetite-like phase was the main responsible for the magnetic enrichment in the polluted soil. Simultaneously, non-polluted soils have a small amount of the single domain (SD) particles and high coercivity minerals such as haematite and goethite. The MS of the urbanized soils were 4 to 6 higher than non-urbanized soils. The frequency dependence of the magnetic susceptibility (χfd) was up to 3-4 for soil sampled in urbanized sites, which shows the predominance of the multidomain (MD) grains of anthropogenic origin.

Sample	$\chi \times 10^{-8}$ m³/kg ($\kappa \times 10^{-6}$ for dust)	χ_{fd}, %	ARM, Am²/kg	$\chi_{ARM} \times 10^{-8}$ m³/kg	S_{ratio}	Bc, mT	Bcr, mT	Mr mAm²/kg	Ms mAm²/kg
Reference topsoil	9	-	1.62E-05	2.03E-07	0.71	11.5	40	0.701	6.497
Polluted roadside soil	109	2.2	1.36E-04	1.71E-06	0.99	9	29	10.362	135.288
Polluted roadside and railway soil	92	2.0	1.47E-04	1.85E-06	0.75	8	29.5	7.504	116.902
Reference dust	6	-	3.35E-06	4.21E-08	0.69	12.5	38	0.831	8.871
Roadside soil	18	-	1.24E-05	1.56E-07	0.79	8	33.5	1.635	26.810
Roadside and railway dust	27	-	2.10E-05	2.64E-07	0.80	8	33	2.502	37.227

Magnetic properties of Truskavets soils and dust

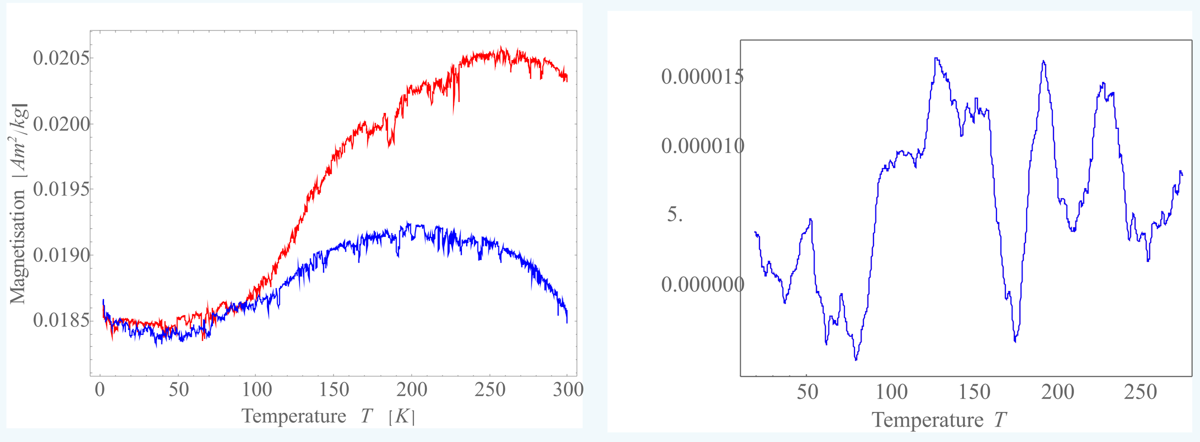


Spatial distribution of mass specific magnetic susceptibility of polluted roadside topsoil in the semi-urban area of Truskavets



a b c

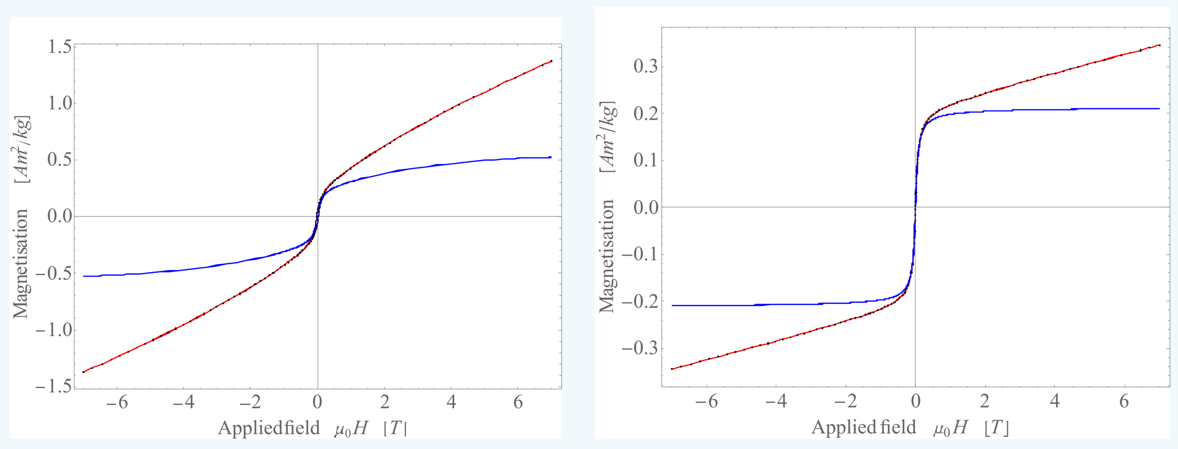
Temperature dependence of magnetic susceptibility of the Tp-2b sample of soil affected by both road traffic and railway pollution: a – the first heating-cooling cycle, b – the second heating-cooling cycle. Red lines – heating curves, blue lines – cooling curves. c – low temperature measurement



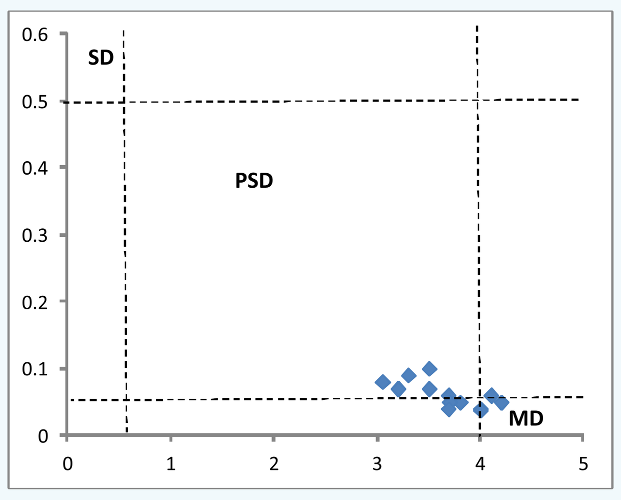
a b

Low temperature dependence of magnetization of the Tp-2b sample of soil affected by both road traffic and railway pollution: a – red line – heating curves (ZFW), blue line (ZFC) – cooling curves; b – the 1st derivative of the difference ZFC- ZFW

Hysteresis loops of the Tp-2b sample of soil affected by both road traffic and railway pollution: a – hysteresis at 30 K; b – hysteresis at 300 K. Red and blue curves refer to raw data and the high-field slope corrected data, respectively



a b



Day plot (Day et al. 1977) for the samples of polluted soil from Truskavets

Magnetic measurements were performed in the Laborotary of Environmental Magnetism of the Royal Meteorological Institute of Belgium. Special thanks to Dr. Simo Spassov and geophysics workgroup for kind support.

CONCLUSION

Our results confirmed that magnetic measurements are low cost, non-destructive and rapid techniques in monitoring levels of soil pollution both in urbanized and non-urbanized sites.