Geophysical Research Abstracts, Vol. 7, 09077, 2005
SRef-ID: 1607-7962/gra/EGU05-A-09077

COMPARISON BETWEEN IN SITU SOIL MAGNETIC SUSCEPTIBILITY MEASUREMENTS AND HEAVY METAL CONCENTRATIONS: THE CASE STUDY OF THE AGRI VALLEY, BASILICATA ITALY.

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Introduction

Actually, chemical techniques are used to analyse collected samples of soil and sub-surface soil in order to determine pollutants levels and their spatial-temporal patterns (*Sterckeman et al., 2000; de Matos et al., 2001)*. These techniques are very expensive and they require long times for the sample chemical pre-treatment and for the elemental analysis. Contemporaneously there is an increasing requirement of data on contamination levels of soil. So, it needs to develop innovative monitoring methods that are fast, not expensive and not invasive and that able to provide detailed information in real time about the temporal and spatial evolution of pollutants in soil and subsoil. In this context, the techniques of surface and sub-surface sensing, based on the measurements of electrical and magnetic parameters of soil, represent suitable tools for identifying innovative experimental procedures (*Dannowski et al., 1999; Silevitch et al., 2000*; *Desenfant et al., 2004*).

In particular, the integration of traditional chemical techniques with soil magnetic sus-

ceptibility measurements may be an interesting way for monitoring of heavy metal levels in superficial soil (*Heller et al., 1998; Bityukova et al., 1999; Durza, 1999; Goluchowska, 2001; Strzyszcz et al., 2001; Xie et al., 2001; Hanesh et al., 2002; Schibler et al., 2002; Chaparro et al., 2004; Desenfant et al., 2004).*

In this work, we present the results of an integrated field survey aimed to compare magnetic susceptibility measurements and chemical determinations of heavy metal concentrations in an industrial area of Southern Italy. The final goal is to develop a speditive experimental procedure for soil contamination monitoring that could have large application and that could be interesting for local Environmental Agencies.

1 Test site and experimental procedure

We focus our attention on high Agri Valley (Basilicata Region).This zone has relevant naturalistic aspects and the main land use is agriculture. In recent years it has been interested by a significant increase of anthropogenic activities connected with the extractive activities of hydrocarbons . At present the activity with the highest release of pollutant emissions is the crude oil pre-treatment, in which oil stabilisation and gas conditioning are performed principally by means of the torch combustion of the gases contained in crude oil. It is clear that Agri Valley will be subject to a growing anthropic pressure and it seems to be an optimal site to develop and test new low cost monitoring tools, able to survey large areas of territory in which the contamination phenomena are increasing very rapidly (*Cosmi et al., 2000*).

We have defined a sampling grid including 3 transects with 23 georeferenced sampling points. This grid covers an area of 4 km^2 all around the oil pre-treatment plant. Georeferentiation of sampling points allows us not only to compare different informative layers obtained by the different monitoring techniques, but also to repeat measurements in the same sampling points in different periods for monitoring the evolution of pollution phenomena.

For each sampling point, we carry out four soil magnetic susceptibility measurements at the vertices of a square with L=1 m, and we assume the mean value as the magnetic susceptibility of the sampling point. The magnetic susceptibility measurements have been performed using a Bartington MS2 meter, a field survey MS2D probe a loop with a diameter of 185mm for surface measurements (*Schibler et al., 2002*). Contemporaneously, for each sampling point, we collect a sample of superficial soil (5-10 cm), in which we measure total concentrations and bioavailable fractions of 9 heavy metals (Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, Zn) with FAAS and GFAAS techniques.

The data coming from the application of the two different kinds of techniques have been analysed by means of multivariate statistical tools in order to highlight the correlation structure.

2 Results and discussions

The magnetic susceptibility values measured in Agri Valley, present a large range of variability, from 8 x10^{-5} SI to 185 x10^{-5} SI. In particular, we record the higher values in the sampling points located near to a road with high volume of traffic (the magnetic susceptibility values near to this road vary from 97 x10^{-5} SI to 185 x10^{-5} SI). We measure magnetic susceptibility high values also in a vineyard (from 54 x10^{-5} SI to76 x10^{-5} SI). Instead, the lowest magnetic susceptibility value (8 x10^{-5} SI) is recorded in an uncultivated area.

Regarding to heavy metal concentrations, data show that, in the examined area, we measure Cu, Co, Pb values higher than the limit established by Italian law for residential and private use soil. In fact, the concentrations of Cu, Co and Pb measured in soil of Agri Valley are 341 mg/kg, 25 mg/kg and 179 mg/kg respectively; while the limits established by Italian law for these heavy metal concentrations are 120 mg/kg, 20 mg/kg and 100 mg/kg. We may suppose that high values of Pb and Co are ascribable to traffic emission, while Cu high concentration is related to the presence of vineyards treated with verdigris.

The use of multivariate statistical tools allows us to discriminate between different pollution sources of heavy metals in soil. We identify two clusters: the first cluster is formed by Fe, Ni and Mn, heavy metals strictly related to natural characteristics of soil; the second cluster is formed by Cu, Pb and Zn, that are heavy metals related to anthropic activities. In particular, this statistical analysis highlights that magnetic susceptibility of soil is related to the metals included in the second cluster. This result agrees with data present in literature (*Bityukova et al., 1999; Xie et al., 2001; Hanesh et al., 2002*) and we may assume that, for the examined area, soil magnetic susceptibility is a good indicator of pollutions coming from anthropic activities such as traffic emissions and agricultural practices.

3 References

Bityukova L., Scholger R. e Birke M., **1999**. *Magnetic susceptibility as indicator of environmental pollution of soils in Tallinn.* **Physics and Chemistry of the Earth (A)**. Vol. 24, pp. 829-835.

Chaparro M.A.E.,. Bidegain J.C,. Sinito A.M, Jurado S.S.,. Gogorza C.S.G., **2004**. *Relevant magnetic parameters and heavy metals from relatively polluted stream sediments – vertical and longitudinal distribution along a cross-city stream in Buenos Aires province, Argentina*. **Study in Geophysics and Geodesy**. Vol. 48, pp. 615-636.

Cosmi C, D'Apuzzo G., Macchiato M., Mangiamele M., Salvia M., **2000**. *Environmental impact assessment of minino activities in the productive system of Basilicata Region.* In **Air Pollution VIII.** Eds. Longhurst J.W.S., Brebbia C.A., Power H. WIT Press, pp. 221-231.

Dannowski G., Yaramanci U., **1999**. *Estimation of water content and porosità using combined radar and geoelectrical measuements.* **European Journal of Environmental Geophysics.** Vol. 4.

de Matos A.T., Fontes M.P.F., da Costa L.M., Martinez M.A., **2001**. *Mobility of heavy metals as related to soil chemical and mineralogical characteristics of Brazilian soils.* **Environmental Pollution.** Vol. 11, pp. 429-435.

Desenfant F., Petrovský E., Rochette P., **2004**. *Magnetic signature of industrial pollution of stream sediments and correlation with heavy metals: case study from South France*. **Water, Air and Soil Pollution.** Vol. 152, pp. 297-312.

Durza O., **1999**. *Heavy metals contamination and magnetic susceptibility in soils around metallurgical plant.* **Physics and Chemistry of the Earth (A)**. Vol. 24, pp.541-543.

Goluchowska B. J., **2001**. *Some factors affecting an increase in magnetic susceptibility of cement dusts*. **Journal of Applied Geophysics.** Vol. 48, pp 103-112.

Hanesch M., Scholger R., **2002**. *Mapping of heavy metal loadings in soils by means of magnetic susceptibility measurements.* **Environmental Geology**. Vol. 42, pp. 857-870.

Heller F., Strzyszcz Z. e Magiera T., **1998**. *Magnetic record of industrial pollution in forest soils of Upper Silesia, Poland,* **Journal of Geophysical Research.** Vol. 103, pp. 17767-17774.

Schibler L., Boyko T., Ferdyn M., Gajda B., Holl S., Jordanova N., Roseler W. and

MAGPROX Team, **2002**. *Topsoil magnetic susceptibility mapping: data reproducibility and compatibility, measurements strategy*, **Study in Geophysics and Geodesy**. Vol. 46, pp. 43-58.

Silevitch M. B:, McKnight S. W., Rappaport C**, 2000**. *A unified discipline of Subsurface Sensing and imaging*. **Systems Plenum Publishing Corporation**. Pp 3-19.

Sterckeman T., Douay F., Proix N., Fourrier H., **2000.** *Vertical distribution of Cd, Pb, and Zn in soils near smelters in the North of France.* **Environmental Pollution.** Vol. 107, pp. 377-389.

Strzyszcz Z., Magiera T., **2001.** *Record of industrial pollution in polish ombrotrophic peat bogs*. **Physics and Chemistry of the Earth (A).** Vol. 26, pp. 859-866.

Xie S., Dearing J. A., Boyle J. F., Bloemendal J., Morse A. P., **2001**. *Association between magnetic properties and element concentrations of Liverpool street dust and its implications,* **Journal of Applied Geophysics.** Vol. 48, pp. 83-92.