IX International Congress

BIOMEDICINE AND GEOSCIENCES – INFLUENCE OF ENVIRONMENT ON HUMAN HEALTH

III International Students' Workshop PUPIN MEETS NOBEL

BOOK OF PAPERS

July 6-9, 2021, Kopaonik Mt., Serbia

IX International Congress

BIOMEDICINE AND GEOSCIENCES - INFLUENCE OF ENVIRONMENT ON HUMAN HEALTH

III International Students' Workshop

PUPIN MEETS NOBEL

July 6-9, 2021, Kopaonik Mt., Serbia

Under the auspices of Ministry of Education, Science and Technological Development of the Republic of Serbia

PROCEEDINGS

IX International Congress
BIOMEDICINE AND GEOSCIENCES - INFLUENCE OF ENVIRONMENT ON HUMAN HEALTH

III International Students' Workshop
PUPIN MEETS NOBEL

Editor

Prof.Dr. Snežana Komatina, *AGES*, Belgrade, Serbia

Publisher
Association of Geophysicists and Environmentalists of Serbia (AGES)

For Publisher
Snežana Komatina, *AGES,* Belgrade, Serbia

Cover design
Dejan Bajić, *Technical Faculty "Mihajlo Pupin", University of Novi Sad*, Zrenjanin, Serbia

Technical preparation
Dejan Bajić, *Technical Faculty "Mihajlo Pupin", University of Novi Sad*, Zrenjanin, Serbia

Printed by
Copy Link Studio d.o.o., Belgrade, Serbia

Published: 2021, Belgrade, Serbia

Copies: 200

All papers in Proceedings are reviewed.

The Book of Papers has been published by the financial support of the Ministry of Education, Science and Technological Development of Serbia.

ORGANIZERS

Association of Geophysicists and Environmentalists of Serbia (AGES), Belgrade, Serbia
SEG/SPE Student Section, Technical Faculty *Mihajlo Pupin*, Zrenjanin, Serbia
EAGE (European Association of Geoscientists and Engineers)

ORGANIZING COMMITTEE

Prof.Dr. Snežana Komatina, *AGES*, Belgrade, Serbia - President
Assist.Prof.Dr. Aleksandra Kolarski, *Technical Faculty "Mihajlo Pupin", University of Novi Sad*, Zrenjanin, Serbia - Vice-President
Dr. Saša Đurović, Instititute of General and Physical Chemistry, Belgrade, Serbia
Gordana Leković, *Ministry of Education, Science and Technological Development of the Republic of Serbia*, Belgrade, Serbia
M.Sc. Mila Đuričić, *Technical Faculty "M. Pupin", Univ. of Novi Sad*, Zrenjanin, Serbia
M.Sc. Una Petrović, *AGES,* Belgrade, Serbia
M.Sc. Tomo Obrenović, *AGES,* Brčko, Brčko district, BiH
Isidora Popov, *Technical Faculty "M. Pupin", University of Novi Sad*, Zrenjanin, Serbia
Đurica Surla, *Technical Faculty "M. Pupin", University of Novi Sad*, Zrenjanin, Serbia
Dejan Bajić, *Technical Faculty "M. Pupin", University of Novi Sad*, Zrenjanin, Serbia
Aleksandar Radičev, *Technical Faculty "M. Pupin", Univ. of Novi Sad*, Zrenjanin, Serbia

SCIENTIFIC COMMITTEE

Prof.Dr. Snežana Komatina, *AGES*, Belgrade, Serbia - President
Assist.Prof.Dr. Snežana Filip, *Technical Faculty "M. Pupin", Univ. of Novi Sad*, Zrenjanin, Serbia - Vice-President
Koya Suto, *Terra Australis Geophysica Pty. Ltd.*, Queensland, Australia, ASEG
Prof.Dr. Miomir Komatina, *AGES*, Belgrade, Serbia
Prof.Dr. Vladislav Brkić, *University of Zagreb,* Zagreb, Croatia
Dr. Dan Herold, *Parallel Geoscience Corp.*, USA
Dr. Takao Aizawa*, Suncoh Consultants,* Tokyo, Japan
Prof.Dr. Bayraktutan Memet Salih, *Igdir Univ., Faculty of Engineering*, Igdir, Turkey
Dr. Jun Sugawara, *Department of Transport and Main Roads, Queensland Government,* Queensland, Australia
Assist.Prof.Dr. Aleksandra Kolarski, *Technical Faculty "M. Pupin", Univ. of Novi Sad*, Zrenjanin, Serbia
Assist.Prof.Dr. Toni Nikolić, *University "Džemal Bijedić", Faculty of Civil Engineering*, Mostar, BiH
Dr. Saša Đurović, Research Associate, *Institute of General and Physical Chemistry*, Belgrade, Serbia
M.Sc. Magdalena Marković Juhlin, *Uppsala University*, Sweden
M.Sc. Mila Đuričić, *Technical Faculty "M. Pupin", Univ. of Novi Sad*, Zrenjanin, Serbia
M.Sc. Marko Vanić, *NIS NTC*, Novi Sad, Serbia
M.Sc. Una Petrović, *AGES,* Belgrade, Serbia

CIP - Каталогизација у публикацији - Народна библиотека Србије, Београд

614.2(082)
502/504(082)
550.8(082)

МЕЂУНАРОДНИ Конгрес Биомедицина и геонауке - утицај животне средине на људско здравље (9 ; 2021 ; Копаоник)

[Proceedings] / The IX International Congress Biomedicine and Geosciences - Influence of Environment on human Health [and] III International Students' Workshop Pupin meets Nobel, July 6-9, 2021, Kopaonik Mt., ; under the auspices of Ministry of Education, Science and Technological Development of the Republic of Serbia ; [editor Snežana Komatina]. - Belgrade : Association of Geophysicists and Environmentalists of Serbia (AGES), 2021 (Belgrade : Copy Link Studio). - 192 str. : ilustr. ; 30 cm

Tiraž 200. - Bibliografija uz svaki rad. - Summaries.

ISBN 978-86-80140-10-0

1. International Students' Workshop Pupin Meets Nobel (3 ; 2021 ; Kopaonik)

2. Srbija. Ministarstvo prosvete, nauke i tehnološkog razvoja 3. Asocijacija geofizičara i ekologa Srbije (Beograd)

а) Здравље - Заштита - Зборници b) Животна средина - Зборници

COBISS.SR-ID 46696201

C O N T E N T S

NEW INOVATED METHODOLOGY FOR ENVIRONMENTAL PROTECTION

Marjan Delipetrev*, Blagica Doneva*, Gorgi Dimov*

* Faculty of natural and technical sciences, Stip, Republic of North Macedonia

Abstract

Identification and monitoring of contaminated areas is a crucial activity for environmental protection and sustainable use of land. The investigations are aimed to assessment of the specific needs of the region about the mapping of existing and potential soil contamination. This will contribute to greater awareness about the state of the soil resources in the partner countries and for an improved resource management efficiency with regard to soils. This paper represents the implementation of environmental screening and monitoring of soils using innovative methodology as a pilot tool. for soil samples collection, processing, analyzing and data representation, which is based on innovative geophysical methods for cost effective, sensitive and fast evaluation of the environmental quality of soils.The main advantage of this new methodology is its high sensitivity and possibility for smart adaptation of the method according to the site and the problem. Also, this method is much faster and cheaper than traditionally used chemical analysis.

Introduction

Magnetic features of soils

Soils with enhanced magnetic properties are a result of the presence of ferromagnetic minerals (commonly iron oxides). These minerals are derived from a number of sources. These sources can be grouped around several key processes end members, including:

1. Magnetic minerals weather directly from basic and ultrabasic bedrock and result in the accumulation of primarily coarse grained (~ 10 μm) minerals (commonly with Ti and Ni substitutions) in overlying soils. These minerals are of primary lithogeny origin and are relatively unaltered by soil processes.

2. A 'fermentation' mechanism involves the weathering of iron from magnetic and nonmagnetic soil parent material; the weathered product is transformed to magnetic phases via soil forming processes under oxidizing-reducing conditions. These processes tend to form fine-grained (<0.1 μm) secondary magnetite / maghemite with stable single domain (SSD) and superparamagnetic / viscous (SP) properties. In much of the early literature this is referred to as 'magnetic enhancement', indicating the topsoil has elevated values of magnetic susceptibility and frequency dependent magnetic susceptibility in comparison to the subsoil and soil parent material.

3. Fire transforms non-magnetic iron oxides to magnetic minerals of predominantly fine grained SSD and viscous SP grains.

4. Allochthones sources include atmospheric pollution, and soil erosion and deposition. Atmospheric pollution from combustive sources such as coal-fired power and steel works tend to

form large (~ 10 μm) minerals with varied compositions. Magnetic soil material eroded from other areas has the potential to be of mixed composition.

5. Other potential minor sources may include micrometeorites (allochtonous) and SP minerals from magnetic bedrock (in-situ).

Magnetic susceptibility of soils

Magnetic susceptibility, quantitative measure of the extent to which a material may be magnetized in relation to a given applied magnetic field. The magnetic susceptibility of a material, commonly symbolized by χm, is equal to the ratio of the magnetization M within the material to the applied magnetic field strength H, or $\chi m = M/H$. This ratio, strictly speaking, is the volume susceptibility, because magnetization essentially involves a certain measure of magnetism (dipole moment) per unit volume.

During recent years, the measurements of magnetic susceptibility have become a broadly applied method to research the spatial distribution of pollution and to identify polluted sources. Measurements of magnetic susceptibility provide an alternative to conventional chemical analysis. These measurements are fast and cheap alternative. Magnetic susceptibility was proved to be extremely useful in disclosing industrial pollutants, traffic emission and other atmospheric pollutants. Magnetic susceptibility mapping of soils and sediments turn out to be very important tool for evaluation of the anthropogenic pollution. Magnetic susceptibility measurements have been used to map the spatial distribution of pollution and degree of anthropogenic pollution around power plants, cement and metallurgical industries. Investigations demonstrated that two powerful applications of susceptibility measurement of soils, are the identification of polluted areas and the detailed mapping of these areas in order to reveal the extent of pollution. The use of magnetic measurements as proxy of heavy metal pollution is based on the fact that origins of heavy metals and magnetic particles are genetically related. Environmental magnetism studies have demonstrated the relationship between heavy metal contents and magnetic properties in soils. According some scientists, there is highly significant correlation between magnetic susceptibility and heavy metal content in soils. Because of this, susceptibility can be used as an indicator for contaminants and their spatial distribution.

Methodology for screening of magnetic suspectibility

Magnetic susceptibility corresponds to the ability of a material to be magnetised in an external field. Bulk (volume) susceptibility χ_{vol} can be directly related to the relative permeability (μ_r) of a material: $\chi_{vol} = \mu_r - 1$ and where μr is the ratio of permeability of material/permeability of vacuum. Magnetic susceptibility expresses the ability of a material to be magnetized and depends on the concentration of the ferromagnetic material. Therefore, several steps of the magnetic susceptibility monitoring protocol at the selected test sites should be strictly followed:

Field measurements

The assessment was implemented with the Barrington MS3 susceptibility system which includes: MS3 Meter, MS2D Surface Scanning Probe and MS2 Probe Handle. The MS2D loop is designed for rapid assessment of the magnetic susceptibility. Each grid cell was examined in a field campaign in order to be selected suitable spots for assessment of the concentration of ferromagnetic materials in the top 60 to 80 mm of the land surface (Bartington Manual). At the suitable locations inside each grid cell, a visibly homogeneous, undisturbed squares with L=1 were selected (Fig. 1). The geographical coordinates of each square were measured by portable GPS. Five independent soil magnetic susceptibility measurements were implemented at the vertices and in the center of a square. The mean value was assumed as the magnetic susceptibility of the testing square. For each measurement the grass was removed from the soil for better soil contact. The sensitivity of the BartingtonMS3 Susceptibility Meter is $1x10^{-6}$ SI. The depth of penetration when is used with MS2D Surface Scanning loop is about 8 - 10 cm when the sensor is in contact with the surface; 50 % at 15 mm and 10 % at 60 mm from the surface. The measures were implemented when the sensor is in contact with the surface.

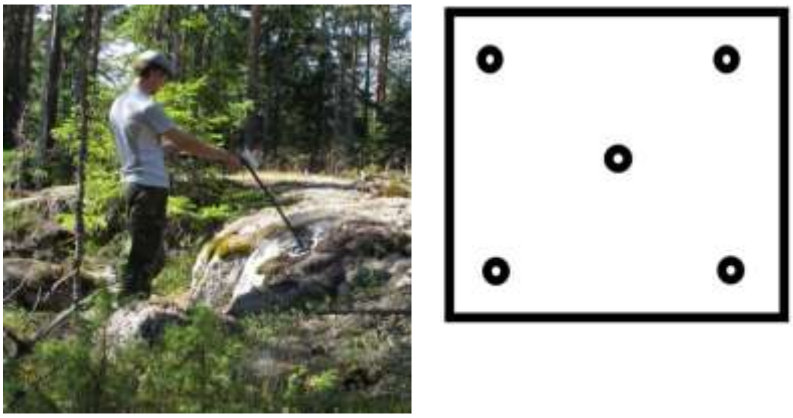

Figure 1. *Scheme of the measurement spots inside the testing square with a side of 1 m*

Sample collection

In soil, the total ferrimagnetic component may include primary minerals such as titanomagnetites with geo- logical origins, secondary minerals, such as magnetite and maghemite derived through chemical and bacterial processes or produced during burning, and pollution dusts containing magnetic spherules. The magnetic susceptibility of polluted soils increases due to their enrichment with technogenic magnetite, maghemite, metallic iron, and magnesio-ferrite. The content of magnetite and other magnetic minerals in the polluted soils can be tens and hundreds of times higher than their background values. To distinguish if the high values of the magnetic susceptibility are due to presence of primary minerals or because of the presence of industrial pollutant, samples for additional laboratory measurements of the frequency depended susceptibility must be collected. Sample extraction must be implemented according the methodology of Yordanova et al. (2008). Material of about 50 g will be taken from the top-soil a teach corner and in the center of the square (Fig. 4). It resulted in a pooled sample of roughly 250 g, considered as representative for the point. The material will be kept and transported to the laboratory in closed plastic bags.

Laboratory measurements

Whereas background soils are dominated by thin super paramagnetic and single domain particles, large multi domain particles prevail in urban soils. Field measurements for assessment of the magnetic susceptibility are useful instrument for detecting the presents of ferromagnetic materials in the soils, however field sensors do not provide absolute values of mass-specific susceptibility, but a kind of relative volume-related data instead, because of that additional investigation is needed to obtain the frequency depended susceptibility and to distinguish if the high values of the magnetic susceptibility are due to presence of primary minerals that are connected with the process of pedo-genesis or because of the presents of industrial pollutant. In order to calculate the contribution of the pedogenic, ferromagnetic minerals a Frequency-dependent susceptibility ($\chi FD\%$)) can be calculated and used as indicator for the relative contribution of the pedogenic ferromagnetic minerals to the total magnetic fraction in the soil. The formula is $\chi FD\%=100$ □$((\chi LF-\chi HF)/\chi LF$ (Yordanova, 2008). Following the protocol developed by Yordanova et al. (2008), magnetic susceptibility will be measured in the laboratory on homogenized material, sieved through 1 mm-mesh. The material will be filled in 10 cm^3 of plastic cylindrical containers and magnetic susceptibility will be measured by Bartington MS3meter, equipped with dual-frequency sensor MS2B at two frequencies - 0.46 (KLF) and 4.6 kHz (KHF). The weight of the samples will be measured and used for calculation of the mass-specific magnetic susceptibility (χLF). In order to achieve reliable results, the signal and the weight of the empty containers will be subtracted from the readings.

The rest of the material is used for traditional chemical analysis to confirm the results obtained.

Figure 2. *Bartington MS2B Dual Frequency Censor (on the left) and MS3Meter (on the right)*

Chemical analysis of soil samples

The main purpose of the new methodology, including the field and the laboratory magnetic susceptibility measurements, is to obtain reliable and cheap alternative of the traditional chemical methods for analyses of the anthropogenic pollution and the presents of heavy metals in the soils. In order to verify the reliability of the results and the effectiveness of the methodological approach, fifty of the samples with high susceptibility values for each test site will be analyzed for the presence of trace elements/heavy metals (As, Pb, Zn, Cu, Fe). The analysis will be executed according to the laboratory standards and traditional methods for chemical analysis. The analyzed material (50 gr in sealed plastic bags or containers) will be separated from the one that will be collect on the field for measurement of frequency depended susceptibility in the laboratory.

Validation of the results

Independent chemical analyses of selected samples from the study area will be made on statistically correct number of selected samples from all test sites. The analyses of the samples will be executed in an independent laboratory. The testing material (50 gr in sealed plastic bags or containers) for these analyses will be extracted from the same material that was collected for the evaluation of the frequency depended susceptibility.

Visualization

The results from the soil pollution assessment in the four test sites (two in each country) will be displayed on a GIS based map having the possibility to be complemented and updated with additional results including the one that will be obtain during the long-term monitoring of the test sites. The maps will comprise the results of the soils magnetic susceptibility measures and will also visualize the spatial distribution of the major pollutants (As, Pb, Zn, Cu, Fe…) obtained by the traditional chemical analyses.

Conclusion

From the performed test measurements of the new methodology, it can be concluded:

1. Conducted research contributes to new knowledge of environmental protection and implementation of a new methodology for soil testing;

2. The high quality of the obtained data for measuring the magnetic susceptibility and field tests for chemical analysis confirms the successful implementation of this innovative method;

3. The performed measurements of the magnetic susceptibility, showed that our equipment meets the highest standards for measuring technique;

4. Measurements performed with the Barrington MS3 susceptibility measurement system, which include: MS3 Meter, MS2D Surface Scanning Probe and MS2 Probe Handle, have shown that it can be successfully used in field prospecting;

5. From the study of the previous observations at the given locations on the territory of the Republic of North Macedonia, in order to maintain the continuity, continuous monitoring of the given locations is required;

6. Maps of magnetic susceptibility and chemical analyzes for heavy metal pollution will be made;

7. A correlation will be made between the field measurement data, chemical analysis and laboratory analysis of the magnetic susceptibility of the tested samples;

8. The field measurements and magnetic susceptibility studies represent a successful start for a new methodology for environmental protection;

9. Application of innovative methodology for identification and monitoring of contaminated soils can find wide application in all activities where there is heavy metal pollution;

10. The conducted researches and the results that will be presented are a good basis for further in-depth study in other fields that are polluted or protected areas in the Republic of North Macedonia, so that they do not become contaminated.

References

Zajkova-Paneva, V. at all. (2009) Determination of heavy metal content in soils from Zletovo. Natural resources and technologies, 3 (3). ISSN 185-6966

Zendelska, Afrodita (2010) Evaluation of the quality of water, soil and sediments in the vicinity of the tailing dam of Sasa mine and its impact on the environment. Masters thesis, University Goce Delcev Shtip.

Standard ISO 18227:2014 Soil quality — Determination of elemental composition by X-ray fluorescence

Operation Manual for MS3 Magnetic Susceptibility Meter