University of Belgrade
Technical Faculty in Bor,
Mining and Metallurgy
Institute Bor

# 54th International October Conference on Mining and Metallurgy

# PROCEEDINGS

Editors:
Ljubiša Balanović
Dejan Tanikić


18-21 October 2023, Bor Lake, Serbia

**PROCEEDINGS,**

**54th INTERNATIONAL OCTOBER CONFERNCE**

**on Mining and Metallurgy**

**Editors:**

**Prof. dr Ljubiša Balanović**

**Prof. dr Dejan Tanikić**

*University of Belgrade, Technical Faculty in Bor*

**Technical Editor:**

**M. Sc. Miljan Marković**

*University of Belgrade, Technical Faculty in Bor*

**Publisher:** University of Belgrade, Technical Faculty in Bor

**For the publisher:** Dean Prof. dr Dejan Tanikić

**Circulation:** 200 copies

CIP - Каталогизација у публикацији Народна библиотека Србије, Београд

622(082)(0.034.2)
669(082)(0.034.2)

INTERNATIONAL October Conference on Mining and Metallurgy (54 ; 2023 ; Borsko jezero)
Proceedings [Elektronski izvor] / 54th International October Conference on Mining and Metallurgy - IOC 2023, 18-21 October 2023, Bor Lake, Serbia ; [organized by] University of Belgrade, Technical Faculty in Bor and Mining and Metallurgy Institute Bor ; editors Ljubiša Balanović, Dejan Tanikić. - Bor : University of Belgrade, Technical Faculty, 2023 (Niš : Grafika Galeb). - 1 USB fleš memorija ; 1 x 1 x 5 cm

Sistemski zahtevi: Nisu navedeni. - Nasl. sa naslovne strane dokumenta. - Tiraž 200. - Preface / Ljubiša Balanović. - Bibliografija uz svaki rad.

ISBN 978-86-6305-140-9

a) Рударство -- Зборници b) Металургија -- Зборници

COBISS.SR-ID 126659849

---

Bor Lake, Serbia, October 18-21, 2023

Conference is financially supported by
The Ministry of Science, Technological
Development and Inovation
of the Republic of Serbia

# Platinum Donors

ZIJIN SERBIA ZIJIN MINING

ZIJIN SERBIA ZIJIN COPPER DOO

SEVOJNO VALJAONICA BAKRA COPPER MILL

# Gold Donors

HBIS GROUP HBIS SERBIA

Dundee PRECIOUS METALS AVALA

# Silver Donor

trokuttestgroup

# Exhibitions

Labtim

Altium

metalurg

MERIS

1969 ZAJEČAR FMT

REFRATEC

# Friends of the Conference

DONAU LAB BEOGRAD

DONCAFÉ

LOLA INSTITUT

THE FOUNDATION 'B.SC. ENG. BOŠKO INJAC'

## ***SCIENTIFIC COMMITTEE***

**Prof. Dr Dejan Tanikić** *(Serbia) - president*
**Prof. Dr Nada Štrbac** *(Serbia) - vice-president*
**Prof. Dr Radoje Pantović** *(Serbia) - vice-president*

**Dr Ana Kostov** *(Serbia)*
**Prof. Dr Adam Grajcar** *(Poland)*
**Prof. Dr Adina Negrea** *(Romania)*
**Dr Andrei Rotaru** *(Romania)*
**Prof. Dr Batrić Pešić** *(USA)*
**Dr Biserka Trumić** *(Serbia)*
**Prof. Dr Boštjan Markoli** *(Slovenia)*
**Dr Branislav Marković** *(Serbia)*
**Prof. Dr Cornelia Muntean** *(Romania)*
**Prof. Dr Daniela Grigorova** *(Bulgaria)*
**Prof. Dr Dejan Ivezić** *(Serbia)*
**Prof. Dr Desimir Marković** *(Serbia)*
**Prof. Dr Dimitris Panias** *(**Greece**)*
**Prof. Dr Dimitriu Sorin** *(Romania)*
**Prof. Dr Dmitry Vasilyev** *(Russia)*
**Dr Dragan Komljenović** *(Canada)*
**Prof. Dr Dragan Manasijević** *(Serbia)*
**Dr Dragan Milanović** *(Serbia)*
**Prof. Dr Dragan Milovanović** *(Serbia)*
**Prof. Dr Dragoslav Gusković** *(Serbia)*
**Prof. Dr Dušan Oráč** *(Slovakia)*
**Prof. Dr Duško Minić** *(Serbia)*
**Prof. Dr Endre Romhanji** *(Serbia)*
**Prof. Dr Essen Suleimenov** *(Kazakhstan)*
**Prof. Dr Farzet Bikić** *(Bosnia and Herzegovina)*
**Prof. Emeritus Fathi Habashi** *(Canada)*
**Prof. Dr Grozdanka Bogdanović** *(Serbia)*
**Prof. Dr György Kaptay** *(Hungary)*
**Prof. Dr Ivan Mihajlović** *(Serbia)*
**Prof. Dr Iveta Vaskova** *(Slovakia)*
**Prof. Dr Jakob Lamut** *(Slovenia)*
**Prof. Dr Jasmin Suljagić** *(Bosnia and Herzegovina)*
**Dr Jasmina Stevanović** *(Serbia)*
**Dr Jasna Stajić Trošić** *(Serbia)*
**Prof. Dr Jovica Sokolović** *(Serbia)*
**Prof. Dr Jožef Medved** *(Slovenia)*
**Prof. Dr Kaikun Wang** *(China)*
**Prof. Dr Karl Heinz Spitzer** *(Germany)*
**Prof. Emeritus Karlo Raić** *(Serbia)*
**Prof. Dr Kemal Delijić** *(Montenegro)*
**Prof. Dr Komnitsas Konstantinos** *(Greece)*
**Prof. Dr Kostas Matis** *(Greece)*
**Prof. Dr Krzysztof Fitzner** *(Poland)*
**Prof. Dr Luis Filipe Malheiros** *(Portugal)*
**Prof. Dr Milan Antonijevic** *(Serbia)*
**Prof. Dr Milan Trumić** *(Serbia)*
**Dr Mile Bugarin** *(Serbia)*
**Dr Milenko Ljubojev** *(Serbia)*
**Prof. Dr Milovan Vuković** *(Serbia)*
**Prof. Dr Mira Cocić** *(Serbia)*
**Mirjam Jan-Blažić** *(Slovenia)*
**Prof. Dr Mirjana Rajčić Vujasinović** *(Serbia)*
**Prof. Dr Mirko Gojić** *(*Croatia*)*
**Dr Miroslav Sokić** *(Serbia)*
**Prof. Dr Mirsada Oruč** *(Bosnia and Herzegovina)*
**Dr Nadežda Talijan** *(Serbia)*
**Prof. Dr Natalija Dolić** *(*Croatia*)*
**Prof. Dr Nedeljko Magdalinović** *(Serbia)*
**Prof. Dr Nenad Radović** *(Serbia)*
**Prof. Dr Nenad Vušović** *(Serbia)*
**Prof. Dr Nicanor Cimpoesu** *(Romania)*
**Prof. Dr Nobuyuki Masuda** *(*Japan*)*
**Prof. Dr Onuralp Yucel** *(*Turkey*)*
**Prof. Dr Pavel Broz** *(*Czech Republic*)*
**Prof. Dr Petr Solozhenkin** *(*Russia*)*
**Prof. Dr Petrica Vizureanu** *(Romania)*
**Dr Sun Zhongmei** *(**China**)*
**Prof. Dr Ridvan Yamanoglu** *(*Turkey*)*
**Prof. Dr Rodoljub Stanojlović** *(Serbia)*
**Prof. Dr Rositsa Paunova** *(**Bulgaria**)*
**Prof. Dr Sead Ćatić** *(Bosnia* and *Herzegovina)*
**Prof. Dr Sergey Krasikov** *(*Russia*)*
**Dr Slavomír Hredzák** *(*Slovakia*)*
**Prof. Dr Snežana Milić** *(Serbia)*
**Prof. Dr Snežana Šerbula** *(Serbia)*
**Prof. Dr Srba Mladenović** *(Serbia)*
**Dr Srećko Stopić** *(Germany)*
**Prof. Dr Stojan Groudev** *(Bulgaria)*
**Prof. Dr Sulejman Muhamedagić** *(Bosnia and Herzegovina)*
**Prof. Dr Svetlana Ivanov** *(Serbia)*
**Prof. Dr Tatjana Volkov-Husović** *(Serbia)*
**Prof. Dr Tomaš Havlik** *(Slovakia)*
**Prof. Dr Velimir Radmilović** *(Serbia)*
**Prof. Dr Velizar Stanković** *(Serbia)*
**Prof. Dr Vesna Grekulović** *(Serbia)*
**Dr Vladan Ćosović** *(Serbia)*
**Vladan Mihailović** *(Serbia)*
**Dr Vladan Kašić** *(Serbia)*
**Prof. Dr Vladimir Krstić** *(Canada)*
**Prof. Dr Vladislav Kecojević** *(USA)*
**Dr Walter Valery** *(Australia)*
**Prof. Dr Xuewei Lv** *(China)*
**Prof. Dr Yong Du** *(China)*
**Prof. Dr Žarko Radović** *(Montenegro)*
**Prof. Dr Zdenka Zovko Brodarac** *(Croatia)*
**Dr Zoran Stevanović** *(Serbia)*
**Prof. Dr Željko Kamberović** *(Serbia)*

## ***ORGANIZING COMMITTEE***

**Prof. dr Ljubiša Balanović, Full Professor** *(UB TF Bor) - president*
**Prof. dr Saša Stojadinović, Full Professor** *(UB TF Bor) - vice-president*
**Prof. dr Srba Mladenović, Full Professor** *(UB TF Bor) - vice-president*
**Dr Ana Kostov, Principal Research Fellow** *(MMI Bor) - vice-president*

**Prof. dr Nada Štrbac,** *Full Professor (UB TF Bor)*
**Prof. dr Dragan Manasijević,** *Full Professor (UB TF Bor)*
**Prof. dr Vesna Grekulović,** *Full Professor (UB TF Bor)*
**Prof. dr Đorđe Nikolić,** *Full Professor (UB TF Bor)*
**Prof. dr Milan Radovanović,** *Full Professor (UB TF Bor)*
**Prof. dr Marija Petrović Mihajlović**, *Full Professor (UB TF Bor)*
**Prof. dr Zoran Štirbanović,** *Associate Professor (UB TF Bor)*
**Prof. dr Milan Gorgievski,** *Associate Professor (UB TF Bor)*
**Prof. dr Saša Marjanović,** *Associate Professor (UB TF Bor)*
**Prof. dr Ivana Marković,** *Associate Professor (UB TF Bor)*
**Prof. dr Žaklina Tasić,** *Associate Professor (UB TF Bor)*
**Doc. dr Dejan Petrović,** *Assistant Professor (UB TF Bor)*
**Doc. dr Anđelka Stojanović**, *Assistant Professor (UB TF Bor)*
**Doc. dr Uroš Stamenković,** *Assistant Professor (UB TF Bor)*
**Dr Jasmina Petrović,** *Assistant with PhD (UB TF Bor)*
**Vladimir Nikolić,** *Assistant (UB TF Bor)*
**Milica Zdravković,** *Assistant (UB TF Bor)*
**Miljan Marković,** *Assistant (UB TF Bor)*
**Milijana Mitrović,** *Assistant (UB TF Bor)*
**Milan Nedeljković,** *Assistant (UB TF Bor)*
**Avram Kovačević,** *Teaching Assistant (UB TF Bor)*
**Sandra Vasković,** *English Lecturer (UB TF Bor)*
**Oliver Marković,** *IT service (UB TF Bor)*
**Violeta Aleksić,** *Liquidator (UB TF Bor)*

# PREFACE

On behalf of the Organizing Committee, it is a great honor and pleasure to welcome all esteemed participants of the 54th International October Conference on Mining and Metallurgy (IOC 2023), scheduled to take place at the picturesque Bor Lake, Serbia, from October18th to 21st 2023.

The collaborative efforts of the University of Belgrade, the Technical Faculty in Bor, and the Mining and Metallurgy Institute Bor have meticulously organized this year's IOC. Our focus remains unwavering on showcasing the latest research findings and advancements in geology, mining, metallurgy, materials science, technology, environmental protection, and other engineering disciplines. Our primary objective is to foster a dynamic environment where academics, researchers, and industry professionals can come together to share their knowledge, experiences, and innovative ideas while exploring opportunities for collaborative research endeavors.

Our conference agenda is rich and diverse, encompassing plenary sessions, engaging invited lectures, technical presentations, enlightening oral and poster sessions, informative technical tours, a diverse exhibition, and memorable social gatherings. At the heart of this event lies our strong commitment to sustainable development within the mining and metallurgy sector. We are dedicated to exploring ecologically conscious methodologies, responsible resource extraction practices, and cutting-edge technologies that reduce the industry's environmental impact and enhance the well-being of local communities.

The conference proceedings comprise 129 papers authored by individuals from universities, research institutes, and industries in 22 countries. We are proud to welcome participants from Bosnia and Herzegovina, Bulgaria, Canada, China, Croatia, Germany, Greece, India, Iran, Kazakhstan, Libya, North Macedonia, Montenegro, Morocco, Romania, Russia, Slovakia, South Africa, Spain, Turkey, United States, and, of course, Serbia.

We are excited to host the 8th International Student Conference on Technical Sciences (ISC 2023) as part of IOC 2023. This event offers students from Serbia and the wider region a unique chance to showcase their research and discuss the future of their fields with experts.

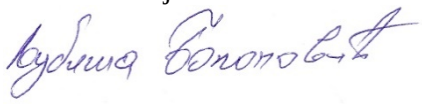
We sincerely thank the Ministry of Science, Technological Development, and Innovation of the Republic of Serbia for their generous financial support. In addition, we express our profound gratitude to all our sponsors, exhibitors, and friends of the Conference for their contributions and unwavering support for playing a pivotal role in ensuring the success of IOC 2023.

We would like to express our heartfelt thanks to all authors, committees, reviewers, speakers, and chairpersons for their invaluable contributions in shaping IOC 2023.

We look forward to welcoming you to the 55th International October Conference on Mining and Metallurgy (IOC 2024), which will be held in October 2024.

On behalf of the 54th IOC Organizing Committee,

Prof. dr Ljubiša Balanović



# TABLE OF CONTENTS

## Plenary Lectures



## Invited Lectures



## Conference Papers

```
```

# ATMOSPERIC BULK DEPOSITION AS ENVIRONMENTAL QUALITY INDICATOR

**Tanja Kalinović, Jelena Kalinović, Jelena Milosavljević, Ana Radojević, Snežana Šerbula**

University of Belgrade, Technical Faculty in Bor, V.J. 12, 19210 Bor, Serbia

**Abstract**

*Atmospheric bulk deposition (ABD) could be used as an environmental quality indicator, not only of the atmospheric but also of the soil and water resources. Contents of ABD, as well as Pb, Cd, As, and Ni in ABD were evaluated for a 10-year period (2013–2022), at four measuring sites in the urban-industrial, urban and industrial zones in the area of the City of Bor, which were under the influence of the polluting substances from the copper mining and smelting operations. The number of the measuring sites at which contents of ABD were above the Maximum Allowable Concentration (MAC) decreased over time, which was in accordance with the general decline of ABD contents, especially at the measuring sites Bolnica and Šumska sekcija. The measuring site Institut was the exception, due to the increasement of contents of the analysed polluting substances in the recent years. This could be the consequence of the wet and dry deposition of the dispersed particulates of the flotation copper concentrate, in the course of handling it and the vicinity of the road and railway transportation routes to the measuring site Institut. The implementation of the flesh smelting technology and continuous reconstructions of the copper smelter facilities have led to the general improvement of the annual air quality in the City of Bor concerning the contents of ABD and the analysed elements in ABD, but it seems that new nonstationary sources of the environmental pollution could change pollution trends in future years.*

***Keywords**: atmospheric bulk deposition, Pb, Cd, As, Ni*

## 1. INTRODUCTION

Atmospheric bulk deposition (ABD) represents air polluting substances which were deposited from the atmosphere to the earth's surface through three main mechanisms: wet, dry and occult deposition [1]. Dry deposition of air polluting substances occurs as a result of several processes, but mainly though sedimentation of particulate matter with diameter greater than 10 μm. Wet deposition occurs mainly as a result of inclusion or solution of air polluting substances in raindrops and snowfall [2,3]. Occult deposition manifests throught capturing the polluting substances by water droplets in the form of fog, mist, or by cloud interception [1]. Deposition of air pollutants plays a vital role in cleaning the air, but it also brings toxic elements to the receiving terrestrial and aquatic ecosystems. That is the way how deposited pollutants threaten human health through food chains, which is a key part of their biogeochemical cycles [4]. Heavy metals and metalloids in atmospheric bulk deposition are found to exhibit strong correlations with road proximity and traffic volume, as well as with significant effect of the copper smelter and many other anthropogenic sources of inorganic and organic air pollutants [5-9]. Taking this into account, it is possible to use those elements of the ABD as environmental quality indicators for quantification of the contribution of emissions to an area's environmental stress [10,11].

The aim of this study was to evaluate the contents of atmospheric bulk deposition and concentrations of Pb, Cd, As and Ni in ABD, at four measuring sites for the 10-year period (2013–2022), in the area of the City of Bor in which mining and smelting of copper sulphide ores have been performed for more than 100 years.

## 2. EXPERIMENTAL

The main anthropogenic source of the polluting substances, such as $SO_2$, and suspended particulate matter ($PM_{10}$) with high content of heavy metals and metalloids, in the study area was copper smelter of sulphide concentrates, as well as flotation tailing ponds located at the edge of the City of Bor and in the vicinity of several rural areas. The City of Bor represents the historical air pollution hotspot in South–Eastern Europe [12,13]. In order to improve production efficiency and environmental quality, the outdated technology of smelting sulphide concentrates was replaced with the flesh smelting technology which was in the status of running–in during 2015 [13]. The copper smelter operated at full capacity from the beginning of 2019, while the copper smelter did not operate from April 2022 to the end of 2022, due to the reconstruction. It should be noted that in the recent years a new copper mine and copper ore flotation plant were opened in the area about 5 km in the SSE direction from the City of Bor.

Monitoring of concentrations of air polluting substances in the City of Bor during the analysed period 2013–2022, was performed by the Mining and Metallurgy Institute Bor (MMI). The monthly and annual reports are available for public on the official web site of the City of Bor [14] as well as at the web site of the Serbian Environmental Protection Agency (SEPA) [15]. Contents of atmospheric bulk deposition and concentrations of elements in ABD were determined monthly (30±2 days). The obtained values were expressed as mg/m$^2$/day and μg/m$^2$/day, for the ABD contents as well concentrations of elements in ABD, respectively.

Contents of atmospheric bulk deposition and Pb, Cd, As and Ni in ABD were determined in the samples from four measuring sites, 3 of which were located in the City of Bor and one near the rural area of Oštrelj. The measuring sites Bolnica and Šumska sekcija were located in the urban-industrial zone, the site Institut in the urban zone, and the site Oštrelj in the industrial zone. The measuring sites were about 1 km (Bolnica and Šumska sekcija), 2 km (Institute) and 4.5 km (Oštrelj) from the copper smelter. The dominant winds in the study area by which the polluting substances were transported from the copper smelter to the measuring sites were: NE for the Bolnica, ENE for the Šumska sekcija, NNE for the Institut and WNW for the Oštrelj measuring site.

## 3. RESULTS AND DISCUSSION

The annual ABD contents at four measuring sites for the 10-years period are given in Figure 1. It should be noted that there were 7 months of measuring (June–December) at the measuring sites Bolnica and Oštrelj during 2015, as well as 11 months of measuring (January–October and December) at the measuring site Šumska sekcija during 2021. In Figure 1, red line represents the maximum allowed concentration (MAC) for ABD (200 mg/m$^2$/d), for the averaging period of one calendar year, according to the Regulation of the Republic of Serbia [16].

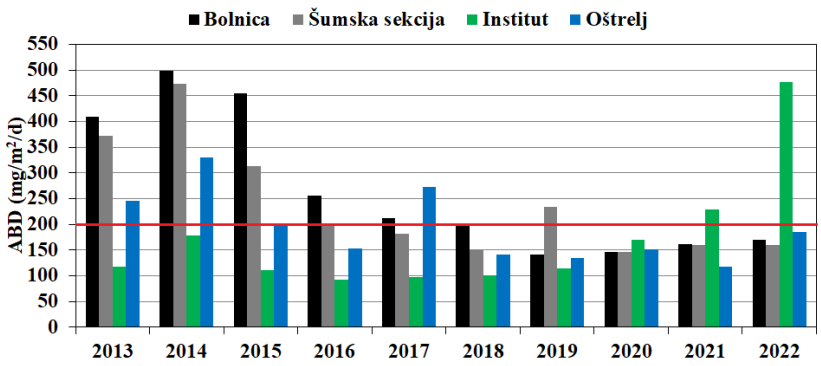



Figure 1 - Annual contents of ABD at four measuring sites during 10-year period

The exceedances of the MAC were noted at three measuring sites (Bolnica, Šumska sekcija, Oštrelj) during 2013 and 2014, at two measuring sites during 2015 and 2016 (Bolnica, Šumska sekcija) and 2017 (Bolnica, Oštrelj), as well as at one measuring site during: 2019 (Šumska sekcija), 2021 and 2022 (Institute). The contents of ABD at the measuring sites Oštrelj (2015) and Bolnica (2018) were below, but close to the MAC (199.3 mg/m$^2$/d and 199.5 mg/m$^2$/d, respectively). This trend indicated general improvement of the air quality in terms of ABD, from 2013 to 2022. The measuring site Bolnica was the most polluted with ABD during five years (in the period 2013–2016 and in 2018), followed by the measuring site Šumska sekcija (the most polluted during 2019). This could be the consequence of the close vicinity to the copper smelter, and the location of the mentioned measuring sites relative to the prevailing wind directions which bring the pollution from the pollution sources. The measuring site Oštrelj was the most polluted with ABD compared to the other measuring sites, during 2017. In the period 2020–2022, the measuring site Institute stood out with the highest pollution with ABD, compared to the other sites, with the noticed trend of increasing ABD contents from 2016 to 2022. The especially interesting data were for the 2022 when copper smelter was not working from April, due to the reconstruction. There has been more intensive mining and copper ore processing in the City of Bor and in the new copper mine and flotation plant, about 5 km from the City, in the recent years. The handling of the copper concentrate obtained in the flotation plant in the City of Bor and newly constructed flotation plant during transportation by railway and roads adjacent to the site Institut probably caused dispersion of very small particulates of copper concentrate, which reached the earth surface by wet and dry deposition. This probably was the main source of the polluting substances determined in the form of ABD at the measuring site Institute.

The average annual concentrations of Pb, Cd, As and Ni in ABD at four measuring sites (Bolnica, Šumska sekcija, Institut and Oštrelj), from 2013 to 2022 are given in Figure 2.

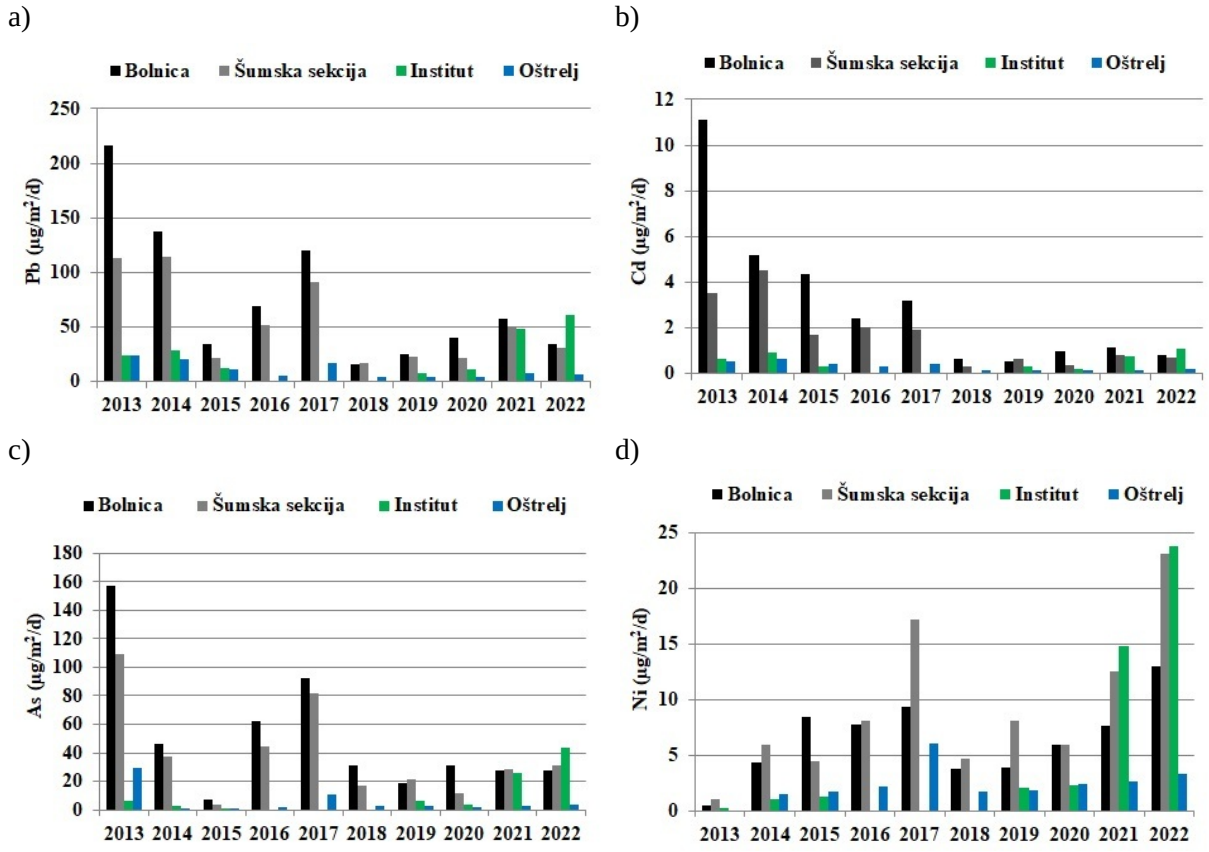



Figure 2 - Average annual contents of a) Pb, b) Cd, c) As and d) Ni in ABD at four measuring sites

The annual concentrations of the analysed elements followed the trend of the annual content of ABD. During the examined period, the measuring sites Bolnica and Šumska sekcija represented the most polluted locations. At the measuring site Bolnica, the concentrations of Pb and Cd were the highest during the examined period, except during 2018 and 2022, and except during 2019 and 2022, respectively. The concentration of As was the highest at the site Bolnica, except in 2019, 2021 and 2022. At the measuring site Šumska sekcija, the most pronounced pollution was with Ni during 6 years (2013, 2014, 2016, 2017, 2018, and 2019). Compared to the other sites, the Oštrelj site was less polluted with the analysed elements, except in 2018 when the highest concentration of Pb was observed. As in the case of ABD, at the measuring site Institute the concentrations of Pb, Cd, As and Ni were the highest in 2022 and the concentration of Ni in 2021.

## 4. CONCLUSION

The annual contents of atmospheric bulk deposition (ABD) as well as Pb, Cd As, and Ni in ABD, in the urban-industrial, urban and industrial zones which were under the influence of the polluting substances from the copper smelter and flotation tailing ponds, were analysed for 10-year period (2013–2022), in the City of Bor and the surroundings. The number of measuring sites with contents of ABD above the Maximum Allowable Concentration, decreased over the years, which is an indication that the change of copper smelting technology, and the reconstructions of the industrial facilities lead to the general improvement of the air quality in terms of ABD, from 2013 to 2022, in the study area. Contents of ABD and analysed elements increased throughout the years at the measuring site Institut, reaching the maximum during 2022, although the copper smelter did not operated from April, due to the reconstruction. Such trend could be linked to the nonstationary sources of the pollution, such as handling during transportation of the copper concentrate obtained in the flotation plants in the City of Bor and in the newly constructed flotation plant located about 5 km SSE from the City of Bor, by the railway and the roads adjacent to the measuring site Institute.

## ACKNOWLEDGEMENTS

*The authors are grateful to the Ministry of Education, Technological development and Innovation of the Republic of Serbia for financial support, within the funding of the scientific research at the University of Belgrade, Technical Faculty in Bor (No. 451-03-47/2023-01/200131). Our thanks go to English language teacher Mara Z. Manzalovic from the University of Belgrade, Technical Faculty in Bor, for providing language assistance.*

## REFERENCES

[1] F. Brugnone, W. D'Alessandro, F. Parello, *et al*., Atmosphere, 14 (737) (2023).
[2] M. Peretti, G. Piñeiro, M. E. Fernández Long, *et al.*, Atmos. Environ., 237 (2020) 117580.
[3] L. He, S. Wang, M. Liu, *et al*., The JHM Advances, 9 (2023) 100218.
[4] Y. Pan, J. Liu, L. Zhang, *et al*., Atmosphere, 12 (283) (2021).
[5] M. Tasić, Z. Mijić, S. Rajšić, *et al*., Journal of Physics: Conference Series 162 (2009) 012018.
[6] B. S. Davis and G. F. Birch., Water Air Soil Pollut., 214 (2011) 147-162.
[7] J. Hančuľák, T. Špaldon, O. Šestinová, Journal of the Polish Mineral Engineering Society, 1 (43) (2019) 1-8.
[8] M. Berti, A. Berton, S. Bertini, *et al*., EQA, 44 (2021) 18-25.
[9] D. Feng, P. Gong, Y. Li, *et al*., Heliyon, 9 (2023) e18858.
[10] I. Hůnová, P. Kurfürst, M. Schreiberová, *et al*., Atmosphere, 14 (2023) 19
[11] H. Wang, J. Wu, Z. Tian, Air Qual. Atmos. Health, 16 (2023) 1479-14872023.

[12] S. M. Serbula, J. S. Milosavljevic, A. A. Radojevic, *et al*., Sci. Total Environ., 586 (2017) 1066-1075
[13] S. M. Serbula, J. S. Milosavljevic, J. V. Kalinovic, *et al*., Sci. Total Environ., 777 (2021) 145981.
[14] MMI, 2014-2023. Mining and Metallurgy Institute Bor, Annual Reports about Quality of Ambient Air in Bor for 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022 and 2023. Sector for Measuring and Control of Gaseous and Dust Parametres. Department Chemical–Technical Control, Bor, Serbia (in Serbian). (https://bor.rs/ekologija/).
[15] SEPA, 2016, 2017, 2018. Serbian environmental Protection Agency, Ministry of Environmental Protection, Republic of Serbia, Annual report on the state of air quality in the Republic of Serbia for 2016, 2017 and 2018 (in Serbian).
http://www.sepa.gov.rs/index.php?menu=5000&id=1304&akcija=showDocuments&tema=Vazduh&godina&godina=2016
[16] Official Gazette of Republic of Serbia, 2013. Regulation on the conditions for monitoring and requirements of the air quality. No 11/10, 75/10, 63/13 (in Serbian).

ISBN-978-86-6305-140-9

IOC M&M 2023

IOC M&M 2023

Proceedings IOC M&M 2023

УНИВЕРЗИТЕТ У БЕОГРАДУ
ТЕХНИЧКИ ФАКУЛТЕТ У БОРУ
1961

INSTITUT