

Advances in Science, Technology & Innovation
IEREK Interdisciplinary Series for Sustainable Development

Attila Çiner · Md Firoz Khan · Amjad Kallel ·
Jesús Rodrigo-Comino · Mario Parise · Rahim Barzegar ·
Zeynal Abiddin Ergüler · Nabil Khelifi · Imran Ali *Editors*

Recent Research on Environmental Earth Sciences, Geomorphology, Soil Science, Paleoclimate, and Karst

Proceedings of the 1st MedGU, Istanbul 2021
(Volume 4)

Advances in Science, Technology & Innovation

IEREK Interdisciplinary Series for Sustainable Development

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ASTI series has now been accepted for Scopus (September 2020). All content published in this series will start appearing on the Scopus site in early 2021.

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Editors

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Editors

Attila Çiner
Eurasia Institute of Earth Sciences
Istanbul Technical University
Istanbul, Türkiye

Amjad Kallel
Sfax National School of Engineering
University of Sfax
SFax, Tunisia

Mario Parise
University Aldo Moro
Bari, Italy

Zeynal Abiddin Ergüler
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Kütahya, Türkiye

Imran Ali
Jamia Millia Islamia University
New Delhi, India

Md Firoz Khan
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Dhaka, Bangladesh

Jesús Rodrigo-Comino
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Granada, Spain

Rahim Barzegar
Groundwater Research Group (GRES)
Research Institute on Mines and Environment
(RIME)
Université du Québec
en Abitibi-Témiscamingue (UQAT)
Amos, QC, Canada

Nabil Khelifi
DAAD Alumni Researcher
Heidelberg, Germany

ISSN 2522-8714 ISSN 2522-8722 (electronic)
Advances in Science, Technology & Innovation
ISBN 978-3-031-42916-3 ISBN 978-3-031-42917-0 (eBook)
IEREK Interdisciplinary Series for Sustainable Development
<https://doi.org/10.1007/978-3-031-42917-0>

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This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

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About MedGU



Steps toward the creation of a Mediterranean Geosciences Union (MedGU)

Mediterranean Geosciences Union (MedGU) aims to create a unique federation that brings together and represents the Mediterranean geoscience community specializing in the areas of Earth, planetary, and space sciences.

MedGU will be structured along the lines of American Geophysical Union (AGU) and European Geosciences Union (EGU).

The plan is to establish a large organization for the Mediterranean region that is more influential than any one local geoscience society with the objective of fostering fundamental geoscience research, as well as applied research that addresses key societal and environmental challenges.

MedGU's overarching vision is to contribute to the realization of a sustainable future for humanity and for the planet.

The creation of this union will give the Earth sciences more influence in policy-making and in the implementation of solutions to preserve the natural environment and to create more sustainable societies for the people living in the Mediterranean region. It is hoped that the union will also provide opportunities to Mediterranean geoscientists to undertake interdisciplinary collaborative research. MedGU plans to recognize the work of the most active geoscientists with a number of awards and medals.

Although MedGU has not yet been officially inaugurated, its first annual meeting is planned for November 2021 in Istanbul. This will provide a forum to achieve a consensus for the formation of this non-profit international union of geoscientists. Membership will be open to individuals who have a professional engagement with the Earth, planetary, and space sciences, and related studies, including students and retired seniors.

Nabil Khélifi and Attila Çiner have taken an ambitious approach to the launch of the first MedGU Annual Meeting 2021 and hope to develop it in the near future into the largest international geoscience event in the Mediterranean and the broader MENA region. Its mission is to support geoscientists based in this region by establishing a Global Geoscience Congress.

It is expected that hundreds of participants from all over the world will attend this first MedGU Annual Meeting 2021, making it one of the largest and most prominent geosciences events in the region. So far, over 1300 abstracts have been submitted from 95 countries. The meeting's sessions will cover a wide range of topics with more details available on the Conference Tracks.

This first 2021 Annual Meeting will have a "hybrid" format, with both in-person and virtual participation. Springer, its official partner, will publish the proceedings in a book series (indexed in Scopus) as well as a number of special issues in diverse scientific journals (for more details, see Publications). The official journal of MedGU is Mediterranean Geoscience Reviews (Springer).

Conference Tracks

The scientific committee of the MedGU invites research papers on all cross-cutting themes of Earth sciences, with the main focus on the following 16 conference tracks:

- Track 1. Atmospheric Sciences, Meteorology, Climatology, Oceanography
- Track 2. Biogeochemistry, Geobiology, Geoecology, Geoagronomy
- Track 3. Earthquake Seismology and Geodesy
- Track 4. Environmental Earth Sciences
- Track 5. Applied and Theoretical Geophysics
- Track 6. Geo-Informatics and Remote Sensing
- Track 7. Geochemistry, Mineralogy, Petrology, Volcanology
- Track 8. Geological Engineering, Geotechnical Engineering
- Track 9. Geomorphology, Geography, Soil Science, Glaciology, Geoarcheology, Geoheritage
- Track 10. Hydrology, Hydrogeology, Hydrochemistry
- Track 11. Marine Geosciences, Historical Geology, Paleoceanography, Paleoclimatology
- Track 12. Numerical and Analytical Methods in Mining Sciences and Geomechanics
- Track 13. Petroleum and Energy Engineering, Petroleum Geochemistry
- Track 14. Sedimentology, Stratigraphy, Paleontology, Geochronology
- Track 15. Structural Geology, Tectonics and Geodynamics, Petroleum Geology
- Track 16. Caves and Karst, a special session on the occasion of International Year of Caves and Karst

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Preface

This proceedings volume is based on 57 papers accepted and presented during the 1st Mediterranean Geosciences Union (MedGU-21) Conference organized in Istanbul, Turkey, in 2021 under the auspices of Springer Nature. Although more than half of the contributions come from the Mediterranean region, many other countries around the globe also actively participated in developing this volume. In detail, almost half of this volume's papers (29) are related to the Environmental Earth Sciences. In the second part, a total of 19 articles contain works from Geomorphology, Soil Science, Landslides, Paleoclimate, Geoarcheology, and Geoheritage.

Last but not the least, the third part includes nine papers dealing with karst research. These were submitted to the special session on the occasion of the International Year of Caves and Karst (IYCK), declared for 2021 by the International Union of Speleology (UIS) under the auspices of UNESCO. Following the main goals of IYCK, the focus was on all spheres related to the fragile karst environment, especially regarding important issues such as the protection of caves and their natural resources and sustainability.

The book is relevant to all researchers and students on the topics mentioned above, presenting an updated view on field studies, laboratory analyses, and modeling in earth sciences.

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Attila Çiner
Md Firoz Khan
Amjad Kallel
Jesús Rodrigo-Comino
Mario Parise
Rahim Barzegar
Zeynal Abiddin Ergüler
Nabil Khelifi
Imran Ali

Contents

Environmental Earth Sciences

Evaluation of the Radiation Doses and Excess Lifetime Cancer Risks Due to Natural Radioactivity in Drinking Groundwater in the United Arab Emirates. . . .	3
Rahaf Ajaj, Samar El-Sayed, and Mohammed A. Salem Al Yafei	
Indicators of Complex Urban Geochemical Transformation in Russian Metropolises.	7
A. Ryanskaya, A. Seleznev, I. Yarmoshenko, and G. Malinovsky	
Study of Zn Pollution of a Large City Based on Analysis of Stable Zinc Isotope Ratios in Urban Surface-Deposited Sediments	11
Tatiana Okuneva, Andrian Seleznev, Darya Kiseleva, and Natalia Soloshenko	
Lead Fluxes in Suspended Particulate Matter from a Tropical Estuary to the Atlantic Ocean	15
Lyndyanne Dias Martins, Vinícius Pereira Bacurau, Jorge Marcell Coelho Menezes, Francisca Denise Pereira Almeida, Rômulo De Araujo Soares, Francisco José Da Silva Dias, Kassandra Kelen Borges, Felipe Dos Santos Gonçalves, Willian Avelino Lopes, Raimundo Nonato Pereira Teixeira, and Francisco José De Paula Filho	
Geochemical Transformation of Water Bodies in an Urban Environment Under Contemporary Surface Sedimentation in the Catchment.	19
Andrian Seleznev, Tatiana Okuneva, Iliia Yarmoshenko, and Georgy Malinovsky	
Liquid Digester from Urban Wastewater Treatment Plants for <i>Chlorella vulgaris</i>' Growth and Nutrient Recirculation	23
Gassan Hodaifa and Amani Belaiba	
Wastewater Treatment in the Skikda District: Current Situation and Interactions of the New Treatment Plant Project.	29
Nabil Bougherira, Dounia Nechem, Hicham Chaffai, Sara Badach, Mohammed Bendjerad, Azzedine Hani, and Larbi Djabri	
Lead Removal from Water Solutions Using Alginate-Immobilized Peach Stone Particles	33
Zorica Lopičić, Jelena Milojković, Tatjana Šoštarić, Anja Antanasković, Marija Koprivica, Vladimir Adamović, and Linda Mitić	
Characterization of Natural and Modified Clay Used for a Filtration System Aiming at the Removal of Contaminants from Surface Water.	37
Laura Scrano, Mauro Pallara, Roberto Buccioni, Giovanni Mongelli, Sabino Aurelio Bufo, and Rocco Laviano	

Heavy Metal Pollution in the Core Sediment of Strait of Malacca	41
Wan Nur Izwani Mior Baharudin, Lavannia Ravikumar, Vishalini B. Maran, Dorinda Anthony Anthony Dass, Nur Aliah Syakirah Rosli, Najah Karimah Mustaffa, Noor Fazreen Dzulkafli, and Meng-Chuan Ong	
Removal of Pb(II), Cu(II), and Cd(II) from Aqueous Solution by Alginate-Immobilized Aquatic Weed <i>M. spicatum</i>	47
Jelena Milojković, Zorica Lopičić, Marija Mihajlović, Milan Kragović, Biljana Gligorijević, Tatjana Vojvodić, and Jelena Avdalović	
Physico-chemical and Geotechnical Properties of Moroccan Phosphate Mining By-Products for the Application of Compacted Earth Bricks	51
M. Dadda, L. Saadi, K. Abdelouhadi, Y. Daafi, and M. Waqif	
Transport Process of Microplastics from Terrestrial to Aquatic Environment: Evaluation of the Current Knowledge	55
Hande Mahide Okutan, Philippe Le Coustumer, Bedri Kurtuluş, and Moumtaz Razack	
Quantification and Identification of Marine Litter on Five Beaches of the North-Central Algerian Coast	59
Yousra Ghezali, Boualem Hamdi, Shernai Safia, and Setiti Skander	
Determination of Critical Self-Ignition Temperature of Tropical Peat Land: A Case Study from Indonesia	63
Krison V. Manulu, Ferian Anggara, Kyuro Sasaki, and S.S.Rita Susilawati	
Impact of Lockdown on Air Pollutant Variation in Metropolitan Cities	67
Pallavi Pradeep Khobragade and Ajay Vikram Ahirwar	
Evaluation of Background Concentrations of Tropospheric Ozone Using Dynamic Phase Portrait Methodology	71
Aleksandr Khaustov and Margarita Redina	
Contribution of Google Earth and Images from the Sentinel-2 Satellite to the Monitoring of the Silting of Cap Djinet Harbor (Algeria)	75
Nour el islam Bachari, Hocine Dahmani, Nacef Lamri, Mohamed Mazouzi, Bilel Bensari, and Fouzia Houma	
Bio-based Materials: Composite and Paper Productions from Tunisian <i>Opuntia Ficus-Indica</i> (Cactaceae) Feedstock	79
Faten Mannai and Younes Moussaoui	
Sediment Type and Their Relation to the Presence of Seagrass <i>Posidonia oceanica</i> in the Mediterranean Lagoon	83
Karim Ben Mustapha, Abderraouf Hzami, Oula Amrouni, Aya Hammami, Chrystelle Montigny, Gil Mahé, and Hechmi Missaoui	
Planning Ecological Corridors to Integrate into a Regional Green Infrastructure	89
Rocío Losada-Iglesias, Andrés M. García, and David Miranda	
Toxicological Evaluation of Intermediate Products of Tetracycline Photocatalytic Treatment Using Brine Shrimp (<i>Artemia salina</i>) Model System	93
Nassima Belhouchet, Boualem Hamdi, Omar Bouras, Leila Korichi, Ouahiba Lazzouni, and Haroun Chenchouni	

GUIDE–Cell De-clustering Application: A Case Study on Groundwater Arsenic Contamination	97
Gunes Ertunc	
Forecasting of Water Level Fluctuations with Periodic Fuzzy Logic Models for Two Shallow Eastern Mediterranean Lakes	101
Özlem Yağbasan and Vahdettin Demir	
Simulation and Evaluation of Thermal Interference Between Ground Source Heat Pumps (GWHP) in Kutahya Residential Area (Western Anatolia, Turkey)	107
Ali Samet Ongen and Zeynal Abiddin Erguler	
Sensitive Space Changes Analytical Model: An Application in Prieto Diaz, Sorsogon, Philippines	111
Ana Marie R. Abante	
A Turbulent Hybrid Model to Simulate a Partially Pressurized Flow	115
Wahiba Mokrane	
Critical Evaluation of Methods for Calculating the Carbon Footprint: The Experience of RUDN University	119
Aleksandr Khaustov, Margarita Redina, and Zhandos Kenzhin	
Wildfire Spreading Capacities of Vegetated Surfaces Within the Metropolitan Region of Northwestern Türkiye	123
Artan Hysa and Aqil Tariq	
Geomorphology, Landslides, Soil Science, Paleoclimate, Geoarchaeology	
Features of the Elenina Bank (Sea of Azov)	129
Viacheslav Krylenko and Marina Krylenko	
Morphodynamic Approach of a Beach in Sedimentary Stability: Case of Beninese Coast from Djondji to Fidjrosse	133
Moussa Bio Djara, Raoul Adéniyi Laibi, Christophe Kaki, Tinonkiyè Sylvestre Yantikoua, Mamadou Sadio, Amadou Tahirou Diaw, and Lucien Marc Oyédé	
Evolution of the Tuzla Spit from Natural Geosystem to Natural-Technogenic One	143
Marina Krylenko and Viacheslav Krylenko	
Relative Sea-Level Changes in the Central Aegean from the Late Roman/Early Byzantine Period Onwards	147
Eleni Kolaiti, Nilhan Kızıldağ, Harun Özdaş, and Nikos Mourtzas	
Estimation of Glacial Lake Dynamics in the Sikkim Himalayas by the Inferential Statistical Techniques	151
Deepali Gaikwad, Supratim Guha, and Reet Kamal Tiwari	
Morphostructure of Landslides: Characterization Through Electrical Resistivity Tomography (ERT)	155
Javiera Fuenzalida, Pierre-Yves Descote, Gustavo Gatica, Luis F. Robledo, Diego Villalobos, Sergio Carvajal, Xaviera Palma, Cristóbal Ramírez, Ivo Fustos, Mauricio Calderon, Wen Nie, and Wei Xie	

Landslide Susceptibility Analysis Using 3D Modeling: A Case Study in San José de Maipo, Chile (33°38'S)	159
Diego Villalobos, Pierre-Yves Descote, Cristóbal Ramírez, Mauricio Calderon, Luis F. Robledo, Gustavo Gatica, Javiera Fuenzalida, Sergio Carvajal, Xaviera Palma, David Ruete, Wen Nie, and Wenbin Jian	
The Red-Colored Weathering Crusts of the Lagonaki Highland (Adygea Republic, Russia)	163
Anna Revunova and Olga Khokhlova	
Impact of Secondary Salinization in Alluvial Soils on Organic Carbon Stock: A Case of the Lower Medjerda Valley in Northern Tunisia	167
Nadhem Brahim, Hatem Ibrahim, Jamel Jaouadi, and Roland Bol	
Salinity Load and Ion Transport in Clay Soils: A Case Study in a Salt Production Area, Sakon Nakhon Province, Thailand	171
Sarunya Promkotra, Thidarat Cotanont, Pitchaporn Intamol, and Tawiwat Kangsadan	
A Case Study to Present Test Results and a Possible Framework for the Determination of the Anisotropy of Tropical Residual Soils in Mauritius	175
Reshma Rughooputh and Adityam Koomar	
Peat-Forest Fire Impact on the Soil Quality: Assessing the Chemodiversity of Organic Matter Extracted from Tropical Malaysian Peat Swamp Forest Soil	179
Noor Fazreen Dzulkafli, Norakma Mohd Nor, Norazlina Idris, Nurhafizah Ibrahim, Ainilhawa Sazali, and Noor Hidayah Pungot	
Classification Tests and Sensitivity Analysis of a Residual Tropical Soil	183
Reshma Rughooputh and Vedna Devi Gopal	
Controlling Sand and Dust Storms Hot Spots in the Mesopotamian Flood Plain	187
Ali Al Dousari, Mohamad Al Rawi, Peter Petrov, Modi Ahmed, Noor Al Dousari, Abeer Al Saleh, and Teena William	
Nutrient Dynamics in a Tropical Estuary Under a Semiarid Climate	191
Maria Aparecida Pereira Santos, Ana Celia Maia Meireles, Lyndyanne Dias Martins, Francisca Denise Pereira Almeida, Vinícius Pereira Bacurau, Willian Avelino Lopes, Felipe Dos Santos Gonçalves, Jorge Marcell Coelho Menezes, Francisco José Da Silva Dias, and Francisco José De Paula Filho	
A Model for Quantitative Recovery of Paleoclimate Evolution Using Pollen Assemblage: A Case Study of the Fourth Member of the Shahejie Formation in the Chezheng Depression	195
Tao Chen and Jinliang Zhang	
Meghalayan Climate and Environment Changes Inferred from Geochemical, Paleontological, and Sedimentological Proxies of Lagoonal Sediment Sequences of the Thapsus Coast (Eastern Tunisia)	199
Mohamed Kamoun, Martin R. Langer, Chahira Zaibi, Mohamed Ben Youssef, Amjad Kallel, and Fekri Kamoun	

Palaeoclimate and Dietary Niche of Family Cervidae from the Siwaliks (Pakistan): Does Coeval Occurrence of Species Leads to Niche Partitioning?	205
Muhammad Tahir Waseem, Abdul Majid Khan, Jay Quade, Abdul Ghaffar, and Ghulam Sarwar	
Lasergrammetry and Photogrammetry for a Survey and 3D Representation of Caves and Its Interest in the Development of Loco-Regional Geo-Tourism: Case of Kef El Baroud Cave, Province of Benslimane, Morocco	209
Hicham Benani, Lalla Amina Ouzaouit, Larbi Boudad, Sofia Hakdaoui, Ayoub Nehili, and Najib Bahi	
Caves and Karst, a Special Session on the Occasion of the International Year of Caves and Karst (2021)	
Karst Aquifers, a Strategic Tool for Mitigating the Impact of 100-Years Droughts.	217
Bernard Collignon and Fouzia Bensaoula	
Springs and Deep Water Wells in Karst: Which is Preferred More Than the Other?	221
Kamal Taheri, Petar Milanovic, and Chris Groves	
Hawraman Summer Camps: The Last Legacy of Water Scarcity Adaptation in the Western Zagros Karst Territory	227
Aziz Mostafaei, Kamal Taheri, Mario Parise, Sayed Mukhtar Hashemi, and Pouria Khaledi	
Human-Karst Landscape Interactions and the Anthro-Karstosphere: Toward a Nexus of Geoethics, Groundwater, and a Sustainable Society.	231
Kamal Taheri and Chris Groves	
Present-Day Rates of Processes in NW Dinaric Karst.	237
Mitja Prelovšek	
Morphological and Hydrogeological Features of Sinkholes in Coastal Settings.	243
Isabella Serena Liso, Stefano Margiotta, and Mario Parise	
Geophysical Investigation of Recently Formed Collapse in Latvia	247
Pēteris Džeriņš, Jānis Karušs, and Jurijs Ješkins	
Karst Phenomenon in Gypsum and Interference with Quarry Activity: Examples from Monferrato Area (NW Italy).	251
Chiara Caselle and Sabrina Maria Rita Bonetto	
Impact of Geological Fracturing on the Development of Karst Networks in the Western Region of the City of Jijel—Northeastern Algeria	255
Mustapha Tekkouk, Riad Benzaid, and Chahra Yellas	

About the Editors



Attila Çiner is a Sedimentology and Quaternary Geology Professor at the Eurasia Institute of Earth Sciences at Istanbul Technical University, Turkey. After graduating from the Middle East Technical University in Ankara (1985), he obtained his M.Sc. degree at the University of Toledo, USA (1988), and his Ph.D. at the University of Strasbourg, France (1992). He works on the tectono-sedimentary evolution of basins and Quaternary depositional systems such as moraines, fluvial terraces, alluvial fans, and deltas. He uses cosmogenic nuclides to date these deposits. He primarily focuses on the glacial deposits and landscapes and tries to understand paleoclimatic and paleoenvironmental changes since the Last Glacial Maximum. Lastly, he was part of the Turkish Antarctic Expedition. He spent two months working on the site recognition and decision of the future Turkish scientific research station to be implemented on the continent. He is Editor-in-Chief of *Mediterranean Geoscience Reviews* and Chief editor of *Arabian Journal of Geosciences*, both published by Springer. He has published more than 100 peer-reviewed articles and book chapters.



Dr. Md Firoz Khan is an Associate Professor at the Department of Environmental Science and Management, North South University, since 2022 and a Leader of the AEROSOL LAB (pollutAnts-hEalth inteRactiOn eStimatiOn Lab). Before that, he taught Environmental Science and Geoinformatics for eight years in multiple countries, including Malaysia and China. His fields of expertise include but are not limited to air pollution/causes and effects, atmospheric chemistry, environmental chemistry, air pollution modeling, environmental toxicology, etc. He received his education in Japan (Ph.D.), the UK (M.Sc.), and Bangladesh (B.Sc.). He is an author or co-author of >110 peer-reviewed research articles published in many top-tiering journals. He engages with >20 research grants as a PI or CoPI received from national and international funding bodies in environmental research. Dr. Firoz is a lead lecturer and developer of a micro-credential online course titled “Chemometrics in Air Pollution” under the Future Learn Website. He evaluates research grants from the SWISS National Science Foundation (SNSF) and the Qatar National Research Fund (QNRF). Under his supervision (main and co-supervision), around 30 research students have received undergrad, postgrad, and Ph.D. degrees in air

pollution-health interaction. With immense experience in air pollution research, Dr. Firoz plays a vital role as an Associate Editor in several journals, i.e., *Observation and Modeling of Air Pollution* (a special issue of Sustainability, MDPI, Impact Factor: 3.889); *Elementa: Science of the Anthropocene* (Impact Factor 6.053, California University Press); *Frontiers in Environmental Engineering—Air Pollution Management* and *Arabian Journal of Geosciences* (Springer, Impact Factor: 1.827); and also serves as an expert member to Atmospheric Environmental Remote Sensing Society (AERSS) (Working Group-8: Air Quality, Climate, and Health).



Dr. Amjad Kallel is currently an Associate Professor of Environmental Geology in the Sfax National School of Engineers at the University of Sfax, Tunisia. He holds a B.Eng. in Georesources and Environment (1998) from the University of Sfax (Tunisia) and an M.Sc. degree and a Ph.D. degree in Georesources and Environment (2004) from Hokkaido University (Japan). He joined Venture Business Laboratory (VBL) at Akita University, Japan (2005–2006), as a researcher focusing on refining and recycling technologies for the recovery of rare elements from natural and secondary sources. On his return to Tunisia, he worked at the University of Gabes from 2006 to 2011, where he contributed to the elaboration of teaching programs at the Higher Institute of Water Sciences and Technologies of Gabes. Since 2011, he has joined the Sfax National School of Engineers. There, he has also been involved in various research projects related to Environmental Geology and Environmental Geotechnics. Dr. Kallel has co-organized many prestigious workshops, seminars, and international conferences. In 2016, Dr. Kallel joined the *Arabian Journal of Geosciences* (Springer) and the *Euro-Mediterranean Journal for Environmental Integration* (Springer) as Chief Editor and Managing Editor, respectively.



Jesús Rodrigo-Comino a graduate in Geography, currently works as an Assistant Professor at the University of Granada and was included for the second time in the World's Top 2% Scientists ranking by Stanford University. He got a Master in Territorial Planning and Geographic Information Systems (2013) at the University of Málaga/Granada, whose final work was divided into three national publications and a monograph. During his predoc stage, he obtained three scholarships for doctoral studies: DAAD (German Academic Exchange Service), La Caixa Foundation, and FPU (Ministry of Education, Spain). During this period, he completed his first doctoral thesis in Geography between the University of Trier (Germany—2 years) and Malaga (2 years) in 2018: “Actual Geomorphological Processes in Sloping Vineyards. A Comparison Between Ruwer-Mosel Valley (Trier, Germany) and Montes de Málaga (Málaga, Spain)”. In 2023, he defended his second doctorate in engineering in Geomatics and Topography at the Polytechnic University of Valencia. His research career consists of four complete monographs (Nova, Springer, etc.) and some edited books (Elsevier, CRC, Nova),

>200 indexed publications in Scopus and WoS, leading international collaborations with research teams over the world. He is a regular reviewer in more than 150 indexed international journals, a member of two doctoral theses committees, and an evaluator of projects for the Ministries of Science of Chile, Peru, the United States, Serbia, Switzerland, Kazakhstan or Poland, and postgraduate scholarships for DAAD. He has organized several international scientific meetings and congresses (for example COST Actions, Biohydrology, and Fire in the Earth), sessions at international conferences (EGU, TerraEnvision, Conference of the Arabian Journal of Geosciences, etc.), oral presentations, and conference master classes (Germany, Bulgaria, Norway, Algeria, etc.). He is Editor-in-chief of the indexed journal (Scopus and ESCI; Q2) *Air Soil and Water Research* (SAGE) and *Euro-Mediterranean Journal for Environmental Integration* (Springer). In addition, he was Associate Editor at *Scientific Reports* (Nature) and *Hydrological Science Journal* (Taylor & Francis) and continues in the *Arabian Journal of Geosciences* (Springer), and *Journal of Mountain Science* (Springer). He has participated as a researcher in R+D+I projects on social issues related to housing or the census, or transfer and knowledge at a European level, such as the INTERREG Smart-Light HUB project (light pollution) or COST FIRElinks (fires). He has been invited to give lectures on agriculture, sustainable management, and erosion. He has supervised five final degree projects and three master's degrees. He has taught regulated and certified teaching at the Universities of Granada, Valencia, Málaga, León, Oviedo, Trier (in German), Quito (Ecuador), and La Habana (Cuba) on geopolitics, geomorphology, Geographic Information Systems, remote sensing, and statistical techniques. He managed some international (FIRElinks COST Action), national (BBVA Foundation), and regional projects and supervised two Ph.D. theses.



Mario Parise Graduated with honors in Geology at the Faculty of Sciences of the University Federico II, Naples, Italy. Since 1990, he has developed research mainly into the geological and geomorphological analysis of slope movements, namely with the identification of the areas susceptible to different types of slope movement (from debris flows, to deep-seated gravitational slope deformations, to general mass wasting processes) by means of stereoscopic interpretations of aerial photographs and field surveys. Particular focus is given to multi-temporal analysis, aimed at understanding the likely evolution of slopes, even in relationship with anthropogenic activities, and/or as a consequence of specific triggering events (rainfall, earthquakes, etc.). For several sites in southern Italy, he has outlined a framework of the influence of weathering in the predisposition of slope movements. He has also contributed to the analysis of rapid landslides (debris avalanches, rock avalanches) in different geological settings in Italy and abroad, and to studying the occurrence of debris flows and erosional processes in areas recently affected by wildfires. He has

studied various landslides in Italy and the USA, and within this research activity he has developed an expertise in the recognition and investigation of slope failures, production of thematic maps, and also collaborating in the interpretation of monitoring data and in slope stability analyses. In addition, since 2002 he is working in the field of karst research, focusing on the evaluation of the natural and anthropogenic hazards occurring in karst territories, with particular regard to sinkholes and to underground instability and failures. This research is carried out also thanks to the caving activity in which he is active since 1998. He is the author of over one hundred papers published on international journals and proceedings of international conferences. He has given several presentations in international symposium and workshops. He has acted as Guest Editor in 10 special issues for ISI international journals, and has published three books with the Geological Society of London. He is a Member of the Editorial Board of *Natural Hazards and Earth System Sciences*, *Journal of Mountain Sciences*, *Carbonates and Evaporites*, *Natural Hazards*, *Bulletin of Engineering Geology and the Environment*, *Opera Ipoega*, and *Journal of Cave and Karst Studies*.



Dr. Rahim Barzegar is a Postdoctoral Fellow in the Department of Bioresource Engineering at McGill University in Canada. Before joining McGill in 2019, he obtained a Ph.D. and M.Sc. in Hydrogeology and a B.Sc. in Geology from the University of Tabriz, Iran. He has worked as a postdoctoral researcher in joint projects at the University of Tabriz in Iran and Wilfrid Laurier University in Canada. His main research focuses on the exploration of new methods in machine learning- and deep learning-based hydrological modeling. His other research activities also revolve around time series analysis, water quality assessment, water resources management, and climate change impacts on water resources. Dr. Barzegar also acts as an Associate Editor for the *Arabian Journal of Geosciences* (Springer publication), *Earth Science Informatics Journal* (Springer publication), *Communications Earth and Environment* (Nature publication), and Topic Editor for *Water Journal* (MDPI).



Prof. Dr. Zeynal Abiddin Ergüler is a Full Professor at the Geological Engineering department at Kutahya Dumlupinar University (Turkey). Dr. Erguler holds a B.Sc. (1998), an M.Sc. (2001), and a Ph.D. degree (2007) in Geological Engineering from Hacettepe University (Turkey). His research interests mainly focus on rock mechanics, engineering geology, environmental geology, and soil mechanics. His current investigation is to understand and model the thermo-hydro-mechanical behavior of shale rocks in the area of shale gas production. In addition to performing many types of research and industry-funded projects, he has also taught and supervised undergraduate and graduate students. In 2017, Dr. Erguler joined the *Arabian Journal of Geosciences* (AJGS) as an Editor responsible for evaluating submissions in the fields of rock mechanics, engineering geology, environmental geology, and soil mechanics.



Nabil Khelifi undertook fellowships at the System for Analysis, Research and Training (START) in 2005 and the German Academic Exchange Service (DAAD), as part of my Ph.D. studies in Marine Geosciences at the University of Kiel in Germany (2006–2010). After my Ph.D., I received a research grant from the German Science Foundation (DFG) to conduct research projects at the GEOMAR Ocean Research Centre in Kiel on oceanography and climate reconstructions in the North Atlantic and the Mediterranean (2010–2013). My research findings have been presented at international conferences and published in esteemed journals. From 2009 to 2013, I co-organized with my Kiel colleagues two workshops on the Pliocene climate at the University of Bordeaux, France (2009), and the University of Bristol, UK (2013), funded by the European Science Foundation (ESF). In late 2013, I received the Swiss Government Excellence Scholarship to pursue my postdoctoral research career. In 2014, I joined Springer (now Springer Nature) in Heidelberg, Germany, as an Editor, and was promoted to Senior Editor in 2017 responsible for developing their publishing program in the Middle East and Africa, which consists of managing 20 journals and two book series. From 2015 to 2022, I was active in educational seminars for authors, reviewers, and editors to help improve publication output and quality. In 2015, I was also a visiting lecturer at King Saud University, KSA, and University of Sfax, Tunisia, where I gave lectures on publishing techniques. Recently, I launched two international conferences (more details at www.emcei.net and www.medgu.org) aiming at promoting two journals that I was managing at Springer. In 2016, I was awarded the Africa Green Future Leadership Award for my promotion of publications from Africa. In 2020, I received the Saudi Society for Geosciences Award.



Prof. Imran Ali is a world-recognized academician and researcher. He completed his Ph.D. at the Indian Institute of Technology Roorkee, Roorkee, India. Professor Ali is known globally due to his great contribution to pharmaceutical analysis by chromatography and capillary electrophoresis, the development of anticancer drugs, nanotechnology for water treatment, and water splitting for hydrogen green fuel generation. He has published more than 500 papers in reputed journals including papers in *Nature* and *Chemical Reviews* of more than 72 impact factors. He has also written six books published by Marcel Dekker, Inc., USA; Taylor & Francis, USA; John Wiley and Sons, USA; John Wiley and Sons, UK; Elsevier, The Netherlands; and Springer, Germany. His total citation is 35,500 with an h-index of 102 and an i10-index of 323. He is a member of various scientific societies globally. He is Editor-in-Chief of 02, Editor of 03, Associate Editor of 06 journals, and is on the editorial board of 40 journals.

Environmental Earth Sciences



Lead Removal from Water Solutions Using Alginate-Immobilized Peach Stone Particles

Zorica Lopičić, Jelena Milojković, Tatjana Šoštarić, Anja Antanasković, Marija Koprivica, Vladimir Adamović, and Linda Mitić

Abstract

Fruit processing industries generate millions of tons of organic waste annually, often improperly disposed of at open landfills. Based on the circular economy and waste management concepts, reusing these bio-waste materials is one of the future sustainable demands. Furthermore, recent investigations have shown that this material type can be reused as high-quality sorbents, with certain modifications that should be applied. Considering this, we have investigated the possible application of lignocellulosic waste-peach stones (*Prunus Persica* L.), immobilized in sodium alginate, as heavy metals sorbent. The immobilized particles (IPS) were utilized to remove metals from synthetic water solutions. Among all metals (Pb, Cu, Cd, and Zn), IPS has shown superior performance in Pb removal, governing further investigations. Dried IPS spheres were characterized by FTIR, SEM/EDX, and TG techniques. The batch reaction system investigated the effects of the contact time, initial Pb concentration, and mass-to-volume ratio. Optimized operational parameters were used in kinetic and isotherm studies. Obtained data were modeled using a nonlinear form of pseudo-first, pseudo-second, Elovich, Freundlich, and Langmuir equations. The results showed pseudo-second-order kinetics with Freundlich isotherm fitting Pb removal, indicating a heterogeneous IPS surface with the multilayer adsorption and adsorbed molecule interaction. As obtained from Langmuir isotherm, IPS particles have removed Pb by saturation capacity of

80.40 mg Pb/g. These preliminary results indicate that IPS can be applied to purify waters contaminated with lead metal.

Keywords

Waste biomass · Immobilization · SEM/EDX · Lead removal

1 Introduction

The growth of industrial activity and uncontrolled or improper release of pollutants into the environment induced the need for new methods and materials that might be used to solve environmental pollution issues. Many techniques have been developed for different pollutant removal. Still, most of them are often ineffective, economically or technically demanded, especially if the pollutant concentration (e.g., metals) falls below 100 mg/L (Abdolali et al., 2014). Sorption techniques using low-cost, abundant lignocellulosic waste (LCW) material might be applied for that purpose. Although LCWs pose some disadvantages concerning their direct applications as purification agents (Abdi & Kazemi, 2015; Abdolali et al., 2014), their properties might be improved by different modifications and immobilization in various polymer matrices (Chatterjee & Schiewer, 2014).

This paper investigates the possibility of lead (Pb) removal by immobilized LCW peach stone particles. Lead was chosen as a high-toxicity heavy metal, resistant to chemical or biological degradation, presenting a hazard to living and non-living environments (Check & Marteel-Parrish, 2013). On the other hand, recent investigations have shown that LCW generated by the fruit processing industry represents a stable matrix that might be efficiently used in wastewater purification (Lopičić et al., 2017). Therefore, to improve the sorption properties of the raw

Z. Lopičić (✉) · J. Milojković · T. Šoštarić · A. Antanasković · M. Koprivica · V. Adamović
Institute for Technology of Nuclear and Other Mineral Raw Materials, 11000 Belgrade, Serbia
e-mail: z.lopicic@itnms.ac.rs

L. Mitić
Faculty for Environmental Protection, Educons University, 21208 Sremska Kamenica, Serbia

material as well as the overall separation process, we have immobilized mechanically treated peach stones (*Prunus Persica* L.) in the sodium alginate and applied it as an efficient sorbent in lead removal.

2 Materials and Methods

All the chemicals used in this study were of high purity. Peach stones (PS) were obtained as waste from a local juice factory. After washing, grinding, and sieving (to a diameter less than 0.1 mm), mechanically treated PS particles were immobilized in Na-alginate according to the method described by Yuan and Viraraghavan (2001). Formed alginate beads (IPS) were further used for the characterization and sorption experiments.

Dried IPS spheres were characterized by FTIR (Thermo Fisher Scientific Nicolet IS-50 spectrophotometer, ATR mode), SEM/EDX (model JEOL JSM-6610LV), and TG (Netzsch STA 409 EP) technique.

Sorption experiments were done in triplicate in a batch reactor with mixing (200 rpm) at constant temperature (25 °C) with optimization of operational parameters. Obtained values were further used in kinetic and isothermal studies. The analytical Pb(II) measurements were done using AAS (Perking Elmer AAS Analyst 300). The percent of Pb(II) removal, R (%), as well as the amount of Pb(II), sorbed per unit mass of IPS, q (mg/g), was calculated as described in Lopičić et al. (2017).

3 Results

3.1 IPS Sorbent Characterization

Figure 1a, b shows SEM images of the IPS sphere. IPS represents a regular sphere of 5 mm average diameter, with PS evenly entrapped within the matrix, regularly exposed to a highly developed surface. Opposite to native material (Lopičić et al., 2019), the presence of macro pores is not evident. EDX analyses showed typical LCW composition (Lopičić et al., 2019) with higher Ca picks than in native material, while after Pb(II) sorption, reduced peaks of Ca, as well as a new peak of Pb(II), are observed in the EDX spectrum (image not shown). Figure 1c presents a TG/DTA analysis of the IPS sample. The first negative peak at 86 °C on the DTA curve is assigned to the loss of free water and water linked through hydrogen bonds. The second mass loss corresponds to the thermal decomposition of IPS composite with the fracture of glycosidic bonds and release of H₂O, with a degradation peak moved from lower (pure alginate) to a higher temperature (333 °C). This result suggests the

composite sorbent poses high thermal stability than the alginate itself. The final step of mass loss with a peak at 443 °C may be attributed to the carbonate formation, partial lignin, and cellulose degradation.

All bands' characteristics for raw PS have been seen on the FTIR spectrum of IPS (not shown), but due to the presence of the alginate with reduced intensity. The identified chemically active IPS groups were characterized as polysaccharides, cellulose, hemicellulose, and lignin, all present in composite material.

3.2 Batch Sorption Results

The immobilized particles of *Prunus Persica* L. waste biomass (IPS) were utilized to remove heavy metals from the synthetic water solutions. Among all metals (Pb, Cu, Cd, and Zn), IPS has shown superior performance in Pb(II) removal, so further sorption experiments were performed only with this pollutant. According to the literature review, the initial pH was set to 5.00 and was not adjusted during the sorption process. A significant decrease in pH (up to 3.98) is observed by the end of the process, owing to the presence of carboxylic groups as the main cation exchangers. The effect of the sorbent dose on the amount of Pb(II) sorbed by IPS and its corresponding removal percentage was investigated in the range 0.25–20 g/L. The results have shown an increase in percentage in Pb(II) removal (from 27.4 up to 90.8%) with an increase in IPS dose from 0.25 to 2.0 g/L. Further, an increase in sorbent dose increased R but significantly decreased Pb(II) sorbed. The influence of contact time revealed slow kinetics (equilibrium up to 24 h), which was the best fit by the pseudo-second-order model (Fig. 2a). Isotherm data showed the best correlation with the Freundlich model (Fig. 2b), indicating a multilayer sorption mechanism onto complex IPS surfaces.

4 Discussion

IPS characterization revealed a spherical sorbent shape with a high surface area and plenty of functional groups suitable for lead removal. This sorbent type posed higher thermal stability than the alginate itself and higher ash content than the raw PS, owing to crosslinked Ca in its matrix. Lead removal was superior to other sorbates investigated (thanks to ion exchange Ca–Pb). The typical overall adsorption efficiency (R (%)) was between 27% (for 0.25 mg/L of 1 M Pb solution) and 99% for the final value of 20 g of IPS/L. This removal efficiency did not appreciably increase with an increase in the mass-to-volume ratio higher than 2 g/L, and this operating parameter was selected for kinetic and isothermal investigations. Investigating the influence of contact

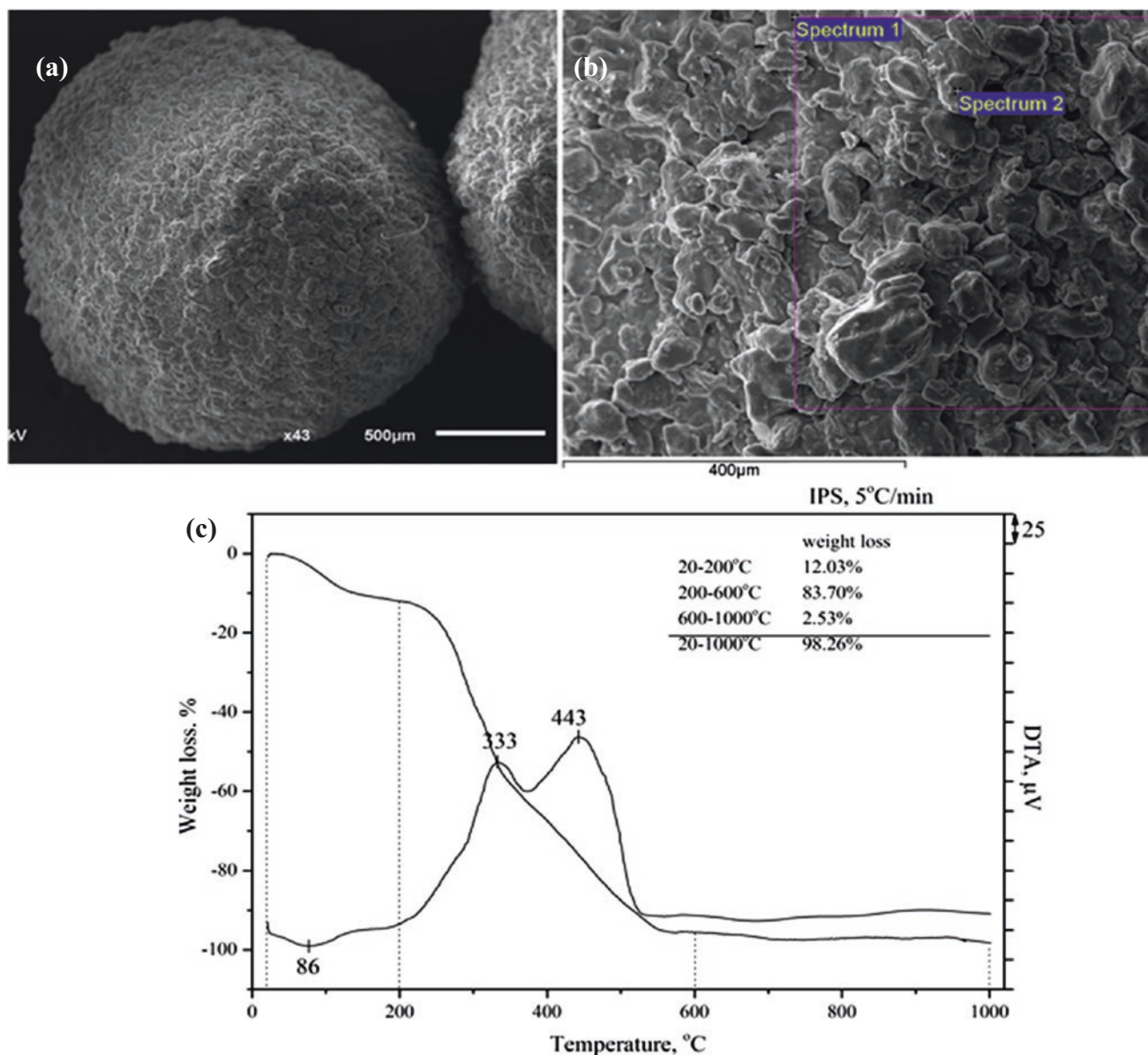


Fig. 1 a and b SEM micrographs of IPS at different magnitudes and c TG/DTA analysis of IPS sample

time showed slow kinetics best fitted by a pseudo-second-order equation. The results of isotherm investigations have demonstrated that the Freundlich isotherm fits better with the removal of Pb, indicating a heterogeneous IPS surface with multilayer adsorption and interaction between adsorbed molecules. Calcium alginate-immobilized PS particles have removed Pb by a saturation capacity of 80.40 mg Pb/g, as obtained from Langmuir isotherm. This value is much higher than the one for raw PS, which was calculated as 28.64 mg Pb/g under the same operational conditions. During the sorption process, calcium, added as a crosslinking agent, was exchanged with lead due to the affinity of the weak acid cation exchanger, the carboxyl group, which has a higher selectivity toward the lead.

5 Conclusions

Although LCW often has limited sorption capacity compared to current commercial sorbents, a good sorbent selection with a proper modification can considerably improve its sorption properties. Furthermore, based on the circular economy and waste management concepts, the reuse of LCW materials is one of the future demands in achieving economic and environmental sustainability. Preliminary results presented in this paper indicate that IPS can be applied to purify waters contaminated with lead metal. Thus, further investigations into the IPS application should be conducted.

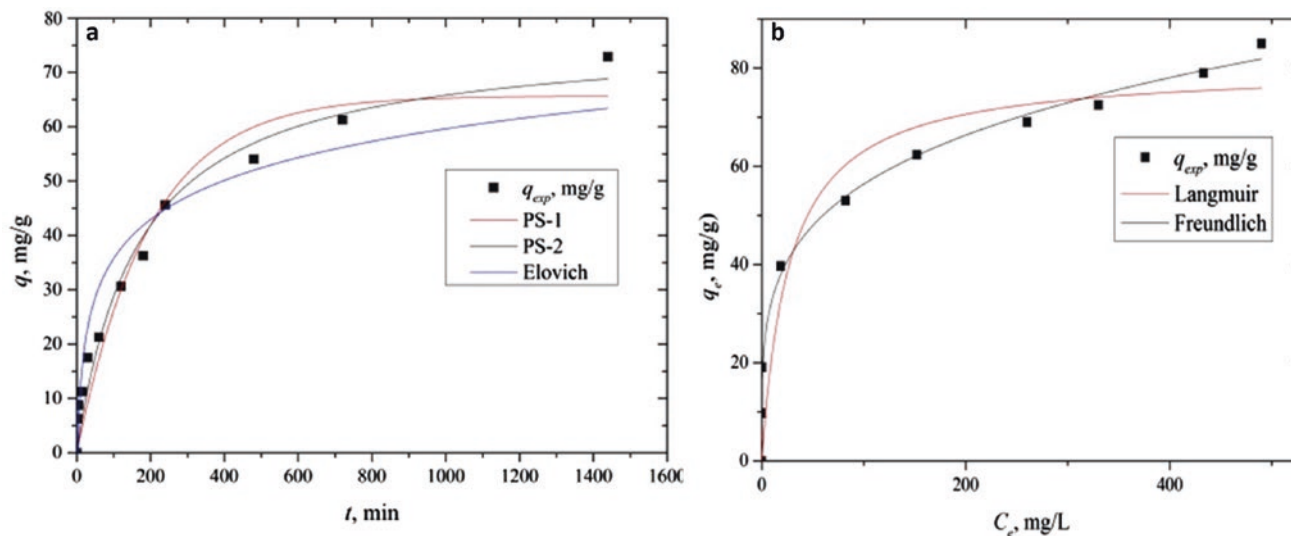


Fig. 2 a Kinetics and b equilibrium of Pb(II) uptake by IPS

Acknowledgements These results are part of the investigations supported by the Ministry of Education and Science of the Republic of Serbia (Grant number 451-03-9/2021-14/200023).

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