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

Attila Çiner · Santanu Banerjee · Federico Lucci · Ahmed E. Radwan · Afroz Ahmad Shah · Domenico M. Doronzo · Zakaria Hamimi · Wilfried Bauer *Editors*

Recent Research on Sedimentology, Stratigraphy, Paleontology, Tectonics, Geochemistry, Volcanology and Petroleum Geology

Proceedings of the 1st MedGU, Istanbul 2021 (Volume 2)

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Advances in Science, Technology & Innovation

IEREK Interdisciplinary Series for Sustainable Development

Advances in Science, Technology & Innovation (ASTI) is a series of peer-reviewed books based on important emerging research that redefines the current disciplinary boundaries in science, technology and innovation (STI) in order to develop integrated concepts for sustainable development. It not only discusses the progress made towards securing more resources, allocating smarter solutions, and rebalancing the relationship between nature and people, but also provides in-depth insights from comprehensive research that addresses the **17 sustainable development goals (SDGs)** as set out by the UN for 2030.

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The series particularly features conceptual and empirical contributions from various interrelated fields of science, technology and innovation, with an emphasis on digital transformation, that focus on providing practical solutions to **ensure food, water and energy security to achieve the SDGs.** It also presents new case studies offering concrete examples of how to resolve sustainable urbanization and environmental issues in different regions of the world.

The series is intended for professionals in research and teaching, consultancies and industry, and government and international organizations. Published in collaboration with IEREK, the Springer ASTI series will acquaint readers with essential new studies in STI for sustainable development.

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.

Attila Çiner • Santanu Banerjee •
Federico Lucci • Ahmed E. Radwan •
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About the Conference

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 Khelifi 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 a 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, Geoarchaeology, 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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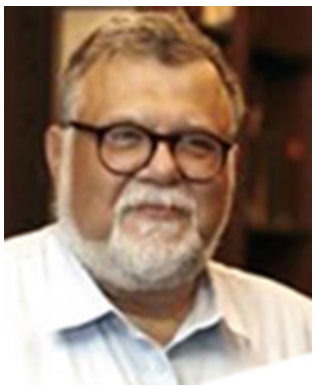

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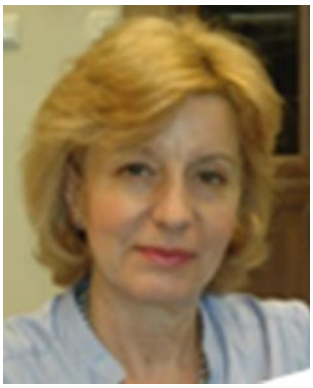

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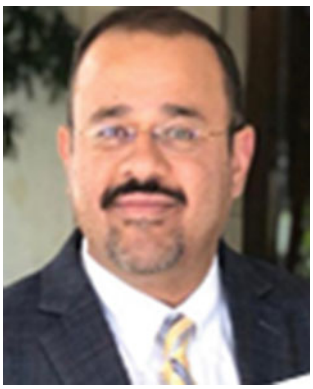

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Preface

This proceedings volume consists of 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. Here, we assembled a set of contributions investigating, through multidisciplinary and advanced methodologies, the most recent advances in the comprehension of geodynamic scenarios, geological processes and linkage with the anthropic environment.

The first part is related to Sedimentology, Stratigraphy and Paleontology. It contains 15 studies dealing with depositional environments, chronostratigraphy, chemostratigraphy, fossil records, paleoecology and paleoenvironment reconstruction.

Under the Geochemistry, Mineralogy, Petrology and Volcanology part, 19 papers address petrogenetic studies, geochronological investigations, ore geology works, mineralogical characterizations, hydrothermal and geothermal contributions and volcanological findings. Additionally, this section also contains contributions investigating volcanological hazards and environmental recovery.

The third part includes five articles focused on Structural Geology, Tectonics and Geodynamics, exploring the Meso-Cenozoic scenario from the western Mediterranean to the Iranian Makran, passing through the Balkans and Turkey.

Finally, the fourth part, with 18 contributions, is fully dedicated to the advancements in Petroleum and Energy Engineering and Petroleum Geology.

Although more than half of the inputs come from the Mediterranean region, many other countries around the globe also actively participated in contributing to this volume. This collection of studies is related to disciplines spanning from sedimentology and paleontology to structural geology and geodynamics, from petrology and mineralogy to volcanology, from geochemistry to ore geology and petroleum geology. Therefore, it could represent a privileged point of view for a better understanding of the Earth System.

The book is of interest to all researchers, practitioners and students in the abovementioned fields, presenting an updated complementary view on field studies, laboratory analyses and modeling aimed at better quantifying process-product binomials in geosciences.

Istanbul, Türkiye — Attila Çiner
Mumbai, India — Santanu Banerjee
Bari, Italy — Federico Lucci
Kraków, Poland — Ahmed E. Radwan
Gadong, Brunei — Afroz Ahmad Shah
Rome, Italy — Domenico M. Doronzo
Benha, Egypt — Zakaria Hamimi
Halban, Oman — Wilfried Bauer

July 2022

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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 the editor-in-chief of *Mediterranean Geoscience Reviews* and the chief editor of *Arabian Journal of Geosciences*, both published by Springer. He has published more than 100 peer-reviewed articles and chapters.

Santanu Banerjee currently works as a professor at the Department of Earth Sciences, Indian Institute of Technology Bombay. He does research in sedimentology and petroleum geology. His research areas include authigenic iron silicates, microbially induced sedimentary structures, basin analysis, provenance interpretations and alternate potash fertilizer. He is on the editorial board of *Journal of Palaeogeography*, *Minerals*, *Arabian Journal of Geosciences* and *Journal of Earth Systems Science*. He has published more than 150 papers in SCI-indexed journals, which have received more than 5000 citations.

Federico Lucci holds a B.Sc. in Earth Sciences (2004), an M.Sc. in Earth Sciences (2006) and a Ph.D. degree in Earth Sciences (2010) from Università degli Studi Roma Tre (Italy). Since February 2022, He is a researcher (RTDb) of petrography and petrology at the University of Bari, where he is dealing with the teaching course petrography of metamorphic rocks. His research is focused on modeling and timing of magmatic complexes as key constraint for understanding regional tectonics and geodynamic scenarios, through a multidisciplinary approach that integrates field survey, rock fabric characterization, mineral chemistry, geochemistry, geochronology, inverse and forward thermobarometry and FC-AFC-mixing modeling.

Dr. Ahmed E. Radwan is an adjunct professor at the Institute of Geological Sciences of the Jagiellonian University (Poland). He has academic and industrial experience, since he obtained his Ph.D. in geophysics at Sohag University, Egypt, besides his proficient work in the oil and gas industry as the department head at the exploration department of the Gulf of Suez petroleum company (Gupco), Egypt. As a postdoctoral research scientist, he attended Innsbruck University in Austria in 2019. In 2020, he joined the Jagiellonian University in Poland. Despite his youth, he has received numerous awards from international organizations such as the International Union of Geological Sciences (IUGS), the Geochemical Society (GS), the Clay Minerals Society (CMS), the Austrian Forschungsgemeinschaft (FG), the Narodowa Agencja Wymiany Akademickiej (NAWA), the Austrian Federal Ministry of Education, Science, and Research (BMBWF) and petroleum companies. He has authored more than 90 papers in highly indexed international peer-reviewed journals, published four chapters and presented at numerous international conferences. He is an associate editor in *Asian Earth Sciences*, *Marine and Petroleum Geology*, *Geoenergy Sciences and Engineering*, *Petroleum Exploration* and *Production Technology*, the *Geological Journal*, *Energy Geosciences and Petroleum Research*, in addition to being an editorial board member of *Unconventional Resources*. He is a book reviewer and a research article reviewer for several publishers and journals, and he organizes many special issues in different journals with the leading publishers. His research interests focused on multidisciplinary research integrating geosciences (geophysics, geochemistry and geology), petroleum engineering and reservoir engineering, as follows: (1) Geology areas include petroleum geology, reservoir characterization, sedimentology, facies analysis, depositional environment, diagenesis, paleoenvironment interpretations, subsurface analysis, basin analysis, reservoir quality, fluid flow, fractures, formation evaluation and unconventional and conventional resources; (2) petroleum engineering (petroleum geomechanics, drilling, fluids and casing design); (3) reservoir engineering (reservoir geology and geophysics, reservoir damage, production optimization, water

flooding, stimulations, fluid flow and enhanced recovery); (4) the geophysics fields of study (ex. formation evaluation, petrophysics, borehole geophysics and rock typing); (5) geochemistry fields of study include geochemical characterization, basin modeling, petroleum systems and isotope analysis; (6) petroleum geomechanics (pore pressure, wellbore stability, in situ stress orientation and magnitudes); (7) machine learning applications in the energy industry; (8) energy storage.

Afroz Ahmad Shah is an assistant professor of Structural Geology at the Department of Geosciences, Universiti of Brunei Darussalam (UBD). He completed Ph.D. at James Cook University, Australia, in 2010, a postdoctorate at Earth Observatory of Singapore in 2013 and joined his first academic job as a senior lecturer of Structural Geology at Curtin Sarawak, Miri, Malaysia, before joining UBD. His research mainly involves the brittle deformation of lithospheric plates, focusing on earthquake-causing faults in South and Southeast Asia. It also includes floods, landslides and land subsidence hazards. He works on earthquake science education and outreach and frequently writes in newspapers, magazines and blogs.

Dr. Domenico M. Doronzo holds a B.Sc., a M.Sc. and a Ph.D. degrees in Earth Sciences from Università degli Studi di Bari Aldo Moro, Italy. Investigation specialties related to those degrees are physical volcanology, experimental and computational fluid dynamics, petrology and natural hazards. Then, he has worked in volcanology and sedimentology, fluid dynamics and combustion, environmental sciences and rock physics in the USA, Mexico, Spain and Italy. Currently, he is a contract researcher at Istituto Nazionale di Geofisica e Vulcanologia, Italy. Particularly, he has received the Rittmann Medal from Associazione Italiana di Vulcanologia and Istituto Nazionale di Geofisica e Vulcanologia, which is assigned to the best young Italian volcanologist. His research interests focus on integrating theory, field measurements, numerical modeling, laboratory and outdoor experiments to study geological processes and products in volcanic areas (Vesuvio, Campi Flegrei, Etna, Vulcano, Colli Albani, Tenerife, Altiplano Puna, Colima) from fluid dynamic and natural hazard perspectives. He studies specifically pyroclastic energy currents, pre-eruption conditions, ground deformations, eruption forecasting, lahars and debris flows, flow-building interactions, sand and dust storms, turbidity currents, man-made environmental phenomena and geo-resources. Recently, he has published the first comprehensive review on the famous 79 CE "Pompeii" Plinian eruption of Vesuvius by means of a multidisciplinary approach in volcanology. He is a chief editor of the *Arabian Journal of Geosciences* responsible for evaluating submissions in the fields of Geochemistry, Mineralogy, Petrology and Volcanology.