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GUEST EDITORIAL

Guest Editorial: Special Issue on the 25th Electromagnetic Induction Workshop, Çeşme, Turkey

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Division VI of IAGA (International Association of Geomagnetism and Aeronomy) on Electromagnetic Induction in the Earth and Planetary Bodies (www.emiw.org) is the home organization for more than 500 scientists investigating all theoretical and practical aspects of the spatial distribution of electrical properties within the Earth's interior and planetary interiors. The main property is the electrical conductivity, where studies are applied to elucidate geological structures and processes ranging from meter to mantle scale. The international Electromagnetic (EM) Induction Workshops organized by the Division are the premier events for the community; they gather academic researchers from around the world in order to exchange views on the latest developments in the field of electromagnetic geophysics. Moreover, they are important for a number of sectors of industry and government that use EM methods for geothermal, mining, petroleum and energy exploration, for groundwater and environmental resource evaluation, for geohazard monitoring and in many other fields.

These Workshops have taken place on a biennial basis since 1972. The global COVID-19 pandemic resulted in postponing the Workshop originally planned for 2020 by two years. Therefore, the 25th Electromagnetic Induction Workshop was held between September 11 and 17, 2022. The Workshop venue was Çeşme, Turkey, located on the coast of the Aegean Sea in the ancient region named Ionia, which is of high importance in the history of science. Thales, Anaximander and Anaximenes were famous Ionian pre-Socratic philosophers who predicted solar eclipses and who first formulated scientific rules for the nature of the Earth. The word 'magnet' comes from the ancient city of Magnesia, and 'meander' derives from the Menderes River in the region. The badge of the Workshop (Fig. 1) includes the statue of ancient Goddess Arete that symbolizes the Workshop theme of 'virtue,' and the ancient Library of Celsus, in Ephesus, which was the destination of the traditional Workshop excursion day.

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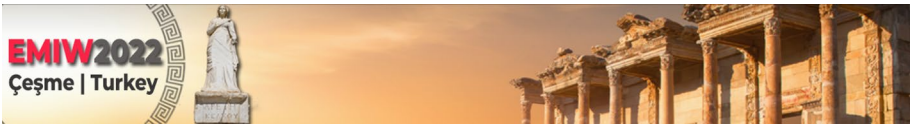


Fig. 1 The Electromagnetic Induction Workshop conference badge

The number of participants attending the Workshop was 168. Representing 36 countries, they submitted a total of 210 abstracts that were presented in eight sessions:

1. Instrumentation, sources and data processing,
2. Theory, modeling and inversion,
3. Exploration, monitoring and hazards,
4. Tectonics, magmatism and geodynamics,
5. Marine EM,
6. Rock and mineral resistivity and anisotropy,
7. Global and planetary studies,
8. Electromagnetic induction education and outreach.

The community traditionally invites keynote speakers to give review talks on recent leading-edge developments in the area of electromagnetics at every Workshop. It is also the tradition that articles emerging from these talks are published in a Special Issue of Surveys in Geophysics, formerly Geophysical Surveys. This latest Special Issue on the 25th Electromagnetic Induction Workshop includes three review papers.

The review by Alexander Grayver (2024) is dedicated to the progress made in fundamental research on the electrical resistivity of the solid Earth and—to some degree—other planets during the last twelve years. The source signals used for probing crustal to mantle depths cover the period range from seconds to years, and all are of natural, i.e., magnetospheric, ionospheric and oceanic (tidal), origin. Handling these complex sources together with, usually, a three-dimensional resistivity structure described in spherical coordinates is highly demanding. It requires the most advanced tools for forward and inverse modeling, together with modern continental-scale ground-based, sea-bottom, or satellite datasets, and interdisciplinary approaches including the latest laboratory measurements made under mantle conditions to provide the necessary constraints. The author presents an abundance of recent research in this area in a comprehensive and encouraging way, pointing to the potential—and opportunities—offered by this field for scientists who are ready to cross the borders of their own disciplines.

The review by Liangjun Yan (2024) leads us into a different domain of electromagnetics, where controlled-source signals are applied to explore the first few kilometers of the subsurface for reservoirs of hydrocarbons. Since such investigations often take place in a context of well-logging and seismic exploration, it is worth emphasizing the capability of electromagnetics to resolve relevant structures that can pose a challenge for seismics. This applies in particular to a class of reservoirs referred to as unconventional hydrocarbon resources. These include shale gas, especially so-called sweet spots, where the hydrocarbon deposit is embedded in typical geological surroundings and depths. The author shows how the specific properties of such reservoirs in terms of resistivity contrast to the surroundings, electrical anisotropy and induced polarization have successfully been used to detect and assess them for total organic carbon. Moreover, not only does he present examples

of how the propagation of fracking fluids has been monitored but he also sheds light on a number of new developments in the field of controlled-source electromagnetics applied in China.

The third review focuses on the details of gridding, which is an integral part of the modeling business, and not only in geophysics. Klaus Spitzer (2024) discusses both historical and recent developments in subsurface resistivity modeling by electromagnetic fields, including discretization methods for structured, unstructured and non-conforming meshes. The finite-element (FE) method is emphasized since it is more readily used with tetrahedral meshes that are, in turn, able to better represent topography, bathymetry and complicated geological structures than rectangular meshes. A number of impressive, close-to-reality models from the recent literature are shown. The relation between guiding the adaptive mesh refinement, the sensitivity function and error estimation is introduced to the reader; the sensitivity plays an important role in geometry mapping and local refinement.

Two further review talks (Near surface EM technologies—Archaeological and environmental applications by İrfan Akca and Electromagnetic studies in the Eastern Mediterranean Region with Special Reference to Major Strike-slip Faults by Sabri Bülent Tank) were presented at the Workshop, but did not make the schedule for publication in this Special Issue.

As Guest Editors, we would like to express our gratitude to the Editor-in-Chief of Surveys in Geophysics, Michael J. Rycroft, for his help with the editorial process, as well as to Colin Farquharson and a number of anonymous referees for their constructive and helpful reviews, and to the staff of Springer Nature.

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