

Recent Advances in Sedimentology

George Kontakiotis ^{1,*}, Angelos G. Maravelis ² and Avraam Zelilidis ³

¹ Department of Historical Geology and Palaeontology, Faculty of Geology and Geoenvironment, National and Kapodistrian University of Athens, Panepistimiopolis, 15784 Athens, Greece

² Department of Geology, Aristotle University of Thessaloniki, 54124 Thessaloniki, Greece; angmar@geo.auth.gr

³ Department of Geology, University of Patras, 26504 Patras, Greece; a.zelilidis@upatras.gr

* Correspondence: gkontak@geol.uoa.gr

1. Introduction

Sedimentary rocks represent a vital component of the Earth's geological framework, playing a significant role in the Earth's surface morphology, as well as in paleoenvironmental reconstructions. Over the last few decades, apart from their geological significance, the diverse and dynamic nature of sedimentary deposits has intrigued academic researchers and industrial companies striving to obtain sustainable resource management applications, particularly in construction [1] and hydrocarbon exploration and production [2], highlighting their economic potential. Despite considerable progress in sedimentary geology, several knowledge gaps persist, necessitating a more comprehensive examination of both carbonate and clastic sedimentary systems. Through an interdisciplinary approach, drawing upon cutting-edge research and the latest methodological advancements and insights in this dynamic field, this Special Issue addresses gaps in the research and fosters interdisciplinary collaboration between the scientific and industrial communities. By focusing on the paleoenvironmental conditions and clarifying the interplay between the depositional processes, diagenetic alterations, and inherent geochemical signatures, researchers can unravel the complex history of sedimentary successions and discern the driving factors behind their evolution. Depositional characteristics provide invaluable insights into the environmental conditions and sedimentary processes that govern the formation of sedimentary rocks [3], particularly the decipherment of sedimentary facies and structures, bedding patterns, and fossil assemblages in carbonate and/or clastic formations, which can serve as archives of past climates, tectonic events, and biological evolution [4–8]. Geochemical indicators such as isotopes and trace and major elements are extremely sensitive to paleoenvironmental reconstructions [9–12], and therefore, their application is essential in the context of geochemical and mineralogical investigations. Diagenetic processes such as dolomitization, compaction, cementation, and dissolution can modify the original mineralogy, texture, and porosity of sediments, thereby influencing their reservoir properties and hydrocarbon potential [13–18]. In this regard, the addition of the geological time dimension through the integration of sedimentological and sequence stratigraphic data and related correlations offers crucial information for potential reservoir characterization and exploration strategies [19,20].



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2. An Overview of Published Articles

The Special Issue “Recent Advances in Sedimentology” of the *Journal of Marine Science and Engineering* comprises a selection of ten peer-reviewed research articles, half of which are presented in Session S1, “Evolving techniques in the study of sediments” from the 16th International Congress of the Geological Society of Greece that was held in Patras, Greece, from 17 to 19 October 2022. This session was organized by the Hellenic Committee of Sedimentology of the Geological Society of Greece and focused on the presentation of recent results of sedimentological research in Greece. The other five scientific articles published in

the current Special Issue represent important sedimentary geology-related topics beyond Greece, such as different sedimentary basins within the Kara Sea, the Mediterranean Sea, and the Proto-Tethys Ocean. Although each of them focuses on a particular topic and often a particular region, they mark the recent advances in this discipline and, taken together, are valuable for realizing the complexity of the conceptual framework of sedimentology. Overall, based on their fundamental principles to advance cutting-edge methodologies, all these contributions improve the state of the art of their corresponding sub-disciplines by facilitating comprehension and fostering a deeper appreciation of the complexities inherent within described sedimentary sequences, offering further diverse perspectives and challenges.

Bilal et al. (Contribution 1) offer an in-depth exploration of the sedimentological and diagenetic processes of the Eocene carbonate deposits of the Ceno-Tethys Ocean employing a multi-proxy approach, which involves field observations, sedimentological microfacies characterization, paleontological, petrographic, and scanning electron microscopy analyses. This study provides valuable insights into the complex history of Early–Middle Eocene Margalla Hill Limestone and Chogali Formation across the eastern margin of the Upper Indus Basin in Pakistan, shedding light on the depositional diagenetic stages and highlighting the reservoir characteristics of these carbonates for possible hydrocarbon exploration in the future.

The research by Kanellopoulos et al. (Contribution 2) examines the biodiversity and biomineralization processes in caves. The authors are particularly focused on those recorded in the hot spring environment of the Aedipos area (NW Euboea Island, Greece). This study presents a comprehensive analysis through the mineralogical composition of speleothems and the cyanobacteria biomineralization processes, highlighting the importance of the geo-micro-biological study of such deposits, particularly in the extreme environments of hot springs.

Moving forward, Moforis et al. (Contribution 3) present a comprehensive, integrated sedimentological analysis of the pelagic carbonates of the Ionian zone (Epirus, western Greece), including lithostratigraphic determination, microfacies analysis, depositional environments, and the diagenetic history of Senonian and Microbreccious Limestone Formations in the Gardiki section. This study also provides valuable biostratigraphic and paleoecological insights across the Late Cretaceous–Early Paleocene Transition, highlighting any gradual or sudden foraminiferal extinctions and the related evolutionary and/or ecological crises that occurred globally during that time. Moreover, it provides a basis for the further evaluation of the hydrocarbon potential in western continental Greece, which contains proven reserves and is of crucial economic and strategic importance.

The fourth contribution by Lapietra et al. deals with the geomorphological, sedimentological, and geophysical characterization of two Apulian sandy beaches (Torre Guaceto and Le Dune beach), which are representative of the coastal dynamics of a large sector of the central/northern Mediterranean Sea involving the southern Adriatic Sea and the northern Ionian Sea. The authors propose a potential procedure for monitoring the morphosedimentary processes of sandy beaches by analyzing the textural and compositional characteristics of sand and quantifying the volumes involved in the coastal dynamics.

Zhang et al. (Contribution 5) investigate the effects of mud supply and hydrodynamic conditions on the sedimentary distribution of estuaries. In this study, the effects of mud concentration, mud transport properties, fluvial discharge, and tidal amplitude on the sedimentary characteristics of an estuary are systematically analyzed using sedimentary dynamic numerical simulation. The results indicate that the sedimentary dynamic numerical simulation can provide insights into an efficient quantitative method for analyzing the effects of mud components on the sediment processes of estuaries.

Zelilidis et al. (Contribution 6) provide insights into the depositional conditions of the Messinian evaporites on Zakynthos Island, highlighting the significance of their origin, thickness, and distribution for the sealing capacity in hydrocarbon exploration targets within the Mediterranean Sea.

Ali et al. (Contribution 7) offer an in-depth exploration of the Proto-Tethys Ocean during the Cambrian period on the northern margin of the Indian Plate, employing a multi-proxy approach involving sedimentological and petrographic characteristics of the Abbottabad Formation in the Muzaffarabad area, Upper Indus Basin, Pakistan. The detailed litho- and petrofacies characterization, along with the elemental analysis and sedimentological hierarchy of the dolomitic facies, offer valuable contributions to our understanding of carbonate systems worldwide.

Mehmood et al. (Contribution 8) performed a study on the Maastrichtian Pab Formation in the Rakhi Gorge, Eastern Sulaiman Ranges, Pakistan, which represents part of the eastern Tethys. The paleoenvironment and sequence stratigraphy were studied in the Cretaceous fluvio-deltaic sandstone succession through lithofacies analysis and associated architectural elements.

Qureshi et al. (Contribution 9) investigate the sedimentary processes, depositional architecture, and reservoir rock potential of the Mid-Triassic mixed siliciclastic and carbonate succession of the Tredian Formation in the Salt and Trans-Indus Ranges. The depositional environment was reconstructed based on lithofacies characterization, while the paragenetic sequence was determined based on petrographic and SEM observations.

The paper by Kokin et al. (Contribution 10) presents an application of the ^{210}Pb dating of the largest ice scour in the Baydaratskaya Bay area (Kara Sea). This method of dating using the study of ice-scouring processes has become very important in recent times due to climate change. In this regard, the authors consider that the studied ice scour was formed no later than the end of the Little Ice Age. Such findings on the sedimentation chronology in ice scours help to establish the periods of active ice scouring on the glaciated continental margins and supplement knowledge about sedimentation on the Arctic shelf.

Conflicts of Interest: The authors declare no conflicts of interest.

List of Contributions

1. Bilal, A.; Yang, R.; Mughal, M.S.; Janjuhah, H.T.; Zaheer, M.; Kontakiotis, G. Sedimentology and Diagenesis of the Early–Middle Eocene Carbonate Deposits of the Ceno-Tethys Ocean. *J. Mar. Sci. Eng.* **2022**, *10*, 1794. <https://doi.org/10.3390/jmse10111794>
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