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Editorial

Geological Oceanography: Towards a Conceptual Framework

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Research into modern oceans, seas, and their coastal zones, as well as marine ecosystems, provides valuable information for deciphering the geological dynamics. For instance, studies of the modern sea floor are essential for the analysis of sedimentary facies and conceptual environmental reconstruction through the integration of sequence stratigraphic and sedimentary models. Similarly, observations of traces of life from various organisms on the sea bottom facilitate ichnological interpretations of the deep past. Geological oceanography is, however, not only about the present, as it also includes marine deposits, palaeoenvironments, and fossils, some (if not many) of which do not have modern analogues. Geological oceanography also provides important frameworks for interpreting mineral and hydrocarbon deposits, which occur beneath modern oceans and seas, or are formed in connection to significant ancient water masses. Geological oceanography also includes emerging directions of geoscience research in the form of geoheritage studies, as a significant portion of unique geological and geomorphological objects represent either ancient or modern environments.

Geological oceanography is, therefore, a broad field of research. As such, any conceptual framework needs to be regularly updated due to two reasons: On the one hand, numerous investigations bring a multitude of new lines of evidence. On the other hand, planning research in this field requires systematic arrangement of the prior observations and knowledge to outline gaps and interpretive perspectives. No single article or monograph can address these challenges comprehensively, but joint efforts of specialists with different research interests and representing different countries can contribute to the ongoing conceptualization of geological oceanography.

The present Special Issue comprises twenty-one research papers addressing various issues of geological oceanography. Although each of them focuses on a particular topic and often a particular region, they mark the recent advances of this discipline, and, taken together, they are valuable for realizing the complexity of the conceptual framework of geological oceanography. Below, we introduce the content of this Special Issue systematically and outline the common aspects across the discipline. Generally, four main themes can be outlined: modern marine geological environments, Quaternary marine studies, palaeoenvironments and palaeo-ecosystems, and applied marine geology.

The first theme represents the diversity of geological processes in the modern marine environment. Petropoulos et al. [1] demonstrate how the interaction of different forces, including wave activity, landslides, and human activity, influence sediment transport and beach dynamics in a bay of the small island in the Ionian Sea. Hussian and Al-Ramadan [2] investigate the deeper environment, where sands in fans facilitate carbon burial and enhance long-term carbon cycling. Yutsis et al. [3] recognize several contourite depositional systems in the Caspian Sea, which is evidence of a complex organization of deep-marine sedimentation in the enclosed basin. Hayat et al. [4] document the spatio-temporal variations in the coccolithophore fluxes in the Eastern Mediterranean, which are partly dependent on deep-water hydrogynamics; the related processes reflect some patterns of bio-geodynamics in the deepest parts of this sea.

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The second theme reflects the evolution of marine environments and ecosystems throughout the Phanerozoic. Tolokonnikova and Ruban [5] demonstrate how the series of biotic and environmental crises made bryozoans vulnerable to external negative influences at the Devonian–Carboniferous transition. Ali et al. [6] document shelfal sedimentation in the Late Permian of the Salt Range of Pakistan. Garcia et al. [7] undertake a state-of-the-art approach to identify as many as ten taphofacies in the Late Jurassic coquina deposits of the Lusitanian Basin. The investigation by Wang et al. [8] offers an explanation of how deep-sea sediments with rare earth elements and yttrium found from the Pacific formed as a result of local topography (seamounts) and significant palaeoceanographical re-organizations in the Oligocene–Miocene. Ruban [9] implemented a historical approach to gather the old data for accurate outlining of the changes in the configuration of the Late Miocene Tanais Bay of the Paratethys Palaeosea. The insightful and comprehensive review by Johnson [10] focuses on the Pliocene episode of warmth when tropical cyclones became an important factor of sedimentation.

The third theme comprises Quaternary marine studies. The work by Arce-Chamorro et al. [11] traces interrelations between sea-level changes, coastline dynamics, and aeolian dune development at the very edge of the Iberian Peninsula in the Late Pleistocene–Holocene. Wang et al. [12] establish the sedimentary and geochemical archives of the global mid-Pleistocene climatic changes in the Central Pacific and demonstrate the links between the processes in this deep-ocean domain and the remote Asian landmass. Giamali et al. [13] report the Holocene ecological patterns from the North Aegean Trough, where water column stratification and upwelling influenced foraminiferal and pteropod assemblages.

The fourth theme considers the application of the marine geological process to the understanding of petroleum geology. Maravelis et al. [14] characterize the Upper Miocene possible source rocks and the related traps in the Crete Island. Janjuhah et al. [15] classify porosity in the Miocene carbonate reservoirs from Malaysia. Two contributions address the issue of overpressure in marine sediments. Li et al. [16] characterize physical, chemical, and biological mechanisms of overpressure development, with special attention given to gas hydrate systems. Dubinya et al. [17] describe various methods for prediction of overpressure zones. The other application is linked to deep-sea mineral resources. Dai et al. [18] consider seafloor massif sulphides in light of simulation experiments. Environmental aspects are also addressed in this Special Issue. Fazal et al. [19] interpret geochemical patterns of shales accumulated in the Cretaceous Hazara Basin (Pakistan) and note that the high amount of some elements in these shelfal deposits can lead to pollution of both soils and water. Khan et al. [20] demonstrate that both natural and anthropogenic factors influence the sedimentary processes in the Indus River basin and, particularly, the fan of this massive river. Finally, research in geological oceanography has importance for geotourism applications. Ruban [21] explains how finding evidence of palaeoislands of the Mesozoic Caucasian Sea facilitates the evaluation of the regional geoheritage resources and their potential for geotouristic use.

The themes considered in this Special Issue and the particular research questions raised in the 21 contributions point to the contemporary agenda of geological oceanography. Nonetheless, a number of research questions in this discipline remain unanswered. For instance, more attention should be paid to the state of Precambrian oceans, the anthropogenic factors of marine sedimentation (even on the planetary scale), and marine and underwater geoheritage.

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