

Advanced Research on Marine Geology and Sedimentology

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1. Introduction

The ocean floor is a vast, uncharted territory, rich with geological and sedimentological secrets waiting to be uncovered. Advanced research in marine geology and sedimentology is pivotal for understanding the Earth's history, climate change, and the formation of natural resources [1].

Utilizing cutting-edge technology, such as deep-sea submersibles, autonomous underwater vehicles, and advanced sonar systems, scientists delve into the abyss to map the seafloor, study tectonic plate movements, and collect samples of sediment and rock [2,3]. These studies provide insights into the geological processes that shape our planet, including the formation of underwater volcanoes, the shifting of oceanic trenches, and the creation of abyssal plains [4–6].

Sedimentology, the study of sediments, complements this research by examining the layers of sediment on the ocean floor. These layers act as a historical archive, recording changes in sea level, ocean currents, and past climates [7]. By analyzing the composition and structure of these sediments, researchers can reconstruct ancient environments and track the evolution of marine ecosystems [2,8,9].

2. Overview of the Special Issue

The papers collected in the Special Issue “Advanced Research on Marine Geology and Sedimentology” are diverse, including nine research papers.

- Effect of Relative Wavelength on Excess Pore Water Pressure in Silty Seabeds with Different Initial Consolidation Degrees (Contribution #1).
- Distribution of Excess Pore Water Pressure in Layered Seabed Induced by Internal Solitary Waves (Contribution #2).
- Seasonal Circulation Characteristics of Oceanic System in the Beibu Gulf Based on Observations and Numerical Simulations (Contribution #3).
- Assessment of Storm Surge Disaster Response Capacity in Chinese Coastal Cities Using Urban-Scale Survey Data (Contribution #4).
- Analysis of Shoreline Change in Huizhou-Shanwei Region (China) from 1990 to 2023 (Contribution #5).
- Adaptive Penetration Unit for Deep-Sea Sediment Cone Penetration Testing Rigs: Dynamic Modeling and Case Study (Contribution #6).
- Investigating the Element Geochemical Behavior and Provenance of Surface Sediments in the Offshore Area of Sierra Leone, Africa: Insights from Major and Trace Elements (Contribution #7).



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- Turbidity Currents Carrying Shallow Heat Invading Stable Deep-Water Areas May Be an Unrecognized Source of “Pollution” in the Ocean (Contribution #8).
- Features and Constitutive Model of Hydrate-Bearing Sandy Sediment’s Triaxial Creep Failure (Contribution #9).

The contributions span from shallow sea to deep sea, including wave-seabed interactions, ocean dynamics, shoreline changes, sediment properties, deep-sea turbidity currents, etc.

Li et al. (Contribution #1) found that the excess pore pressure (EPP) magnitude monotonically increases with wavelength in an initially liquefied seabed, while in an initially consolidated seabed, there is a maximal response wavelength that is inversely related to the consolidation degree. Furthermore, they found two opposite EPP responses to cyclic surface wave loading under varying seabed conditions in initially liquefied and consolidated seabeds. That is, under the same waves, the EPP magnitude is inversely related to the consolidation degree in initially liquefied seabed, while the EPP magnitude is positively related to the consolidation degree in initially consolidated seabed.

Tian et al. (Contribution #2) proposed that increases in saturation and permeability coefficient lead to deeper penetration of excess pore water pressure into the seabed by internal solitary waves (ISWs). Conversely, the effects of shear modulus and porosity are relatively minor and inversely related to the depth of influence of excess pore water pressure. When stratification occurs in the permeability coefficient and saturation of the seabed, significant alterations are observed in the downward propagation of excess pore water pressure. Saturation stratification exhibits similar effects, with soil layers exhibiting higher saturation levels being more conducive to the transmission of excess pore water pressure by ISWs.

Liu et al. (Contribution #3) integrated one-year current observations from four in situ current observation stations (B1–B4) with simulations using the Regional Ocean Modeling System (ROMS) to characterize circulation dynamics in the gulf. Observations show persistent northward subtidal currents west of Hainan Island year-round, primarily sustained by tidal-induced residual currents. These currents briefly reverse southward during strong northerly wind events, whereas subtidal currents in the northern Beibu Gulf are more wind-dependent, showing pronounced seasonal variations. Numerical results confirm that winter circulation is dominated by a basin-wide cyclonic gyre driven by northeasterly monsoons. In summer, circulation in the northern gulf is cyclonic under southeasterly winds, but turns anticyclonic when southwesterly winds prevail, indicating strong sensitivity to summer monsoon wind direction.

Zhu and Cui (Contribution #4) focus on 52 Chinese coastal cities as the research subject by the Hazard–Exposure–Vulnerability (H-E-V) framework and PPRR (Prevention, Preparedness, Response, and Recovery) crisis management theory. The evaluation system for the disaster response capabilities of Chinese coastal cities was constructed based on three aspects: the stability of the disaster-incubating environment (S), the risk of disaster-causing factors (R), and the vulnerability of disaster-bearing bodies (V). The results indicate that Wenzhou has the best comprehensive disaster response capability, while Yancheng has the worst. Moreover, Tianjin, Ningde, and Shenzhen performed well in the three aspects of vulnerability of disaster-bearing bodies, risk of disaster-causing factors, and stability of disaster-incubating environment separately. On the contrary, Dandong (tied with Qinzhou), Jiaxing, and Chaozhou performed poorly in the above three areas.

Li et al. (Contribution #5) obtained the length and structure data of the shorelines in eight periods by manual visual interpretation of Landsat RS (remote sensing) images from 1990 to 2023. The results show that during 33 years, the length of the shorelines increased 15.83 km, with an average growth rate of 0.48 km/y; the value of the intensity

of change in the shorelines was 0.08%. The overall change in the fractal dimension of the shorelines was small, between 1.0395 and 1.0673. As far as the influencing factors are concerned, the influence of the natural environment is a long process, and human activities are more capable of changing the length and shape of the shorelines in a short period of time, with factors such as the degree of economic development having a greater impact on the shorelines.

Zhu et al. (Contribution #6) proposed a load-adaptive sediment rig that minimizes zero-velocity points, ensures data continuity, and contributes to sedimentology research. This paper analyzes the mechanical properties and layering patterns of sediment, along with the interaction mechanisms between sediment and mechanical structures. Subsequently, a mechanical structure–sediment integrated model with adaptive control logic is established. Finally, real sediment data are introduced into the physical model for simulation experiments. The simulation results demonstrate that the load-adaptive rig reduces data breakpoints by 50% and increases the maximum single penetration stroke to 1.8 m. Additionally, the load-adaptive rig provides redundancy between penetration force and stroke, automatically reducing penetration force for greater stroke when encountering low-strength sediments and, conversely, sacrificing part of the stroke for greater force.

Hu et al. (Contribution #7) tested the grain size and major and trace elements of 35 surface sediments in the offshore area of Sierra Leone, and made a comparative study with the sediments in the offshore area of China. The results show that sandy silt is the main sediment type in the research area, and the average sediment mean grain size (M_z) is 4.15Φ . The content of Ca in the samples is the highest among the major elements (except Si), with an average of 5.1%. The content of Sr is the highest among the trace elements (except Ti, P, and Mn), with an average of 378.2 $\mu\text{g/g}$. The results of correlation analysis and factor analysis show that there are three main sources of sediments in the research area, namely, terrigenous weathering products, ilmenite-dominated ore, and oceanic biochemical substances. Compared with the sediments in China offshore, the sediments in the study area are more affected by marine biochemistry and have special ore input characteristics.

Tian et al. (Contribution #8) conducted systematic experiments on warm turbidity currents to understand how sediment-driven turbidity currents lead to mixing in stable stratification using existing environmental entrainment numbers. The experimental results show that the dimensionless numbers Rs , RT , and $R0$ control the flow process of warm turbid plumes, and corresponding functional relationships are summarized. The frequent occurrence of warm turbidity current events caused by increasingly prominent environmental problems cannot be ignored, as it directly affects the deep-water environment of lakes or coastal oceans, which may be an important contribution to heat transfer that has not been evaluated in previous ocean events.

Sun et al. (Contribution #9) take hydrate-bearing sandy sediment as the research object and conduct triaxial compression creep tests at different saturation degrees (20%, 30%, and 40%). The results show that the hydrate-containing sandy sediments have strong creep characteristics, and an accelerated creep phenomenon will occur under the long-term action of high stress. The longstanding destructive power of the specimen progressively increases with the increase in hydrate saturation, but the difference in the triaxial strength of the specimen progressively increases. This indicates that the damage to the hydrate structure during long-term loading is the main factor causing the strength decrease.

3. Conclusions

Advanced research on marine geology and sedimentology is crucial for expanding our understanding of the Earth's systems and for guiding the sustainable use of our oceanic resources. Understanding the geological structure of the ocean floor can aid in the search

for mineral and oil resources, while the knowledge of sedimentary processes can inform strategies for environmental conservation and disaster mitigation.

The contributions in this collection demonstrate how different research fields can be combined to address the rapid development of marine geology and sedimentology. The research scope covers multiple sea areas and includes technological innovation. The editor of this Special Issue would like to thank all the authors who participated in the project and invite further scientific activities in this field.

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List of Contributions

1. Li, H.; Zhang, Y.; Ma, A.; Wen, M.; Zhao, Z.; Zhang, S. Effect of Relative Wavelength on Excess Pore Water Pressure in Silty Seabeds with Different Initial Consolidation Degrees. *Water* **2025**, *17*, 2829. <https://doi.org/10.3390/w17192829>.
2. Tian, H.; Jia, L.; Zhao, J.; Wang, L.; Kan, J.; Wu, F.; Tian, Z. Distribution of Excess Pore Water Pressure in Layered Seabed Induced by Internal Solitary Waves. *Water* **2025**, *17*, 2532. <https://doi.org/10.3390/w17172532>.
3. Liu, G.; Zhang, N.; Yang, Y.; Wang, C. Seasonal Circulation Characteristics of Oceanic System in the Beibu Gulf Based on Observations and Numerical Simulations. *Water* **2025**, *17*, 2365.
4. Zhu, L.; Cui, S. Assessment of Storm Surge Disaster Response Capacity in Chinese Coastal Cities Using Urban-Scale Survey Data. *Water* **2025**, *17*, 2245. <https://doi.org/10.3390/w17152245>.
5. Li, S.; Gui, F.; Feng, J.; Wang, Y.; Song, Y.; Wang, W.; Lin, C. Analysis of Shoreline Change in Huizhou-Shanwei Region (China) from 1990 to 2023. *Water* **2025**, *17*, 1460. <https://doi.org/10.3390/w17101460>.
6. Zhu, Y.; Zhang, Z.; Yang, X.; Fei, Z.; Guo, L.; Xue, G.; Liu, Y. Adaptive Penetration Unit for Deep-Sea Sediment Cone Penetration Testing Rigs: Dynamic Modeling and Case Study. *Water* **2025**, *17*, 1159. <https://doi.org/10.3390/w17081159>.
7. Hu, M.; Zhu, Y.; Chen, W.; Yu, B.; Zhang, P.; Hu, C.; Jin, R. Investigating the Element Geochemical Behavior and Provenance of Surface Sediments in the Offshore Area of Sierra Leone, Africa: Insights from Major and Trace Elements. *Water* **2024**, *16*, 3540. <https://doi.org/10.3390/w16233540>.
8. Tian, H.; Xu, G.; Zhao, J.; Ren, Y.; Wu, H. Turbidity Currents Carrying Shallow Heat Invading Stable Deep-Water Areas May Be an Unrecognized Source of “Pollution” in the Ocean. *Water* **2024**, *16*, 3521. <https://doi.org/10.3390/w16233521>.
9. Sun, S.; Zhang, X.; Zhou, Y. Features and Constitutive Model of Hydrate-Bearing Sandy Sediment’s Triaxial Creep Failure. *Water* **2024**, *16*, 2947. <https://doi.org/10.3390/w16202947>.

References

1. Zeng, L.; Wang, C.; Foster, D.A.; Su, M.; Cui, H.; Jia, J. Controls on sediment transport from rivers to trenches in passive and active continental margins. *Sci. China Earth Sci.* **2024**, *67*, 3868–3880. [[CrossRef](#)]
2. Li, H.; van Loon, A.J.; Xu, Y.; He, Y.; Yang, Z.; Zhou, W.; Liu, S.; Li, Y. Reservoir characteristics and potential of a shallow-marine fan in the Miocene Huangliu Fm. within the DF1-1 Gas Field (Yinggehai Basin, S China). *Geoenergy Sci. Eng.* **2023**, *230*, 212202. [[CrossRef](#)]
3. Yang, Z.; Wang, K.; Xu, W.; Xu, J.; Liu, M.; Hu, L. Multi-proxy sedimentary records in the northeastern South China Sea: Implication for sea level and East Asian Summer Monsoon evolution since 13 ka BP. *Palaeogeogr. Palaeoclimatol. Palaeoecol.* **2025**, *675*, 113099. [[CrossRef](#)]
4. Zhu, B.; Pei, H.; Yang, Q. Reliability analysis of submarine slope considering the spatial variability of the sediment strength using random fields. *Appl. Ocean Res.* **2019**, *86*, 340–350. [[CrossRef](#)]

5. Chen, H.; Xie, X.; Mao, K.; He, Y.; Su, M.; Zhang, W. Depositional Characteristics and Formation Mechanisms of Deep-Water Canyon Systems along the Northern South China Sea Margin. *J. Earth Sci.* **2020**, *31*, 808–819. [[CrossRef](#)]
6. Fan, C.; Tian, Z.; Cui, K.; Huang, J.; Bian, S.; Yang, L.; Zhang, T. A new discovery of source contribution and transport mechanism of clay minerals in Taiwan Canyon-Manila Trench. *Deep. Sea Res. Part I Oceanogr. Res. Pap.* **2025**, *224*, 104571. [[CrossRef](#)]
7. Tian, H.; Ren, Y.; Chen, Z.; Tao, W.; Wu, H.; Xu, G. Numerical Study of the Transport Process of Shallow Heat Carried by Turbidity Currents in Deep-Sea Environments. *J. Geophys. Res.-Ocean.* **2023**, *128*, 29. [[CrossRef](#)]
8. Wu, J.; Yu, L.; Guo, X.; Xie, Y.; Ma, Z. Application of resistivity in the characterization of shear failure process of gas bearing marine silt. *Mar. Georesources Geotechnol.* **2023**, *41*, 1001–1012. [[CrossRef](#)]
9. Zhang, Y.; Sun, Z.; Lei, B.; Li, M.; Guo, X.; Zheng, T.; Luo, J. Morphology of brine-Seawater interface and spatial distribution of submarine Groundwater discharge windows in the muddy coast. *Geophys. Res. Lett.* **2024**, *51*, e2024GL111193. [[CrossRef](#)]

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