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Editorial: Deep-sea sampling technology

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Editorial on the Research Topic
Deep-sea sampling technology

With the increasing demand for the marine scientific research and the harvesting of deep-sea resources, such as crude oil, natural gas hydrate and polymetallic nodules, the investigation of deep-sea environment has become increasingly important. It is essential to develop high-accuracy and reliable deep-sea detection technologies, including *in-situ* multidisciplinary observation, and high-fidelity sampling of fluids, sediments and benthos. In this Research Topic, we have collected several progresses made in recent years.

For *in-situ* observation technologies, Ge et al. developed and tested an instrument for the long-term monitoring of the seabed strata deformation for gas hydrate exploitation. The instrument was composed of multiple MEMS (Micro-Electro-Mechanical System) sensors which were placed in the sensor chamber. Corrugated pipes were used as soft joints connecting the sensor chamber, which could bend and twist if slides or deformation have occurred in the strata. The instrument can be deployed through the ROV (Remote Operated Vehicle) and working at the maximum sea-depth of 3000 m. Wang et al. developed a lander loaded with an imaging system to monitoring the dynamics of SPM (Suspended Particle Matter), which played an important role in material transport, deposition, resuspension and the function of benthic communities' processes in deep sea. They were able to capture the *in-situ* digital video images at the water depth of 1450 m in South China sea, based on which they defined an image signal that was the ratio between the area of the SPM and that of the total image, to characterize the SPM concentration. Liu et al. developed an *in-situ* observation system for microscopic targets in the deep sea, which was successfully deployed by the ROV on the seabed in South China Sea with a depth over 770 m. The system integrated microscopic imaging and Raman detection techniques, by which compositional analysis of shell fragments, seabed rock samples, and live sea stars were successively performed. The system illustrated a considerable potential of combining Raman spectroscopy and microscopic imaging in marine research. Guo et al. designed a double decelerating lander for *in-situ* detection and monitoring at the water depth of 6000 m. In order to avoid damage of the OBS (Ocean Bottom Seismometer) due to the impact when the lander, which is released and then touched the seabed during the deploying process, the double decelerating unit were developed as a safeguard for OBS to ensure a low impact rate. The lander was successfully deployed at the water depth of

2240 m and 1790 m, respectively, in South China sea, with the temperature, salinity, Eh (redox potential), turbidity, underwater acoustic environment, and OBS data being successfully monitored

For sampling technologies, Liu et al. developed an active deep-sea low damage pressure-retaining samplers for organisms. They used a HSMPS (Hydraulic Suction Macro-biological Pressure-retaining Sampler) to capture less damaged hadal snailfish samples *via* pumping. They realized active sampling of deep-sea organisms by controlling the flow rate of the pump, designing a pressure compensation mechanism to compensate for the pressure drop in the recovery process of the sampler, and using thermal insulation materials to realize the low-temperature environment inside the sampler. They also suggested a low damage of the sampler capture process of deep-sea organisms by controlling the flow rate in the range of 131 L/min to 174 L/min. Guo et al. proposed and tested a pressure-retaining separation and transfer system for the sediment and the overlying seawater to investigation of methane leakage and the sediment-water interface at the ambient pressure of 30 MPa. The device has the ability to transfer respectively the overlying water by compressing the internal volume and the sediment by secondary sampling. Fang et al. designed a gas-tight water sampler by displacement sampling method, by which the prefilled deionized water is replaced by the water sample. Factors such as indirect displacement, shape and diameter of sampling inlet, Coanda distance, sampling rate and other factors on the displacement effect were investigated. The developed sampler was tested in South China sea at the water-depth reaching 3000 m, and the purity of the collected water sample reached 100%. Wang et al. conducted a concise survey on the isobaric sampling apparatus and essential techniques for deep-sea macro-organisms, and provided an overview of the history and utilization of isobaric samplers for deep-sea creatures developed by researchers worldwide over the past century. They further summarized the key technologies of isobaric samplers, encompassing pressure compensation, insulation, and sealing.

We learn that considerable progress has been made on deep-sea sampling and *in-situ* observation technology at the water depth of about 3000 m. In recently years, mining of deep-sea polymetallic nodules has attracted increasing interest, and intensive survey on the benthonic environment is essential in order to assess the environmental impact due to the mining process. This requires reliable *in-situ* monitoring technologies, as well as time series sampling methods on the sediment, pore water, and benthos, et al., throughout the trail harvesting process at the depth of 6000 m. However, way to achieve such goal is still limited and is expected to be developed in the near future.

Author contributions

YL wrote the first draft of the manuscript. JC and ZS wrote sections of the manuscript. All authors contributed to manuscript revision, read, and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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