frontiers in Earth Science

EDITORIAL
published: 25 March 2022
doi: 10.3389/feart.2022.852059

Editorial: Advances in Ocean Bottom Seismology

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Keywords: marine, ocean, seismologic observatories, active source, passive

Editorial on the Research Topic

Advances in Ocean Bottom Seismology

Among the physical sciences, seismology is relatively young; with the continued advances in instrumental technologies and computer capacity, ours has to be one of the most rapidly evolving subject areas within the Earth Sciences writ large. Exploration of the Earth by way of seismic observation and modeling is expanding not only in the range of capabilities - from reservoir scale to whole-Earth sensing - but in recent decades seismology has resolutely marched from the Earth's continents and sea shores into the oceans, which cover nearly 75% of the Earth and have until recently hindered our ability to more fully explore the planet.

The past few decades have brought about advances in design and deployment of ocean bottom seismic sensors and their data acquisition capacity, resulting in an exponential increase in seafloor seismic experiments driven by both pure scientific inquiry as well as economic development. With the increasing focus on what is arguably Earth's last frontier for seismology, it is timely that we present some of the latest new results, observations, modeling and technological advances in ocean bottom seismology.

Many traditional seismic techniques that have been used in special land-based deployments are also undertaken by marine seismologists. Their work is made more challenging by difficult deployment requirements and the long time gap between station installation and data retrieval. Hindering many fundamental analyses is the appreciable seismic noise environment on the ocean floor, inaccessibility of sensors for validation of precise location, attitude and orientation, coupling and response issues and possible errors or mishaps that cannot be addressed in near real time as they would on land. Nosov et al. present here an intriguing new approach to evaluate the impacts of these issues, however. Such difficulties have not daunted researchers, who have been able to gain unprecedented observations and new understanding of geodynamic processes in spreading centers, triple junctions and transform systems, such as Núñez-Cornú et al.'s TSUJAL passive experiment offshore Western Mexico and the active-source profiling near the Mexican Islas Marias combined with passive data (Madrigal et al.; Núñez et al.) to further explore tectonic structures and correlate the observations with detailed bathymmetry.

Evaluation of seismic hazard and improved location capability for near-shore offshore events - including potentially tsunamigenic earthquakes - are historically difficult when observations are restricted to onshore networks, but a better picture of offshore seismicity for assessing hazards is demonstrated for an OBS experiment in the Ionian Sea by Sgroi et al.

Innovative application, or adaptation, of new and specialized seismic methods are demonstrated with seafloor data, providing an exciting opportunity for insights and uses for these sometimes

OPEN ACCESS

Edited and reviewed by:
Carolina Lithgow-Bertelloni, University of California, Los Angeles, United States

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Specialty section:
This article was submitted to Solid Earth Geophysics, a section of the journal Frontiers in Earth Science

Received: 10 January 2022
Accepted: 27 January 2022
Published: 25 March 2022

Citation:
Rowe CA, Núñez-Cornú FJ, Núñez D, Bilek S and Lindsey N (2022) Editorial: Advances in Ocean Bottom Seismology. Front. Earth Sci. 10:852059. doi: 10.3389/feart.2022.852059

challenging observations. Laske demonstrates robust observations of normal modes using broadband OBS data, making a convincing case that the best possible sensors should be deployed in marine experiments, allowing for exploitation of observations beyond those which may be initially targeted by a particular deployment. Along the same vein, Tonegawa et al. show that the often-problematic seafloor seismic noise can be exploited, as in on-land noise surveys, to derive structural information in the absence of earthquake or air gun sources in some circumstances.

Creative application of techniques not previously applied to seafloor data are demonstrated by González-Fernández, in his full-wave extension of the generalized reciprocal method on refraction data to image structure beneath the Gulf of California, while Bayrakci et al. apply seismic anistropy methods to seafloor data to illuminate fractures that may be associated with seafloor methane venting in the North Sea, a significant concern for climate change. Dhakal and Kunugi report on strong motion analyses using the cabled S-net and K-net OBS deployments offshore of Japan, and the implications for earthquake early warning.

Finally, looking ahead, we have promising efforts underway in instrumentation and analytical advances related to seafloor cables themselves. Howe et al. and Matias et al. bring reports on developments for new capacity on seafloor cables. The planned deployment of Science Monitoring And Reliable Telecommunications (SMART) cables in the north Atlantic, targeting the Azores and offshore seismic sources impacting Iberia will exploit not only the cables' repeater-housed sensors but also Digital Acoustic Sensing (DAS) and laser interferometry techniques to provide real-time high-resolution observations and analysis of this tectonically active and hazardous area. The overall motivation, current status and important contributions anticipated by the SMART Cables initiative and its worldwide impact on seafloor geophysics (and oceanography) for not only earthquake observations and both earthquake and tsunami early warning, but also critical climate change data, provide us with a vision for ubiquitous sensing and real-time data return that is moving closer to reality for our science.

Any volume of research and review papers can only provide a snapshot in time of the state of the science, but we hope the wide spectrum of projects and analyses presented here can motivate additional research, new ways to exploit data already acquired and new approaches to solving the perplexing problems associated with expanding our seismic view into the oceans.

AUTHOR CONTRIBUTIONS

Editorial written by CR, edited, modified by all other guest editors.

ACKNOWLEDGMENTS

This is Los Alamos publication LA-UR-22-20191.

Conflict of Interest: NL is employed by Fibersense.

The remaining 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.