

Autonomously Deployed Deep-Ocean Seismic System (ADDOSS) – the emerging technology for Ocean Seismic Network

Raja Acharya

India Meteorological Department, Regional Meteorological Centre, Kolkata (Ministry of Earth Sciences)

The Autonomously Deployed Deep-Ocean Seismic System (ADDOSS) is primarily used with the goal to navigate the oceans with seismic instrumentation which will help in monitoring of earthquakes, advances in tsunami warning systems, and research on deep Earth structure.

Features of this system: This novel technology is introduced by the Scripps Institution of Oceanography at UC San Diego. It is autonomously deployable, communications gateway designed to provide long-term and near real-time data from ocean observatories. The new system has the ability to telemeter sensor data from seismometers deployed on the seafloor top shore via satellite and to be deployed without a ship, thereby greatly reducing life-cycle costs.

Ocean Surface Gateway: The system consists of a free-floating surface communications gateway which utilizes a Liquid Robotics wave glider.

Wave Glider: The surfboard-sized float is towed by a tethered, submerged glider, which converts wave motion into thrust. The surface float is equipped with solar panels, an Iridium satellite telemetry modem/GPS, and a small processor to provide commands to steer the system via a rudder on the glider. The Wave Glider has demonstrated the ability to “swim” thousands of kms across the open ocean and to hold station in a very small watch circle. The subsea instruments (ocean bottom package) and the surface gateway are connected through Acoustic Communications link, while communications between the gateway and land are provided by the Iridium satellite constellation.

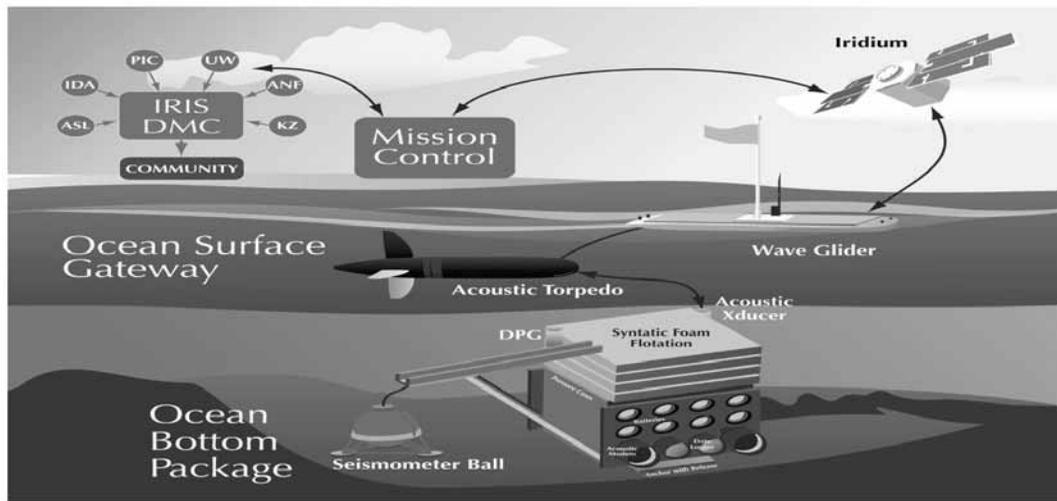
Performance: Tests of the surface gateway in 4350 m depth of water demonstrated that it has the ability to send 4 channels of compressed, 1 sample per second data from the ocean bottom to the gateway with an average power draw of approximately 0.15 W and a latency of less than 3 minutes.

The Objective and Benefits of introducing ADDOSS: The establishment of approximately high quality broadband permanent ocean seismic stations has long been envisioned to provide seismic data coverage in areas lacking nearby island or continental sites. In the **IRIS** (Incorporated

Research Institutions for Seismology) grand challenges report (Seismological Grand Challenges in Understanding the Earth’s Dynamic Systems) the need to extend seismological observations to the seafloor was clearly articulated which will address the issue of OSN (Ocean Seismic Network). Of the 10 “Grand Challenges” identified, seven explicitly called for such seafloor stations to address the scientific problems such as improved tomographic imaging of the structure of the lower mantle (especially in the Southern Hemisphere), the core-mantle boundary, and the role of subducting slabs and plumes in deep mantle circulation. Studies of regional structure and tectonics of many areas also require observations from oceanic areas. The lack of good coverage in oceanic areas seriously degrades the accuracy of determination of earthquake parameters such as location and moment and this is particularly critical for tsunami warning systems.

Moreover, since the seafloor deforms under the loading of surface gravity waves, a broadband seafloor seismic sensor combined with a traditional bottom pressure sensor will respond to a tsunami travelling overhead and contribute useful real-time data to a tsunami warning system. While this system addresses a global seismic network (GSN), it has the potentiality for addressing other scientific problems including the monitoring of ice sheet and shelf breakup and telemetering data from many other types of seafloor and water column sensors. The life cycle costs for this system will be much less than the cost of maintaining buoys, with accompanying tethers, for scientific observations including climate. This sets the ground for introduction of an autonomously deployed, deep-ocean seismic system (ADDOSS) to provide long-term and near-real-time seismographic observations from the deep oceans. The system circumvents traditional ocean-floor seismometer deployments and data retrieval that involve ship time, expensive deployments via ships and long time lags in recovery.

Future Plans: ADDOSS is planned as a 20- station array with each unit spread 2,000 kms (1,242 miles) apart across the oceans where no islands exist. ADDOSS data will be integrated into Project IDA (the International Deployment of Accelerometers), the global seismographic network operated by Scripps Oceanography’s Cecil H. and Ida M. Green Institute of Geophysics and Planetary Physics.



ADDOSS Schematic diagram

CONCLUSION

This new technological capability would make it realistic to consider the deployment of seafloor observatories in any remote areas of the oceans. In addition to addressing fundamental questions of Earth structure and tectonics, providing real-time data from stations in oceanic areas will significantly increase the accuracy of earthquake parameters such as location and moment. The next-generation wave gliders will be large enough to tow smaller, disposable OBS packages to a remote deployment site without the need of a ship. This provides independence from ship schedules, ship costs, and the possibility of deployments in very remote ocean locations. Ultimately the ADDOSS will also replace the need for ship deployment of ocean buoys for monitoring oceanic and meteorological parameters as it will have the potential to deploy such ocean buoys in future

ACKNOWLEDGEMENTS

This technical news has been compiled using internet information, basically to propagate the importance of ADDOSS. I unequivocally state that the technical details given above have not been developed by me either

directly or indirectly. I thank the Chief Editor of JIGU for editing and publishing this technical news item.

BIBLIOGRAPHY

1. ADDOSS: Autonomously Deployed Deep-ocean Seismic System Communications Gateway for Ocean Observatories by Gabi Laske, Jon Berger, John Orcutt and Jeff Babcock
2. An autonomously deployed, deep-ocean, broadband seismic network Jon Berger (1), John Orcutt (1), Neil Trenaman (2), Tim Richardson (2), and Gabi Laske (1) (1) University of California, San Diego, Scripps Institution of Oceanography, La Jolla, United States (jorcutt@ucsd.edu), (2) Liquid Robotics, 1329 Moffett Park Drive, Sunnyvale, CA 94089
3. Development of an Autonomously Deployed Deep-Ocean Seismic System by Berger, Jonathan Orcutt, John Laske, M. Gabrielle Babcock, Jeffrey
4. Journal Nature Volume 507, issue 7491: Article: Global seismic network takes to the seas by Nicola Jones.
5. https://www.iris.edu/hq/workshops/2015/05/future_seismic_and_geodetic_facility_needs_in_the_geosciences
6. Connecting The Seafloor To Space With Persistent, Unmanned, Surface Vehicles By Justin Manley, Milsat Magazine, Oct 2016 Edition.

Diamonds from the deep

The oxidation state of Earth's silicate-rich mantle has had a profound effect on our planet's evolution, including core-mantle differentiation, mineral formation, and the distribution and availability of carbon, hydrogen, and oxygen. Most measurements derive from the highly oxidized upper mantle, yet theory and experiments suggest that the deep mantle should include chemically reduced regions and metallic iron alloys. Now Evan Smith of the Gemological Institute of America and colleagues report that a certain class of large gem-quality diamonds—including the 3106-carat Cullinan, the largest ever found—provides direct verification of those predictions: metallic inclusions of a solidified mixture of iron, nickel, carbon, and sulfur.

(Source: Physics Today 70, 2, 80 (2017); doi: <http://dx.doi.org/10.1063/PT.3.3475>).