Optimization of hybrid surveys with drop & pop nodes: an innovative approach

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Introduction

Recent advances in marine seismic processing are increasingly supporting the use of sparse OBN in conjunction with low-frequency sources in order to provide ever-lower frequencies, longer offset and wider azimuth datasets well suited to FWI purposes. However, conventional OBN systems show operational limitations when employed for sparse nodal operations. On one hand, node-on-a-rope (NOAR) operations are limited to relatively shallow water depths and are not optimal for sparse deployment as they require long cable sections between each OBN and with deployment only at a slow vessel speeds (~ 2 knots). On the other hand, OBN deployment by ROV (Remotely Operated Vehicles) is well adapted to operations in deep waters, but is a very costly approach, all the more so when nodes are deployed over a wide area. Free-fall seismometers are less known by the seismic industry, albeit they have been in use for decades for scientific purposes. Since 2004, Ifremer and Sercel have manufactured an innovative free-fall / self pop-up unit, MicrOBS, which is an autonomous deep ocean-bottom seismometer, deployable from any vessel of opportunity and with the capability to surface by itself.

Lessons learned after 18 years of free-fall, self pop-up OBN operations

The early motivation to design the MicrOBS ocean-bottom seismometer lay in addressing the scientific community's requirement for equipment dedicated to deep-water exploration. Rated down to 6000 m, the first version of the node incorporated a hydrophone and 3C geophones able to record PP and PS waves continuously for 24 days. At such extreme depths, free-fall deployment proves to be the best option: an approximate landing target position is suitable for a sparse receiver grid, while the overall small system size enables the use of vessels of opportunity. The main innovation lies in the approach to node recovery (Aufret, 2002). The node is released from its iron ballast only when the on-board hydrophone detects a specific acoustic signal sent from the surface vessel. Once it has surfaced, the node can be located by radio for ease of pick up. Several thousand deployments over 18 years have confirmed the efficiency of this approach, with an excellent recovery rate of 99.22%.

Useful seismic signal with offsets up to 700 km could be recovered with the early version of the node, equipped with dedicated VLF seismic sensors. As Oil & Gas industry's interest in sparse OBN acquisition has increased (e.g., Moldoveanu 2020), an upgrade was deemed necessary to address expectations that differ from those of the scientific community. The node design was consequently thoroughly reviewed, and the recovery automated to optimize operational performance when rolling nodes on ~1 km receiver grids which are about 10 times denser than those used for oceanographic purposes.

Recent MicrObs node upgrade

On the latest release of the MicrObs^{NT} (Figure 1 left), 3C geophones are replaced by the very latest 3C MEMS. These third generation seismic MEMS sensors enable signals to be acquired with true verticality and vector fidelity when used in 3C configuration (Tellier 2020), this is in addition to their inherent true amplitude and true phase sensing capability (Tellier 2021). Still rated for a 6000 m water depth, the node size has been reduced by 30% and they are now stackable to better facilitate deck operations and storage. The autonomy is rated to 50 days with rechargeable batteries, or 180 days when using standard, non-rechargeable batteries. The node electronics and operational model (user interface, harvesting etc.) are similar to that of the field-proven GPR300 conventional OBN.

Operational optimization for not-so-sparse receiver grids

The most challenging aspect of self pop-up OBN acquisition traditionally lies in the recovery phase, where all nodes have to be sequentially located before being hauled on board. Indeed, owing to the large distances between receivers in sparse nodal acquisition, and the large numbers deployed in hydrocarbon

surveys, the streamlining of the nodes recovery, while avoiding any slowing of the vessel, is absolutely key to maximizing crew productivity.
In the proposed approach, node recovery is performed at a steady and relatively fast 4-5 knots speed (with no requirement to slow the vessel). The recovery vessel is guided by the nodes themselves towards their popup positions, using a combination of VHF telecommunication, and satellite geo-positioning coupled to the vessel's navigation system. For extra measure each node is equipped with a high visibility flashing beacon. The vessel navigation system is also coupled to the MicrOBS management software and acoustic release module. This allows for the pop-up command to be triggered automatically while taking into account the time required for the node to rise from the seafloor to the surface. Once a node has surfaced, the vessel approaches close to the node, which is then guided by deflectors towards an automated mechanical lift system which brings it safely up on deck. (Figure 1 right). When compared to NOAR or ROV operations that are significantly constrained in respect of productivity (sparse node spacing) and cost (specialized vessels associated with complex, expensive LARS (Launch And Recovery System)) the turnaround time of the proposed system, for deployment and recovery, is 2 to 3 times faster. The associated operational costs are therefore greatly reduced. This simple and entirely retractable and removable LARS has been designed to adapt to vessels of opportunity, with a reduced installation time and no requirement to modify the vessel's superstructure nor any detriment to its oceangoing performance. Fully containerized, this LARS is designed with a particular focus on efficiency and safety, reducing the HSE exposure associated with these types of operations.

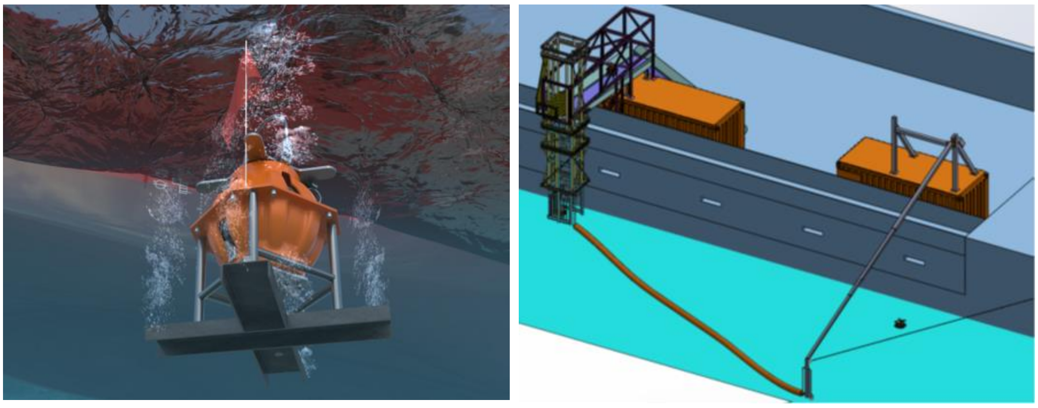

Figure 1 *The MicrObsNT (left) and its recovery system (right)*

Conclusions

The implementation of sparse OBN is gaining more and more attention from the seismic industry. Indeed, when used in combination with low-frequency sources and/or streamer acquisition, it can deliver the low frequencies required for FWI and at a reduced cost. While conventional OBN technologies used for conventional surveys are not well suited for such sparse surveys, oceanographic applications have demonstrated the soundness of sparse OBN when using the free-fall, self-popup concept. We have herein demonstrated that, by designing a simple LARS coupled to smart navigation software, it is now feasible to use a vessel of opportunity to deploy sparse OBN spreads, while reducing significantly the associated operational cost and HSE exposure.

References

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