

Sensing Seismic Signal in OBN without Equipment Artefacts with the 3rd Generation of MEMS

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Abstract

OBN projects are taking an increasing market share over towed streamer surveys, including in the Middle East where the most ambitious OBN surveys are ongoing or planned. In OBN, each node is equipped with a pressure sensor (hydrophone) and three motion sensors (typically, geophones). However, the now century old geophone technology has inherent shortcomings that alter the signal recorded. Technical specifications (in particular natural frequency, damping and sensitivity) are affected by changes in temperature, sensor aging and manufacturing tolerances. As an example, the variation in response reaches 3 dB in amplitude and 10° in phase for 15 Hz omnitilt geophones within their range of manufacturing tolerances. These uncertainties in sensor response are particularly difficult to model in practice, and become a concern especially when operated in a point-receiver or blending context.

A high-fidelity alternative to geophones today is digital seismic accelerometers based on MEMS (Micro-Electromechanical Systems). Their specifications are not affected by temperature, aging or manufacturing tolerances, making the signal recorded accurate (no error) in both phase and amplitude on the entire seismic bandwidth of interest. The coil-free design makes the sensor insensitive to electromagnetic noise, and the harmonic distortion (-90 dB) is much lower than that of geophones (-62 dB). As individual MEMS can detect the gravity vector, the integration of this sensing technology into OBN has in addition recently demonstrated that 3C MEMS provide without pre-processing seismic signal with true verticality, while the vector fidelity error (error in orthogonality between the 3 sensors) is an order of magnitude lower than for 3C geophones. The excellent low-frequency capability of the latest, 3rd generation of MEMS opens in addition the way to new achievements in FWI, especially when operated in combination with very low-frequency marine sources.

This added to other properties of MEMS, makes this sensor a probable driver for the development of OBN acquisitions - especially for sparse or blended acquisition, where the sensing fidelity more than ever matters. At the time of writing, an 18,000 channel MEMS-based OBN project is going on in the Middle East, and delivering a promising dataset according to ongoing early processing stages. Further comparisons between MEMS and geophones in OBN context will be presented and discussed, supported by field data from the Middle East.