

OBN Interferometry for Velocity Model Building in a Challenging Salt Context from Barents Sea

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Abstract

Large salts diapirs reaching the sea floor represent a real challenge for velocity model building in the Nordkapp basin. With the aim of improving the imaging of this underexplored area, a hybrid blended acquisition combining streamers and sparse nodes (OBN) was performed in 2021. The node carpet provides wide azimuths and very long offsets up to 90 km, which have demonstrated the potential for providing deeper FWI updates (Vigh et al., 2022). Continuous recording seismic data were acquired over a period of 3 months using active sources with minimum frequency of 1 Hz.

With seven sources shooting almost simultaneously, raw receiver gathers were heavily affected by blending noise. Despite a comprehensive deblending flow, the signal to noise ratio of the deblended data below 3 Hz remained too low for a stable FWI update. Following recent successful experiments carried out for Middle East land datasets (Le Meur et al., 2020), interferometry was used to generate ultra-low frequency virtual shot gathers from the raw OBN continuous records. The obtained virtual gathers contain diving waves with useful frequencies down to 1 Hz. These virtual shots (reconstructed at every node location) were then used in the FWI, allowing to start the inversion at 1.5 Hz. For the starting model, we used a smooth initial model without any salt a-priori information. The velocity model obtained by inverting the virtual data well catches the salt flank contrast, reducing the need of a-priori in the initial velocity model. FWI was then carried on using active seismic data starting from 3.5 Hz.

The virtual gathers also enclosed surface waves with minimum frequency of 0.3 Hz, which were used in a joint inversion framework (Bardainne 2018). The combined use of first breaks and surface waves from virtual gathers provided an initial estimate of both compressional and shear wave velocities over 1 km depth. This allows deriving a first estimation of the V_p/V_s ratio as well as an initial V_s model for elastic FWI.

OBN interferometry offers a robust way to reconstruct the missing low-frequency diving-wave information necessary to stabilize FWI and avoid the cycle-skipping pitfall. The reconstruction of ultra-low frequency surface waves allows getting an initial V_s estimation, paving the way towards elastic FWI (Leblanc et al., 2022).