

Efficient Frontier Exploration Using Towed Streamer EM and Broadband Dual Sensor Seismic Data

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Abstract

By using a Towed Streamer EM system to acquire Controlled Source EM (CSEM) data it is possible to determine efficiently the sub-surface resistivity at the regional and prospect scale. In addition, 3D broadband dual sensor seismic data enables separated wavefield imaging that produces high resolution images of the sub-surface, and fully populated angle gathers, even when a wide 3D seismic spread is employed in shallow water.

The Towed Streamer EM system enables a single vessel to acquire CSEM data at the same time as broadband dual sensor seismic with obvious efficiency benefits. Simultaneous acquisition enables CSEM data to be acquired early in the exploration workflow (e.g. as part of a 2D basin scale survey). It also provides co-located seismic and EM data that can be processed, and interpreted together. The concept has been proved in the Barents Sea by linking known discoveries, undrilled production licenses as well as open acreage.

Even when acquiring only CSEM data the Towed Streamer EM system enables large areas to be covered efficiently. For example, in less than four months PGS acquired recently nearly 12 000 km² of 3D Towed Streamer EM data in the Barents Sea South East. The survey covered all areas nominated for inclusion in the recent Norwegian 23rd licensing round. Part of the EM survey covered 3D broadband dual sensor seismic data that has now been processed using a complete wavefield imaging workflow that, in addition to wavelet shift tomography and full waveform inversion, uses separated wavefield imaging to produce images and gathers that span the complete range of incidence angles. Therefore, Amplitude Versus Angle analysis is possible even for the relatively shallow plays of interest in the Barents Sea South East.

Appealing to case studies we demonstrate that valuable prospectivity information can be gained by integrating an unconstrained resistivity with an interpretation of the seismic data, and that the interpretation may be enhanced when only weak structural constraints are employed in the EM inversion. In addition, we illustrate that when both 3D broadband dual sensor seismic and Towed Streamer EM data are available then there is potential to combine both quantitative seismic interpretation (e.g. AVA analysis) and quantitative EM analysis (e.g. prediction of hydrocarbon saturation) to identify leads and develop them into de-risked prospects.