Using Dual-Sensor Streamers to Address Seismic Imaging Challenges in OML 133, Offshore Nigeria

Chris Tapie [1], Yvonne Paisant [1], Per Eivind Dhelie [2], and Robert Lory [3]
[1]*ExxonMobil Exploration Company, Houston, TX.*
[2]*PGS, Lysaker, Norway.*
[3]*Esso Exploration and Production Nigeria Ltd, Lagos, Nigeria.*

Seismic images of the Erha and Erha North reservoirs in deepwater Nigeria are significantly impacted by the presence of a shallow channel complex located near the water bottom. Signal energy is attenuated and diffractions are generated, which in turn cause diffracted multiples that occur at the same time as the reservoir. Consequently, survey designs using conventional marine streamers must balance the desire to emphasize lower frequencies that penetrate the channel while preserving higher frequencies needed to optimize resolution of targets not affected by this channel. The most important survey design parameters that influence temporal bandwidth are the source and streamer tow depths and associated surface ghosting. Erha time-lapse 4D surveys—acquired with intermediate 5 m source and 6 m streamer tow depths—are an example of this design compromise. The Erha 4D survey offered a unique opportunity to perform a comparison between dual-sensor and conventional streamer technology for imaging and repeatability.

A controlled test program using dual-sensor streamers was acquired over the Erha field in an effort to address this challenge. Acquired concurrently with 2009 Erha 4D Monitor 1 survey, this 144 km 2D test program consisted of multiple sequences acquired with different source and streamer depth combinations. Repeat lines with identical parameters were acquired to assess repeatability of the technology. Test lines were located along sail lines from the conventional 4D streamer survey to provide an additional comparison.

Dual-sensor streamers use collocated hydrophones and geosensors to record acoustic pressure and particle velocity, respectively. Due to the negative reflection coefficient at the air-water interface, down-going energy is reflected with an opposite polarity to up-going energy. Since pressure is a scalar quantity, hydrophones record up-going and down-going energy with opposite polarity. In contrast, the geosensors record up-going and down-going energy with the same polarity. In the frequency domain, this results in complementary amplitude spectra where notches caused by the surface ghost in one sensor coincide with peaks in the other.

Preliminary results from the processing of the test program illustrate the tradeoffs associated with tow depth selection. Final processing is expected to demonstrate the extent to which the unique abilities of the dual-sensor streamer can reduce the need for a compromise in survey parameters.