Leveraging advanced acquisition and processing technologies to maximize seismic programs.

CONTRIBUTED BY WESTERNGECO

The WesternGeco multiclient group benefits from access to the industry’s most comprehensive range of integrated GE&G software and advanced seismic acquisition techniques. Decisions about where and how to acquire multiclient data are driven by detailed analysis of basin prospectivity and the particular imaging challenges of targets with the highest hydrocarbon potential, as well as by the timing of future license rounds. A detailed study was performed with the help of PetroMod petroleum systems modeling software to evaluate the potential of basins offshore Mozambique, which, following many years of civil war and political instability, is becoming more open for hydrocarbon exploration. More than 35,000 km (34,175 miles) of 2-D seismic data were interpreted, and the results were integrated with available gravity, well, and other geological data. The study evaluated if and how reservoirs may have been charged with hydrocarbons, including the source and timing of hydrocarbon generation, migration routes, quantities, and hydrocarbon type in the subsurface or at surface conditions. Significant natural gas discoveries have recently been made in the Kovuma basin in the north of the country, and the study indicated that hydrocarbon potential extends south to the Mozambique basin including the Zambezi delta area, which will soon become available for licensing. Following the geological study, WesternGeco survey evaluation and design specialists developed plans for an efficient and effective seismic program.

Acquisition of more than 31,000 km (19,262 miles) of new long-offset, 2-D seismic data covering the majority of the offshore territory commenced in April 2013. The survey is being acquired in collaboration with the National Petroleum Institute of Mozambique (INP) and is fully supported by industry prefining. The data are being acquired using the ObliQ sliding-notch broadband acquisition and imaging technique, which optimizes the recorded bandwidth of the seismic signal enabling more detailed imaging of the subsurface and more reliable extraction of rock properties. Two vessels, both equipped for onboard processing, have been deployed to ensure the data are ready for evaluation in time for the license round applications. The long records will help evaluate the position and shape of the basement as well as the thickness of the sedimentary section. New gravity data will become available for integration into the geological model. Advanced processing techniques, including depth imaging, amplitude-vs-offset (AVO) analysis, and amplitude-vs-angle (AVA) analysis will help reduce uncertainties in interpretation.

The ObliQ technique was combined with Coil Shooting single-vessel, full-azimuth acquisition in a 2012 multiclient 3-D survey in the Barents Sea Nordkapp basin, covering an area of more than 750 sq km (290 sq miles). The Nordkapp basin is an intracontinental syn-rift basin containing many complex salt structures. The salt is late Carboniferous to early Permian in age, with regional extension in the Triassic initiating the salt movement and subsequent tectonic phases allowing growth and distortion of these diapirs. Further uplift and erosion in the Tertiary may have generated salt-related traps in the Triassic and Lower Jurassic. These structures are notoriously difficult to image with conventional seismic techniques due to the generation of strong multiples from the seafloor and the top of the shallow salt structures. Seismic shadow zones and structures within the salt – possibly shale and carbonate rafts and stringers – cause severe diffractions, and prospective areas adjacent to the salt have proved to be elusive. The Coil Shooting technique acquires data using a vessel sailing in a series of overlapping continuously linked circles. It is enabled by the Q-Marine point-receiver marine seismic system, which accurately controls the depth and lateral position of the streamers. A fully braced acoustic positioning network provides accurate positioning information for all in-sea equipment. Finely sampled point-receiver recording and proven noise attenuation methods handle crossflow noise without harming signal fidelity. The technique has proved successful in imaging complex geological situations through better target illumination thanks to greater azimuthal coverage and higher signal-to-noise ratios than conventional 3-D methods. For all recent multiclient projects, the Nordkapp basin data are being processed using state-of-the art demultiple and prestack depth-imaging techniques, including reverse time migration (RTM) using an anisotropic velocity field. The results have allowed mapping of salt walls, overhanging structures, and potential traps that have never before been seen in seismic data from the region.

The Coil Shooting method has been extended to deliver both fullazimuth data and the very long offsets required to illuminate subsalt hydrocarbon plays in deepwater areas of the Gulf of Mexico, which often present severe imaging challenges related to thick salt bodies with complex morphology. The Dual Coil Shooting multivessel full-azimuth acquisition technique involves two recording vessels with their own sources and two separate source vessels sailing in interlinked circles. Since 2010, more than 27,000 sq km (10,425 sq miles) have been surveyed using the method in the Revolution program of multiclient projects. The datasets have been processed using anisotropic RTM schemes appropriate for the complex geology and steep dips around the subsalt targets. Three-dimensional prestack acoustic full waveform inversion has been used to build high-resolution velocity models.

The WesternGeco multiclient group also is taking advantage of the IsoMetrix marine isometric seismic technique launched during EAGE 2012. It was used for acquisition of the 2013 Ice Bear-2 3-D survey in the western Barents Sea, which targeted the Jurassic reservoirs already proven in neighboring areas and also potential plays in the Triassic sequence and in turbidite fan sediments above the Base Cretaceous Unconformity. The processing workflow is designed to use the acquired broad bandwidth and fine isometric spatial sampling to deliver the highest resolution 3-D imaging yet achieved in the area.

For more information about WesternGeco acquisition and processing technologies, go to slb.com/multiclient or visit booth 930.