EAGE

SSP04

Survey Design and Evaluation for Advanced Marine Acquisition in a Subsalt Environment

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SUMMARY

The goal of this study is to present a survey evaluation and design (SED) methodology that will determine an optimum acquisition geometry to properly image complex subsalt structures such as that in the Red Sea area. The key objectives are to analyze the impact each survey design has on the illumination of the target horizons, to quantify the improvements in seismic data quality and establish which strategy provides an optimum and cost effective acquisition scenario.

Introduction

The goal of this study is to present a survey evaluation and design (SED) methodology that will determine an optimum acquisition geometry to properly image complex subsalt structures such as that in the Red Sea area. The key objectives are to analyze the impact each survey design has on the illumination of the target horizons, to quantify the improvements in seismic data quality and establish which strategy provides an optimum and cost effective acquisition scenario.

Methodology

The project focused on the modeling of multiple survey acquisition strategies including conventional narrow azimuth (NAZ), wide azimuth (WAZ), rich azimuth (RAZ), shooting in circles (COIL) and ocean bottom node survey (OBN). Analysis included accurate estimation of seismic amplitudes across the target horizons after migration, horizon maps depicting lateral distribution of reflection points and number of illuminated reflection angles, aperture size (CMP-CRP) variation and the optimum recording time needed to capture most of the critical events. The study was extended to estimate the resolution of the seismic data at key depth points within the target reservoir by employing a new PSDM simulator, which is based on ray tracing technology. Adding this technology into our SED enabled us to build an efficient workflow that considers the illumination and resolution benefits of multiple surveys while still honoring the effects of the acquisition geometry, overburden and reservoir properties.

Model Description and Results

Figure 1 illustrates a velocity-depth model that covers an area of approximately 60 km by 130 km with a vertical extension of 11 km. Water depth ranges from 35 meters on the shelf to more than 1,500 meters in the basin. Faulting causes the model to split into a large number of different blocks. The relatively low velocity in the upper sub-surface (1,700-2,200 m/s) is underlain by a package of high velocity layers and blocks (3,600-4,700 m/s). Several salt bodies (4,500 m/s) are floating in this package, significantly disturbing modelled ray paths due to their shapes and velocity contrast.

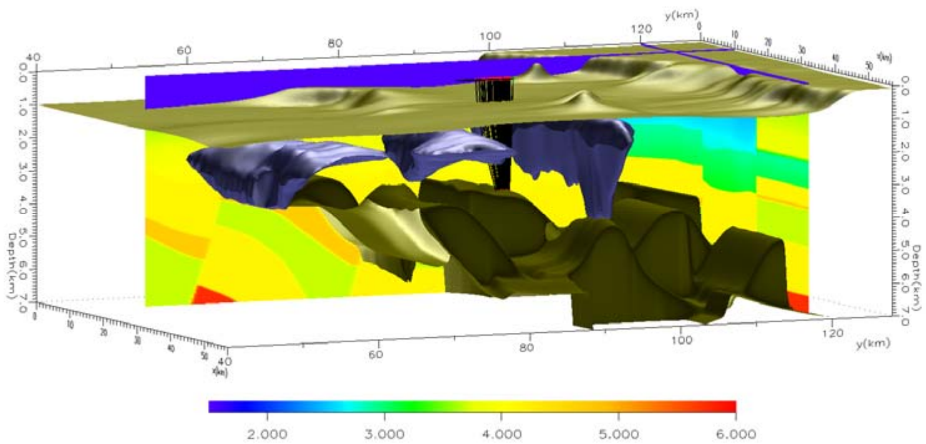

Figure 1 Ray paths indicating the result of a single shot of a narrow azimuth streamer survey, shot parallel to the main strike-slip faulting direction but across the strike of a deeply buried system of troughs and ridges.

Conclusions

The survey evaluation and design workflow presented takes advantage of the efficiency and accuracy of the ray tracing approach. The seismic modeling software has enabled the generation of results that provide diagnostic information such as optimal survey orientation and design, distribution of seismic amplitudes across the target, horizon maps depicting number of reflection points and reflection angles, identification of optimum listening time, etc. In addition, use of the advance PSDM simulator has facilitated the accurate generation of seismic resolution and illumination attributes at key depth points within the reservoir in a time efficient manner.