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Preliminary Results of the Genesis Field Time-Lapse Seismic Project, Gulf of Mexico

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Abstract

A seismic survey was acquired over the Genesis Field in the deepwater Gulf of Mexico in October, 2002, 33 months after first production, for the purposes of reservoir monitoring and field management. The 1991 baseline survey was co-processed with the 2002 monitor survey to minimize differences between the surveys except those related to production. Interpretation of the resulting seismic reflection and acoustic impedance (AI) volumes indicate that the 4D project will add significant value to the field.

The 4D data have been interpreted for the field's five primary reservoir sands revealing production-related, time-lapse anomalies including an increase in travel time of up to 10 ms at the top of the producing interval due to reservoir compaction and overburden dilation and changes in reflection strength due to fluid movement and pressure reduction. Updip potential was recognized and/or geological risk for remaining reserves reduced in three reservoirs and connectivity uncertainties in several reservoirs were resolved, leading to better understanding and modeling of reservoir behavior.

Initial value of the 4D project has been indicated by the elimination of one anticipated sidetrack, saving over $10 million. Another sidetrack had its geological risk reduced and estimates of recoverable reserves increased. Several future sidetracks should be affected similarly. Updates to the geological model with corresponding adjustments to the reservoir simulation should lead to better well placement, better recovery estimates, and improved reservoir management.

Introduction

Genesis Field is located in the Gulf of Mexico, 150 miles south-southwest of New Orleans in the northeastern quadrant of the Green Canyon protraction area (Fig. 1). Water depth across the field varies from 2500 feet to 3000 feet. The field was discovered in 1988 and the first proprietary 3D seismic survey was shot in 1991. Delineation wells were drilled from 1990 to 1995 followed by project sanction in 1996. Production started in January, 1999 and peaked in June, 2001 with 14 wells producing at a combined rate of 55,145 BO and 95,610 MMCFG per day. By the time the monitor 3D seismic survey was shot in October, 2002, the field had produced over 57 MMBO, 89 MMCFG, and 19 MMBW. To date, over 115 MMBOEG have been produced.

The geology of the area around Genesis Field is dominated by complex salt ridges, small piercement salt domes, and intrasalt minibasins filled with Miocene to Pleistocene age, turbidite, sand-shale sequences (Fig. 2 and 3). The depositional environment of the reservoir sands includes amalgamated turbidite channels, ponded fill and spill sequences, channel/levee/overbank, and distal sheet sands. The field is located on the east flank of a north-plunging salt ridge and consists of a combination of structural and stratigraphic traps between 11,000 and 16,000 feet subsea. Reservoirs host oil columns of up to 1400 feet (Fig. 4) and produce through moderate water drive, depletion drive, or a combination of both. Originally all of the major reservoirs contained undersaturated oil with no gas caps.

4D Seismic Project

The principles, methodology, and utility of time-lapse seismic principles are well established (Greaves and Fulp, 1987; Jenkins et al, 1997; Johnston and McKenny, 1998; Talley et al, 1998; Boyd-Gorst et al, 2001; Gouveia and Johnston, 2004). Changes in the distribution of hydrocarbons in the producing reservoir are identified by comparing a pre-production (baseline) seismic survey and subsequent repeat (monitor) surveys. The seismic response to production varies with lithology, porosity, and fluid type. The steps taken to establish the feasibility of time-lapse seismic at Genesis were:

1. Calculating predicted changes to seismic response associated with saturation and pressure changes from log-derived petrophysical parameters.
2. Laboratory testing of conventional core plugs to confirm the acoustic response to changes in saturation and pressure.
3. Modeling changes to seismic response over time with a predicted production schedule and demonstrating that measurable changes in seismic response should be discernable as early as 2001.

The differences between simulated and actual well performance supported the application of time-lapse seismic to help resolve these discrepancies and provide a better understanding of the field. Optimum timing, acquisition and processing parameters, and potential value were addressed