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Seismic, Core and Well Log Reservoir Characterization of the Cardium Formation, Ferrier Pool Area, West-Central Alberta

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Summary

3D seismic was shot in the Ferrier pool, one of the largest Cardium oil and gas producers in Canada. Seismic shows high and low amplitudes with the high amplitudes trending southeast to northwest. Objective for the project is to determine reason for the linear seismic trend. Cores in the study area were examined and broken up into facies and compared to the seismic trend. Using well logs, a series of net pay maps, and porosity meter maps were made to compare with the seismic. Early work shows 3D seismic amplitude maps correlating well with the net pay and porosity maps, but poorly to net sand maps and facies. Early results conclude that the 3D seismic may be able to recognize areas of increased reservoir potential.

Introduction

The Late Cretaceous Cardium Formation contains some of the largest oil pools in Canada. With the development of horizontal drilling and multistage hydraulic fracturing, areas with marginal pay have become economic and the Cardium has again become a hot exploration play. This study demonstrates that 3D seismic can be used to map reservoir quality within an area of conventional type Cardium reservoirs.

The study area is located in the Cardium Ferrier Pool area. The Ferrier Pool is the 3rd largest oil pool, and the 2nd largest gas pool of the Cardium in terms of marketable reserves. The Ferrier contains $6.2x10^7$bbl of oil and 0.45 bcf of gas. The study area has, in recent years, been an area of recent drilling targeting dry-gas within the Cardium. The study area of 1.5 townships has complete 3D pre-stacked migrated seismic data coverage.

The Cardium Formation contains two sands within the study area. The younger sand, informally known as Cardium "A", is a continuous fine to very-find grained blanket of hummocky cross-bedded sandstone extending over the entire area, which is relatively homogenous over the entire study area. The older sand, informally known as Cardium "B", is a straight, thin elongate sandstone body running northwest-southeast across the study area. The upper sand is overlain by conglomerate lag, and encapsulated by marine shales. 3D seismic data is available across the study area, and several Cardium horizons were picked and evaluated. Amplitude analysis of the Cardium "A" sandstone horizon brings out a distinct linear seismic feature, which trends from the northwest to the southeast. The objective of this study was to understand what in the reservoir geology or reservoir fluid content causes this distinct seismic feature. Early results show the high seismic amplitudes to correspond to areas of high net-pay and porosity-meter values.

Method

Based on 16 Cardium cores within the study area, sedimentary facies was classified and their variation in facies and thickness was mapped. Using the core as a calibration for sand thicknesses, 60 well logs were examined to create net sand, net pay and porosity meter maps. In addition, thin sections were integrated to better evaluate reservoir properties.

Results

The majority of Cardium core covers the Cardium "A" sand. Five distinct facies were identified. At the base, intensely bioturbated mud-rich siltstone with 5-10 centimeter massive interbedded fine-grained sandstone beds, likely tempestites, represents a proximal offshore environment. An interval of interbedded bioturbated sandstone and mud beds overlay the siltstone. This in turn is overlain by hummocky cross-stratified sandstone of the Cardium "A", which thicknesses ranging from 2 meters to 14 meters. The lower meter of the sandstone often contains rounded dark-grey clay clasts, which disappear in abundance upwards. The sandstone is unconformably overlain by a transgressive conglomerate lag, often containing one or both of either a matrix supported conglomerate with a mudstone matrix and a grain-supported conglomerate with a siltstone matrix. The conglomerate is overlain by dark-grey distal offshore shale, which little to no visible bioturbation present.

The net sand map of the Cardium "A" sandstone shows it to be relatively uniform in thickness across the area, insomuch that no pattern of thickening and thinning was evident. In contrast, both net pay and porosity meter maps show linear northwest-southeast trends of highs and lows.

Conclusions

These early results indicate 3D seismic can be used to evaluate reservoir potential of the Cardium, and that 3D seismic can be a strong tool in identifying areas of increased pay and possibly production.

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