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Impact of Seismic Data on the PSVM Development

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Summary

The PSVM ultra-deep water oil development started up in December 2012. The development, in the northern part of Block 31, comprises 9 segments in 4 main field areas – Plutao, Saturno, Venus and Marte. Oil recovery is mainly by waterflood, but three segments also have gas injection. Multiple seismic datasets have been acquired, processed and interpreted since block award and development drilling began. This presentation aims to look at the impact of key seismic data sets on development drill-out and reservoir management in the PSVM development.

Introduction

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Impact of different seismic data sets

Initial field drill-out was undertaken on conventional high-resolution towed streamer 3D data (isotropic time-migration, 2005 vintage). Using these data, it was possible to map key stratigraphic surfaces and seismic facies within the reservoirs. Successful ramp-up hinged on the ability to target high-quality axial sands in the mainly channelized reservoirs. Drilling results proved that this was possible. However, re-processing the data to incorporate velocity information from VSPs had an immediate impact. The resulting anisotropic depth-migrated data had a better-positioned image, which enabled more accurate well positioning and container description in the salt-occluded segments (Figure 1).

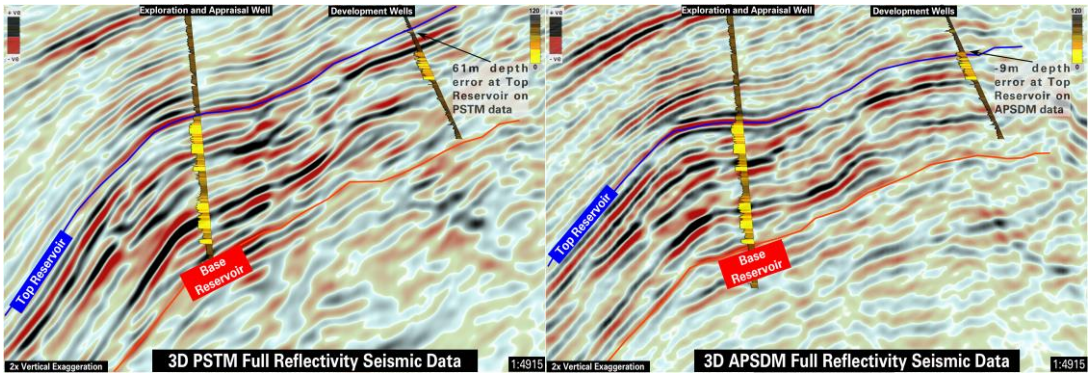

Figure 1 *Fast-track APDSM data delivered in Q3 2013 led to real-time revision of the prognosis & trajectory of this well. Left hand image is the isotropic time-migrated data, right hand image is the anisotropic depth-migrated data. The structure has flattened considerably in the right hand image.*

The first PSVM 4D seismic monitor was acquired from June-September 2014; not all field segments were on production by this time. Value was initially realized over a 6 to 12-month time-frame, firstly by impacting water injection strategy and offtake optimization (Figure 2), and then by influencing well placement in some late wells and the decision to do a water shut-off in an early producer.

Detailed mapping of the monitor survey has also highlighted the heterogeneous nature of sweep within some of the thicker channel axes. In addition, there is limited evidence of sweep outside the channel axes, although the monitor was acquired early in field life (Figure 3). In some areas where the 3D interpretation was ambiguous the presence of 4D anomalies helped refine the stratigraphic and/or facies interpretation. A second monitor survey – planned for 2018 – will provide further insight into sweep patterns and reservoir architecture in the PSVM reservoirs, and enable us to understand the distribution of remaining hydrocarbons more clearly.

The 4D data also provided insight into reservoir energy in PSVM. Early production data indicated that the reservoirs have high average energy. 4D seismic timeshift data confirmed that compressibility is a significant source of energy, and 4D difference volumes also showed the volume of aquifer influx in some fields - a second major component of reservoir energy.

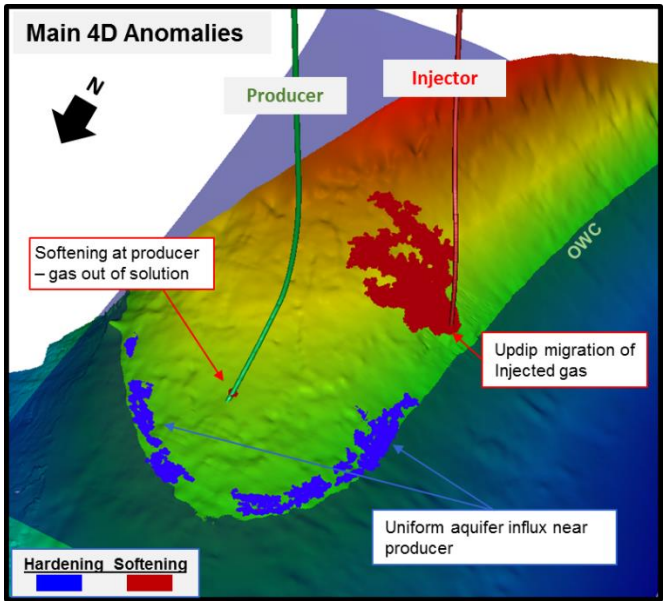

Figure 2 *Value of 4D in offtake optimization where the 4D data showed uniform aquifer influx towards the producing well, and gas moving updip. Offtake strategy was managed to delay breakthrough.*

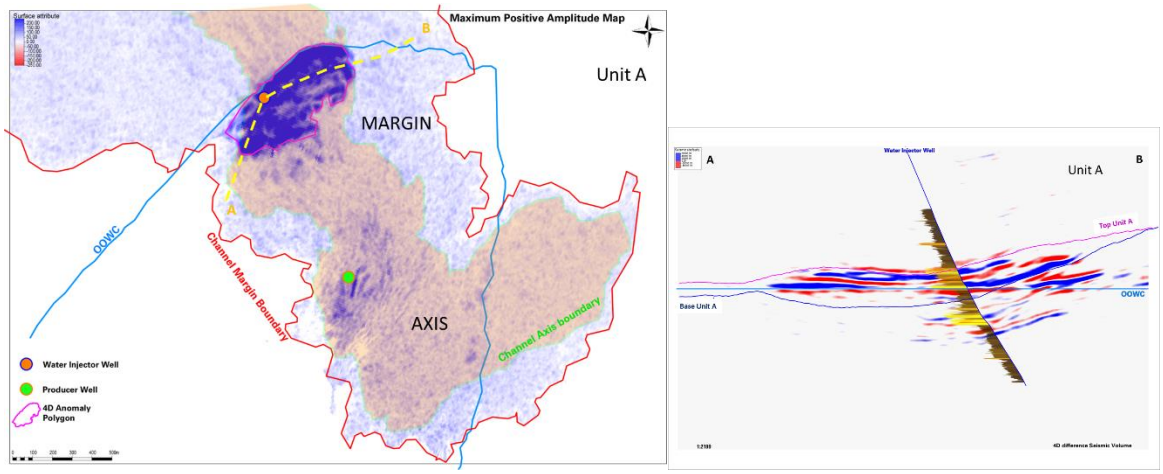

Figure 3 *Left hand image - 4D MPA map of a thick channel complex, showing preferential water movement in the channel axis. Right hand image – 4D difference line A-B.*

In addition, Broadband data were acquired and processed over PSVM during the early part of the development. Benefits included an incremental uplift in imaging, particularly of the structurally complex fields, and improved net prediction in thinner reservoirs. One late well was dropped from the programme, as the enhanced image indicated a significant decrease in volume and likely better connectivity of the target to the existing producer.

Acknowledgements

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