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LoFS Processing for 4D Attributes at the BC10 Field – Offshore Brazil

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SUMMARY

The BC10 LoFS system is providing early benefits from its investment. Fast-track 4D results were obtained within only 7 days after the field data arrived at the processing centre in Houston. These 4D results have been confirmed by the follow-on full-fidelity processing of the down-going wavefield. The 4D results indicate clear hardening at the injector wells and softening at the producing wells. These 4D results correlate accurately with the documented performance of the wells in the field.

Introduction

The BC-10 field is a producing offshore asset located 325 kilometres northeast of Rio de Janeiro, Brazil. In order to provide life of field seismic (LoFS) monitoring of this field, 986 four-component sensor packages were deployed in approximately 90 kilometres of ocean-bottom cables (OBC) at an average water depth of more than 1600 metres. Figure 1 displays the layout of the BC10 LoFS array. The array consists of 14 parallel cables connected on their northeast terminus to a "backbone" that in turn connects to the umbilical that leads to the recording system on the FPSO at the surface. The array is now permanently connected to a recording system located on the FPSO that is supporting production activities in the field. This equipment arrangement facilitates the need to mobilize only a shooting vessel to record subsequent monitor seismic surveys for field surveillance. The nominal shooting area to monitor this field is approximately 135 square kilometres.

Acquisition of the baseline survey was completed in November 2013. Subsequent to the acquisition of the baseline survey a processing workflow was established with the intention of streamlining the processing steps to be applied to all follow-on monitor surveys. The first monitor survey was acquired during the month of June 2014. Utilizing the processing methodology developed during the time period between the base and monitor survey we produced fit-for-purpose seismic data that was used to obtain 4D results.

Methodology

The asset in charge of the BC10 field desired a method to economically monitor water-flood containment and overburden integrity during the injector start-up and throughout the production life of the field. In addition, there was the desire to provide surveillance on the progression of the waterflood at the injector wells and monitor rock properties at the production wells to update the existing reservoir model. In order to meet these objectives the BC10 LoFS array was designed and deployed. The BC10 LoFS array was the deepest documented installation of a LoFS system in the petroleum industry at the time of deployment. In order to defray the cost of deploying the LoFS system, the line spacing between cables was set at 400 metres.

Shell's Upstream Americas Geophysics – Marine Imaging Team provided complete processing services for the BC10 LoFS data. This included all processing from reformatting the raw SEG-D field data thru final 4D volumes. The processing flow developed and applied to the LoFS data has proven to be very effective and has resulted in NdRMS values at reservoir level of 2.5% for the down-going wavefield per the description of 4D attributes by Stammeijer and Hatchell (2014).

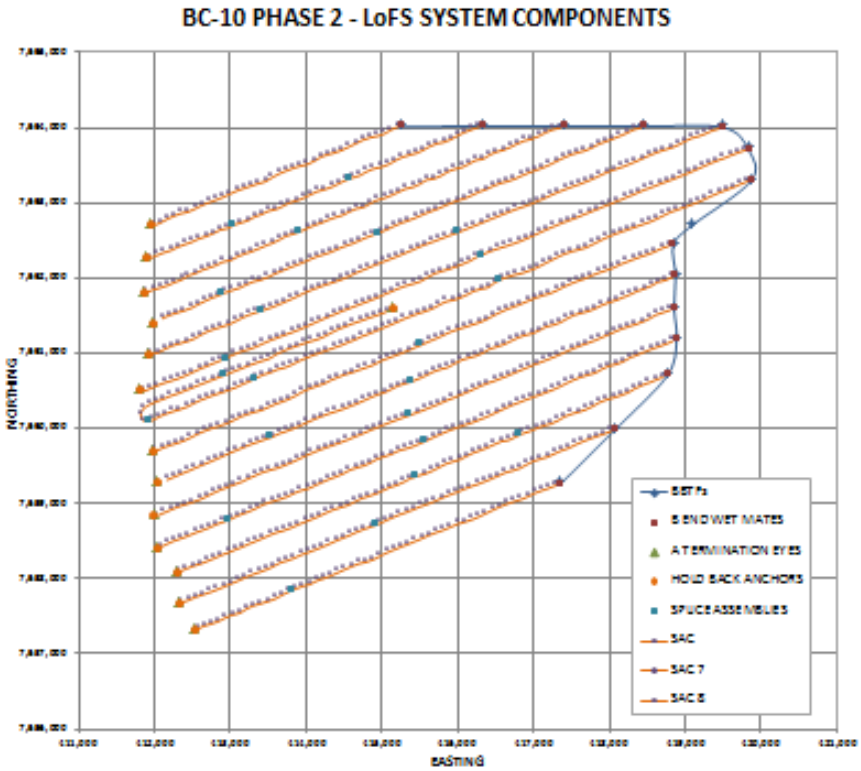

Figure 1 *Layout of the BC10 LoFS array. The array consists of 986 four-component sensors imbedded in 14 cables. The inline spacing of the sensors is 100 metres while the cross-line spacing is 400 metres. The average depth of deployment is more than 1600 metres.*

Conclusion

The BC10 LoFS system is providing early benefits from its investment. The 4D results indicate clear hardening at the injector wells and softening at the producing wells. These 4D results correlate accurately with the documented performance of the wells in the field.

We have shown that by utilizing the Shell 4D processing methodology we are capable of providing processed LoFS data that is fit for purpose to produce valid 4D results to meet the needs of the asset with regard to effective reservoir management.

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References

Stammeijer,J.G.F. and Hatchell, P.J. [2014] Standards in 4D Feasibility and Interpretation. *Leading Edge*, **33**(2), 134-136.