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BS04

Enablers for the Success of Land Seismic Imaging: Sampling, Broadband, WAZ and Recording Techniques

S. Mahrooqi* (PDO - Petroleum Development Oman), S. Rawahi (PDO), S. Yarubi (PDO) & F. Clow (PDO)

SUMMARY

Quality, cost, and risk are key considerations to acquire fit for purpose seismic data. While it is difficult to quantify 'quality' of seismic, and there is no 'fits all' acquisition geometry template, it is clear that escalating technology improvements and channel cost reductions have enabled improved 'fit for purpose' sampling in both the in-line and x-line, at least at target depths.

The emission and recording of high density broadband land seismic data provides greater potential for imaging the entire geological subsurface. Petroleum Development Oman (PDO) along with their seismic contractors have succeeded in delivering reliable, full bandwidth production data, utilising broadband sweep, WAZ data, employing 24/7, slip sweep, dynamic fleeting acquisition techniques, without compromising safety and costs.

Introduction

Quality, cost, and risk are key considerations to acquire fit for purpose seismic data. While it is difficult to quantify 'quality' of seismic, and there is no 'fits all' acquisition geometry template, it is clear that escalating technology improvements and channel cost reductions have enabled improved 'fit for purpose' sampling in both the in-line and x-line, at least at target depths.

The emission and recording of high density broadband land seismic data provides greater potential for imaging the entire geological subsurface. Petroleum Development Oman (PDO) along with their seismic contractors have succeeded in delivering reliable, full bandwidth production data, utilising broadband sweep, WAZ data, employing 24/7, slip sweep, dynamic fleeting acquisition techniques, without compromising safety and costs.

Phenomena to Resolve

Land Seismic data suffers from near surface phenomena including ground roll with varying frequencies and velocities, back scatter, multiple generators, also complex subsurface geology. Ambient noises both transient and persistent are becoming increasingly apparent as the activity footprint of the seismic crews becomes larger, together with recording of Low Frequencies. On the other hand, the earth filter (geologically filtered) noise 'multiples' are still the phenomena that cannot be easily resolved, especially if there are no velocity separations between primaries and multiples.

As the requirements evolve to develop more complex reservoirs and subtle, stratigraphic traps, the demand for a high fidelity noise free image becomes increasingly important.

Enablers for Better Seismic Imaging

There have been a number of technologies, both in acquisition and processing, attempting to deal with the near surface phenomena. Not surprisingly, it has been apparent that improved sampling, Broadband and WAZ geometry at target are key for better subsurface imaging.

To support the investment required for these recording techniques, enablers must be deployed in order to optimise production efficiency, including short weeps, slip sweep and DSSS.

For PDO, evolution of receiver geometry, together with sources has been developed since 2008. For shallow targets with low acoustic impedance and severe multiple contamination the use of a WAZ template with 25x25m source and 25x100m receiver grid has proved optimal. Conversely for relatively good data areas, a WAZ template with 100x25m (or 50x50 m) source and 25x250m receiver grid has been used.

To acquire densely sampled WAZ geometries with faster turnaround while maintaining or reducing unit costs, a number of innovative technological enablers were introduced and implemented, without jeopardizing data quality. High channel counts enabled improved receiver sampling as well as being able to acquire larger areas. Shorter sweeps with single, point source and laterally, heavier vibrators provided adequate broadband frequencies. Implementation of 'Slip Sweep' and 'Dynamic Fleeting, Distance Separated Simultaneous Recording' techniques expedited high productivity acquisition.

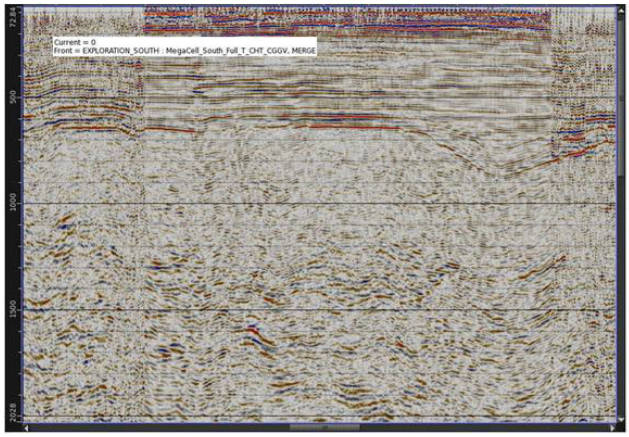

Figure 1 *Legacy Data.*

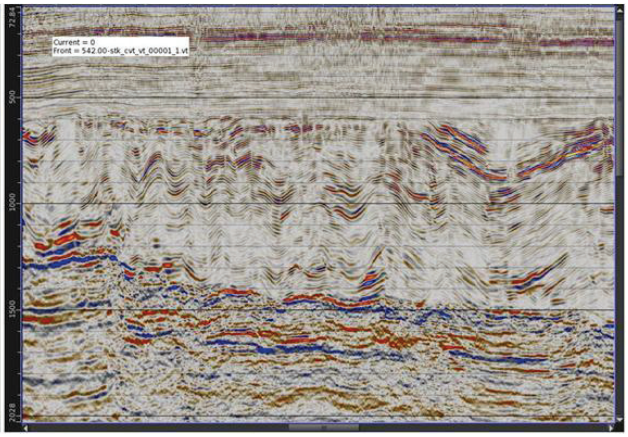

Figure 2 *Improved Seismic Image with latrest.*

Conclusion

Recent technological advancements in seismic acquisition have resulted in densely-sampled, broadband, wide-azimuth seismic as a step towards delivering a fit for purpose seismic image.

The benefits of the presence of Low Frequency will enable better deep imaging and satisfy the full potential of advances in processing such as Full Waveform Inversion.

Finally it is very positive to observe that the industry still foresees further exciting innovative techniques to meet the challenge of accurate subsurface imaging, together with improved efficiency initiatives.

Acknowledgements

The authors would like to thank Petroleum Development Oman and the Minister of Oil and Gas, Sultanate of Oman, for permission to publish this paper. We also wish to acknowledge Ardiseis, BGP, Sercel, INOVA and ION for their ultimate support with the field acquisition. Great thanks to CGGV processing in PDO, and all PDO geophysicists and its Company Site Representatives for the support throughout the PDO geophysical journey.

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