M07

Geophysical Benefits and Operational Characteristics of Steerable Marine Seismic Streamers

B.P. Donnelly* (ION Geophysical Corporation)

SUMMARY

Multi-streamer marine acquisition is possibly the most successful application of 3D seismic. However, the method has problems and short-comings. Cables are influenced by tides and currents, and precise control of streamers is not possible. In order to prevent tangling the streamer separations are high, so that the high-fold acquisition is difficult to achieve. Streamers are affected by the dynamics of the towing vessel, leading to phenomena such as 'fantailing'. Time-lapse surveying is now commonplace, to monitor production-induced changes in the reservoir. 4D effects are subtle, so it is essential to remove sources of error that could mask the actual differences. Repeatability is a measure of how well the original survey has been emulated by the monitor surveys, by replicating source and receiver positions. This is difficult with existing technologies. The solution is to control the lateral behaviour of the streamers. Vertical control of seismic cable positions is achieved using 'birds'. This concept can be used to control horizontal motion, i.e. employing a vertically mounted fin. This enhances streamer control so that cable separations can be reduced, enabling higher density acquisition. Results will be shown based on modelled data and case studies.

Introduction

Multi-streamer marine acquisition is arguably the most successful and productive application of the 3D seismic method. The relative ease of lay-out and retrieval makes this the most cost-effective method for large area geophysical imaging of offshore basins. However, as with all field techniques, there are inherent problems and short-comings. The sea is a dynamic and often unpredictable environment, and seismic streamers are at the mercy of the tides and currents. Precise control of the streamers' lateral and vertical motions is not possible. Further, in order to prevent tangling the streamer separations are high, so that the high-fold acquisition is difficult to achieve. The streamers are affected by the motion of the towing vessel, e.g. interaction with the prop wash is the cause the 'fan-tail' effect, causing loss of fold and a significant increase in the time and money spent infilling coverage. Apart from its expense, infilling of seismic data can lead to processing issues with uneven fold and offset.

Another technology which is now seeing widespread use is time-lapse surveying, or 4D seismic. Multiple surveys are shot over a number of years to monitor production-induced changes in the reservoir. 4D effects are subtle, so it is essential to remove sources of error that could mask the actual differences which you are trying to measure. Repeatability is introduced as a measure of how well the original survey has been emulated by the new 'monitor' surveys, by correctly replicating source and receiver positions. This is difficult with existing technologies.

We see that there are three particular issues with marine cable systems:

- Lack of control over fold of coverage, leading to uneven coverage and additional expense due to infill.
- Problems in acquiring high density, high-fold data due to cable separation issues
- Difficulty in ensuring a high level of repeatability for 4D monitor surveys.

All of these issues can be ameliorated if it is possible to control the lateral behaviour of the streamers. Vertical control of seismic cable positions is achieved using 'birds', i.e. external units with fins that can be moved to change the streamer trim. Such devices are an integral feature of any marine seismic. This same concept can be used to control horizontal motion, i.e. a vertically mounted fin can be used to steer the streamers as desired. These allow enhanced streamer control so that cable separations can be reduced, enabling higher density acquisition.

Probably the greatest contribution will be in 4D, allowing interpreters to better quantify reservoir changes, and so confidentially predict reservoir depletion.

Operational Characteristics and Benefits

In addition to the geophysical benefits mentioned above, the ability to steer seismic cables has considerable implications for how multi-streamer seismic surveys are acquired. In marine seismic, as in many other fields, it is an absolute truism that 'Time is Money'. Daily running costs for large 3D vessels are in the tens of thousands, and anything that reduces time spent in acquisition is a bonus.

Some of the ways that steerable streamers can save acquisition time:

- Layout and retrieval. Since the streamers can be steered away from each other it is straightforward to layout multiple streamers simultaneously without fear of tangling.
- Shorter line changes. The cables can be steered onto line during the line change, allowing for tighter, shorter turns.
- Reduced infill. Cable feather can be controlled and matched for adjacent lines, and loss of near-mid offsets due to fan-tailing can be reduced.
- Steerable streamers allow for closer approaches to obstructions, and better results from undershoot operations

To show the possible benefits, some acquisition data from real surveys has been modelled, using fairly conservative parameters. The analysis shows that for a fairly typical configuration there is a saving of ~ 10%, or in other words the vessel has over 30 days extra productivity in a given year. With today's day rates this amounts to a considerable amount of money.

Conclusion

The geophysical and operational arguments for the adoption of steerable streamer technologies are very telling, and in future lateral control of streamers will be as much the norm as vertical control is now. This is good news for both seismic contractors and oil companies: the former achieve better production and can earn more from their prize assets, their vessels; the latter receive seismic data with better coverage and offset distribution in a shorter time.