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Improving seismic data while decreasing costs

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Challenging the status quo to optimize 3D acquisition

Introduction

Well in advance of the current shift in commodity prices, Cenovus initated a pilot to decrease the cost of acquiring 3D seismic data. The challenge was to decrease costs while maintaining data quality and safety standards. Previous surveys in the area had been acquired with a dynamite source and an orthogonal 3D design. Bins size was either 10x10m or 15x15m with a fold of 14 to 16 at the target zone. This data represented the standard for comparison to any changes in acquisition parameters.

Monitor 4D's frequently made use of Vibroseis as an infill source as the setback distance around infrastructure is smaller than for a dynamite charge. Testing done in 2013 indicated that Vibroseis acquisition could replace future baseline surveys, however investigation and testing was required before making any significant changes.

Modelling suggested that in this area, the cost to acquire a Vibroseis survey is approximately 20% less than an equivalent dynamite survey. Additionally, Vibroseis offers 'on the fly' program scope changes which are difficult to achieve with dynamite sources. These points as well as others led us to investigate the possibility of acquiring future 3D's in the area with Vibroseis.

Method

Making such a significant change to our acquisition warranted extensive testing to prove the concept. Field testing was required to validate any modelled sweep given the current and future seismic objectives.

With background knowledge of the spectral content of the existing data, sweeps were designed to optimize both the PP & PS data. These data have differing requirements – a broad spectrum for PP, and a strong low end requirement for PS data.

The challenge was to design a sweep that moves smoothly through the bandwidth, dwelling in areas where the recorded energy is attenuated, and transitioning between ranges without causing artifacts, from harmonic feedback. Numerous sweeps were designed and evaluated by the team. Seven sweeps were brought forward for simulation and refinement prior to being executed in the field. Three sweeps were included for benchmarking: A traditional linear sweep, a simple high dwell and a low dwell sweep.

In February 2014 a 1.4km 2D line was acquired using our standard dynamite source parameters and the seven test sweeps. These lines were processed to structure stacks and analysis was performed on stacks and gathers. In addition to the analysis of the various source parameters, optimal sweep effort and bin size were also established through decimation of the dataset.

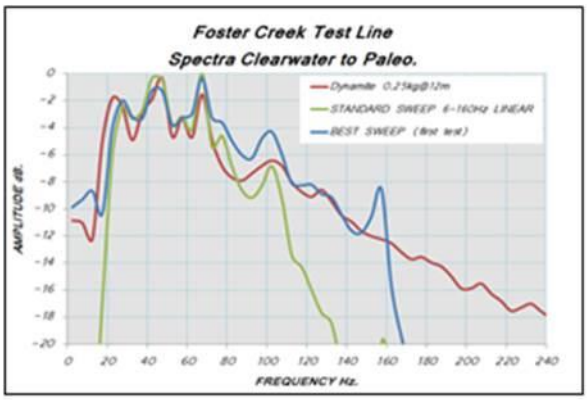

Figure1) Spectra achieved with dynamite and two different Vibroseis sweeps

This initial test clearly proved that an appropriate Vibroseis sweep could replace dynamite on future 3D surveys in the area.

In January 2015 prior to 3D acquisition, two additional 2D test lines were acquired each with differing near surface issues. The goal of this test was to further refine the sweep. Sweeps from 8s to 22s were evaluated against other dynamite options. This test also served as a 'final check' for Vibroseis acquisition with poor near surface conditions.

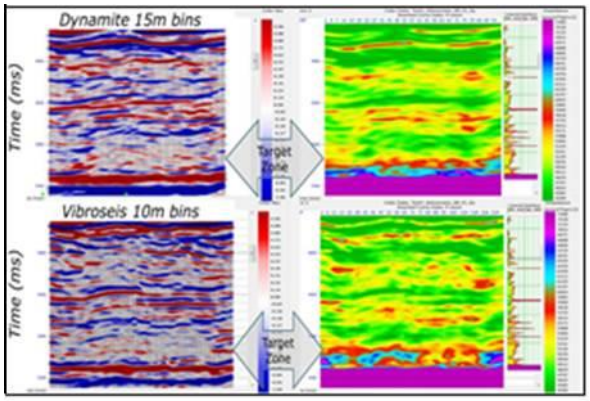

Figure2) Dynamite at 15m bins and Vibroseis at 10m bins

During our analysis it became clear that the bandwidth of the data had been extended beyond what we achieved with the dynamite source. This prompted a reduction in the bin size as better lateral resolution was attainable. The 3D geometry was redesigned to a natural bin of 10x10m with a natural fold of 18 at the target zone.

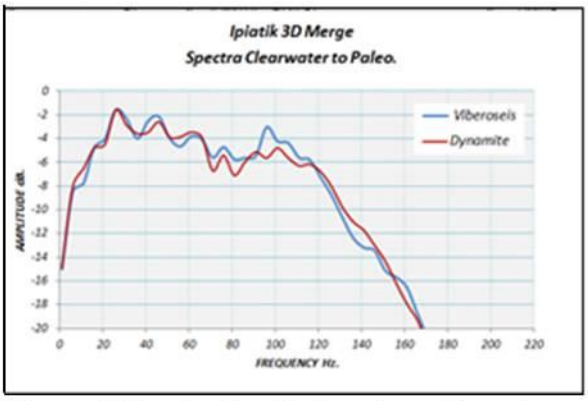

Figure3) Production 3D Spectra achieved with Vibroseis segmented sweep and adjacent dynamite 3D

In February 2015, a 37 km^2 3D was acquired with Vibroseis and a redefined orthoginal design. Some of the 20% savings associated with Vibroseis acquisition was diminished by the additional costs to decrease the line spacing. However additional savings were achieved through sweep effort optimization.

The actual acquisition costs were reduced by 22.5% over the equivalent dynamite survey.

Conclusions

In our area the response of the PP data proved Vibroseis to be a viable alternative to dynamite. However 2D test lines in this experiment showed the PS data at the reservoir level while adequate was poorer than data acquired with the dynamite source. Acquisition geometry and source parameters should be regularly reviewed to find opportunities to improve data quality and/or reduce costs. Through design and testing of various sweeps we have been able to go beyond simple linear or high/low dwell parameters to a stable segmented sweep which is well behaved and replaces dynamite in this area. As the frequency response varies on a regional basis, we plan on future testing in areas where we operate.

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