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Horn River Microseismic Acquisition: Designing a Shallow Array

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Summary

When the Kiwigana Buried Array was installed in March 2011 two main issues were relevant to the design. First, would the 151 stations be adequate to separate the microseismic events from background noise? Second, what effect would the Quaternary channels have? Due to risks involved in drilling through the shallow Quaternary we had designed our geophones to be installed at 30 metres depth. The Quaternary channels had created a degradation of signal on the 3D survey, would the same results apply to the buried geophones?

The focus of this presentation will be on the design parameters of the Kiwigana Buried Array. What is the proper number of stations required to record adequate data? A decimation test of the 151 station data will be presented with results using 100, 30 and 6 stations. What is the error in position and how much does the signal-to-noise ratio (SNR) decrease as stations are removed?

Quaternary geology was a concern when designing the array. Would geophones installed over shallow channels have degraded signal quality compared to others? Analysis of the signal quality in the Quaternary channels will be contrasted with the other stations.

Introduction

Encana along with our partner Kogas Canada installed the Kiwigana Buried Array as part of the development of the Kiwigana property in the Horn River Basin of North East BC. The array was designed to monitor the first 10 wells drilled on the property. The 10 wells had a combined total of 253 completion points that required approximately 90 days to execute.

Monitoring of the Buried Array was contracted to MicroSeismic Inc. During the completion campaign, from late October 2011 to January 2012, MSI staff would collect the data and provide power to each geophone station. Access to the 40 sq. km permanent Buried Array was challenging due to the lack of snow at the start of the program.

Interest in surface monitoring increased for the Kiwigana asset team after discussions with our colleagues in the Haynesville basin of Louisiana. Wells in Horn River are now reaching 6100m of measured depth with over 3000m of lateral length. These conditions make downhole monitoring challenging. Event multi-pathing, tractoring geophones into position and the variability in a completion schedule all led to the test of surface monitoring.

Method

Theoretically a Buried Array will have stations placed in a symmetric pattern centered over the wells being monitored. Introducing restrictions in surface access and shallow geology immediately distorts that array design. In the case of Kiwigana the facilities location and lack off access in the south played a role in where geophones could be situated (Figure #1).

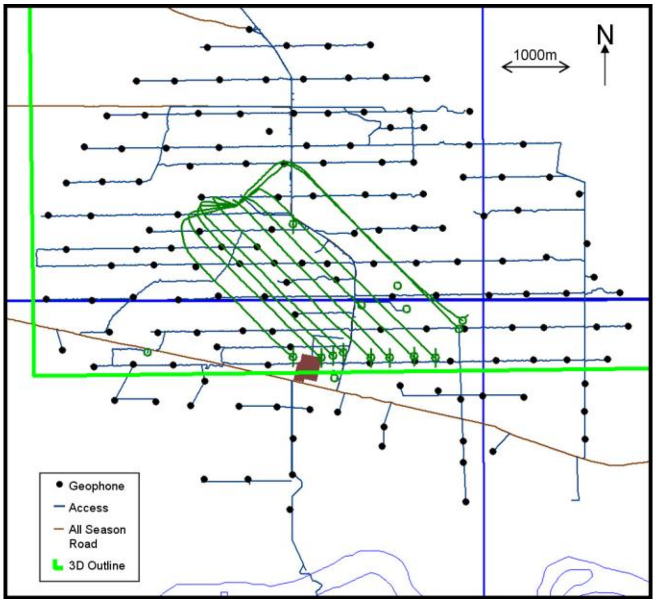

Figure #1 Location map for Kiwigana microseismic.

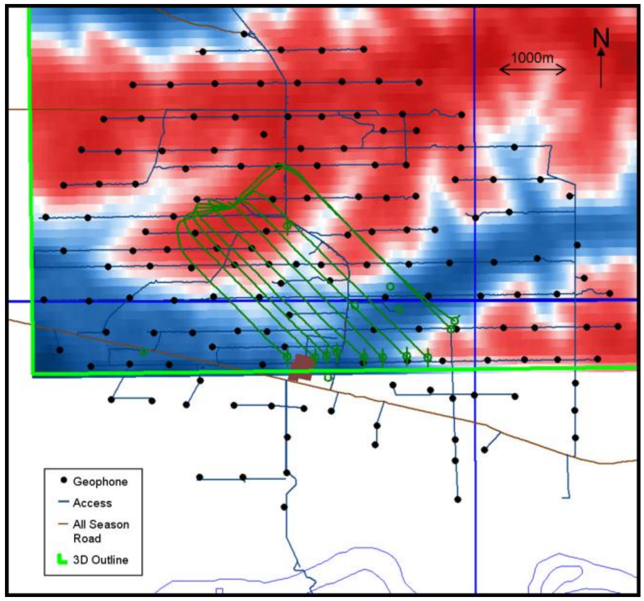

Figure #2 Quaternary Channels in blue.

The static solution from the tomography model was the main source for the Quaternary channels (Figure #2). These channels had been noted on older 2D lines in the region and stand out as areas with low SNR. An effort was made to move as many stations as possible to the edge of the Quaternary channels while retaining a relatively balanced spatial density for monitoring.

Figure #3 contains an example of the signal degradation on the Kiwigana 3D acquired in 2010. It was noted in processing that both the shot and receiver data collected over Quaternary channels had a loss in frequency content and a lower SNR. This variation in data caused a lot of extra work in the processing of the 3D and we wanted to apply those learning's to the microseismic recording.

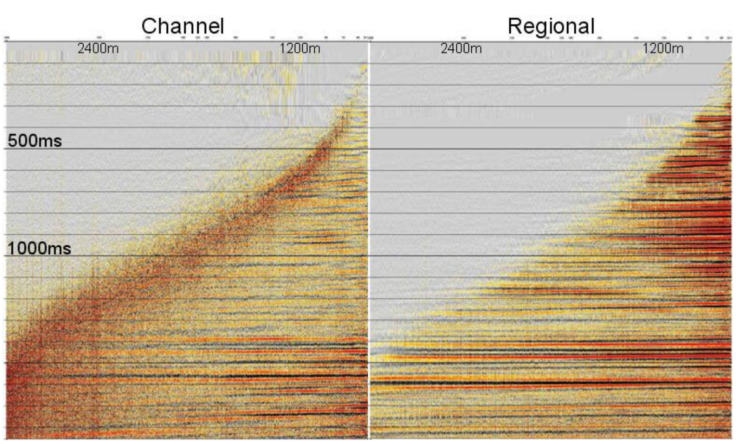

Figure #3 PSTM Gathers from the Kiwigana 3D survey demonstrating the lower SNR in the Quaternary channels.

Decimation tests are currently being conducted on both 30 and 6 station array numbers. The current seismic processing includes the results for the 151 and 100 station data. Estimates indicate that reducing the number of geophone stations by 30% would create a cost savings of 20% assuming recording a similar number of completions.

Positoning error and background noise levels are expected to increase as the number of geophone stations decrease in the array (Eisner, 2009). The largest error derived in positioning the 2 string shots conducted with the 151 stations was 17 metres. An analysis of 306 co-located microseismic events from both the 151 and 100 stations data shows that the 100 station data yields similar results to the 151 station data. The magnitude of error in lateral position was 10 metres for the co-located events. As expected with Buried Arrays (Eisner, 2010) the vertical error was larger at 20m. Overall the SNR dropped approximately 20% percent when reducing the number of stations to 100.

Conclusions

Work continues on the microseismic data set at Kiwigana. The results outlined will be presented and thoughts on how we can cost effectively install an expansion of the array will be given. Finding a balance in the number of stations installed in relation to the sensitivity of the array is a key driver for continuing to refine microseismic recording in an economic fashion.

Acknowledgements

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References

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