Time Lapse Seismic and Neural Network Evaluation of an Alberta Thermal Heavy Oil Prospect

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In 1985 a 3D seismic survey was shot in the Lindberg / Elk Point Area. The survey covered an area of 600 by 600 meters and a bin size of 6 meters. The single geophones/stations were permanently installed 10 meters below surface and the shot holes were cased and cemented for optimum repeatability.

The survey was shot a second time in 1988 with the intention of evaluating the effect of thermal stimulation on the Cummings reservoir. To our knowledge, this analysis was never completed and is presented here using modern evaluation techniques.

Since the field was under production until 1990 using three different recovery schemes: Primary, multi-well CSS and 5-spot, there is an excellent opportunity to evaluate the area for steam conformance and production prediction.

Located in the Northeast Plains region of Alberta, Canada, the Cummings Member of the Lower Mannville Group represents the uppermost part of the transgressive phase of the Mannville deposition. These Cretaceous sediments consist of shoreface sandstones with associated nonmarine, marginal marine and incised valley deposits[1]. (Figure 1)

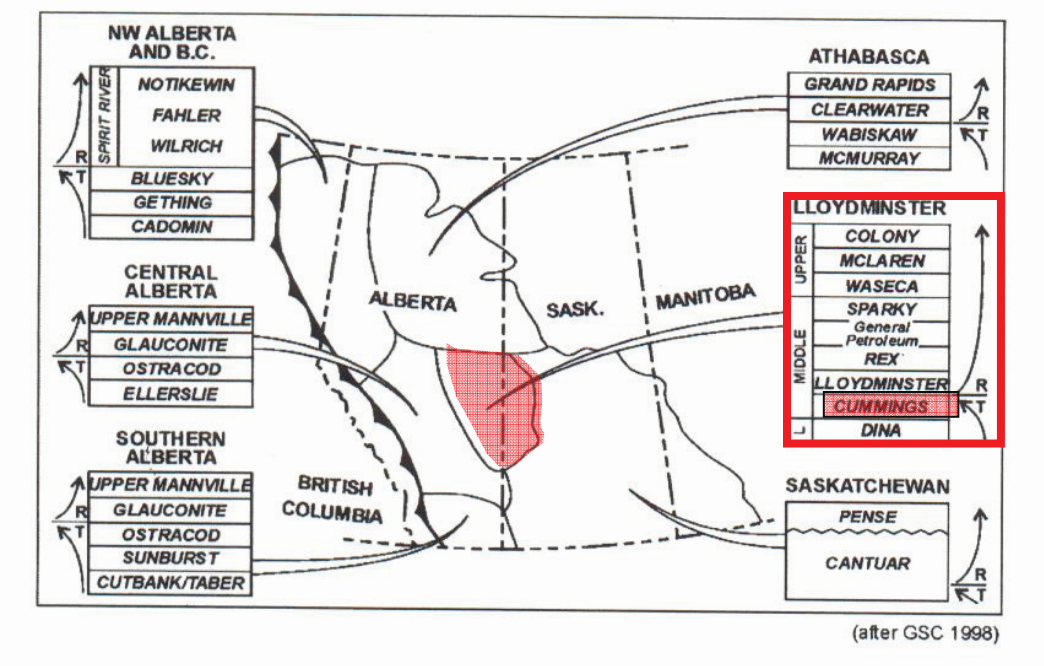

Figure 1. Cretaceous Play Areas

In an effort to understand the conformance of the injected steam, we undertook a 4D evaluation of the two 3D surveys. The seismic data were reprocessed to minimize differences. Correlation coefficients, relative time shifts and other diagnostic tools were then used to measure the similarity between the traces before and after production. Areas of differential time shift, for example, are believed to be areas where production has affected the seismic response between the two acquisition dates. (Figure 2)

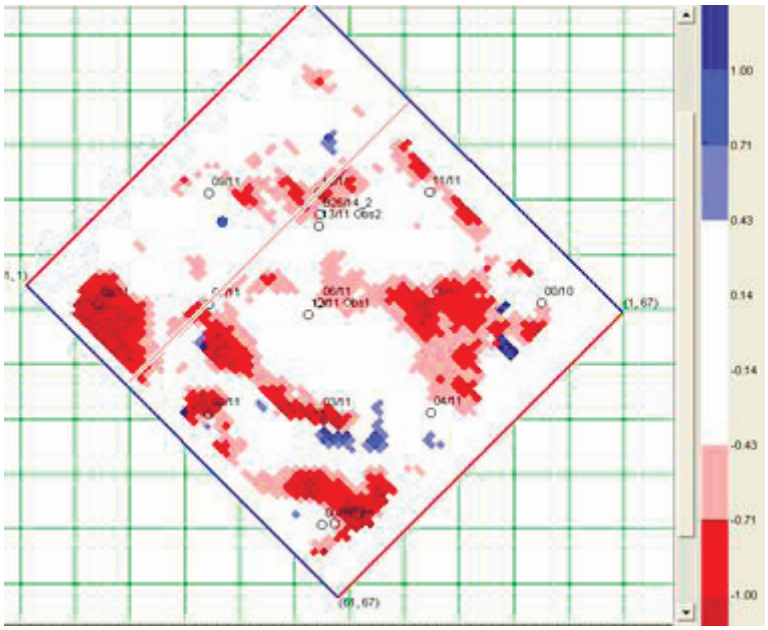

Figure 2. Time shift of surveys 1985 and 1988

Correlations of the observed 4D anomalies with available production/injection rates were made.

In an attempt to examine and understand the observed production/4D anomaly relationships, and put geologic meaning to the time lapse results, subsequent neural network analysis was undertaken. Using 13 wells located within the surveys as reference, porosity and gamma ray volumes were generated. (Figure 3)

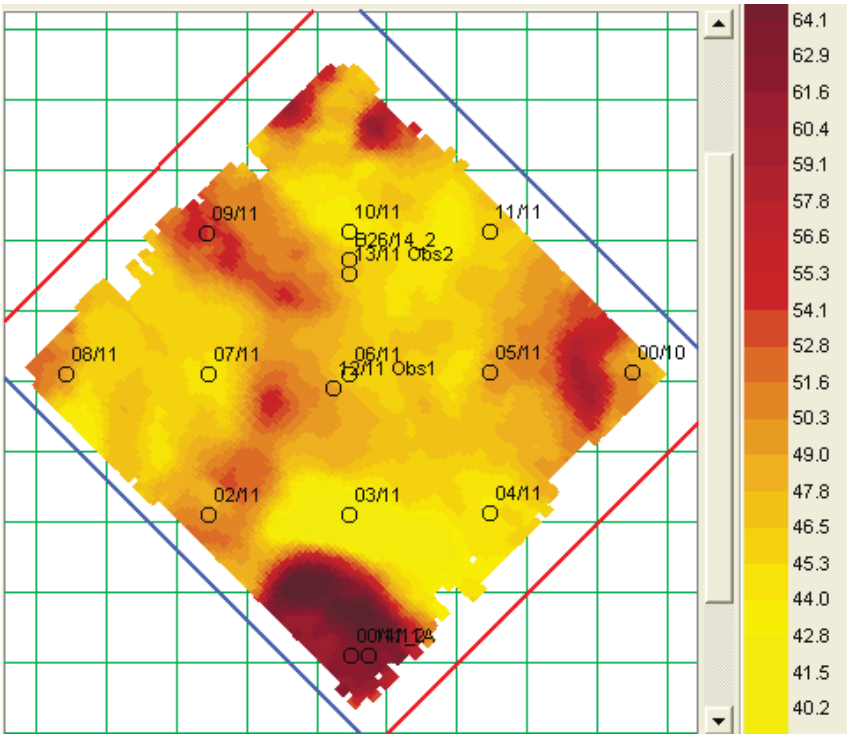

Figure 3. Predicted Gamma Ray result at Cummings Level

In 1989, after the monitor survey was shot, the injection scheme was changed from multi-well CSS to a 5-spot design. A 5-spot is an injection pattern in which four injection wells are located at the corners of a square and the production well sits in the center. Using the results of our 4D and Neural Network analysis, we attempt to corroborate this new injection strategy with historical production information.

References

Conventional Heavy Oil Resources of the Western Canada Sedimentary Basin - August 2001, National Energy Board of Canada: http://www.neb.gc.ca/energy/EnergyReports/