[PS]3D Seismic Attributes Analysis in Reservoir Characterization: The Morrison NE Field, Clark County, Kansas*

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Abstract

Seismic reservoir characterization and prospect evaluation based 3D seismic attributes analysis in Kansas has been successful in building static and dynamic reservoir models and in identifying commercial hydrocarbon prospects. In some areas, reservoir heterogeneities introduce challenges, resulting in some wells with poor economics. Analysis of seismic attributes gives insight into hydrocarbon presence, fluid movement, porosity, and other factors used in evaluating reservoir potential. This study evaluates a producing lease using seismic attributes analysis of an area covered by a 2010 3D seismic survey in the Morrison NE field of Clark County, KS. The target horizon was the Viola Limestone, which continues to produce in four of eight wells completed based off the survey. In order to understand reservoir heterogeneities and its implications for future development plans, we conducted a seismic attributes extraction and analysis with emphasis on indications of amplitude anomalies around producing and plugged wells for comparison. Spectral decomposition was conducted in light of amplitude anomalies to gain insight into what seismic results led to the completion of the eight wells in the area. Further analysis was conducted to determine if the unsuccessful wells completed could have been avoided. Finally the study attempts to present a set of 3D seismic attributes associated with the successful wells, which will assist in placing new wells in other locations in the field.

3D SEISMIC ATTRIBUTES ANALYSIS IN RESERVOIR CHARACTERIZATION: THE MORRISON NE FIELD, CLARK COUNTY KANSAS

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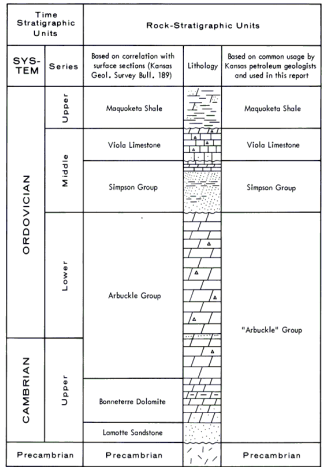
Introduction

This study evaluates a producing lease using seismic attributes analysis of an area covered by a ~3 square mile, 3D seismic survey consisting of 320 inlines and 380 crosslines in the Morrison Northeast field of Clark County, KS. The target horizon was the Viola Limestone in which, according to Richardson (2013), oil production is not necessarily structurally controlled but controlled by the preservation of the upper Viola containing the productive dolomite porosity. This productive porosity lies beneath an erosional unconformity between the Viola and overlying Maquoketa limestones. Thus, the Viola produces from a paleotopographic trap. The goal of this study is to determine what specific seismic attributes successfully explain production in the Viola and to determine if reprocessing the 3D seismic data could have avoided drilling dry holes and wells with poor economics.

Viola Limestone

The producing formation of the wells within the 3D seismic survey is the Ordovician Viola limestone. The Viola limestone is a medium to coarse crystalline vuggy dolomite containing scattered chert throughout with a thickness of 170-200 feet throughout the study area. Vugs within the Viola give it a good porosity/permeability which makes it an excellent reservoir rock for hydrocarbons to be stored (Goebel, 1968). The Viola sits below an erosional unconformity separating it from the overlying Maquoketa Limestone, which has a thickness of about 15-30 feet throughout the study area. A paleotopographic trap within the Viola is the result of this erosional unconformity (Richardson, 2013). Porosity is greater within the Viola than in the overlying Maquoketa limestone and Kinderhookian series which generates amplitude dimming at the top of the Viola. Hydrocarbon presence would generate further amplitude dimming a the top of the Viola.

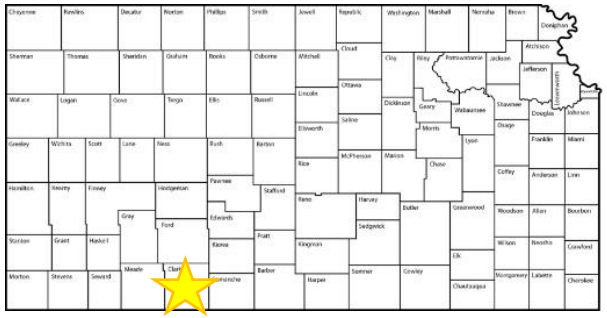


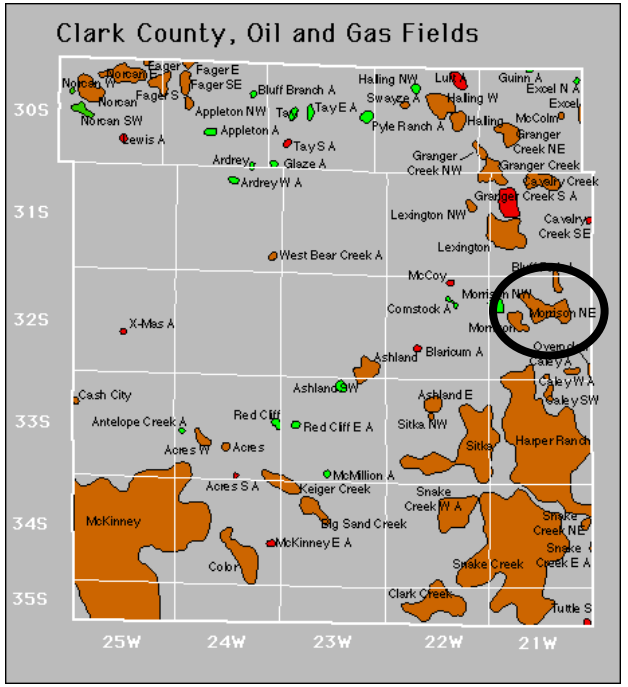
Methods

- Create new project in Kingdom, load and quality check available data
- Synthetic seismogram generation
- Seismic interpretation, horizon tracking and surface generation
- Seismic Attributes generation and analysis: amplitude maps, time structure maps, spectral decomposition, multi-attributes space and cluster analysis in prospect evaluation

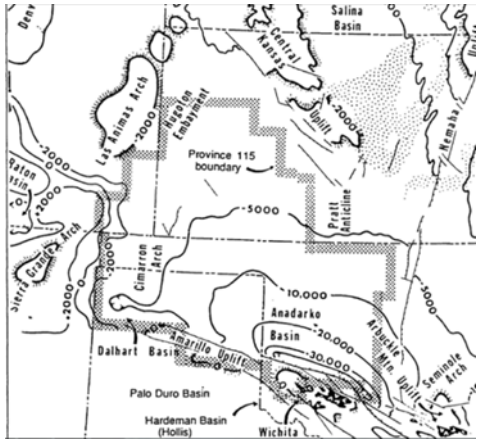
Study Area

County Map of Kansas





Hugoton Embayment

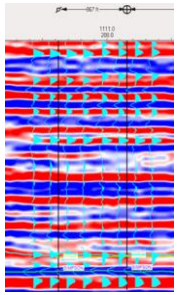


The study area lies within the Hugoton embayment which is a northern shelf-like extension of the Anadarko basin seen above. The area covered by the 3D seismic survey is located in Clark County, KS in the southwestern portion of the state which is identified by a yellow star on the map of Kansas in the upper left corner. Coral Coast carried out a 3D seismic survey in 2010 in the southern portion of the Morrison Northeast field, located in the east-central portion of Clark County, KS. The field location is identified on the Clark County, Oil and Gas Fields map by a black circle.

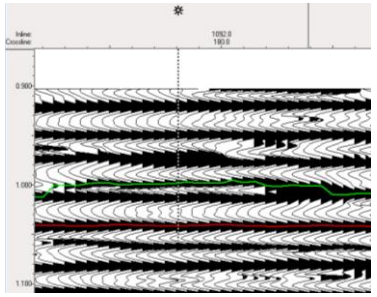
Seismic Interpretation

The 9 wells within the study area were drilled where the Viola thickens which can be seen by the seismic wavelet turning into a doublet. Unfortunately not every well drilled based on this thickening of the Viola produced, resulting in 2 dry holes and a well with poor economics that was converted into a SWD well.

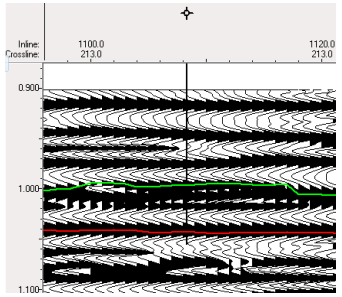
Synthetic seismograms for two wells lain over seismic trace data.



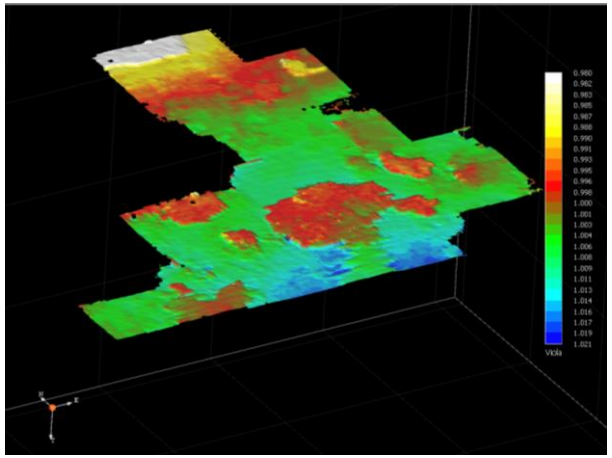
Interpreted paleotopographic trap within the Viola (green) on a producing well.



Interpreted paleotopographic trap within the Viola (green) on a non-producing well.

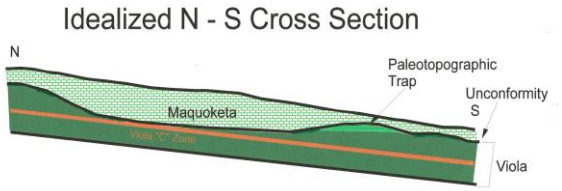


Seismic interpretation began with the generation and quality checking of Synthetic Seismograms (above on left image). These synthetics allowed for initial tracking of horizons throughout the survey volume. Horizons generated via synthetics were quality checked using trace attributes to reveal the paleotopography within the Viola seen in the center and right images above. Wells were placed based on thickening in the Viola limestone (green horizon on middle and right images) which can be seen by the wavelet forming a doublet at the location of the two wells above. However, this thickening did not always result in a productive well. This introduces the problem, what else is controlling production within the Viola, and how can 3D seismic attributes analysis help solve this problem?



Paleotopographic Traps

This time structure map (left) generated from tracking the Viola limestone throughout the survey area shows the paleotopographic traps being targeted. These paleotopographic traps are subtle changes in depth to the top of the Viola limestone as well as increased thickness. On the right is an idealized cross section of a paleotopographic trap, orientated North-South (Richardson 2013). These traps represent zones within the Viola where productive, vuggy porosity has been preserved and hydrocarbons accumulate.



Refrences

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- Coral Coast Petroleum LC – Provider of 3D seismic survey data
- Castagna, J.P., Siegfried, R.W., and Sun, S., 2003, Instantaneous spectral analysis: detection of low frequency shadows associated with hydrocarbons. The Leading Edge, vol. 22, p. 120-127.
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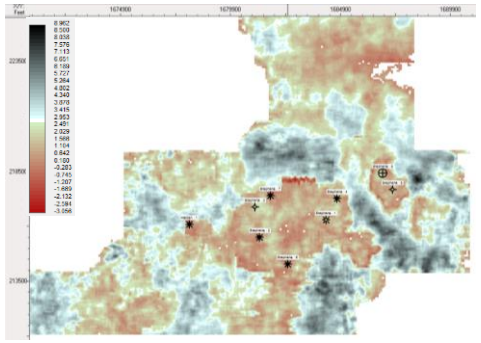
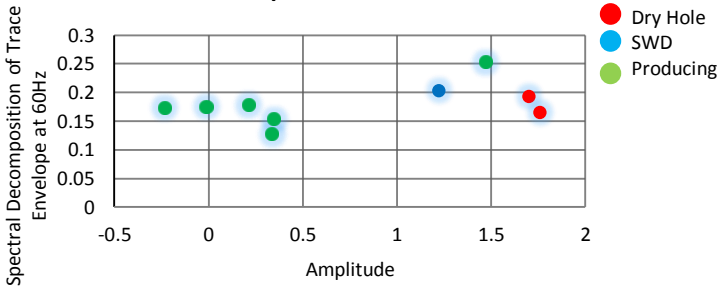
Attributes Analysis



Amplitude map showing low amplitude anomalies associated with well locations

Spectral Decomposition of Trace Envelope vs. Amplitude



Spectral decomposition of Trace Envelope plotted against Amplitude. Dry holes and salt water disposal well cluster at higher amplitudes, while producing wells cluster at lower amplitudes. One producing well clusters with the uneconomical wells.

Conclusions

- Production in the Viola paleotopographic traps is seen at low amplitudes
- Paleotopography is not the exclusive control on production
- Outlying well suggests the possibility of two productive facies

Future Work

- Lithofacies analysis of drill cuttings (2015 Aria Linares)
- Generate multi-attribute displays to gain further insight on productivity controls within the Viola