GeoConvention 2016
Calgary • Canada • March 7-11
OPTIMIZING RESOURCES

Preliminary interpretation and processing of 3D 3C seismic data, Athabasca Oil Sands, Alberta

Bobby J. Gunning, Don C. Lawton and Helen Isaac
CREWES

Summary

Oil sands in the Athabasca region is a major hydrocarbon deposit in northern Alberta. In this project, a multicomponent 3D seismic dataset provided by Canadian Natural Resources Limited is used to study the rock column in the Athabasca Oil Sands region. The initial data consists of fully processed PP seismic data, and three-component raw seismic data. The PP data is used for an initial, full volume interpretation including: picking several pervasive reflection horizons, well log analysis and post-stack impedance inversion. The raw three component data has begun processing and will eventually be processed into PP, PS1 and PS2 seismic volumes.

Introduction

A multicomponent 3D baseline seismic dataset, acquired in 2013, was provided by Canadian Natural Resources Limited (CNRL). The fully processed, stacked PP seismic data and the raw three component shot gathers were licensed for use in this project. This paper will outline the preliminary interpretation of the stacked PP seismic data and the progress to date of the processing of the converted wave seismic volumes. The analysis of the PP seismic data to date includes: stratigraphic interpretation with the aid of well control, seismic attribute maps and volumes, time slices and stratal slices for sedimentary structure identification and post-stack inversion with several input parameters. So far, the multicomponent data has been converted from segd to segy format for use in ProMAX. Geometry has been assigned and the inlines and crosslines have been rotated into radial and transverse components. There are several objectives with the 3D 3C seismic dataset. Processing the multicomponent data to an interpretable point, and utilizing the PP and PS seismic volumes, converted to depth, for joint lithological interpretation is a main goal. Individual post-stack, prestack and joint post-stack and pre-stack inversions will be run on the seismic volumes to develop geomechanical and rock property volumes. The full rock column will be analyzed, but the majority of the focus will be on the reservoir (McMurray Fm) and caprock intervals (shales in the Colorado and upper Manville group). Several software packages are and will be used in the completion of this project including: Seisware, Hampson-Russell, Petrel, GeoScout, and Vista processing software.

Theory and/or Method

There are several regionally extensive geological interfaces with impedance contrasts large enough to generate bright seismic reflections. Several of these reflections were correlated to well data through synthetic seismograms. Seisware and Hampson-Russell software was used to create seismic reflection picks for: Base Fish Scales, Viking Fm, Grand Rapids Fm, Clearwater Fm, McMurray/Wabiskaw Fm and the Paleozoic unconformity. There are several pervasive reflections stratigraphically deeper than the Paleozoic unconformity, but unfortunately well control does not reach these depths. Generating seismic attribute volumes and slices, and post-stack inversion are relatively quick ways to enhance a basic stratigraphic interpretation of post-stack PP seismic data. Isochron maps and stratal slicing utilize previously interpreted horizons to better understand the subsurface. Structural and amplitude seismic attributes can even further boost geological knowledge. Post-stack impedance inversion was performed on the dataset using Hampson-Russell software. Several inversions were run with varying input parameters. Utilizing the inversion volumes can enhance the basic stratigraphic interpretation from the conventional stacked PP seismic data. Impedance volumes display interval properties rather than interface properties. Differentiating the different peak and trough sequences of conventional seismic data is more challenging than clear boundaries common to impedance inversion volumes. Interval property maps, such as RMS, average and summation, can give insight into where geology changes.

Examples

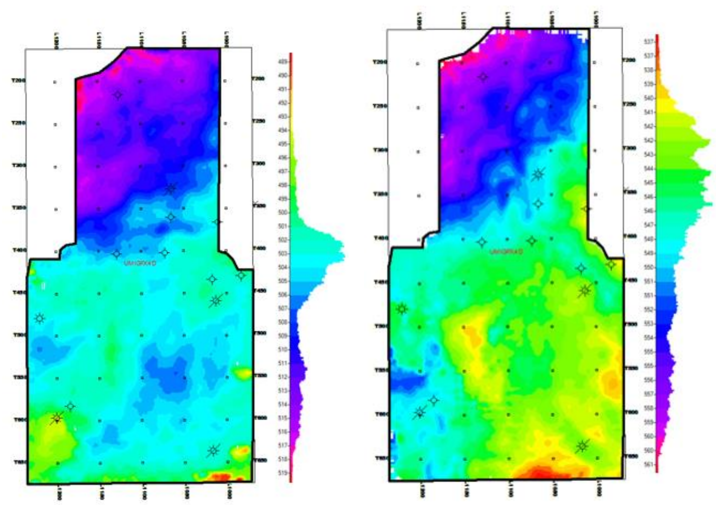

FIG. 1. McMurray/Wabiskaw Formation (left) and Paleozoic Unconformity (right) time structure

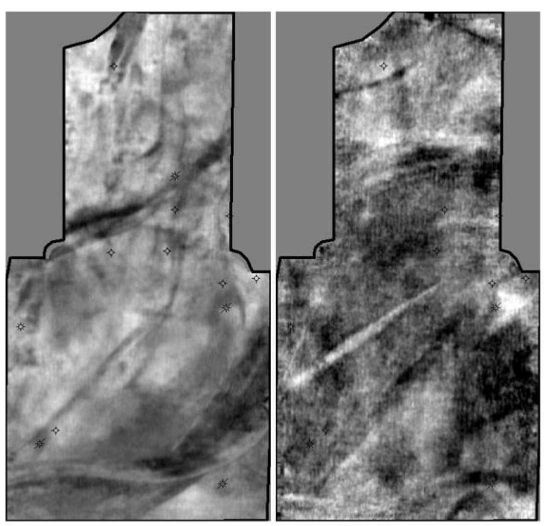

FIG. 2. Two stratal slices displaying fluvial geomorphology, Upper Grand Rapids (left), Middle McMurray (right).

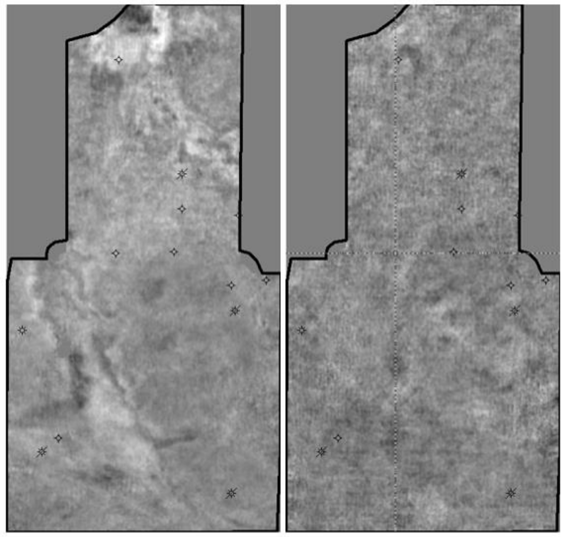

FIG. 3. Time slices in the Colorado Group, Base Fish Scales (left), Joli Fou (right)

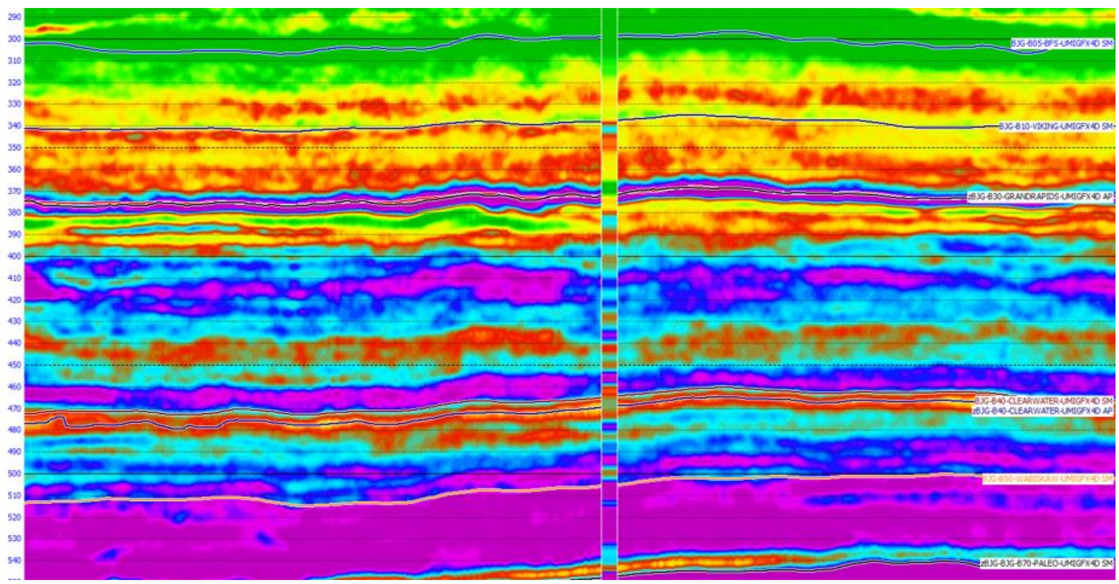

FIG. 4. Impedance inversion section with blind well, stratigraphic interpretation and well based input model

Conclusions

A 2013 multicomponent seismic dataset, provided by Canadian Natural Resources Limited, is analyzed. The full stacked PP seismic data and the raw shot gathers are available for use in this project. A preliminary interpretation consisting of: well tying, horizon picking, impedance inversion and analysis, and well log analysis is performed. The raw multicomponent seismic data has had geometry assigned and has been rotated into radial and transverse components. Several pervasive horizons in the rock column are picked based on tying well data to seismic data. An analysis of dipole sonic logs in the project area is completed and Castagna's linear Vp to Vs relationship is confirmed. This initial interpretation and processing is just the beginning of this multicomponent seismic project. Going forward, project objectives include: complete processing flow of all three geophone components, converted wave volume interpretation, and pre-stack and post-stack individual and joint inversions for geomechanical properties focusing on several intervals of interest.

Acknowledgements

Special recognition is deserved for several individuals and companies in this 3D 3C seismic project. I would like to thank Michael Barnes, Paul Lepper, Juan Joffre, Domenic Torriero, Neil Orr and Ron Jackson from Canadian Natural Resources Limited for their guidance and licensing of the multicomponent seismic dataset. I would like to thank my CREWES supervisor Don Lawton for his expertise and mentorship and Helen Isaac for her assistance with multicomponent seismic processing. I am grateful for the utilization of the software packages: Seisware, Hampson-Russel, Petrel, GeoScout, ProMAX and Vista processing software. This project is funded by CREWES industrial sponsors and NSERC through grant CRDPJ 461179-13.

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