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Data Analytics and Application of Automated Sequence Stratigraphic Approach to Montney Deposition in Fort St. John Graben Area

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Summary

Sequence stratigraphy is a powerful method to assist in the understanding of sedimentary record. It provides a picture of a basins' sedimentary architecture within the timelines at different scale. Sequence stratigraphic model is based on relative sea level and sedimentary influx variations. We have developed a workflow to automate sequence stratigraphy for the well log data interpretation. The automated workflow allows an interpreter to not only get the results faster and more accurate but also to process and understand big data with relative ease. This workflow is tried and tested on the Montney deposition in Fort St. John Graben area.

Method

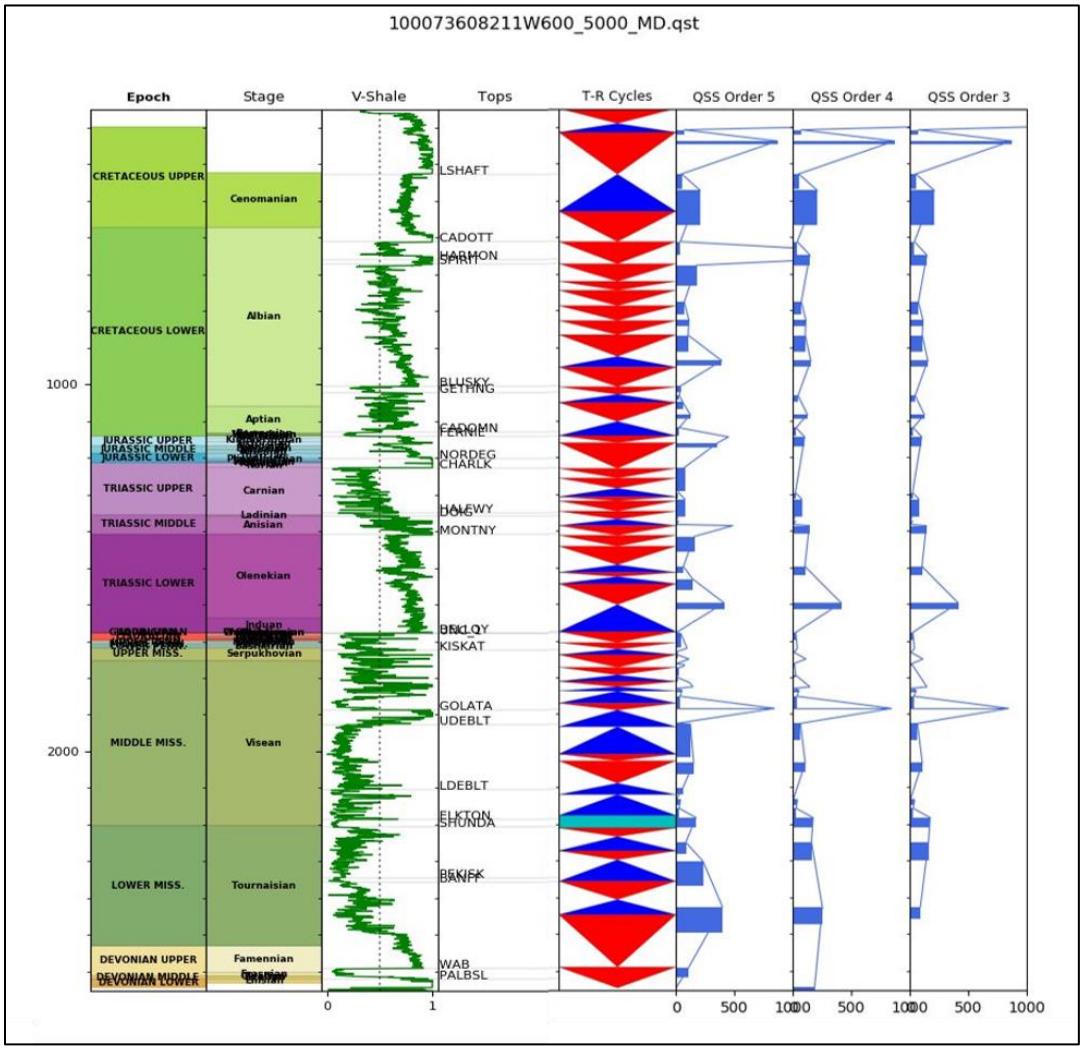
Implementation of automatic sequence stratigraphic workflow requires to follow several steps which are fully explained. We start with the creation of well log database, then, all logs are normalized, and volume of shale (Vsh) curves are generated. Then, reference wells which are representative for large number of wells are identified. The chronostratigraphic tops are picked for the reference wells. Using reference wells, chronostratigraphic tops are picked automatically for the rest of the wells using combined methods of autocorrelation, dynamic time warping and neural networks. Following the method introduced by Ainsworth 2018, called "QSS method", sequence stratigraphic surfaces are added to the wells and automated sequence stratigraphic cross-sections are built. The automation produces 5th order parasequence boundaries. 5th order sequence stratigraphic surfaces are then automatically upgraded to the 4th and 3rd orders through mathematical interpretation of cyclic changes. All stages of automatic sequence stratigraphic workflow explained through its application to Montney Formation.

Results

Montney Fm. of Western Canada Sedimentary Basin (WCSB) is one of the leading gas-condensate resource play of North America. Montney is one of the most productive unconventional reservoirs in western Canada. It occurs over a large continuous area of the WSCB and is characterized by varied stratigraphic and structural frameworks, depositional processes, and hydrocarbon fluid generation and migrations. Numerous publications dealing with the sequence stratigraphy are available to compare the results. Decades of petroleum exploration in this area has created a huge quantity of well data available.

We have used 280 vertical wells in this study covering 800 sq km (20 x 40 km) of area. The well log database was created, resampled, smoothed and converted to Vsh logs automatically. One reference well is chosen for each 100 sq km representing nearly 50 wells in its vicinity. The tops, with age assignment, are picked through the automation process. Also, sequence

stratigraphic surfaces were identified automatically on reference wells with the identification of ranking of sequence stratigraphic surfaces (from 5th order to 3rd order).



The Montney records deposition from the latest Permian to the Mid-Triassic. It consists of two global stages (Induan and Olenekian) which may be subdivided into four regional substages Griesbachian, Dienerian, Smithian and Spathian. Basinwide unconformities occur roughly synchronous with the boundaries between the Dienerian and Smithian and between the Smithian and Spathian providing the basis for the three-fold subdivision of the Montney Formation into basinwide Lower (Griesbachian-Dienerian), Middle (Smithian) and Upper (Spathian) members (Zonneveld, 2018).

These listed sequences stratigraphic division can be seen to coincide with interfaces derived from QSS technique. The sequence stratigraphic surfaces obtained through the QSS technique coincide well with the ones described by researchers. The figure above shows reference well, from left to right, assigned age, calculated Vsh curve, picked tops, T-R sequences (triangles) and QSS curves (5th, 4th and 3rd order sequences), all are automatically identified and assigned.

Maximum value of QSS curve shows flooding surfaces and minimum shows sequence boundaries of different orders.

Conclusion

The stratigraphic architecture of the Montney Fm in Fort St. John graben area is examined and interpreted within sequence stratigraphic context using automatic method of identifying sequence stratigraphic surfaces and upgrading them from 5th order to the 3rd order. That allows to identify sequence stratigraphic surfaces fast and accurate for the large amount of data. By applying the method one can quickly map large area for the average Vsh trends within each parasequence and can separate the areas with high quartz content as well as presence of turbidites.

References

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