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Using a Simulated Horizontal Well to Investigate a 3D Geological Model from the Alberta Fold and Thrust Belt

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Summary

A multistage workflow was designed to build a 3D geological model using geological field mapping data and a digital elevation model (DEM). This mapping data includes outcrops of Jurassic to Cambrian aged rocks from Moose Mountain, which lies 60 km southwest of Calgary in the Alberta fold and thrust belt. The Mississippian stratigraphic interval includes the Turner Valley formation, a carbonate rock, which is one of the major hydrocarbon reservoir rocks in this area. While the model was derived from the outcrop data, it can be used as an analogy for Mississippian structures drilled in the subsurface.

Once a model had been built, a simulated horizontal well path was added into the data set to predict the amount of reservoir that was theoretically encountered in this well. This result could then be used to make decisions on the design of well paths when planning the drilling of structures in the subsurface.

The Work Flow

Initially a geological field mapping data set was acquired from a CSPG field guidebook, Newson et al 1996. The data was digitised using the project datum of NAD 27 Canada NTv2 Grid, Zone 11 in UTM space. Next, a DEM was acquired from the LiDar15 DEM data set by Altalis. The geological data was then draped over this DEM.

The resulting model was then loaded into the Move geological software package. At this stage, the data was used to construct six geological cross sections. These sections were 5000m long and extended vertically from +3000 to -2000 AMSL. The sections were regularly spaced 330 m apart. All the sections had a NE azimuth of 520 from true north, which is parallel to the shortening direction of the fold and thrust belt at this location. The outcrop data was projected onto the sections using down plunge projection techniques. Finally, the sections were systematically drawn using balanced cross section principles. Ten geological horizons from the Jurassic, Mississippian, Devonian and Cambrian aged strata that had been identified in outcrop, were used. This represented a total stratigraphic interval 2000m thick. Key structural features such as fold axis and fault cut-offs seen in outcrop were also projected onto the sections.

The next part of the workflow used the information from all six cross sections to generate a top Mississippian surface in 3D. This gave the correct position of the top of the Mississippian strata in 3D space and it also correctly positioned the fold axis and fault cut-offs that controlled its extent. Using the MOVE software, a simulated horizontal well path with a true vertical depth of 2700m and a horizontal leg of 1100m was added to the model. This was used to enable the acquisition of the 3D and the measured depth location of the intersections of the simulated well path with the key geological strata boundaries. In addition, it provided the bed dip and direction of the intersected surfaces.

Lastly, the lithology of the geological units along the well path were predicted using the RDA software package. To accurately predict the measured depth of the beds intersected by the well path, three sets of data were needed. First a true stratigraphic thickness gamma ray log of the

Mississippian aged strata was taken from nearby drilling in the Moose oil and gas field. Next the well path deviation amounts and directions were obtained from the simulated well survey. Lastly the 3D location and attitude of the intersected beds was also obtained from the geological model. (Figure 1)

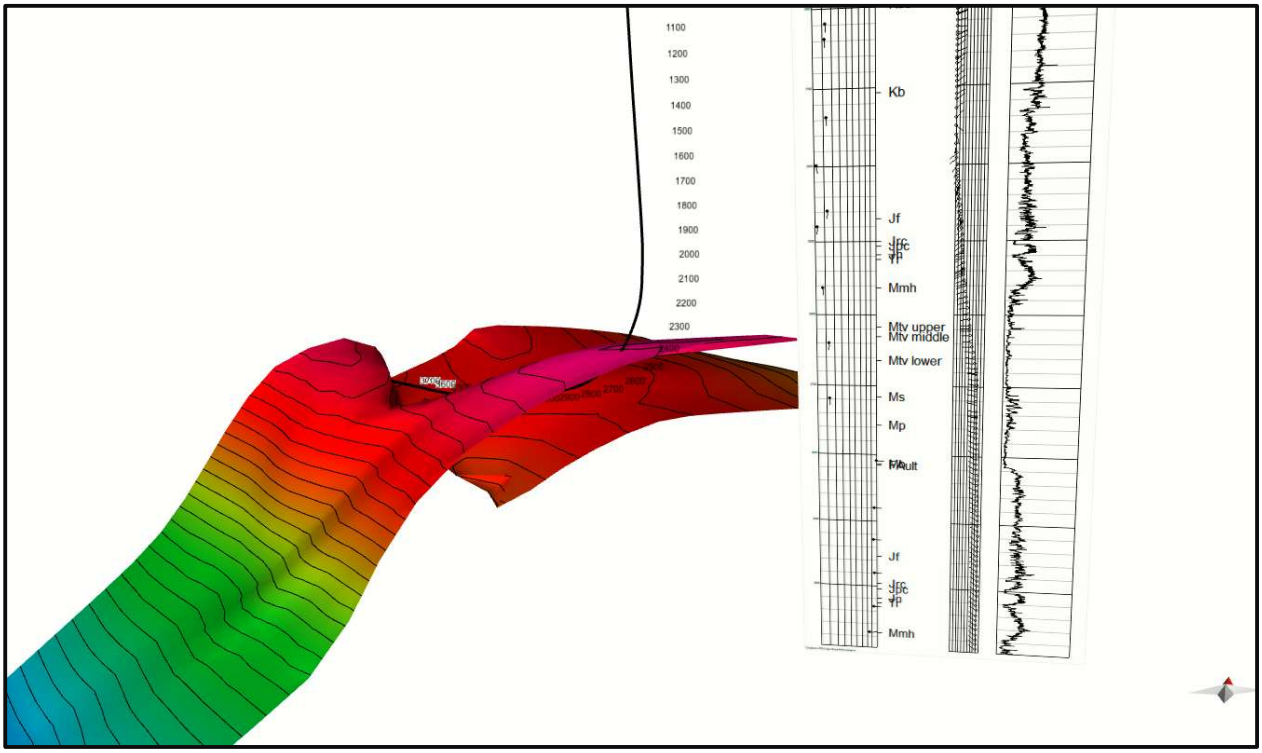

Figure 1: View of the 3D Geological Model from Moose Mountain, showing the top Mississippian structure with the simulated horizontal well path and the predicted gamma ray log in measured depth.

Results

The simulated horizontal well path showed that the length of Mississippian reservoir rock that could be encountered was 600m. This value could then be included in the economic evaluation of similar wells that would be proposed for structures in the subsurface of the Alberta fold and thrust belt.

Acknowledgments

MOVE by Petroleum Experts

RDA by ResDip Systems

References

Newson, A.C., Sanderson, D.A., 1996. Moose Mountain: An example of an oil and gas pool in the Overthrust belt of the Canadian Rocky Mountians. Pools '96, CSPG Conference, Calgary Alberta, June 1996.