Moose Mountain: New insight into its internal structure and relative timing of deformation

David Repol, Martin Kraemer, Ben Stephenson and Irma Eggenkamp
Shell Canada Ltd, Calgary,AB
david.repol@shell.com

Summary

The Moose Mountain structure, 54 km west of the city of Calgary, is located in the southern Foothills of the Canadian Rockies. Early observations of the stratigraphy and structure have been established by MacNeil (1943). At the surface, this conspicuous domal feature is approximately 24 km in length by 10 km in width. The lithostratigraphy exposed in this anticline ranges from lower Carboniferous carbonates in the central part to flanking Jurassic and Cretaceous clastic sequences. In the subsurface, in broad sense, this structure seems to be the result of the imbrication and stacking of Paleozoic (Cambrian to Carboniferous) limestone thrust sheets. However, poor impedance contrast between these stacked massive carbonate has blurred in seismic lines the internal true complexity of this structure.

Using surface geology, current well data, fold shapes and fault-plane seismic reflections and combined crossection balancing techniques, we model the structural styles and kinematics of the fault-related fold features that shaped this structure. This analysis also yields new insight into the relative timing of deformation of this peculiar feature in the southern Foothills of Alberta.

In terms of structural styles Moose Mountain constitutes the perfect example of an antiformal stack and kinematically can be described as an imbricate fault-bend fold. This contractional structure was formed above a regional main detachment level, lodged at the base of the Cambrian (Newson and Sanderson, 1996). Based on our interpretations we divide this structure into two thrust system subsets separated by a major discrete boundary known as the Moose Mountain Thrust Fault [*MMTF*] (Newson and Sanderson, 1996). This structural division is based on size of imbricates and differences in tectonic transport. *Thrust System A (TSA)* is carried above the *MMTF* and is known in the oil and gas industry as *Sheet II*. At Moose Mountain, *Sheet II* is broken up into minor subsidiary thrusts of small offset. Its conspicuous geometry is commonly observed in seismic and given its persistent structural emplacement along strike, inferences can be made about the significant tectonic transport suffered by this thrust sheet. In contrast, underlying the *MMTF*, *Thrust System B (TSB)* is characterized by thrusts of smaller size. It also shows along strike, an increasing amount of stacking and shortening from the northern and southern plunges towards its central part. This later peculiarity seems to be responsible for the characteristic domal shape exhibited at the surface by Moose Mountain. Another particularity of this deeper thrust system, in context with the rest of the structure, is the significantly less amount of tectonic transport when compared to *TSA (Sheet II)*.

The analysis of a series of well penetrations showed in the back limb of the Moose Mountain structure, below the *MMTF*, the presence of updip-thinning lower Jurassic Fernie shales in the backlimb of the *TSB*. Moreover, crestal wells showed a total absence of Jurassic with the direct juxtaposition of Cambrian over Mississippian. These geological relationships seem to indicate that *TSA* progressively cut down section into the underlying *TSB*. This structural behaviour has

significant implications for the relative timing of thrusting sequence being a plausible indication of an out-of-sequence thrusting event in the emplacement of the Moose Mountain.

References

Macneil, D., 1943. Stratigraphy and structure of Moose Mountain Area, Alberta. Bulletin of the American Association of Petroleum Geologists. Vol.27, No. 1, pp. 38-50.

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 Mountains. Canadian Society of Petroleum Geologists Field Trip, Institute of Sedimentary and Petroleum Geology, Calgary.