

Chasing Waterfalls: interpreting Cardium Formation reservoir properties from falls geomorphology

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Summary

Alberta's stunning waterfalls owe much of their character to the underlying geology, with some of the most famous of them underlain by the Cretaceous Cardium Formation. A variety of processes are responsible for the creation and development of waterfalls. Geological drivers such as changes in rock types from a more resistant rock to a softer lithology can lead to erosion of the softer material, steepening the gradient. Faults and zones of uplift or down-warping can also locally increase gradients, while falls in relative sea level may also increase downcutting.

Geomorphological drivers include the existence of high plateaux surrounded by scarps, river diversion due to channel blockage or differential erosion of valleys. Glaciation has over-deepened many valleys creating hanging valleys over which rivers will cascade. Excluding these external mechanisms, when considering a single geological interval, the waterfall character will be influenced by its structural geology and strength, the latter related to the lithologies that make up the substrate over which the waterfall flows and the degree of cementation.

Exposures of the Cardium Formation have created several of Alberta's most famous waterfalls. The Cardium has arguably delivered more barrels of oil than any other Formation in western Canada, much of it from the 9.4 billion barrel Pembina Field. The Cardium was deposited in a coastal setting around 94 million years ago. Most of the reservoir facies are made up of shoreface facies ranging from high permeability, upper shoreface sandstone deposits to muddy offshore deposits. The advent of unconventional recovery techniques, such as horizontal drilling and fracking, have opened up the latter mudstone deposits; the so called "fringe or halo play", giving the Cardium a second lease of life as a hydrocarbon producer.

The character of individual, Cardium-hosted waterfalls such as Ram Falls, Seebe Dam, Sheep River Falls may be considered to relate to existing glacially influenced topography; dip of the beds; lithologies exposed; and to cementation (diagenesis). A simple algorithm has been used to negate the influence of dip, while pre-existing topography is not thought to significantly influence developing waterfall morphology. This indicates that the style of waterfall can be attributed directly to lithology and cementation, providing data on potential reservoir quality in adjacent subsurface occurrences of the Cardium Formation.



Ram Falls, near Nordegg, formed by the Ram River flowing over outcropping Cardium Formation sediments

Theory / Method / Workflow

Results, Observations, Conclusions

Novel/Additive Information

Acknowledgements

References

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