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A Fracture Analysis in Quirk Creek Field in S.W. Alberta

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Summary

This study was conducted to find fracture density (P_{32}), size, and connectivity in a well and its deeper sidetrack in Quirk Creek Field. The work involved finding detailed fracture density and size using methods developed mainly from Berg (2019) along with whole-zone fracture density calculated using a modified version of the method described in Narr, et al. (2006).

Quirk Creek Field is located about 45km southwest of Calgary (Fig. 1). The original well drilled through the “A”, “B” and “C” sheets to 3065m (Fig. 2) but was plugged back to about 2275m and then whip-stocked. The new borehole was then drilled deeper into the “B” and “C” sheets to 2960m.

Method

Image logs provided trace coordinates and dips that, in turn, defined the configuration of each fracture within the borehole. Using methods described in Berg (2019), fracture density, height, length was determined. These methods differ from most published methods for finding these parameters in that they assume that fracture surfaces are rectangular as opposed to spherical or elliptical. This assumption is ideal for strata-bound fractures. Most of the methods used in Berg (2019) have been verified by discrete fracture network modeling. Connectivity is calculated based on a relationship developed by Ozkaya and Mattner (2006) using two-dimensional DFN modeling that found that for fractures to percolate, each fracture must intersect with at least 2 other fractures. This definition was adapted to relationships derived in Berg (2019) to find connectivity of rectangular fractures.

Observations

Fig. 3 shows the upper borehole, which penetrated mostly Mississippian Mt. Head Formation, part of the Rundle group. Connectivity never reached the percolation threshold of 2 intersections per fracture, which may have a role in why this hole was abandoned.

Fig. 4 shows the deeper sidetrack which penetrated mostly Mt. Head Formation and in the lower part penetrated the Mississippian Turner Valley Formation, also part of the Rundle Group. In this borehole, there was little connectivity except in the second occurrence of the Upper Turner Valley formation. The lack of connectivity in the first occurrence of the Turner Valley could be the paucity of fractures.

Conclusions

The lack of connectivity in the Mt. Head Fm. could explain the lack of production in the upper sidetrack. In the sidetrack, although fracture density in parts of the Mt. Head approached that of the lowermost Turner Valley Fm., the connectivity in all the Mt. Head was either very low or nonexistent. It is possible that most if not all the gas production is coming from the second occurrence of the Turner Valley. Production data seem to imply that produced water and gas are

coming from separate reservoirs. Completion and workover records might confirm whether fracture connectivity is responsible for the gas production. In addition, more data, such as porosity logs, are needed to determine the influence of matrix porosity on production.

Acknowledgements

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References

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Narr, W., D. Shechter, and L. Thompson, 2006, Naturally Fractured Reservoir Characterization, Society of Petroleum Engineers, 97 p.

Ozkaya, S.I., and Mattner, J., 2003, Fracture Connectivity from Fracture Intersections in Borehole Image Logs, Computers and Geosciences 29, 143-153, https://doi.org/10.1016/S0098-3004(02)00113-9.

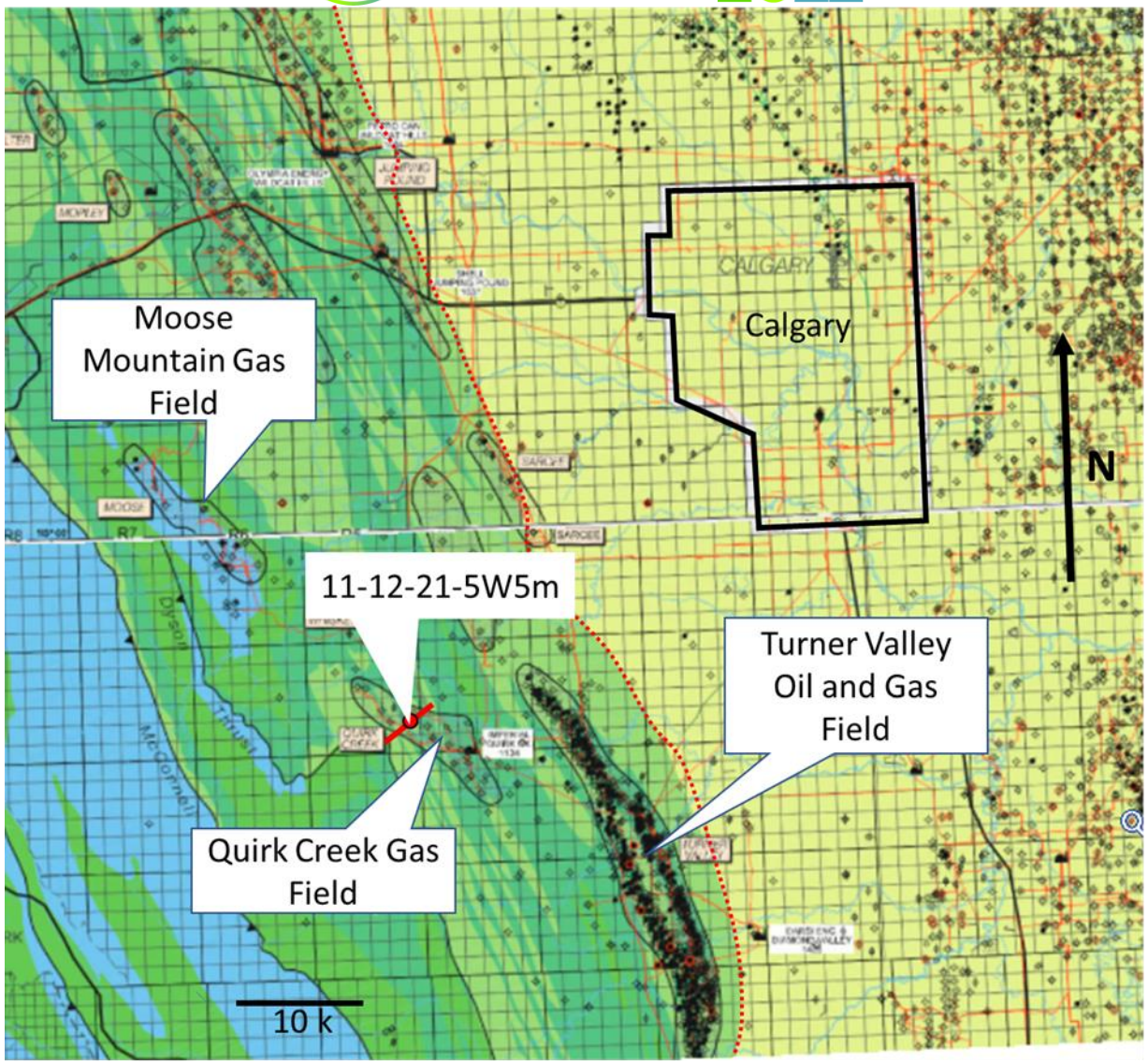

Figure 1. The location of Quirk Creek Gas Field and the well in relation to Calgary and other oil and gas fields.

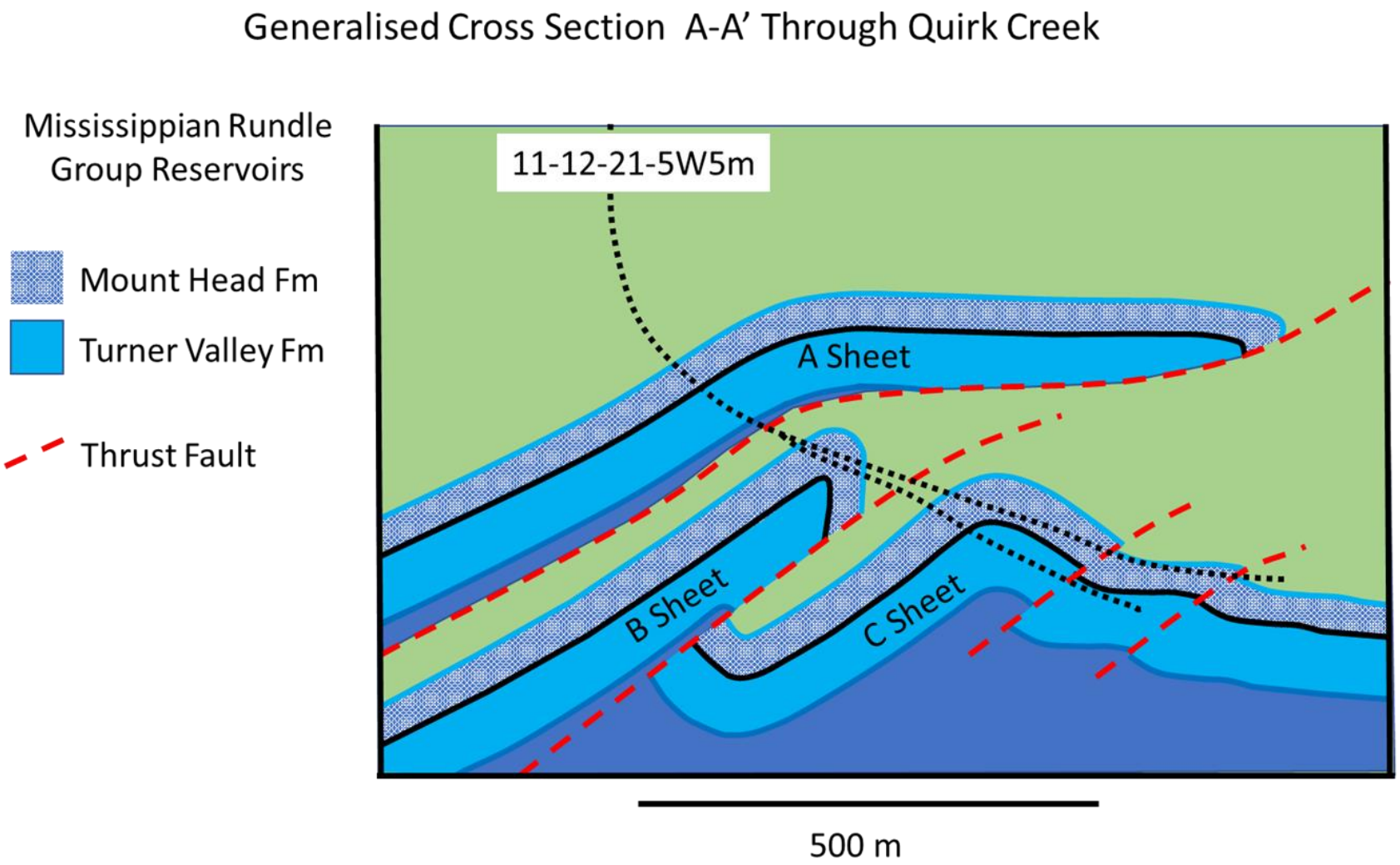

Figure 2. A generalized cross section showing the boreholes in relation to structure.

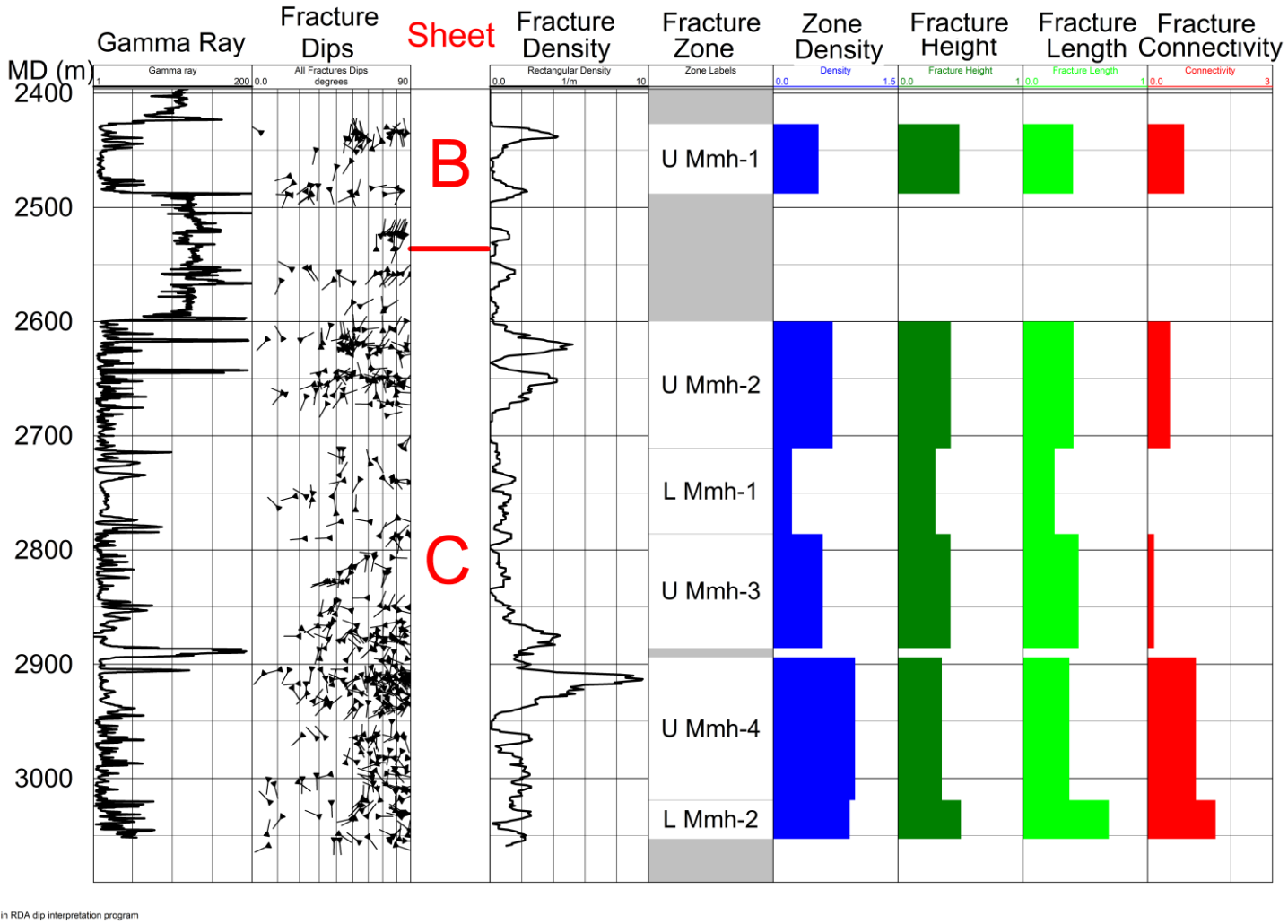

Figure 3. The original hole in the Quirk Creek “B” and “C” sheets. The single vertical line on the connectivity curve is the percolation threshold at a value of two intersections per fracture according to Ozkaya and Mattner (2006). No zone reached that threshold.

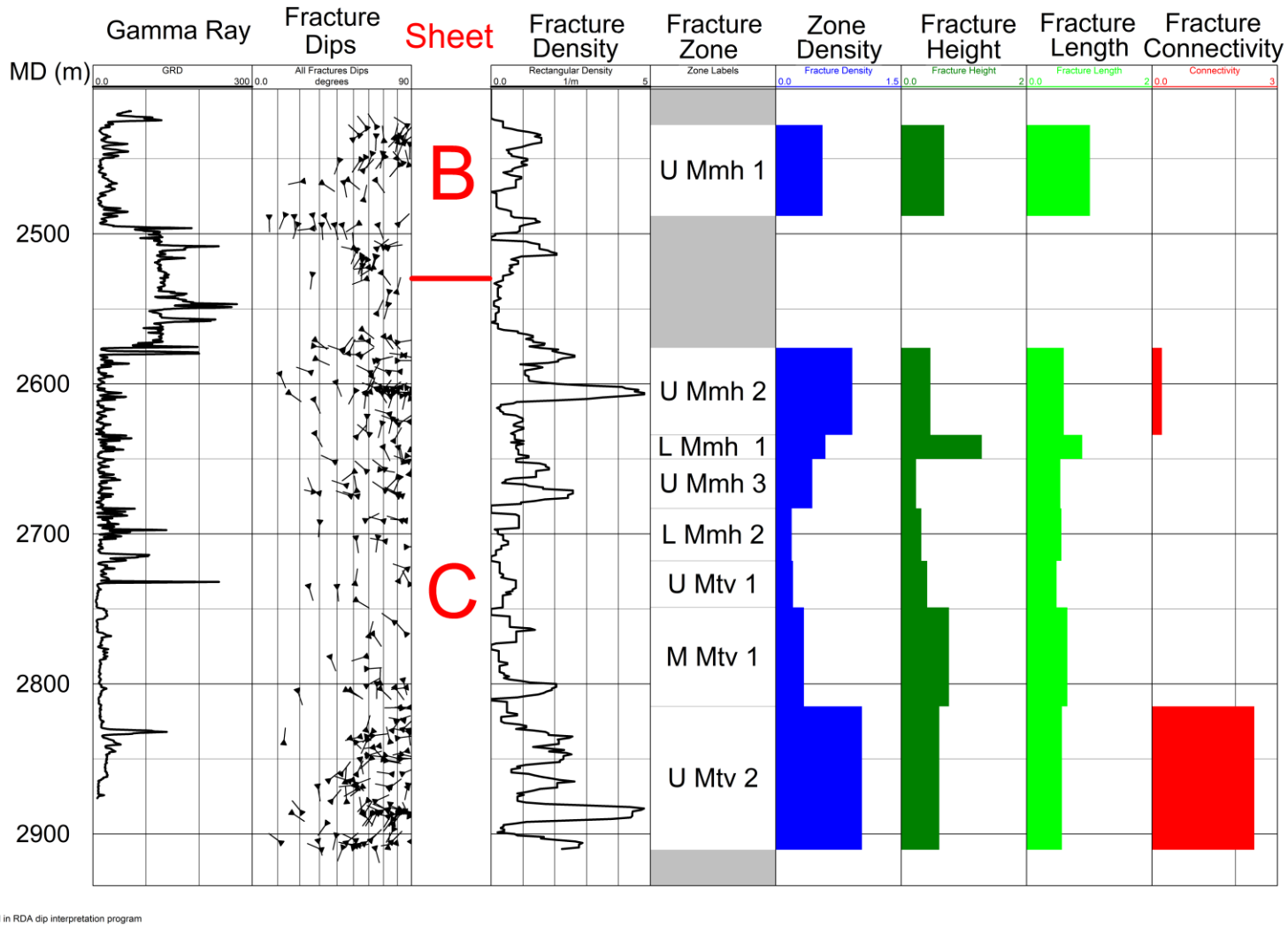

Figure 4. The deeper sidetrack drilled through the Quirk Creek “B” and “C” sheets. As in Fig. 3, the percolation threshold is marked at 2. Note that the Upper Turner Valley in the lowermost zone is the only one in either hole that has crossed the percolation threshold.