Coal Distribution in the McKay Coal Zone, Belly River Group, in the Camrose area, Central Alberta

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Summary

This study was undertaken to map coal distribution within the Belly River Group McKay Coal Zone (MCZ) in the Camrose area, central Alberta, as part of coalbed methane investigations. The thickness of the MCZ averages 20–40 m across much of the study area, and dips to the SW at depths of 150–590 m. Within the MCZ, net coal varies from 0.2–6.3 m, with the highest net coal values (> 3 m) exhibiting a series of NW–SE oriented sub-linear trends. These net coal trends lie parallel to thickness trends in the underlying Basal Belly River Sand (BBRS), with areas of increased net coal coinciding with reductions in the thickness of the BBRS. The area with the greatest potential for gas lies in the north-central region, where well log data suggest higher net coal values are characterized by brighter, low ash coals. Coal seams in the southern part of the study area tend to exhibit higher ash contents.

Introduction

The MCZ represents the lowermost coal-bearing interval in the Upper Cretaceous (Campanian) Belly River Group of central and southern Alberta, and directly overlies the BBRS. Exploration success in Upper Cretaceous coals of central Alberta has generated interest in the MCZ as a potential candidate for coalbed methane production. Based on work by the Alberta Geological Survey and EnCana land holdings, the area encompassed by Twps 42–50, Ranges 15–20W4 was chosen for further evaluation. We present here the results of a detailed mapping exercise, and discuss the distribution of coal within the MCZ and its relationship to the BBRS.

Basal Belly River Sand

The BBRS represents a series of eastward-prograding stacked shoreface sands, and was subdivided into seven Cycles by Hamblin and Abrahamson (1996). The McKay coals are thought to have formed in a back-barrier setting, behind these shoreface sands. Within our study area the dominant Cycle is BBRS Cycle 4.

The BBRS isopach is shown in Fig. 1. A major NNW–SSE oriented linear trend of 15–20 m thickness extends from 42-17W4 to 50-20W4. This feature is referred to here as the Camrose Trend. Sand thickness also shows an increase along the eastern margin of the study area in Range 15W4, with values > 30 m, increasing to 60 m in the NE.

McKay Coals

The MCZ shows a uniform south-westerly dip, at depths varying from 150 m in the NE to 590 m in the SW. The thickness of the MCZ varies from 0.2–68.3 m and is generally 20–40 m, with the thickest sections occurring mainly in the north and east-central parts of the study area. Along Range 15W4 the MCZ is commonly < 20 m thick. Within the MCZ net coal values vary from 0.2–6.3 m, with the net coal isopach revealing a series of NW–SE oriented sub-linear trends of higher net coal (> 3 m) separated by areas of less coal; a second series of trends oriented SW–NE lies in the far south (Fig. 2): none of these trends extend into Range 15W4. The highest net coal values (> 4 m) are concentrated primarily in the north-central area. As many as eight individual coal seams were recorded in wells across the study area, ranging from 0.1–2.4 m (mean = 0.6 m) in thickness. The distribution of individual coal seams shows a similar pattern to

the net coal isopach, indicating that an increase in net coal primarily reflects an increase in the number of coal seams.

Coal Distribution and Quality

Stratigraphic cross-sections suggest the MCZ is subdivided into two sub-zones within the study area (Fig. 3). The degree of distinction between these sub-zones is greatest in the northeast, and becomes less clear towards the south and west. Sediments between sub-zones are primarily sandy in the far north, becoming siltier toward the south and west. The lower sub-zone is dominant throughout most of the study area, containing the majority of coal to the west of Range 15W4, and is largely absent within Range 15W4. Hence, the net coal thickness trends noted in figure 2 do not extend into Range 15W4.

Comparison of the BBRS and MCZ net coal isopach maps shows the areas of higher net coal generally coincide with BBRS isopach values of < 15 m. Areas where the BBRS is > 20 m thick are generally associated with lower net coal values (Fig. 4). Furthermore, the major net coal trends north of Twp 44 all lie parallel to the Camrose Trend. The BBRS thus exhibits control on peat (coal) formation in two specific ways. Firstly, peat was largely confined to the west by the major thickening of the BBRS along Range 15W4. Secondly, these peats were further influenced by thickness variations in the underlying sand of Cycle 4, which controlled local degrees of compaction, and thereby surface topography during peat formation.

Coals in the north-central area are generally characterized by low gamma-ray (< 50 API) and low bulk density (< 1.7 $g.cm^{-3}$) values, indicating peat-formation in this area was largely isolated from major clastic input, possibly in a raised mire setting (Fig. 5). High neutron porosity values (70–80 %) also suggest the presence of relatively brighter coals (more vitrain) in this area. Coal lying on the flanks of the Camrose Trend in the south tends to have higher gamma-ray and bulk density values, indicating higher ash contents (Fig. 5). Neutron porosity values are also lower, suggesting relatively duller coals (less vitrain). This suggests these more southerly peats were subjected to increased clastic input from neighbouring high points lying above the BBRS thicks.

Implications for Coal Gas

The region with the greatest potential for gas lies in the north-central part of the study area, where the MCZ lies at 250–350 m depth, and net coal is typically 3–4 m (up to 6.3 m). Geo-physical well log parameters indicate low ash content and brighter coals in this region, indicating improved gas generation potential, although this can not be fully determined without coal petrographic analysis. Previous work suggests gas-in-place volumes of 0.75–1.5 bcf/section for this area (Beaton *et al.*, 2002), which is among the highest values for the entire MCZ.

Conclusions

The distribution of coal seams within the MCZ is strongly influenced by thickness variations in the underlying BBRS, with areas of thicker net coal and greater numbers of seams occurring where the BBRS thins. The greatest potential for gas is in the north-central region, where the MCZ is characterized by higher net coal values and lower ash contents. These northern coals likely represent peat-formation in a raised mire setting.

Acknowledgements

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References

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Hamblin, A.P. and Abrahamson, B.W. 1996, Stratigraphic architecture of “Basal Belly River” cycles, Foremost Formation, Belly River Group, subsurface of southern Alberta and southwestern Saskatchewan: Bulletin of Canadian Petroleum Geology, 44, 654-673.

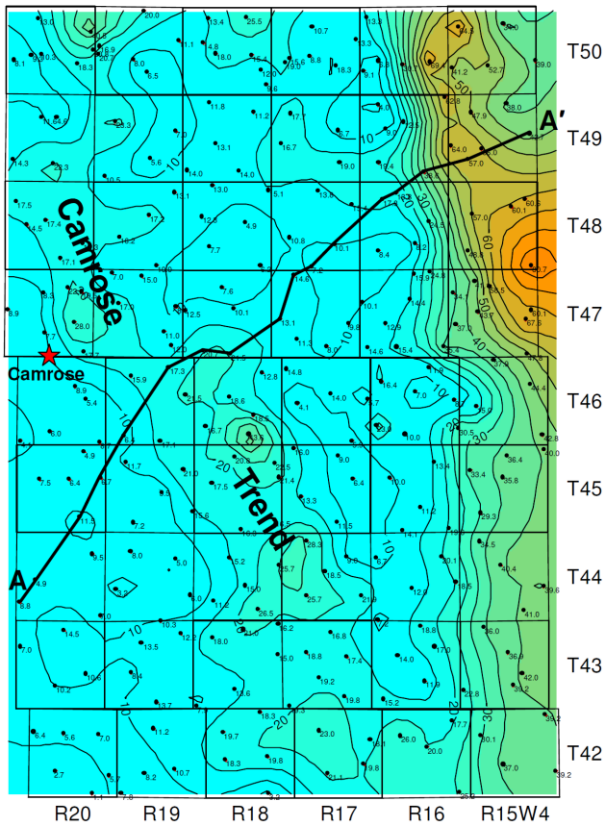

Figure 1: Basal Belly River Sand isopach (in metres). The Camrose Trend is shown oriented NNW–SSE. Location of cross-section A-A′ is also shown.

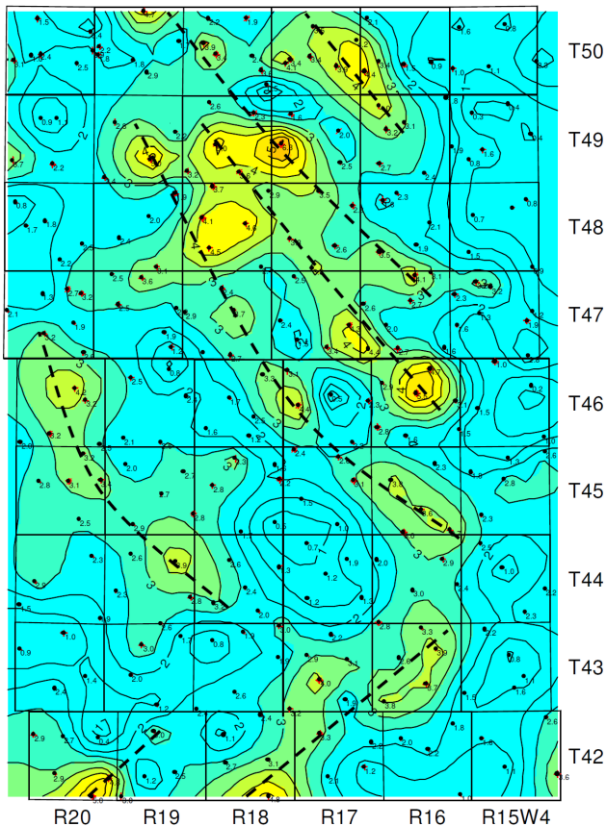

Figure 2: McKay Coal Zone net coal isopach (in metres). Dashed lines indicate apparent thickness trends.

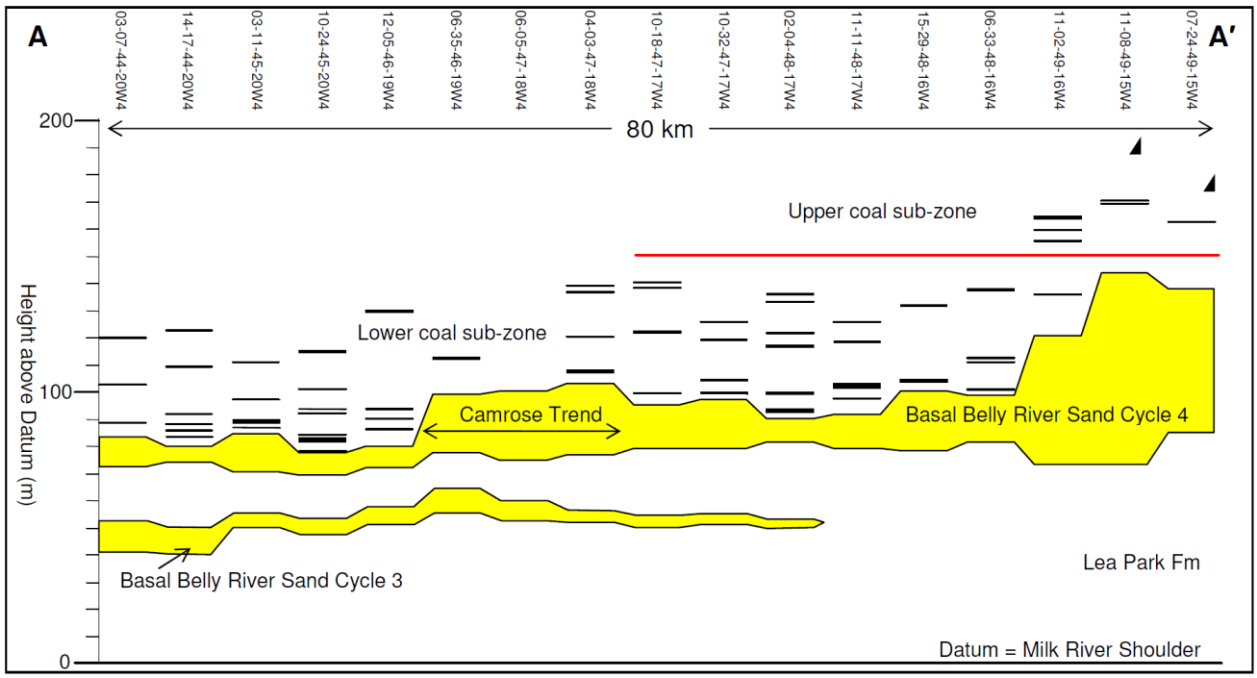

Figure 3: Cross-section A–A′. Black triangles indicate position of surface casing shoe where below the top of the McKay Coal Zone. Basal Belly River Sand of Cycles 3 and 4 of Hamblin and Abrahamson (1996) are also shown. See figure 1 for location.

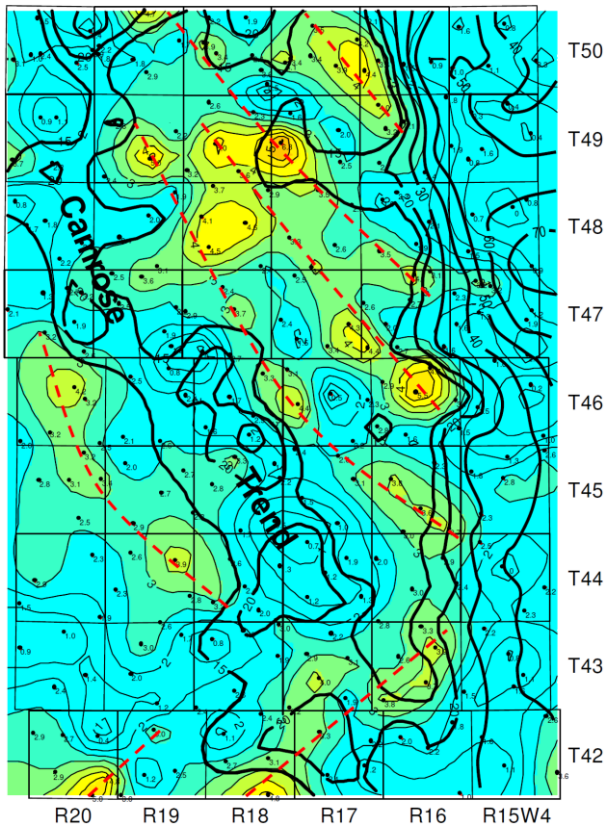

Figure 4: McKay Coal Zone net coal isopach with thickness trends (dashed red lines). The Basal Belly River Sand isopach > 15 m (thick contour line) is superimposed.

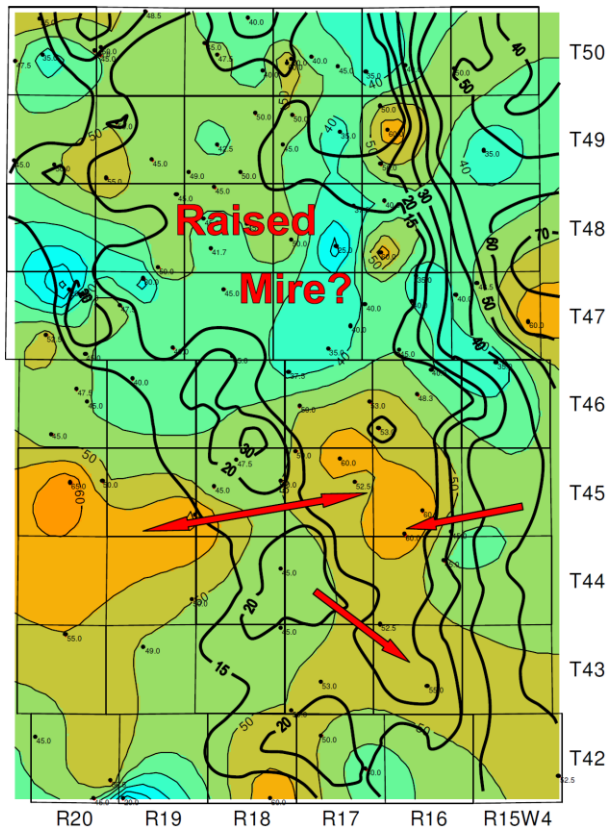

Figure 5: Mean gamma-ray values for coal seams >1 m thick in each well. Lower values in the north suggest a raised mire setting, while higher values in the south indicate increased clastic input (red arrows). The Basal Belly River Sand isopach > 15 m (thick contour line) is also shown.