COAL RANK DISTRIBUTION WITHIN THE BLUESKY–GETHING STRATIGRAPHIC HORIZON OF NORTHEASTERN BRITISH COLUMBIA

(93 I, O, and P)

By R. H. Karst and G. V. White

The top of the Gething Formation is one of the more important formational picks routinely performed by the oil and gas industry during their exploratory and development drilling as this horizon is very continuous through northeastern British Columbia and much of northern Alberta. The name Bluesky is given to the rock unit which occupies this stratigraphic level, namely a sandstone-conglomerate unit of marine origin which separates the continental coal measures of the Gething Formation from the overlying marine shales of the Moosebar Formation (*see* Fig. 32). The Bluesky is commonly glauconitic and has a variable thickness (0 to 50 metres) over relatively short distances and most likely represents shoreline deposition of the rapidly transgressing Clearwater Sea from the north. The Bluesky-Gething is an important petroleum producer in the Fort St. John area.

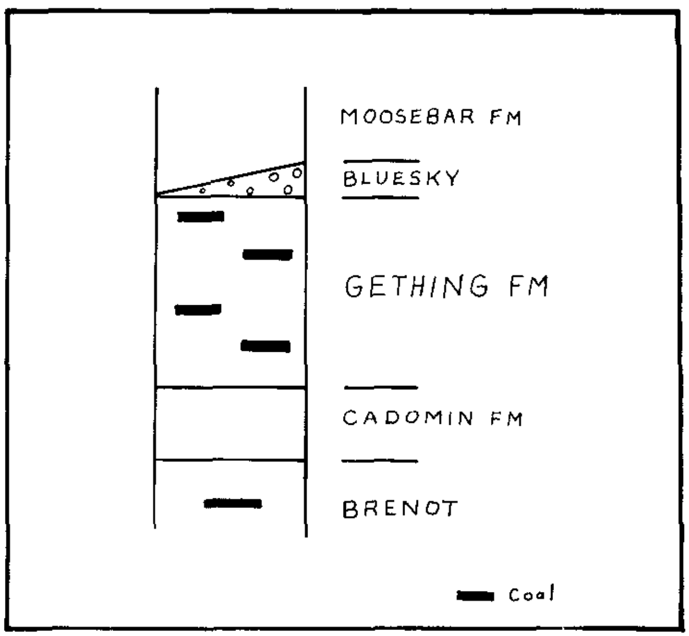

Figure 32. Columnar section, northeast British Columbia.

Coalification is mainly a result of temperature to which the host sedimentary rocks are exposed. In turn, this temperature is determined by the geothermal gradient and the depth of subsidence. Coal rank is therefore a very sensitive indicator of these temperatures. A coal rank map of a specific stratigraphic horizon is particularly useful in portraying regional variations in geothermal heat-flow, tectonism, and post-depositional basin history. Any coal rank variation due to differences in the stratigraphic level of the coal occurrences is eliminated because only one stratigraphic horizon is sampled. This effectively screens out the back-

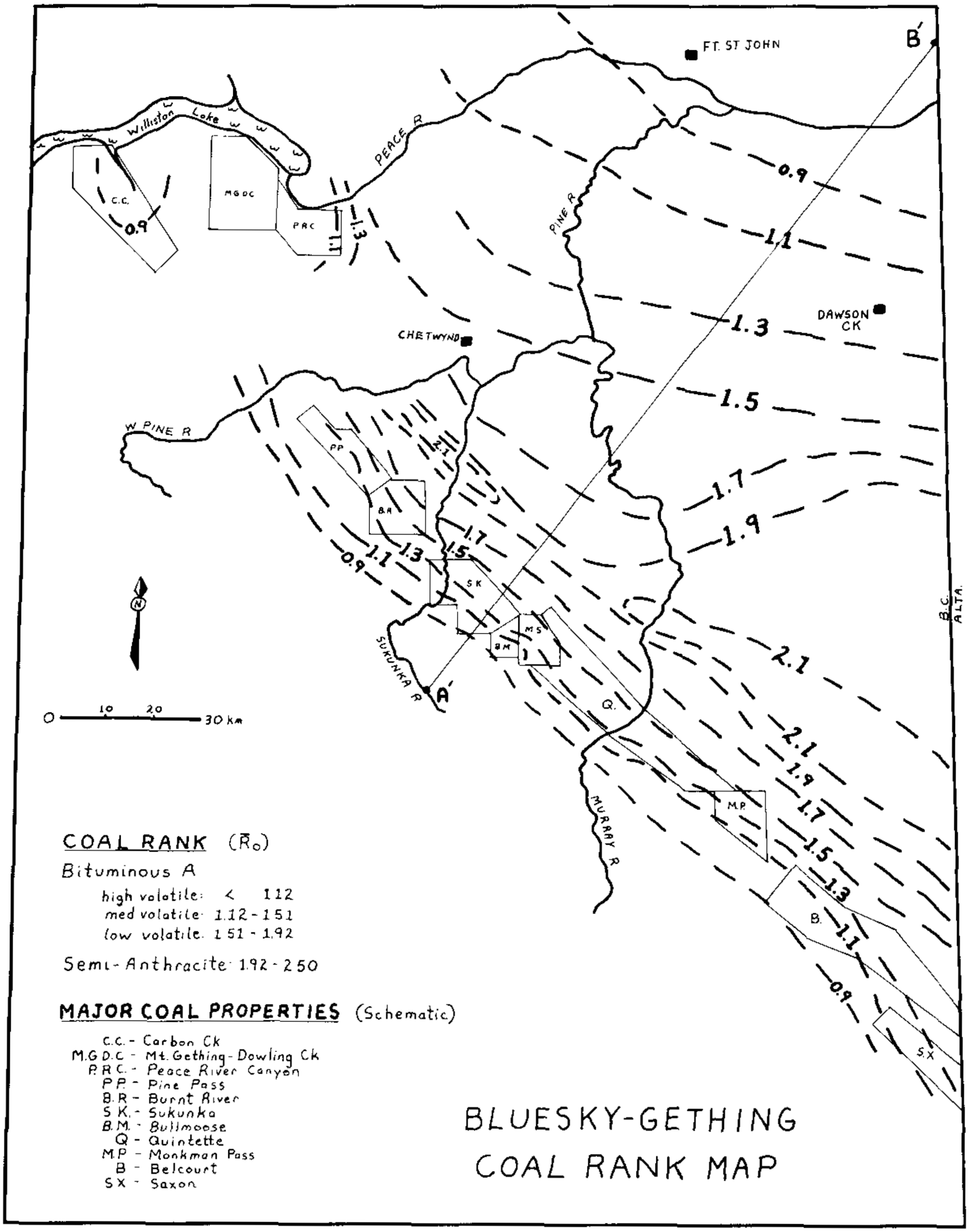

Figure 33. Preliminary coal rank map, northeast British Columbia.

ground noise when interpreting the resulting coal rank map. The top of the Gething Formation was chosen as the specific stratigraphic horizon of this study because of its widespread occurrence and relative ease of identification on oil and gas geophysical logs.

The coal samples collected for this study come from three sources: petroleum well dril bit cuttings; coal industry diamond-drill core; and surface outcrop samples. The first coal below the Bluesky-Gething horizon was sampled in most instances. In a few locations there was no recognizable Gething-Moosebar contact (that is, Carbon Creek and Burnt River areas) and in these cases the stratigraphically highest Gething coal seam was used. All samples had their coal rank determined by petrographic means using the mean-maximum reflectance of vitrinite technique. This method enabled rank determinations to be made on relatively small samples such as the drill bit cuttings. It also had the advantage of not being affected by oxidation of coal from outcrop samples. The values obtained were plotted on a map and contoured at an interval of 0.20 per cent $\bar{R}_o$.

RESULTS

Figure 33 is a preliminary rank map resulting from the 90 coal samples examined to date. No contouring was done between Williston Lake and the West Pine River because of inadequate sample control, but will be added as soon as petroleum drilling for this area is performed.

There are three observations which can be made from the preliminary rank map. They are:

(1) Coal rank increases slowly but steadily from the undisturbed plains region of northeastern British Columbia to the structural margin of the foothills belt (*see* Fig. 34).

This phenomena is due to the geometry of the sedimentary basin and its resultant increase in depth of cover encountered by a specific stratigraphic horizon. This increase in coal rank westward has been well documented in the Alberta portion of the western Canada sedimentary basin.

(2) The increase in coal rank accelerates at the first sign of tectonism and quickly peaks in the deep subsurface of the northeastern boundary of the foothills belt.

The increase in coal rank caused by tectonism can be seen on Figure 34 by the upward steepening of the coal rank profile. The maximum rank increase due to tectonism along this particular cross-section is indicated by the graph to be approximately 0.20 per cent $\bar{R}_o$.

Coal rank reaches a maximum at the very front of the structural margin. The piling-on effect of crustal shortening (stacked thrusts), the frictional heat of rock deformation and failure, and the relative deep position within the sedimentary wedge (before tectonism) would all contribute to these high coal rank values.

(3) After reaching its peak at the structural front, coal rank decreases sharply in a southwesterly direction within the foothills belt itself.

The immediate implication is that much of the coalification undergone by these coals is post-orogenic, or in other words, after tectonism has placed them at their present position. However, this does not explain the severeness of the rank decrease into the foothills belt. This phenomenon was not expected and its reasons can only be hypothesized at this time.

One possible explanation would be that part of the Cordilleran Orogeny (Columbian) had raised the western area of the present foothills belt to a relatively high position at the end of the Early Cretaceous. As a consequence it was not subject to Upper Cretaceous sedimentation and may have actually been the source for some of the Upper Cretaceous sedimentary rocks located to the northeast. This would keep the extreme southwestern Gething coals from being as deeply buried as their northeastern counterparts.

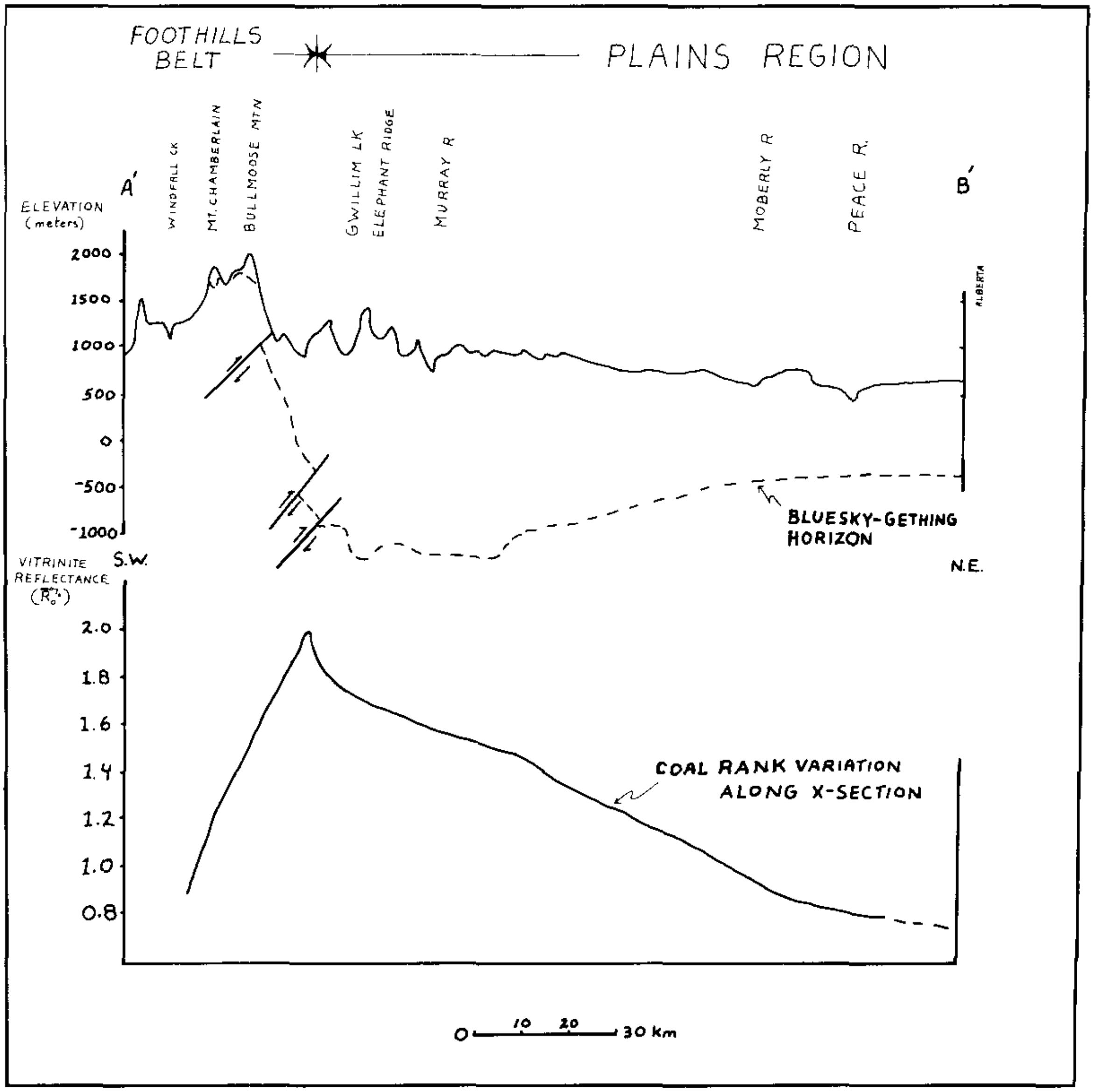

Figure 34. Coal rank variation along cross-section.

Another possible explanation would be that normal faulting is responsible for the rapid subsidence which created the tremendous thickening of Cretaceous sedimentary rocks in a westerly direction. This thickening of Cretaceous strata is observed along the entire western margin of the western Canada sedimentary basin. The sudden drop in coal rank westward would signify that the normal fault zone has been crossed.

Doubtless there are other possible explanations for the rapid drop in coal rank but the preliminary nature of this study does not lend itself to further discussion.

ECONOMIC IMPLICATIONS

The rank map can be used to delineate areas of semi-anthracite and bituminous coal of low, medium, and high-volatile rank within the Upper Gething Formation. Commotion Formation coals will have correspondingly lower ranks than the indicated Gething coals because of their higher stratigraphic position.

A $\bar{R}_o$ of 1.3 per cent is generally regarded as being too high for oil occurrence. That means that any oil which was present in a reservoir rock subjected to these temperatures and pressures would be volatilized into natural gas. Therefore the rank map can be used to delineate those areas where oil can occur within the Bluesky-Gething zone from a viewpoint of organic metamorphism. Predictions of suitability regarding other potential oil reservoir horizons can be made if allowances are made for higher or lower stratigraphic effects. It is apparent that most of the Elmworth-Deep Basin extension into British Columbia exceeds the 1.3 per cent $\bar{R}_o$ rank line and therefore could only contain natural gas, with the oil potential being limited to the northeastern fringe of the Elmworth play and at stratigraphic levels higher than the Bluesky-Gething.

The observation that coal rank declines once into the foothills belt enhances the likelihood that pre-Cadomin coals (that is, Minnes Group) will have coal ranks which are within acceptable coking limits. It also makes it technically possible (at least from a coal rank point of view) that oil could exist within some Lower Cretaceous rocks of the foothills belt.

ACKNOWLEDGMENTS

We wish to thank Heidi Schwab for measuring some of the $\bar{R}_o$ values reported here.

REFERENCES

B.C. Ministry of Energy, Mines & Pet. Res., Petroleum Resources Branch, (1977): Structure Map of Bluesky-Gething, 94 A and 93 P.

Stach, E. (1975): Stach's Textbook of Coal Petrology (second completely revised edition), *Gebruder Borntraeger,* Berlin, Stuttgart.