Vitrinite Reflectance, Thermal Maturity and Coal Rank in Lower Cretaceous Medicine River Coals of South Central Alberta:

Reflectance Suppression and the Role of Liptinite Macerals in Hydrocarbon Generation - Implications for CBM Exploration.

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Summary

Suppressed vitrinite reflectance produces anomalous VRo : depth relationships and regional variations in measured reflectance values (R_o random) in Lower Cretaceous coals from British Columbia and southern Alberta (Kalkreuth, 1982; Gentzis & Goodarzi, 1994) and makes it difficult to accurately determine the coal rank. Furthermore, large ranges in VRo can occur within a single coal sample (this study). For example, VRo ranges of 0.55% to 0.90% (= R_o max range of 0.59% to 0.96%) are not uncommon in deep coal seams (1640m to 2025m) in the Medicine River Formation in south central Alberta suggesting that the coals vary significantly in rank from the lowest end of HVB C to uppermost HVB B rank range. Large variations in telovitrinite reflectance are also clearly visible in polished core samples viewed microscopically.

Mean measured VRo values rarely correspond to other rank indices, such as the colour and intensity of the fluorescence shown by liptinite macerals (alginite, cutinite, resinite and megaspores) in the same coals. The liptinites show dull yellow to golden, medium intensity fluorescence indicating they are thermally mature and suggesting VR_o should be greater than the measured VRo values.

A review of the vitrinite reflectance data in recent studies of the Medicine River coals shows that the measured Ro values obtained from individual samples can be divided into two populations: low values (*suppressed*) and high values *(normal*). In samples with suppressed reflectance, secondary macerals such as Exsudatinite are minor components and perhydrous telo- and detro-vitrinites are common.

Exsudatinite is a microscopic solid bitumen derived from mature resinite, sporinite, cutinite, alginite – a by-product of *in situ* hydrocarbon generation. It commonly occludes mesopores in telovitrinite and teloinertinite, microfractures in vitrinite and micro-cleats in vitrinite-rich microlithotypes. Clearly it

compromises the porosity and permeability of the coal reservoir but it is a minor component in the bright and bright banded coals which are the most prospective lithotypes.

Photomicrographs of Medicine River coals from south central Alberta, show exsudatinite in direct association with resinite, sporinite and alginite. Perhydrous telovitrinites are directly associated with resinites derived from resin cells and resin canals preserved in vitrinite derived from conifer wood (e.g. *Taxodium*). Perhydrous detrovitrinites are directly associated with alginite, sporinite and cutinite, acting as a matrix or groundmass. The low reflectance of the perhydrous telo- and detro-vitrinites is clearly evident and suggests that the perhydrous vitrinites absorbed mobile hydrocarbons generated *in situ* from the thermally mature liptinite macerals while the associated exsudatinite represents the residual, higher molecular weight by-product.

Conclusions

Although clear relationships exist between primary and secondary macerals, thermal maturity of the liptinites and VRo suppression in the Medicine River coals, telovitrinite with “normal” or unsuppressed reflectance (i.e. telovitrinite not derived from conifer wood) can be used for vitrinite reflectance measurement and coal rank determination. It is commonly present in significant quantities in individual coal samples that contain vitrinites with suppressed Ro and most certainly within a single coal seam. For example, a reflectance of 0.72% R_o random VRo was obtained from telovitrinite which does not contain resinite in MR coal at a depth of 1622.9m (= 0.77% R_o max). Telovitrinite in the same coal which is directly associated with mature resinite yields VRo values of 0.57%, which is clearly suppressed. Fluorescence characteristics of alginite and sporinite support the 0.72% Ro values.

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References

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