THERMAL MATURITY OF PALEOCENE COAL FROM SVALBARD – INFLUENCE OF VITRINITE REFLECTANCE SUPPRESSION

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Vitrinite reflectance is a measure of the reflectance of incident light (546 nm) from the polished surface of vitrinite macerals (telocollinite), which are mainly derived from woody tissue of land plants. It is widely used as a parameter to assess thermal maturity of sedimentary organic matter for basin and petroleum systems modelling, mainly because vitrinite is almost ubiquitously abundant in sediments, its near-linear increase with increasing thermal maturity within the range of thermogenic hydrocarbon generation (oil and gas window), and because it is relatively easy and fast to measure (Mukhopadhyay, 1992). However, the method is not applicable for sediments predating the evolution of land plants and it can be complicated if maceral identification is difficult or if suppression of reflectance occurs. Vitrinite reflectance suppression often occurs in hydrogen-rich coals with high contents of liptinite or migrated bitumen, but can also be associated with perhydrous vitrinite. Methods to correct vitrinite reflectance of suppressed samples are based on fluorescence alteration of macerals (Wilkins et al., 1992) or estimation of original hydrogen index values (Lo, 1993). The present study investigates thermal maturity of perhydrous coals using detailed organic petrographic and geochemical analyses of Paleocene coal from Svalbard, for which vitrinite reflectance suppression was reported previously (Orheim et al., 2007, Uguna et al., 2017). These coals are characterized by relatively high hydrogen index (300-400) and low liptinite contents (<10%).
Petrographic analysis of the Longyear coal seam from Mine 7 shows a heterogenous distribution of vitrinite macerals. The top section is dominated by vitrodetrinite with suppressed reflection, whereas unsuppressed collotelinite is small (<50µm) and less abundant. Pseudovitrinite, with characteristic slit pores and higher reflectance than collotelinite, is abundant at the top but does not occur in the lower part of the seam. Additionally, exsudatinite and bitumen filled cleats occur near the top of the seam but are absent at the base, indicating generation and primary migration of hydrocarbons. Collotelinite reflectance shows little variation between seam base and top (0.69 % ±0.02). Compared to collotelinite, the reflectance of vitrodetrinite is lower and pseudovitrinite reflectance higher.
Geochemical analyses also show heterogeous composition of the Longyear seam. Diterpenes (e.g. norisopimarane) and sesquiterpenes (drimanes) are more abundant in the lower part of the seam whereas polyaromatic compounds are more abundant at the top. Hopane and sterane maturity ratios show no significant variation within the Longyear seam, but the methyl phenanthrene index is higher in the upper seam section. The variation in petrographic and geochemical composition within the studied coal seam is most likely caused by different degrees of degradation and microbial reworking, but may also be influenced by different contribution of precursor plant material or by generation and primary migration of bitumen.
This study shows that even though collotelinite is difficult to identify in such a heterogenous coal seam, it is still possible to correctly measure vitrinite reflectance. If vitrodetrinite is measured instead of collotelinite, this would lead to a false maturity trend that decreases from seam base to top.

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