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The diagenetic continuum of hopanoid hydrocarbon transformation from early diagenesis into the oil window

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Hopanoid molecules are ubiquitous in sedimentary rocks and make up a significant proportion of sedimentary organic matter, oils, and bitumen. Due to their relatively stable chemical structure, they are generally well preserved in the rock record, making them extremely useful as biological or geological markers. Despite extensive industry and scientific interest, the early phase of their diagenetic transformation has not been fully demonstrated or examined in a geologic setting. A majority of previous studies have focused on the oil window range from about 0.5-1.0 %VRo, and neglected transformations that happen at maturity levels below this. Additionally, the geological transformation of hopanoids has been extensively applied as a geochemical indicator of thermal maturity, however the mechanisms that result in these transformations are not fully understood.

A major stumbling block in the study of hopanoid diagenesis is the availability of well constrained samples along a single stratigraphic horizon from very low maturity and through the oil window. This study utilizes a natural thermal maturity transect along a single stratigraphic horizon which stretches from thermally immature rocks, up to the middle of the oil window. The purpose of this study is to document the progressive changes in abundance of hopanoid hydrocarbon compound classes and between individual isomers with increasing thermal transformation. Samples for this study were taken from cores of the Upper Cretaceous Second White Specks Formation, a source rock within the Western Canadian Sedimentary Basin, and one that has been extensively mapped and studied. This sample set represents a unique opportunity to examine the changes in hopanoid class with increasing thermal maturity.

69 samples from 8 wells were examined for biomarkers. Thermal maturity was determined using HAWK programmed pyrolysis analysis of 87 samples from 10 wells. These geochemical methods were combined with a known stratigraphic framework to ensure that sampling methods were stratigraphically controlled. Neohopenes, hopenes, ββ-hopanes, βα-hopanes, αβ-hopanes, and diahopanes were differentiated and drastic changes in the proportions of these compound classes were observed with increasing thermal maturity. Thermally immature rocks are dominated by hopenes, neohopenes, and ββ-hopanes, whereas the middle of the oil window is dominated by αβ-hopanes and diahopanes. These results allow a detailed determination of the maturity ranges that correspond to the transformation or disappearance of specific hopanoid molecule classes, for example the loss of hopenes in the maturity range of 0.28-0.35 %VRE. Additionally, this study allows the stages of episodic or punctuated transformations of hopanoid classes to be better delineated and narrowed down to specific maturity ranges. This work represents a novel examination of a natural thermal maturity transect and helps to consolidate our understanding of the early diagenetic transformations of hopanoid compounds.