Geochemical Models for the Hydrocarbon Yield Potential of Source Rocks and Effects of Thermal Stress on Molecular Biomarkers During Hydrous Pyrolysis

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To develop geochemical models for quantifying the hydrocarbon yield potential of Paleozoic marine source rocks, eight Paleozoic rocks (Type I, II and III) were heated under isothermal and stepwise hydrous pyrolysis conditions (closed system) at a series of temperatures ranging from 230 to 400oC. The Rock-Eval pyrolysis of residual rocks suggests that caution is required when applying bulk parameters to estimate the yield potential of these rocks. A systematic change of ∑(S1+S2) is observed in most of these samples with increasing thermal maturity, which leads us to derive additional models to estimate hydrocarbon yield potential. Revised yield models have been developed in this study, suggesting that the Ordovician marine source rocks cannot generate sufficient yield volumes to form commercial accumulations in the Tarim basin, NW China. Further work is needed to put this into basin context.

An investigation was also made into the effects of thermal stress on molecular signatures of chemical fossils in extracts and pyrolysates of hydrous pyrolysis experiments. Our results show that while Pr/Ph is useful as a source indicator, it is also maturity dependent. It appears that pristane precursors are tightly bound in some kerogens and only released at approximately 340oC under our experimental conditions. In our experiments, molecular biomarkers appear to follow specific patterns corresponding to (i) early generation and transformation from the kerogen and bitumen, (ii) very little change within the oil window itself, and (iii) changes related to biomarker destruction in the wet gas window. Biomarkers of source specificity including C24 tetracyclic terpane and 28,30-bisnorhopane might preferentially crack at relatively high temperatures (340-370oC). Some established biomarker maturity parameters (e.g., Ts/Tm, C29 steranes 20S/20R, moretanes/hopanes) are controlled by slow long-term heating rates in nature, in which thermodynamic control plays an important role. Because the anomalous variations of biomarker fingerprints in the hydrous pyrolysis experiments have a kinetic control, further work is required to investigate how these parameters vary with maturation at geological time scales.