FABRIC EFFECT ON HYDROCARBONS FORMATION AND PROPERTIES IN ORGANIC-RICH ROCKS: A CASE STUDY OF WEST SIBERIA, RUSSIA

M.S. Tikhonova¹, A. Baniasad², A.G. Kalmykov¹, G.A. Kalmykov¹, R. Littke²

¹ Lomonosov Moscow State University, Russia
² Institute of Geology and Geochemistry of Petroleum and Coal RWTH Aachen University, Germany

Differences in mineral composition and thermal maturity of organic-rich rocks affect the petrophysical characteristics and the composition of organic matter. Generated hydrocarbons are retained in the pore space prior to expulsion from the source rocks. Concerning the complexity of porous media, there are major uncertainties about the location (open vs. closed pores) and extension of hydrocarbon storage and accessibility. Multi-phase hydrocarbon generation and expulsion in a source rock make this phenomenon even more complicated. Previous studies applied the sequential extraction of soluble organic matter from source and reservoir rocks using a suite of solvents with increasing polarity or in some cases the same solvent applied for different periods of time (Schwark et al., 1997; Mohnhoff et al., 2016) indicating non-homogenous distribution of bitumen throughout the source rock. Maturity and facies variations between the sequential extracts and the grain size fractions has been reported. This study tries to investigate the geochemical characteristics of accessible and inaccessible hydrocarbons stored in open and closed pores, respectively, and to study the effect of fabric and solvents on these characteristics applying a set of organic-rich rocks with different maturities and sequential extraction using different solvents on both plugs and pulverized materials.

To cover different parameters which can affect the generated hydrocarbon characteristics such as mineral composition, porosity and thermal maturation, a set of organic-rich rocks from Jurassic sediments, West Siberia, was selected. The mineral composition of samples slightly varies, e.g. with respect to clay minerals and silica (difference is less than 5-10%). Gas porosity in the selected samples ranges from 0.5 to 6.5% (in-situ conditions). The organic matter contents ranged from more than 20% for a samples at lower maturity to less than 5% for a sample at the maturity of late oil window.

For the purpose of sequential extraction, drilled plugs (30×30 mm) from selected samples were extracted in Soxhlet apparatus using different solvents, i.e. n-hexane, chloroform, and benzene-alcohol. It is assumed that the extraction of plugs allows us to remove bitumen only from the open pores system participating in hydrocarbon expulsion from source rocks. Hexane as a light solvent removes only maltenes and light hydrocarbons, while chloroform and benzene-alcohol have higher polarity and can remove heterocompounds and asphaltenes. In case of blocking the pore throats by fractionation/asphaltene precipitation, these solvents can remove them and extract the trapped hydrocarbons. Extraction proceeds in each stage until the extract concentration reaches to less than 0.000625%. Following the extraction with benzene-alcohol the plug was pulverized and extracted with all aforementioned solvents in the same order. It is assumed that this phase of extraction allows to study the remaining bitumen in closed pores and adsorbed hydrocarbons in kerogen which is only extractable when the fabric of the rock is destroyed. All extracted material (6 extracts for each sample) was then weighted and fractionated. Molecular characteristics of aliphatic and aromatic fractions were then studied by GC-FID and GC-MS.
All extracts from each sample were compared and geochemical similarities and differences were investigated. The samples are characterized by decreasing maltene/asphaltene ratios from extracted material from open pores (plug) to closed pores (pulverized rock) and from hexane to alcohol-benzene solvents. The distribution of \( n \)-alkanes and isoprenoids in most hexane and chloroform extracts are similar, mono-modal, with a distinct maximum in the short chain hydrocarbon range. The extracted material from closed pores by benzene-alcohol, however, is characterized by an even to odd carbon preference indicating lower thermal maturity. Thermal maturity differences among extracted material is further supported by studying the hopanes and steranes biomarkers. Various maturity parameters such as Ts/(Ts+Tm), Ts/C\(_{30}\), and H32 (22S/22S+R) indicate the same maturity level for all extracted material from open pores, while the extracts by hexane and chloroform from closed pores have higher maturities (Fig. 1). The benzene-alcohol extracts from closed pores have the lowest thermal maturity. Experiencing the same temperature history, this variation implies that the isomerization rate of organic matter can be dependent on the location of hydrocarbons in the pore space (open versus closed pores).

The results imply the importance of the fabric effect which in most studies is neglected by pulverizing the samples. This can affect the biomarker ratios significantly, which can cause large interpretive errors in oil-source correlation studies if used carelessly.

![Figure 1](image_url)

*Figure 1* Thermal maturity variations of different extracts (E\(_1\)C-E\(_6\)P) from a selected sample.

References
