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Petrographical and Geochemical Investigation on Maturation and Primary Migration in Intact Source Rock Micro-Plugs: Insight from Hydrous Pyrolysis on Woodford Shale

TIANYU ZHENG[1] AND RALF LITTKE[2]

[1]School of Resources and Safety Engineering, University of Science and Technology Beijing
[2]RWTH Aachen University

his study proposes a new approach to investigate primary migration in Upper Devonian-Lower Mississippian Woodford Shale under laboratory conditions. Hydrous pyrolysis (HP) was performed on polished source rock micro-plugs at different temperatures. Maceral characteristics are observed before and after the different pyrolysis experiments. In situ maceral changes at different maturities are directly visualized at the exact same place after HP at 300, 320, 330, and 340 °C for 24h. The bitumen adsorbed to some of the *Tasmanites* surfaces leads to the brighter fluorescence after chemical extraction. *Leiosphaeridia* are less stable than *Tasmanites*; they first expand and then shrink during thermal evolution partly leaving empty holes in the matrix. *Tasmanites* keep a strong yellow fluorescence and start to bituminize at the edge of the particles. Liptodetrinite shows significantly decreasing fluorescence intensities already at low pyrolysis temperature and disappears to a great extent at 330 and 340°C.

For each experimental temperature, one sample plug was also used to investigate the geochemical differences between retained and expelled bitumen. There is an overall increase of S1 and reduction of S2 peaks, T_{max}, and HI values as expected during thermal evolution. Much of the newly generated bitumen is thermally stable and appears in the Rock-Eval S2 rather than S1 peak.

Phytane may be degraded faster during pyrolysis than pristane. *N*-alkanes seem to be easier expelled from the rocks in comparison to the isoprenoids. Tricyclic terpanes are more easily expelled than hopanes; thus all retained bitumen is dominated by hopanes, while all expelled bitumen is dominated by C_{19-23} tricyclic terpanes. Ts/ (Ts+Tm) increases quite regularly with increasing pyrolysis temperature in retained bitumen, but keeps constant in expelled bitumen. Therefore, Ts may elute more rapidly than Tm at low pyrolysis temperature. The ratios of the most abundant triterpene and hopane in both retained and expelled bitumen over the adjacent *n*-alkane decrease with increasing pyrolysis temperature and confirm the higher thermal stability of n-alkanes compared to cyclic alkanes.

[1] Peters, K. E., Walters, C. C., Moldowan, J. M., 2005. The Biomarker Guide: Volume 2. Biomarkers and Isotopes in Petroleum systems and Earth History. Cambridge: Cambridge University Press. 475-625.