Insights into hydrocarbon formation and preservation in shales

C. OSTERTAG-HENNING[1]* AND L. RICHARD[2]

[1]Federal Institute for Geosciences and Natural Resources (BGR), Stilleweg 2, 30655 Hannover, Germany
*correspondence: Christian.Ostertag-Henning@bgr.de
[2]Carrer de Pontevedra 45-3-2, 08003 Barcelona, Spain
laurentyc.richard@gmail.com

During the past decades, numerous experimental avenues have been followed to mimic the natural formation of hydrocarbons in sedimentary basins. A longstanding issue is whether and to what extent water might play an important role in the maturation of organic matter. Most kinetic data on hydrocarbon formation are derived from open dry pyrolysis experiments – or closed dry pyrolysis on isolated kerogen from source rocks. Some groups [e.g. 1] argued that hydrous pyrolysis experiments produce petroleum resembling natural oil and gas more closely. But even within the group of advocates for hydrous experiments a disagreement exists about whether finely ground or only crushed source rock material should be used for the experiments. The main difference is the available surface area for mineral buffering of the aqueous fluid pH and f_{O2}, and the availability of water molecules at the sites of hydrocarbon release from the kerogen. An additional difference is the timing of the release of the hydrocarbons to the aqueous fluid

Therefore hydrous pyrolysis experiments in Dickson-type flexible gold-titanium cells have been carried out with aliquots of either crushed or finely ground Posidonia shale source rock at 315°C and 120 bars. The aqueous phase was analyzed for hydrocarbons, ketones, alcohols, organic acids, and organic sulfur compounds, as well as H_2, CO_2, and H_2S.

Overall, there are higher aqueous concentrations for all compound classes in the experiments with the source rock powder compared to the rock chips, the difference being most pronounced for the hydrocarbons, less pronounced for the ketones, and only small for the organic acids and the organic sulfur compounds. The concentration of the organic sulfur compounds is proportional to the H_2S concentration in all samples and point to a rapid formation and destruction of these compounds. The concentrations of ketones are always higher than those of the alkanes of the same C-number for C_3 and C_4 and increase in proportion to the organic acids throughout the experiments. The implications for the pathways of petroleum formation and the stability of hydrocarbons in shale gas/oil systems are discussed based on a comparison between the experimental results and a thermodynamic analysis of water-rock-hydrocarbon interactions in the Posidonia shale.

[1] Lewan (1979) *Science* **203**, 897-899