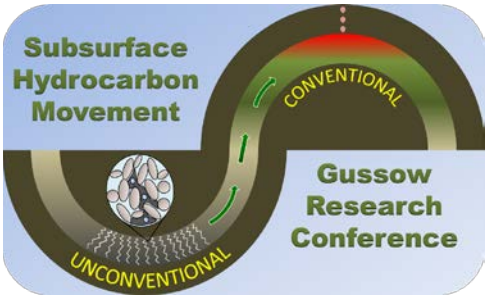

Impact of crude oil composition on γ-ray radiolysis of petroleum: a factor in reservoir fluid residence age dating

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Summary

Fluid residence time in a trap is a key factor in many petroleum systems evaluations, basin modeling and carbon storage studies. It will not only provide constraints for basin modeling but also contribute an alternative approach to caprock efficiency evaluations for carbon storage and oil charge studies. However, dating of fluid flow events in petroleum systems is currently based on indirect methods, and direct assessment of hydrocarbon charge and residence time from analysis of crude-oil is not feasible. The RvW Research Project (ucalgary.ca/prg/research) is aiming at developing a new precise analytical method to permit functional dating of reservoirs by organic geochemical proxies with realistic reservoir gamma ray dose.

Our previous five-year study indicated how nuclear radiation in reservoirs impacts oil composition and defined two general types of organic geochemical proxy systems that might in principle find application to the assessment of natural nuclear radiation dose experienced by a reservoir and petroleum fluids. In previous findings, the majority of Gas Chromatography - Mass Spectrometry (GC-MS) monitored compounds are gradually destroyed under high-dose gamma-ray irradiation. The original concentration of individual compounds (non-irradiated) was considered as an important influencing factor during radiolysis and significantly affected the radiolysis rates for the majority of investigated compound. The radiolysis rates were also highly chemical type dependent, with saturated hydrocarbons such as hopanes being among the most radiation sensitive species and diamondoid alkanes being among the least sensitive to radiation.

In this study, we took a further step to look into the impact of oil composition on the radiolysis effect based on GC-MS proxies. We designed a series of high-dose (50–4000 kGy) gamma ray irradiation experiments and conducted studies on 10 different type of crude oils from the Chinese Tarim Basin to investigate their radiolysis effects and mechanisms. After normalized by the original concentration of each compound, the actual radiolysis rates varied in different oils. The radiolysis rate was negatively correlated with the API value as well as viscosity. The lighter oils were destroyed faster than the heavier oils with high viscosity. In previous findings, a few compounds, particularly *n*-alkanes $C_{9–12}$, were generated after oil radiolysis. While, for the 10 oils in this study, significant compound degradation and production simultaneously happened with variation in rates affected by oil composition. Lighter oils are more reactive with *n*-alkane generation possibly extended to the range of $C_{9–18.}$ And variable levels of stability of aromatic species to radiation depending on the oil matrix. The work suggests the oil composition/matrix, is another important factor in the radiolysis process of crude oils under gamma ray irradiation.

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