The application of single drop vapor phase extraction for the analysis of light ends in unconventional resources

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The successful exploitation of unconventional petroleum resources has resulted from innovation and the adaptation of technology developed for, and applied to, other purposes. In order to increase the success rate and exploration efficiency for unconventional resources, various research groups have similarly been adapting and developing analytical approaches to better understand the underlying chemical and physical controls on the occurrence and producibility of tight oil, tight gas and other unconventional deposits. In addition to new fundamental knowledge of the nature of these resources, these research results also provide leads on how best to adapt development technologies in order to make them more economically interesting.

Organic geochemistry, and more specifically petroleum geochemistry, has for many years used state-of-the-art analytical instrumentation to aid in the assessment and development of conventional petroleum resources and to constrain 4-D basin models used to rank prospects and even predict products (gas versus oil) and reservoir fill factors. Some of these same technologies are now being applied in the context of unconventional resource exploration and exploitation. The methods include bulk analyses that provide information on the total organic carbon content, level of thermal maturity and organic matter type as well as very detailed fingerprint analysis using gas chromatography-mass spectrometry (GC-MS), GCxGC-MS and GC-MS-MS.

Recently, techniques such as single drop vapor phase extraction (SDVPE) have been developed to address oil fractions that are uniquely important to tight oil and tight gas deposits. In addition, the SDVPE method has been modified for the analysis of heavy oil and bitumen samples since we are becoming increasingly aware of the contribution of light ends or volatile liquid compounds and gases which strongly impact physical properties such as viscosity and PVT phase behavior. Figure 1a shows the GC-FID fingerprint of the light end components obtained during SDVPE of a freshly obtained bitumen core. The carbon number ranges from propane, through iso-butane, butane to decane (n-C_{10}). Interestingly, even though the viscosity of the mechanically extracted bitumen was ca. >1,000,000 centipoise (at 20 °C) appreciable quantities of volatile liquid compounds were detected in the sample showing that fresh core represents the best sample material for physical property measurements and hydrocarbon compositional analysis. Figure 1b shows the total hydrocarbon distribution isolated from the bitumen stained core by solvent extraction followed by solid phase extraction.

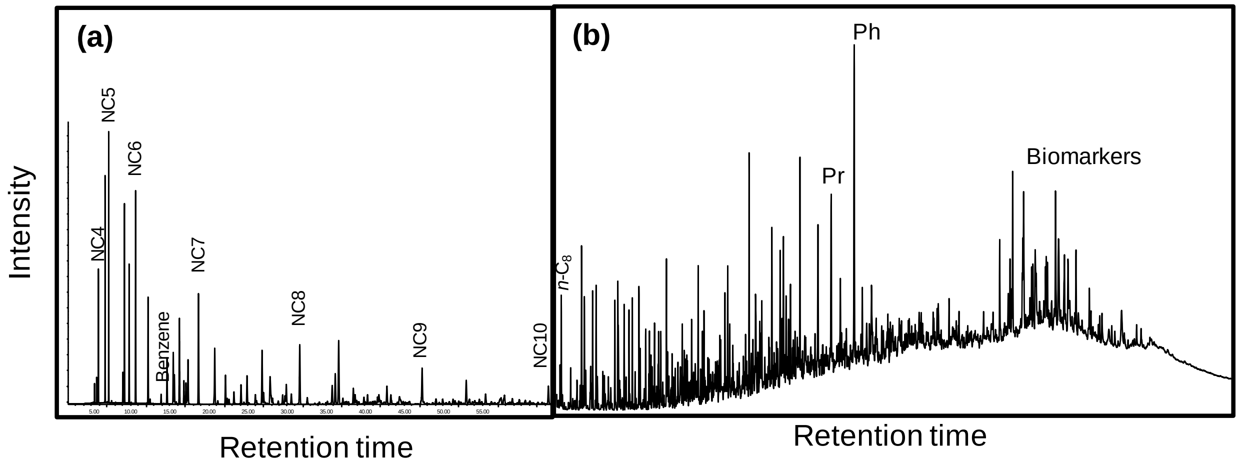

Figure 1. Partial reconstructed (a) GC-FID chromatogram of the volatiles captured by Single Drop Vapor Phase Extraction (SDVPE) and (b) total summed ion (60 ions) chromatogram of the total hydrocarbon fraction of a bitumen stained core sample.

The SDVPE method has also been successfully applied to the analysis of volatile liquid compounds present in core samples collected from source rocks hosting tight oil and gas. Examples of hydrocarbon analysis of bitumen stained cores and tight oil deposits will be presented.