CHARACTERIZATION OF CRETACEOUS AND JURASSIC SOURCE ROCKS: EAST TEXAS, DEEPWATER GULF OF MEXICO, ONSHORE MEXICO

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Cretaceous and Upper Jurassic source rocks explain much of the production in the East Texas Basin (ETB), Deepwater Gulf of Mexico (DGOM), and Mexico's Tampico-Misantla Basin (TMB). The effectiveness of these source rocks is demonstrated by petroleum charge in conventional and unconventional reservoirs. These systems major source rocks are summarized in the table below.

Table 1. List of Cretaceous and U. Jurassic source rocks in ETB, DGOM, and TMB

Period	Age	Onshore East Texas Basin	Offshore Deepwater GOM	Onshore Tampico-Misantla Basin
U. Cretaceous	Cen.-Turonian	Eagle Ford *	Cenomanian *	Agua Nueva
U. Cretaceous	Cenomanian	Dexter/Pepper		
L. Cretaceous	Albian	Kiamichi/Goodland	Albian	
L. Cretaceous	Aptian	Pearsall/Bexar		
L. Cretaceous	Aptian	Pearsall/Pine Island	Aptian *	
U. Jurassic	Tithonian	Bossier *	Tithonian *	Pimienta *
U. Jurassic	Kimmeridgian	Haynesville *	Kimmeridgian *	Taman *
U. Jurassic	Oxfordian	Smackover *	Oxfordian *	Santiago *
* major source rock interval				

In the onshore ETB where unconventional shale gas production has been very successful, U. Jurassic source rocks are gas window mature. As such it has been difficult to characterize original petroleum generation potentials. However, similar age, but immature source rocks have been found in the DGOM and TMB. The availability of low maturity source rocks of these ages enables assessment of source rock characteristics relevant to petroleum production, while mature source rocks and produced oils allow calculation of generation potentials and correlations.

Multiple organofacies in the DGOM and TMB are indicated by data ranging from hydrogen indices to biomarker characteristics. The Tithonian and Kimmeridgian have distinct organofacies, respectively. Hydrogen indices in the upper and lower sections of the Tithonian in the DGOM have average values of 576 and 299 mg/g, respectively, with TOC values of 3.62 and 1.02 wt.%. The lower HI and TOC interval has considerably higher oxygen indices (OI) averaging 57 mg/g as opposed to 27 mg/g for the lower Tithonian interval. The Kimmeridgian interval has three distinct intervals with average HI values of 470, 720, and 724 mg/g with average TOC values of 2.19, 5.60, and 2.63 wt.%, respectively. OI values are higher in the uppermost and lowermost intervals (50 and 38 mg/g, respectively), whereas the middle interval averages 24 mg/g. The Cretaceous Aptian source rocks in the DGOM have similar characteristics as the U. Jurassic lending difficulties in discernment and correlations.

Pyrolysis gas chromatographic yields of immature source rocks from the DGOM show variable yields of gas versus oil (Fig. 1). The Upper Jurassic shows both high yields of black oil and in other cases much higher yields of light oil. Cretaceous source rocks generally show higher yields of light oil, although one interval shows higher black oil yields. The Cretaceous Coniacian shale shows the highest yield of gases.

In terms of biomarkers the low maturity extracts of the immature U. Jurassic in the DGOM show abundant bisnorhopane, which are largely absent in produced oils that are

generated by higher maturity U. Jurassic source rocks. Extracts and oils from both select Cretaceous and Jurassic intervals show high C_{24} tetracyclic terpane/C_{26} tricyclic, high but variable $C_{29}H/C_{30}H$ often greater than one, moderate gammacerane, and elevated C_{35}/C_{34} hopane ratio typical of carbonate or marly marine shales.

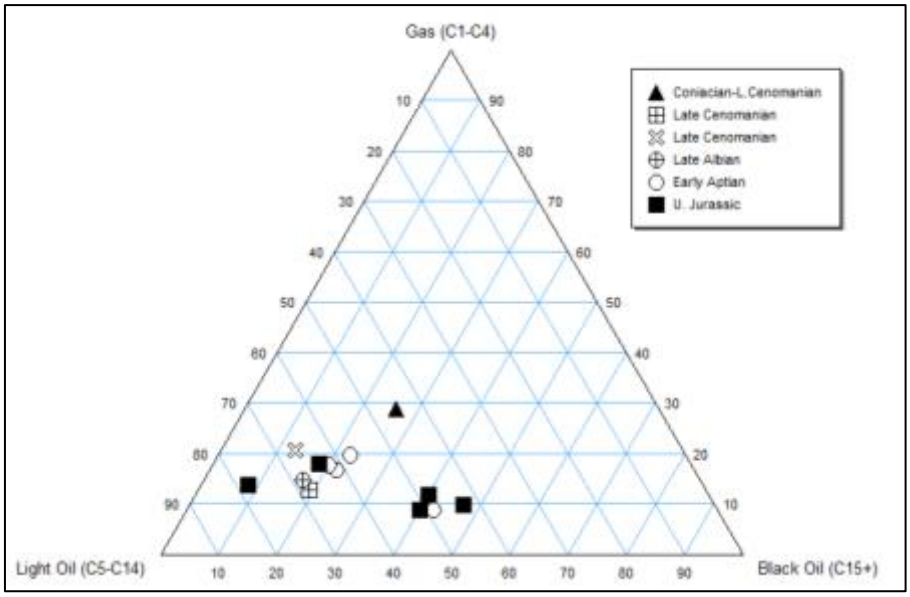

Figure 1. Pyrolysis gas chromatographic yields from immature DGOM source rock samples.

One simple characteristic worth noting is that these carbonate source rocks yield high amount of light aromatic hydrocarbons in particular toluene. When aromaticity ratios (Thompson, 1988) are plotted, these source rocks show aromaticity values above unity often in the range of 1.2 to 3.0. This impacts the assessment of the alteration process referred to as evaporative fractionation (Thompson, 1988) that may rather be an indication of generation from carbonate source rocks. This has been noted in other carbonate-sourced systems such as the Madison Group of the Williston Basin and the TMB.

The decomposition of these source rocks show a distinct pattern consistent with compositional kinetic models (e.g., Behar et al. 2008). Kerogen decomposes into a mixture of hydrocarbons and nonhydrocarbons with the nonhydrocarbon fractions (resins and asphaltenes) dominating the early generated petroleum. With increasing maturity, the asphaltene fraction decomposes more completely than the resin and kerogen resulting in somewhat replenished, but more refractory resins (Behar et al.'s "NSOs 2"). The depletion of the resin fraction shows excellent correlation with the increase in saturate fraction yields in the TMB (linear R^2 of 0.93). The decrease in asphaltenes and initial resins improves the overall fluid mobility whereas increases in the more refractory resins result in decreased permeability as they occlude pore throats. Further, expulsion is will occur as an unsaturated crude oil in oil window maturities or as a gas phase with primarily light hydrocarbons at higher thermal maturities. The consequences for unconventional production are important as the expulsion process more highly fractionates the oil in the late volatile oil window.

References

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