Life in the Cretaceous of North America: The Western Interior Seaway, H_2S-eating Bacteria, PZE, After-β, and Other Wonders of Organic Matter Creation, Preservation and Hydrocarbon Generation

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The geographic, lithologic and stratigraphic distributions of Cretaceous-aged source rocks in what is now western North America are directly related to the existence of the Western Interior Seaway. In very broad terms, the Seaway is associated with the breakup of Pangea and Jurassic subduction of the Farallon tectonic plate. With the ~Mid-Cretaceous transgression of the Arctic Ocean to the south - and eventual linkage with an extension of the Tethys Sea (now the Gulf of Mexico) - the stage was set for episodic organic matter production, preservation, thermal maturation and significant economic hydrocarbon generation.

This presentation will characterize the geochemistry of Cretaceous source-rock packages from the Cenomanian Second White Speckled Shale of the Western Canada Sedimentary Basin, south to the Cenomanian-Turonian Eagle Ford Formation of south Texas. We will compare and contrast on several interpretative levels: For example, the Mowry Shale of the U.S. Rocky Mountain region is a source-rock due more to *enhanced preservation*, while the Niobrara formation is a source-rock due more to *enhanced productivity*. Characterizing produced oils and bitumen extracts from cores and cuttings, we considered such factors as the presence and absence of oleanane (a biomarker for flowering plants); biomarker-based upwelling signatures; the relative abundances of cyanobacteria and of dinoflagellate, diatom and green algae; and the presence/absence of *photic zone euxinia* (PZE), critical to organic matter preservation in many depositional basins.

Euxinic conditions in aquatic environments are defined by the presence of H_2S and absence of oxygen. In the photic zone, specialized photosynthetic bacteria (e.g., green sulfur bacteria) also require H_2S for their metabolic processes. An understanding of paleo-PZE occurrences through analysis of hydrocarbon fluids has been facilitated by application of GC-MS/MS (aka GeoMark QQQ) technology for rapid measurement of C40 aromatic carotenoid compounds such as isorenieratane. The novel 'After β' carotane isomer, a saturated C40 compound, is higher relative to β-carotane in oils from Upper Cretaceous source rocks than in Lower Cretaceous-derived oils and therefore has age-significance. As a further example, only traces of isorenieratane are present in oils from the Niobrara suggesting more open water depositional conditions with little PZE. This contrasts with geochemical evidence for the strong presence of PZE conditions (and resulting enhanced organic matter preservation) in the more restricted Mowry Sea.

The carotenoid biomarker distributions of petroleum systems tend to be distinct so that, in combination with data on isotopes and commonly used sterane and hopane biomarkers, they allow oil-oil and oil-source correlations to be made with significantly greater fidelity. Taken together with other geochemical and geological signatures, the nature of multiple Cretaceous source-rock packages is defined.