Geochemical and Isotopic Changes During Early Stages of Petroleum Generation from Shales

Anna M. Cruse[1], Michael D. Lewan[2], and Jessica S. Magers[1]
[1]*Boone Pickens School of Geology, Oklahoma State University, Stillwater OK;*
[2]*United States Geological Survey, Denver, CO*

Petroleum generation is a two-step reaction: (1) the thermal decomposition of kerogen to form bitumen, and (2) decomposition of bitumen to oil and gas. Bitumen has long been recognized as an intermediate in petroleum formation, we lack knowledge of many aspects of its chemical composition and generation kinetics. To better understand the reaction mechanism by which bitumen is generated from kerogen, the kinetic parameters for its generation were determined through a series of hydrous pyrolysis experiments using the New Albany Shale (Devonian, Type II) and the Menilite Shale, (Oligocene, Type IIS). Bitumen generated during laboratory experiments (225° to 350°C, 72 hours) can be chemically distinguished from the expelled oil based on the proportion of saturates, aromatics, and polar compounds, with the bitumen phase being enriched in NSOs (resins + asphaltenes) and aromatics relative to the expelled oil. Under the experimental conditions, bitumen generation can be modeled as a pseudo-first-order reaction. The activation energy for the bitumen generation and is higher than that reported in previous studies. By comparing the kinetic parameters for the New Albany Shale to those for the Menilite Shale, the role of kerogen composition will be determined for this intermediate reaction. Finally, the stable carbon and nitrogen isotopic composition of the kerogen, as well as the saturate, aromatic, and NSO fractions of extracted bitumen, is examined with respect to maturation. Such data provides evidence for reaction mechansisms suggested by kinetic analysis, and may provide an additional tool to understand the formation of other shale-hosted unconventional reservoirs.