Differences in Oil Shale Organic Matter Across Eocene Lake Uinta Inferred from Fischer Assay Data

Justin E. Birdwell[1], Scott A. Kinney[1], Tracey J. Mercier[1], and Ronald C. Johnson[2]

[1]U.S. Geological Survey
[2]Retired Geologist

Abstract

Over 300,000 Fischer assay measurements from ~1,000 wells in the Piceance Basin display stratigraphic and geographic variability of organic matter deposited in oil shale in Eocene Lake Uinta. These data provide potentially detailed information on the depositional environment during different stages of lake history and in different parts of the lake. Fischer assay measurements originally made to determine the variability in oil yield to assess the resource include specific gravity values of liquid pyrolysates, which we utilize here as an indicator of variations in organic matter properties. The average specific gravity of Piceance Basin oils generated by Fischer assay was previously shown to decrease with depth from the Mahogany zone (~0.93) to the base of the Garden Gulch Member of the Green River Formation (~0.88), an equivalent shift in API gravity of ~10° over approximately 2,000 feet in depth in the basin center. This change in density has been attributed to decreasing kerogen oxygen content with increasing burial depth and thermal maturity, based on a limited set of kerogen analyses. The shallow burial depths across the Piceance Basin, as well as similar trends in deeper and shallower wells however suggest that thermal maturity differences, which range in terms of vitrinite reflectance from approximately 0.3% in shallow areas to just under 0.5% in the lowermost Garden Gulch zone, cannot explain the observed specific gravity trend. Oil specific gravity also varies geographically across the basin within particular oil shale zones, with lighter oils generated by shales deposited in or near the basin center and heavier oils being derived from shales collected near the basin margins, though there are differences between values observed in eastern and western areas. Notably, shales from the western edge of the basin generate particularly heavy pyrolysate oils relative to other marginal areas throughout the depositional record of the Green River Formation. Fischer assay oil specific gravity values were compiled for a diverse set of thermally immature oil shales with different kerogen types and from different depositional environments deposited across geologic time from the Cambrian to the Eocene. The specific gravity values were then compared to elemental data collected on kerogen isolates from the oil shales. Results of this comparison did not show a correlation with kerogen oxygen content but did indicate that total heteroatom content (NSO) may drive changes in pyrolysate specific gravity. This suggests that a combination of organic matter source and paleoenvironmental conditions across Piceance Basin during deposition of the Green River Formation are reflected in pyrolysate properties.

Professional Posters Monday, July 25