Geochemical Characterization of Two Shallow Drill Cores of Upper Cretaceous Units in Central and Western Colorado

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Abstract

Over the last two decades, the U.S. Geological Survey's (USGS) Energy Resources Program has collected shallow drill cores from source rock intervals and compiled geochemical and mineralogical datasets from those cores to support assessments of petroleum systems. These coring projects have occurred adjacent to outcrops, and are typically less than 1,000 feet deep. High-resolution petrophysical logging suites are obtained on wellbores following core extraction. As part of an effort to understand Upper Cretaceous units in western and central Colorado, two research cores, the USGS Adobe Buttes 2-11 (AB-2-11; Mancos Shale near Delta, CO) and the Horse Mountain 1-13 (HM-1-13; Niobrara Formation of the Colorado Group near Wolcott, CO), were collected. These cores have been extensively characterized to expand the available data on the sedimentology, mineralogy, and bulk organic matter properties of these source intervals. Analyses included major and trace element chemistry and mineralogy, total organic carbon (TOC), programmed temperature pyrolysis, and petrographic thin sections to describe inorganic properties and hydrocarbon-generating potential across various facies. The bulk geochemistry results suggest that organic matter in the AB-2-11 core is thermally immature with TOC content up to 3.7 wt. % (average ~3 wt. %) and hydrogen index and Tmax values indicate gas-prone type II-III kerogen. Mineralogical and major element data showed that the rocks are dominated by illite and quartz, confirmed by the high Si and Al and low Ca and Mg contents. The high quartz and clay contents are likely due to the proximal location of the core to the western shoreline of the Cretaceous Western Interior Seaway. This Mancos interval is time equivalent to the Niobrara and contains calcareous peloids composed of coccolithophores, as well as foraminifera that are common to the Niobrara. In contrast to the AB-2-11 well, the HM-1-13 core is likely in the oil window based on Tmax and production index values, with current TOC values between ~1 and 6 wt. %, averaging just under ~2 wt. % through the cored interval. Located in a region more influenced by terrigenous inputs, the mineralogy of the Niobrara near Wolcott is somewhat more clay mineral-rich (illite and kaolinite with some chlorite) than is observed to the east in the Denver-Julesburg Basin, with total carbonate content averaging around 45 wt. %. Comparison of infrared and X-ray diffraction mineralogy results indicate some clay mineral material in the HM-1-13 may be amorphous, but more work is required to verify this observation. These results provide reference data for the Mancos Shale and Niobrara Formation that inform studies of resource potential for these important regional source rocks and help improve our understanding of sedimentological changes from distal to proximal settings in the Rocky Mountain region.