Dispersed Macerals and Extracted Bitumen from Immature to Low Thermal Maturity Devonian Shales in the Appalachian Basin: Can they Identify the Updip Extent of Thermogenic Gas and Vitrinite Suppression?

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Natural gas in Devonian shales in the Appalachian basin occur over a wide range of thermal maturation (%R_o<0.5 to >3.0). Petrographic and geochemical characteristics of immature to low maturity shale source rocks (%R_o<0.5 to 1.0) in Ohio were studied to determine whether they correlate with associated gases of thermogenic, biogenic, or mixed origin. Assessing the origin and distribution of these gases may be complicated by vitrinite suppression as suggested by %R_o values of Pennsylvanian coal beds in Ohio that are greater than those of the underlying Devonian shale.

43 samples collected from the Marcellus, Rhinestreet, and Huron along 4 transects in Ohio and adjoining states were analyzed for TOC, Rock-Eval parameters, %R_o, maceral types, and bitumen-extract geochemistry (whole oil GC). Samples from %R_o 0.5 to 1.00 (Pennsylvanian coal %R_o 0.65 to 0.80) commonly are associated with bitumen macerals and single-peak extract GCs with low molecular weight n-alkanes (n-C_{12} to n-C_{18}). These characteristics are interpreted to be associated with thermogenic shale gas. In contrast, samples with %R_o<0.5 (Pennsylvanian coal %R_o <0.6 to 0.65) commonly are associated with bituminite macerals and bimodal extract GCs with high molecular weight n-alkanes (n-C_{20} to n-C_{26}). These characteristics are interpreted to be associated with biogenic shale gas. However, for many samples in the dataset it is difficult to interpret the origin of associated gases because coexisting macerals and extract GCs give conflicting maturation histories. At this early stage of the investigation, vitrinite suppression is judged to be negligible because samples with %R_o<0.5 are mainly associated with bituminite and bimodal GCs.