Organic Matter Content and Thermomaturation Trends in the Ohio and Sunbury Shales, Eastern Kentucky, Central Appalachian Basin

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ABSTRACT

One hundred fifty-eight samples of Ohio and Sunbury shale core and well cuttings, from 14 bore holes, were sampled along a north/northwest (NNW) to south/southeast (SSE) transect in eastern Kentucky. The transect essentially parallels regional dip, with the NNW end representing an area where the shale is relatively thin (<200 m) with minimal burial depth (0 to 600 m), and the SSE end representing an area where the shale is thicker (>200 m) and more deeply buried (600 to 1,400 m). Sample points from individual cores were selected to best represent the black shale interval at each core location. An additional 21 samples were collected from locations along the Ohio/Sunbury shale outcrop belt in northeastern Kentucky. All of the samples were analyzed for total organic carbon content (TOC) and vitrinite reflectance (VRo). Selected samples were analyzed for solid bitumen reflectance (Bro), Rock Eval pyrolysis, and major, minor and trace element composition as determined from x-ray fluorescence (XRF). TOC values ranged from 0.23 % to 21.64 %, with core average TOC values being higher towards the NNW. Vitrinite reflectance values range from 0.5 - 0.6 % VRo random on the NNW end of the transect to 1.2 to 1.3 % on the SSE end. Solid bitumen reflectance measurements were collected on 21 samples and show a similar pattern, being lowest (0.3 to 0.4 %, BRo random) on the NNW end of the transect, and highest (1.4 to 1.5 %, BRo random) on the SSE end. Rock Eval analyses performed on 64 samples, show a pattern of increasing Tmax from NNW (420 to 4300 C) to SSE (440 to 4600 C), and decreasing Hydrogen Indices (HI) from >500 at locations to the NNW, to <100 at the SSE end. Collectively, the petrographic and Rock Eval thermomaturation data all show an increase from the NNW end of the transect to the SSE end, which is the direction of increasing shale thickness and present depth of burial. Major, minor and trace element concentrations, determined for 21 samples from the outcrop belt on the NNW end of the transect, indicate the Ohio/Sunbury shale to be dominated by SiO2 (avg. 57.9 %) and Al2O3 (15.8 %). The shale samples are also enriched in several trace elements including Cr (avg. 179 ppm), Mo (avg. 241 ppm), Ni (avg. 197 ppm), V (avg. 1194 ppm), Zn (avg. 259 ppm) and Zr (avg. 263 ppm). Element ratios (e.g., Ni/Co, V/Cr and V/V+Ni), used to assess paleoredox conditions, indicate mainly dysoxic to anoxic conditions during sediment and organic matter accumulation.