Thermal Maturity Profiles Determined by Analyses of Source Rocks, Kerogen, and Extractable Organic Matter from the Lower Eagle Ford Shale

Justin Birdwell, Katherine French, and Michael Lewan

U.S. Geological Survey

ABSTRACT

Many thermal maturity proxies are available to assess petroleum source rocks based on petrographic and geochemical measurements on whole and extracted rock, isolated kerogen, and extractable organic matter. However, outside of natural experiments (e.g., dike intrusions into source rock strata) or artificial maturation via pyrolysis, it is difficult to identify sample sets that facilitate testing of thermal maturity parameters across the range of thermal maturities for a consistent source rock lithology. A set of lower Eagle Ford (LEF) Shale samples representing pre-oil through dry-gas generation were collected from core to study thermal maturity parameters and effects on the LEF in southwest Texas. Though the cores are from six different counties across the continuous petroleum resource play area, their consistent mineralogy and trace metal composition indicate that a very similar, though not identical, stratum of the LEF was sampled. These samples have been processed and analyzed to obtain commonly employed thermal maturity parameters on: (1) the whole and extracted rock samples using total organic carbon (TOC) content, programmed pyrolysis, infrared spectroscopy, and vitrinite reflectance; (2) isolated kerogen using CHNOSFe elemental analysis, infrared spectroscopy, and stable carbon isotopes; and (3) extractable organic matter using stable carbon isotopes of the saturate and aromatic fractions and biomarker analysis by gas chromatography with flame ionization detection (GC–FID) and mass spectrometry (GC–MS). Correlation of these thermal maturity proxies generally follow previously observed relationships and were valid over the ranges of maturities identified in other studies. Kerogen H/C atomic ratios, hydrogen index and Tmax values, infrared A–factor (aliphatic/aromatic ratio), isoprenoid ratios, and a range of other biomarker ratios follow trends consistent with typical marine organic matter, though the sulfur content of the immature samples indicate that at least some of the LEF source rocks contain type II–S kerogen (Sorg/C > 0.04).

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