

Gas Character Anomalies Found in Highly Productive Shale Gas Wells

K. Ferworn, J. Zumberge, Geomark Research, Ltd.; J. Reed,
Reed Geochemical Consulting

Stable carbon isotopes measured in gases allow for numerous useful interpretations including the identification of “families”, observing seals and providing evidence of migrated thermogenic gas accumulations. In shale gas plays, where the source rock is also the reservoir, carbon isotopes of ethane and propane are strong thermal maturity indicators and accurately calibrated against measured vitrinite reflectance values. The calibration is particularly useful when coupled with mud gas isotope analyses (MGIA) where gas samples from the mud stream are collected at specific depths and used to generate a “thermal maturity” log. Stable carbon isotopes become increasingly heavier (more positive) with increasing maturity. However, in certain shale gas plays (including the Barnett, Fayetteville, Woodford and Appalachia) an interesting phenomenon occurs at high maturity where the ethane and propane isotope values begin to reverse and become lighter (more negative). In these highly mature shale environments, laboratory testing suggests that in-situ gas cracking is occurring where larger molecules like butanes and pentanes are cracking into smaller molecules with lighter isotopic signatures. A key observation is that many of these “isotopically reversed” wells appear to be the most productive. One possible advantage might be higher reservoir pressures associated with an increase in the concentrations of smaller gas molecules. Furthermore, if the shale has moved past the kerogen and oil cracking stages to reach the gas cracking maturity level, the shale is likely more brittle shale with increased porosity and permeability. The gas cracking behavior has not been observed in all high maturity shales, and perhaps not coincidentally, some of the early wells do not appear as productive as those exhibiting the isotope reversals.