Using Production Gas Stable Isotope Geochemistry to Predict Reservoir Fluid Type: Wattenberg Field, Colorado, USA

Christopher Laughrey[1], Patrick Travers[1], Michael Folan[1], and Steve Cumella[2]

[1]*Dolan Integration Group*
[2]*Endeavor International Corporation*

Abstract

The stable carbon and hydrogen isotopes (δ13C and δ2H) of natural gases serve as powerful predictive tools in petroleum exploration, development, and production. Here we report on publically available Colorado Oil and Gas Conservation Commission (COGCC) and U. S. Geological Survey (USGS) datasets of production gases collected from the Greater Wattenberg Area of Colorado.

The δ13C and δ2H of natural gas can be used to deter-mine the genetic origin of hydrocarbons (i.e., bacterial versus thermogenic; marine versus terrestrial), thermal maturity, migration, mixing, and reservoir compartmentalization, and production allocation. Thermal maturities derived from carbon and hydrogen isotope data can serve as controls on regional maturity maps, which are used to help define areas of oil, wet gas, and dry gas production. Stable isotope analyses can be performed prior to completion on samples collected from mud gas and/or hydrocarbons de-gassed from cuttings and core. These data can help to predict fluid type, API gravity, and gas-oil ratio (GOR), all of which can help guide land acquisition and development/production decisions.

Production gases from the Lower to Upper Cretaceous Muddy "J" Sand, Codell, Niobrara, and Sussex formations are characterized as early-mature to post-mature oil-associated to non-associated dry gases. Progressing from shallow to deeper formations, δ13C of methane, ethane, and propane and δ2H of methane components all increase, reflecting increasing maturity with depth, and the presence of multiple, discrete petroleum systems. Stable carbon and hydrogen isotope values show a strong correlation to both initial and cumulative GOR for the unconventional Niobrara and Codell intervals at Wattenberg field. While this relationship does not hold for wells actively producing from the Muddy "J" sand, this could be a result of geologic compartmentalization due to faulting, migration, and other factors.

Validation of the correlation between Niobrara and Codell production GOR and stable isotope composition was provided by an independent geochemistry data set from the USGS. The predicted GOR values were then used to accurately distinguish reservoir fluid classification. These results demonstrate the potential of natural gas stable isotope signatures as a reliable fluid quality prediction tool.