Stable Carbon Isotope Analysis of Fluid Inclusion Gases for Charge History Reconstruction

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ABSTRACT

Petroleum Inclusion Cluster Counts (PICC), performed on petrographic thin sections from the Central Arabian Basin, shows that petroleum inclusions in a given sample can be highly variable in abundance at a centimeter scale. To explore how their petrographic variability is reflected in isotopic (d13C) composition, sub-samples with high- and low-abundances of fluid inclusions were physically separated and subsequently analyzed. Condensed populations of inclusions were generally darker in color. The content of the fluid inclusions was released using a closed, off-line crushing vessel. After crushing, the fluid inclusion gases were then drawn with a tight needle and introduced to a GC-FID coupled to an IRMS to determine carbon d13C ratios. Results from fluid inclusions were then compared to that from a DST pressurized production gas sample taken from the same reservoir and well. The d13C fingerprints of fluid inclusion hydrocarbon gases (C1-C5) are similar among sub-samples, which, in turn, are similar to those of the production gas sample. This indicates that hydrocarbon gases in both fluid inclusions and production gas likely have a similar origin, with narrow isotopic variations (up to 1.5‰) presumably reflecting maturity progression of several petroleum charges. A complicating factor in the determination of hydrocarbon gas and d13C composition from fluid inclusions is the presence of liquid CO₂ inclusions in the detrital quartz, inherited from the primary quartz-forming processes in the provenance area. These induce an unquantified increase in the CO₂content, which may affect the average d13C value of CO₂. The d13C values of fluid inclusion CO₂are about 5‰ less negative than that of the production gas sample, apparently due to mixed CO₂ origins (provenance-inherited, and gas charge) in the inclusions. Our results allow the distinction of CO₂ from both sources to be made, and for the isotopic composition of the petroleum inclusions to be corrected.