

SUB-SAMPLING METHODOLOGIES FOR GAS AND LIQUID FROM MONOPHASIC RESERVOIR FLUID SAMPLES: INFLUENCE ON GEOCHEMICAL PARAMETERS

J. Cassidy, S. Mehay, A. Stankiewicz

Schlumberger, Houston, USA

Introduction

Reservoir fluids are complex mixtures, consisting of thousands of compounds. Understanding the nature of this complex system offers significant information about the reservoir fluid properties, its origin, behavior, and in-reservoir transformation. While atmospheric samples collected at the surface are expected to provide reliable C14+ data, lighter compounds might be easily affected by evaporation, sample handling, and shipment. Pressurized monophasic samples collected bottom-hole or at the wellhead might be more representative of the reservoir fluid. However, laboratory analyses including gas chromatography (GC) and isotope analysis are performed on gas and liquid samples at atmospheric pressure. Compound partitioning into liquid and gas phase depends on fluid composition, gas-oil-ratio (GOR), and the temperature and pressure of fractionation (van Graas et al., 2000). It is therefore essential to investigate the various laboratory procedures by which gas and liquid samples are obtained from a pressurized monophasic fluid and to determine the potential effect of each procedure on the molecular and isotopic composition of different classes of compounds involved in geochemical parameters for different reservoir fluids (Carpentier et al., 1996; van Graas et al., 2000;). This laboratory procedure is usually referred to as a “flash.”

We present a study of three different flash methods to collect oil and gas samples from pressurized reservoir fluids. The three methods include: 1) “buffer flash”, where a monophasic subsample is slowly depressurized by hydraulic piston to conditions slightly above ambient temperature and pressure; 2) standard or “direct flash”, where a live reservoir sample is immediately depressurized to ambient gas and liquid collection conditions, which is a method commonly used for GOR determination in PVT laboratories; and 3) “circulation flash”, where a subsample is rapidly depressurized, but the gas is circulated through the oil via a pump to enhance equilibrium before collection (a method also known as equilibration flash.) For the study, we selected five reservoir fluids, ranging from gas condensate to heavy oil. In addition, a synthetic mixture using a commercially available light oil and isotopically characterized gas was prepared and included in the study. Each sample was subjected to gas carbon and hydrogen isotope composition analysis, whole oil GC analysis including C7 parameters (e.g., Thompson, 1979), and GC-MS (mass spectrometry) analysis for biomarkers, diamondoids, and 2 and 3-ring aromatics, which are used for calculation of thermal maturity parameters.

Results

For all samples analyzed to date (from 25 to 35 degree API gravity and GOR from 700 to 1200 scf/bbl), we observed a clear difference in the quantitation of light oil compounds when using the “buffer flash” method. For example, light components (up to nC6) concentration increased up to 100% in flashed oil. However, variations in concentration beyond C6 were negligible. C7 parameters such as Isoheptane and Heptane (Thompson, 1979) values were changed by less than 0.05 and 0.2, respectively. Heavier components included in typical geochemistry ratios such as Phytane/nC18 vs. Pristane/nC17 remained unchanged. Data showed little or no deviation in the biomarker abundance and ratios, which primarily consists in quantifying C14+

compounds. However small variations in the concentration of diamondoids and small aromatics were observed and will be further investigated. The “direct flash” and “circulation flash” methods produce similar results in concentration values even for the lighter compounds, likely due to the similar conditions at which the oil sample was collected.

Gas isotopic compositions showed a deviation in values generated by the “buffer flash” method compared to the two other flash techniques, up to 1‰ for $\delta^{13}\text{C}$ values and to 8‰ for δ^{D} values. The most impacted compound was methane, which is expected to be the most sensitive to kinetic isotopic fractionation during the flash process. The “circulation flash” and “direct flash” methods produced gas samples exhibiting very similar isotopic compositions, generally within analytical error, suggesting that the equilibration step performed during the “circulation flash” does not have a significant impact on isotopic composition of the gas compounds.

Preliminary conclusions and ongoing work

Initial results of the study shows that the flash method can lead to slight variations in the composition of gas and lighter oil compounds obtained from monophasic reservoir fluids, and can affect geochemical data interpretation, especially when various flash techniques are used to obtain samples during long-term studies. Ongoing analysis of a gas condensate sample will further strengthen our observations, while the study of a synthetic fluid will provide insight into the impact of each procedure on the accuracy of the measured values. Using the evaluation of the effects of each flash method, one can select the most appropriate technique on the basis of fluid type and analytical program for a time and cost-effective approach without compromising data quality and continuity. Our study also has an important bearing on a general uncertainty of data and interpretation, when using samples from various years, laboratories, and methods.

References

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