Combined Organic and Inorganic Geochemistry as a Tool for Reservoir Production Allocation

Mohammed Abu Alreesh[1], Khaled Arouri[1], Ibrahim Atwah[1], Khalid Mahmoud[1], Constantin Sandu[2]

[1]Saudi Aramco;
[2]Aramco Houston Research Center

Abstract

Objectives/Scope:
Production Logging Tool (PLT) is routinely used for determining production from stacked reservoirs. This can be challenging and costly in certain geological and operational settings. Production allocation using geochemistry offers a cost-effective alternative. Combining organic and inorganic tracers occurring naturally in crude oil increases accuracy in calculating relative contributions from different reservoir units into the total production, which is critical to optimize production strategies.

Methods, Procedures, Process:
Trace and rare earth elements in a large suite of crude oils were measured respectively using ICP-OES (Inductively-Coupled Plasma-Optical Emission Spectrometer) and QQQ-ICP-MS (Triple-Quadrupole ICP-Mass Spectrometer). Bulk and organic molecular, including biomarker, characteristics were measured on the same sample set. Integration of organic and inorganic data -enabled reservoir fluids to be understood in terms of hydraulic connectivity, compartmentalization, and the contributions from various reservoir units into commingled production were calculated. Data collectively provided proxies for the redox conditions of the depositional environments of the inferred source rocks, as well as their lithologies and thermal maturities at the time of expulsion.

Results, Observations, Conclusions:
Fluids from stacked carbonate reservoirs separated by shale members were geochemically characterized in three adjacent accumulations. Multiple tests and samples were conducted and collected; either from individual reservoir units or from mixed zones. The API gravity in the area of interest indicates medium to light oils, with lesser concentrations of trace metals encountered in the lighter oils. Generally, low gas to oil ratio (GOR) is consistent with medium black to light oils in terms of fluids classifications. The combined organic-inorganic geochemical method allowed accurate calculations of production in commingled zones. The source of hydrocarbons in different reservoir units commonly identified to be either from in-situ sourcing or via longer migration from deeper sources.

Novel/Additive Information:
The advantages of geochemical allocation over tools as like Production Logging Tools (PLTs) will be demonstrated, especially regarding cost reduction, mitigating risk of tool failures, and production monitoring. The technique will have benefits not limited to fluids characterization, but also towards understanding variations in commingled production within unconventional reservoirs. The combined organic-inorganic fingerprints of end-members allowed estimation of relative contributions in mixed-zone production, oil-oil and oil-source correlations for risk analysis in field development and exploration.