Development of a Novel Method for Geochemical Production Allocation and Reservoir Production Monitoring Based on Trace and Ultra-Trace Multi-Element Analyses on Crude Oils

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Abstract

Production allocation refers to the practice of quantifying proportions of extracted commingled hydrocarbons across various contributing sources. We tested a new geochemical technique of trace element production allocation by analyzing the mass fractions of specific target elements in fiveend-member natural crude oils and the manually mixed crude oil in precisely controlledproportions. We analyzed target elements by ICP-OES and Triple Quadrupole (QQQ)-ICP-MS techniques in tandem on each sample. In our test, the contributing fractions of the five end-memberoils were measured by weight and mixed in proportions of ~30%, 25%, 20%, 15%, and 10% in the commingled oil. The obtained mass fractions for specific target elements in both the five end-member oils and the commingled oil are input into a program developed called “ALLO-TRACE”. ALLO-TRACE calculates the contributing fractions of all the end-member oils to the commingled oil using multiple analyte-based linear equations. Our repeated tests have shown that the calculated contribution fractions based on the mass fractions of multiple trace elements agree well with their known contribution fractions in the commingled oil. Accuracies of most calculations for all the five end-member oil target proportions are within 4%, and the best can be less than 0.6% for all end members (average 0.17% and median 0.1%). Most calculation uncertainties in terms of relative standard deviations of the

five end-member oils are within 3%, and the best can be less than 2.3% for all end members (average 1.2% and median 0.9%).