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Three Key Applications of Oil Fingerprinting to Unconventional Reservoirs: Characterizing Fracture Heights; Allocating Commingled Production; and Identifying "Cross Talk" Between Horizontal Wells

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Abstract

A typical oil sample contains various amounts of thou- sands of different compounds, and the abundances of those compounds form a “fingerprint” of that oil. This natural “fingerprint” can be used to answer some of the most important questions that arise during development and management of unconventional reservoirs. Oil samples contain so many compounds that even if the composition of the oil in adjacent formations is 99% similar, the abundance of more than 50 compounds in them will be different. Those geochemical differences between oil samples produced from different formations can be used as natural tracers to determine the contribution of each reservoir to a commingled production stream. In fact, oil-fingerprinting techniques can be used to accurately determine the contribution of as many as six zones to a commingled oil stream. This low-cost method can be used to:

- Determine if hydraulically induced fractures have propagated out of the formation containing a lateral wellbore and into an overlying or underlying pay zone, causing the commingling of oil produced from different reservoirs.
- Quantitatively allocate the contribution of individual pay zones to commingled production for (i) optimization of development strategies or (ii) royalty/tax calculations.
- Identify “cross-talk” between the induced fracture networks in wells completed in adjacent formations

Dead oil samples collected in glass jars with Teflon- lined lids are used for this purpose. The abundances of compounds are measured using high-resolution gas chromatography. Approximately 200-250 different natural tracers typically are identified during an oil-fingerprinting project, and the relative contribution of each end-member oil sample to a commingled sample is calculated using a linear-algebra solution of simultaneous equations, where the number of equations equals the number of natural tracers. Because this describes an over-constrained mathematical system (i.e., the number of tracers is much larger than the number of zones), the accuracy of an allocation estimate is very high.