AMPLIFIED GEOCHEMICAL IMAGING LLC

Technical Note

Downhole Geochemical Logging (DGL) and Gas Composition-Isotope Analysis

Amplified Geochemical Imaging LLC's Downhole Geochemical Logging (DGL) provides ***an ultra-sensitive assessment of the hydrocarbons in a well****.*

DGL analyzes downhole cutting samples to directly characterize the composition of hydrocarbons laterally through the prospective section and ***is 1,000 times more sensitive than traditional methods****.*

This methodology has the unique ability to look at a broad hydrocarbon compound range from ***C_2 to C_{20}****, which is significantly more expansive than the limited traditional ranges of C_1-C_5 or C_1-C_9 of other techniques. The result is a broad and accurate characterization of petroleum phase.*

DGL provides the most detailed and granular hydrocarbon data available on the market today.

Additionally, there is never any worry of sticking a tool.

Isotope Analysis

Typical Isotope analysis begins with gas composition analysis. Every sample is screened by measuring for gas composition from C_1 ï C_5. Gas composition analysis utilizes the same carbon range as mud-log data, C_1 ï C_5, but is more sensitive.

Gas composition analysis data are used to measure gas components which are then related to hydrocarbon phase through various ratios. This test is relatively inexpensive, typically less than $100 per sample. Due to the limited carbon range of the method, gas composition analysis cannot directly determine hydrocarbon phase. Therefore, ratios such as butane/isobutene (nC_4/iC_4) must be used to guess at the hydrocarbon phase present.

If some samples show sufficient concentrations of gas, additional testing for isotopes will be completed for methane, ethane, and propane, adding hundreds of dollars to the per sample cost.

Isotope data is used to differentiate thermogenic gas from biogenic gas, as well as to elucidate differences between hydrocarbons in various sections of the well (e.g. identifying different sources, mixing, and seals separating different hydrocarbon isotopes). While isotope data can be of great value, as with any technology, there are some limitations.

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Comparison between DGL and Isotope data

For example:

- Gas composition analysis operates in the low ppm range.
- By only working with 8 compounds any interference with one of those compounds has a dramatic effect on the results, especially since compounds are ratioed to infer the presence of liquids. For example, in instances where alteration to the light gas constituents may occur (e.g. biodegradation, water washing, breached reservoir seals, etc.) C_1 ï C_5 can be substantially altered or lost completely.
- Rapid drilling, or turbo drilling, can generate extreme heat which causes drill-bit metamorphism (DBM) which can lead to thermal cracking of drilling muds. Drill-bit metamorphism results in the generation of methane, ethane, ethene, propane, propene, butane, butene, and many other artifacts. The result is dramatically altered C_1 ï C_5 concentrations.
- If the reservoir is under-pressured the gas in the formation may not be released as they drill though the section, thus, giving a false negative or artificially low results.
- With heavy drilling muds gases may be entrained in the mud and not released also giving a false negative or artificially low results

DGL Advantages:

- DGL sensitivity reaches the ppb range, a 1000-fold increase in sensitivity. This allows for the detection of by-passed pay and seals not detected by other methods.
- DGL is the only technology that directly measures the liquid hydrocarbon range from about nC_{10} ï nC_{20}. This is particularly applicable to oil zones. Thus, the heavier the oil, the less helpful isotope data becomes.
- The use of ~90 compounds aids in identifying interferences and allows for rigorous statistical integration of the data (helping to identify seals, multiple sources, and multiple oil families).
- The C_2 - C_{20} range can more effectively differentiate between multiple liquid signals. For example, a recent DGL project not only identified different liquid hydrocarbons in the upper and lower portions of the well, but also identified a baseline change. This implied different hydrocarbon sources and a seal which was later confirmed by other tests (kinetics, pyrolysis, and TOC).
- DGL can indicate water contact and water saturation in various sections by ratioing aromatics to alkanes; for example, benzene/nC_6 or (benzene + toluene)/(nC_6 + nC_7).

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