Geochemical Logging Oil and Gas Wells in Conventional and Unconventional Prospects with Canned Cuttings and Mud Gas Composition and Isotopic Analyses

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Applicability

Unconventional gas resources can be best exploited by understanding sources and geochemical controls on commercial production. Using basic and new detailed geochemical techniques allows gas fairways and sweetspots to be mapped for the best prospect sites for gas. Extending these data further allows mapping even BTU values of producible gas.

Typical unconventional gas resources include:

- fractured shale gas
- basin center methane
- coal bed methane
- tight gas sands
- shallow basin methane

While the sources for gas in fractured shales and coal bed methane are obvious, the sources of hydrocarbons for basin center methane and tight gas sands are not always obvious or known. The geographic extent of these sources, their potential, and lateral and vertical organofacies variations require detailed analysis of sources and gases associated with these sources.

Completion is generally a major issue with unconventional resources as frac jobs are required for certain of these play types. The yield of gas upon induced fracturing can be predicted from modified geochemical approaches of cuttings gas analysis. Also the extent of seal permeability can be assessed with fingerprinting techniques.

While these techniques are applicable for normally or overpressured unconventional gas resource assessment, they are also useful in most basins such as:

- deepwater prospects (GOM, Brazil, West Africa)
- stacked sand payzone evaluation
- sub-salt prospects
- identification of pay zones in unconventional oil plays especially fractured shales
- evaluation of pre- and post- frac yields
- conventional prospect logging for pay zone or well sweet spot(s) identification and compartmentalization and for data to assess location of other prospective drill sites
- expensive wildcat wells (for evaluation of pay zones and insures geochemical well logging analysis should hole be lost)

Introduction

Well site mud gas logging and evaluation of fluorescence of cuttings are two techniques commonly used to evaluate wells. These techniques are useful for characterizing potential reservoirs virtually while drilling. However, there are key questions that often can be addressed by the addition of detailed geochemical logging of desorbed gases from canned cuttings and mud gases. Canned cuttings gas samples are used to measured desorbed gas yields and yields of gas upon maceration ("frac") of cuttings. Mud gas samples provide yield of "lost" gas, gas which escapes into the well bore during drilling. Mud gas samples are also excellent samples for isotopic analysis where interpretation of results provides a wealth of information on gas type, mixing, compartmentalization, and sealing efficiency (Beeunas et al., 1999; Ellis et al, 1999; Schoell et al, 2001). In addition isotopes can be used for gas-to-source correlations either directly (isotopic matching) or indirectly (based on maturity matching). Mud gas analysis includes quantitative analysis of gas composition and isotopic analysis of methane, ethane, and propane, whenever these compounds are present in sufficiently high concentration.

Detailed canned cuttings and mud gas analyses provide data and capability to interpret the following possibilities:

- **the presence of oil and gas reservoirs – well sweet spots (Fig. 1)**
- **whether shows are "true" or "false" (Fig. 2)**
- **whether gas is economic or non-economic (Fig. 3)**
- **the yield of total gas ("lost" gas, desorbed gas, and frac gas yields) (Fig. 4)**
- **reservoir type (dry gas, wet gas, condensate, oil) (see Fig. 3)**
- **possibility of down-dip pay (see Fig. 3)**
- **reservoir compartments (Fig. 5)**
- **permeability of seals (Fig. 6)**
- **stratigraphic correlations (Fig. 7)**
- **extent of biogenic-thermogenic gas mixing (Fig. 8)**
- **gas maturity (see Fig. 8)**
- **extent of thermogenic gas mixing (Fig. 9)**
- **allocation of commingled production (Fig. 9)**
- **gas-to-source correlations (see Fig. 8)**

For example a common issue of unconventional gas wells, whether they be fractured shale gas, basin center gas, coal bed methane, or shallow basin gas accumulations, is the free gas content (lost gas), desorbed gas, and additional gas that will be released upon fracturing. Using a combination of old and new geochemical techniques these question can be addressed.