Creating a 3-D Hydrocarbon Profile in the Eagle Ford Shale Play and Relating that Information to Field Production

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Abstract

Shale plays are an extremely difficult arena in which to explore. Lack of heterogeneity is not the only problem. The Eagle Ford play, for example, has numerous hydrocarbon sources and multiple stacked zones. These multiple stacked pays result in mixed drilling success with both economic and noneconomic drilling results. In addition there are numerous migration pathways in various parts of the field and charge source or kitchen vary with placement in the field as well.

Amplified Geochemical Imaging and Downhole Geochemical Logging technologies are two applications that can be used in conjunction to provide a 3-dimentional hydrocarbon profile to enhance understanding and success in unconventional exploration.

Amplified Geochemical Imaging is a direct surface hydrocarbon measurement technique that measures the vertical migration of volatile hydrocarbon compounds from subsurface reservoirs. These microseepage hydrocarbon compounds, up to $C_{20,}$ can be captured and measured at the surface resulting in the ability to identify and map subsurface hydrocarbon systems as well as clearly differentiate between various hydrocarbon phases, such as gas, condensate, or oil. These hydrocarbon maps **provide a horizontal assessment of** hydrocarbons across the field and can then be used to demarcate transition lines between the various hydrocarbon phases and direct exploration efforts to areas of higher profitability. This ability makes Amplified Geochemical Imaging a unique tool as a “predrill” technology.
Our Downhole Geochemical Logging technology provides **a vertical assessment of the hydrocarbons in a well**. Downhole Geochemical Logging analyzes downhole cutting samples to directly characterize the composition of hydrocarbons vertically through the prospect section. This methodology has the unique ability to look at a broad compound range from **C2 to C20**, which is significantly more expansive than the limited traditional ranges of C1-C5 or C1-C9 of most well gas logging techniques. The result is a broad characterization of petroleum phase contained in the stratigraphic intervals as well as addressing compartmentalization down the well.

However, while Amplified Geochemical Imaging and Downhole Geochemical Logging technologies aid in determining a 3-dimensional understanding of the hydrocarbons in an unconventional play, production goes beyond that. A recent presentation by Chris Fredd at the ***Second EAGE/SPE/AAPG Shale Gas Workshop*** in the Dubai recently reported that approximately 40% of all shale oil wells were not profitable because many of the frac stages in the lateral well were not effective. While there are many reasons for the lack of effectiveness, one of the most common reasons is the focus on efficiency over effectiveness. Once production drilling begins it is easy to understand the push to standardize drilling operation to preset well spacing, lateral lengths, the number of frac stages, and preset frac spacing to optimize operation and minimize costs.

However, effectiveness also plays an important part in optimizing profitability. For example, setting frac stages in zones of a lateral well that have little or no hydrocarbon concentration and low porosity increase completion costs without increasing production. For example, in this Eagle Ford case study data showed similar production efficacy might have been obtained by using 5 frac stages instead of 8 by using Downhole Geochemical Logging data. Additionally, the Downhole Geochemical Logging data could have been used to optimize lateral placement to maximize production in hydrocarbon and porosity rich zones.
In this lateral well the data helped to:

Improve production by focusing lateral well locations in hydrocarbon & porosity rich zones
Reduce completion costs by optimizing the number of fracing stages
Predict Sweet Spots of higher porosity, hydrocarbon concentration, and natural fracturing.
Identify when drilling efforts are in or out of the target formation

In this vertical well the data helped to:

Serve as a proxy for measuring porosity
Clearly distinguish between various hydrocarbon phases (i.e. gas, condensate, or oil)
Differentiate between multiple gas or multiple oil signatures
Identify by-passed pay
Infer compartmentalization and seals
Identify water saturated zones or oil/water contacts

Thus an attempt will be made in this case study to relate the information garnered from Amplified Geochemical Imaging and Downhole Geochemical Logging technologies to production in the field.