

PS Combining Surface Geochemical Surveys and Downhole Geochemical Logging for Mapping Liquid and Gas Hydrocarbons in the Utica Shale*

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Abstract

Shale plays represent a difficult arena in which to explore since each shale play is unique in terms of organic content and rock property. While general lessons can be translated from play to play there are important differences which control exploration and development decisions. Due to the heterogeneity of resource plays they can even differ within a single field. This means that effectual development of shale plays requires extensive evaluation and coordination of various data sources such as geology, geophysics, geomechanics, petrophysics, and engineering. However, while these conventional disciplines bring a wealth of important data to the discussion, one important data set is often lacking – hydrocarbon data. Given the heterogeneity of shale plays, it is important to identify hydrocarbon variability in a 3-dimensional sense (i.e., both vertically and horizontally). This is particularly true in the Utica shale. The Utica shale play is a complex area in which to explore due to numerous hydrocarbon sources and charged zones. This case hi story will demonstrate how surface hydrocarbon mapping was used to:

- differentiate between economic and noneconomic gas areas in the play
- differentiate and map light and heavy hydrocarbon signatures throughout the area
- image hydrocarbon anomalies aligned with surface lineaments indicating hydrocarbon filled fractures

Additionally, the downhole geochemical logging will demonstrate how vertically detected hydrocarbons were correlated with surface expressions to provide an understanding of:

- from which zone the economic and noneconomic gas may have originated
- why were there surface expressions of heavier hydrocarbons
- from which formations liquid hydrocarbons may have originated.

References Cited

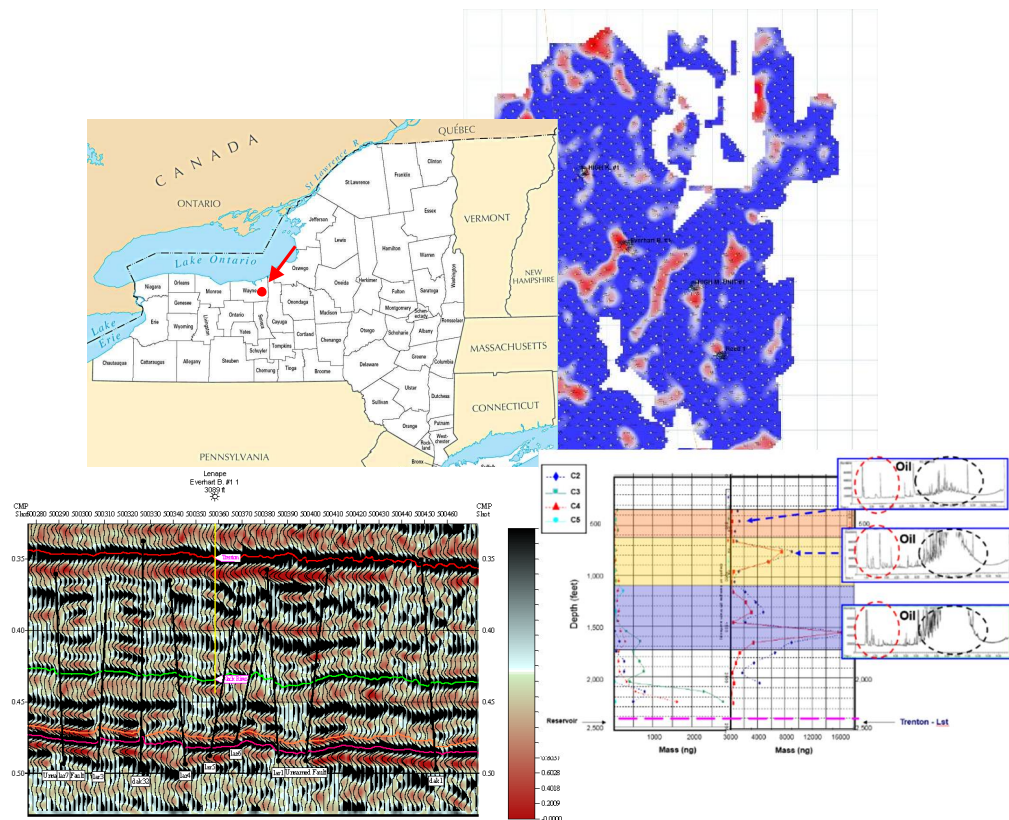
Anderson, H.S., 2006, Amplified geochemical imaging: An enhanced view to optimize outcomes: European Association of Geoscientists & Engineers: First Break, v. 24(8), p. 77-81

Coleman, D.D., W.F. Meents, Chao-Li Liu, and R.A. Keough, 1977, Isotopic identification of leakage gas from underground storage reservoirs – a progress report: Illinois State Geological Survey, Illinois Petroleum No. 111, 10 p.

Durham, L.S., 2012, Shale List Grows: AAPG Explore July, 2012
(<http://www.aapg.org/Publications/News/Explorer/Emphasis/ArticleID/1945/Shale-List-Grows>).

Klusman, R.W., 1993, Soil gas and related methods for natural resource exploration: Wiley, Chichester, 483 p.

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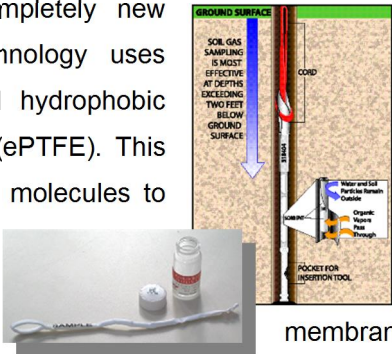
Combining Surface Geochemical Surveys and Downhole Geochemical Logging for Mapping Liquid and Gas Hydrocarbons in the Utica Shale

Shale plays are an extremely difficult arena in which to explore because they are all different. While general lessons can be translated from play to play, there are important differences which control exploration and development decisions. Due to the heterogeneity of resource plays they can even differ within a single field. This means that effectual development of shale plays requires extensive evaluation and coordination of various data sources, such as geology, geophysics, geomechanics, petrophysics, and engineering (Durham, 2012). However, while these conventional disciplines bring a wealth of important data to the discussion, one important data set is often lacking – hydrocarbon data. Additionally, given the current price of gas, it becomes paramount for technologies to emerge that can correctly characterize liquid-rich areas in a field and differentiate these from gas portions of the play. This is particularly true in the Utica Shale.

Hydrocarbon Mapping

There are not many technologies that allow the accurate direct detection and measurement of hydrocarbons beneath the surface. Surface geochemical surveying is one of the few technologies with this ability. Geoscientists have used surface geochemical techniques to detect and measure the presence of subsurface hydrocarbon accumulations since the 1930s. These techniques looked for the effects of minute levels of hydrocarbons that migrate through seal rocks that cover every reservoir and migrate to surface through overlying rock strata, either as macroseepage via faults or as microseepage via microbuoyancy (Klusman, 1993; Coleman et al., 1977). Some of these early techniques were crude and included soil analysis, active soil gas analysis, iodine mapping, and microbial counting. Unfortunately, hydrocarbon mapping using these early geochemical techniques was often disappointing (Anderson, 2006).

Significant advancements were pioneered in 1993 by Ronald W. Klusman of the Colorado School of Mines (1993) and W. L. Gore & Associates (GORE). To cope with many local and regional variations in soil character, such as water saturation and improved sensitivity, a completely new was developed. This new technology uses contains a specially engineered hydrophobic expanded polytetrafluoroethylene (ePTFE). This engineered to allow hydrocarbon molecules to droplets. Due to their small reservoir can move essentially structures and pass through the

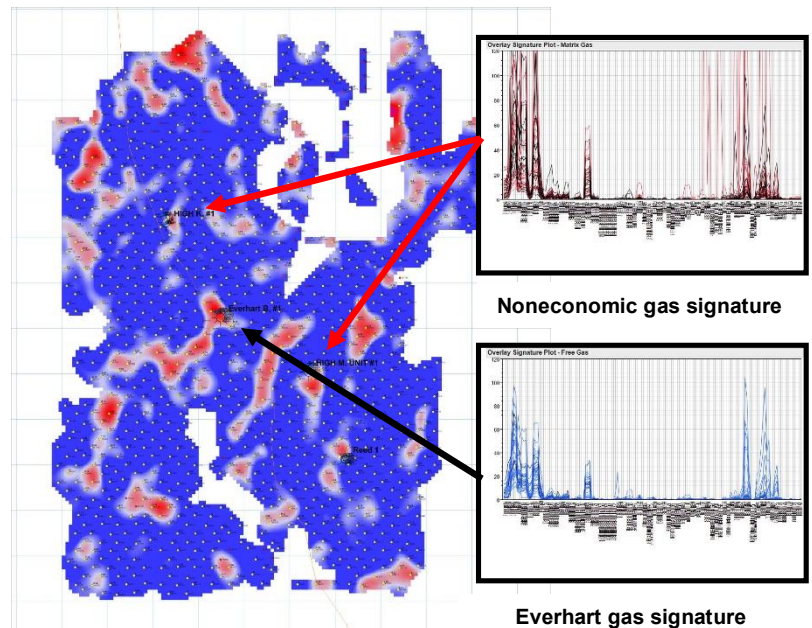


membrane to be captured on the adsorbent material. By placing these proprietary sorbent modules in the soil for approximately three weeks, the mass collected on the adsorbents is increased by two to three orders of magnitude over the above-mentioned older sampling techniques.

Utica Shale Case Study

The initial survey took place in the Utica Shale in 2005 (before the boom in interest in the Utica began). Three wells were drilled prior to the Everhart well and each well was noneconomic. The Everhart well, which targeted the Trenton Formation, was a highly successful gas well with an Initial Production (IP) of approximately 10 MCF/day and then leveled-off to 3

MCF/day. This well was used for calibration purposes during the survey because of its high production. The red anomalies indicate areas where gas is detected that matches the composition of the Everhart production gas. The blue areas represent areas of non-Everhart gas. It should be noted that the blue does NOT mean there is no gas detected in the area. Gas was detected in the High M well and High K well, but the wells were not economic and were plugged and abandoned. The fingerprints for the noneconomic gas and the economic Everhart gas were quite similar. However the ability to monitor between 80 – 90 compounds provides a sufficient number of organic compounds with which



to statistically interrogate the data and differentiate distinct differences between similar hydrocarbons. Thus, in this case, the red survey anomalies indicate the potential location of economic drilling sites for future Everhart-type wells. Additional model results also indicate areas of liquid or heavier hydrocarbons in the field. As a result, the survey data were able to:

- differentiate and map gas and liquid charged areas across the field
- show how hydrocarbon anomalies align with surface lineaments, indicating possible hydrocarbon-filled fractures
- differentiate between economic and noneconomic gas areas in the play
- coincide mapped anomalies with geohazards

Downhole Geochemical Logging

Subsequent to the Utica surface geochemical survey, and based on the Amplified Geochemical Imaging data, the Butler Creek 1 well was air-drilled with the intent to penetrate the economic Trenton Formation at approximately 2,500 ft, as did the previous Everhart well. The cuttings were analyzed by Amplified Geochemical LoggingSM (AGL). AGL uses proprietary

Period	Group	Unit	Lithology
Devonian	Upper	Genesee	Genesee Shale Tully Limestone
		Hamilton	Marcellus Shale
	Middle	TriStates	Onondaga Lst Oriskany Sst
	Lower	Heldeberg	Manlius Lst Rondout Dol Akron Dol
		Salina	Bertie Shale Syracuse Salt Vernon Dol
Silurian	Upper	Lockport	Lockport Dol Rochester Sh Irondequoit Lst
		Clinton	Sodus Shale
	Lower	Medina	Grimsby Sst Queenston Sst Lorraine Siltst Utica Shale
		Trenton/Black River	Trenton Lst Black River Lst
	Lower	Beeman-town	Tribes Hill Lst Theresa Sst Little Falls Dol
Ordovician	Upper	Potsdam Sst	
Precambrian Basement			

technology to directly characterize the composition of hydrocarbons vertically through various prospective sections and has the unique ability to look at a broad compound range from C₂ to C₂₀ at parts per billion (PPB) levels. ***It may also be the only technique to deliver hydrocarbon data on cutting samples in the C₆ – C₁₅ carbon range.*** Additionally, it separates and quantifies approximately 80 individual compounds as opposed to the traditional nine. The result is a broad characterization of petroleum phase that more closely resembles a whole oil fingerprint.

For the Butler Creek 1 well the light hydrocarbon data (C₂ – C₅) were plotted versus depth in addition to the heavier hydrocarbons C₁₂ and the sum of the hydrocarbons greater than C₅. The zones of interest were the Grimsby (sandstone), the Queenston (shale & sandstone), the Lorraine (a siltstone), the Utica (shale), and the Trenton (limestone).

As seen by the light hydrocarbon response on the left-hand side of the depth chart, there was little response in light gas hydrocarbons until approximately 2,200 ft. There was liquid or heavy hydrocarbon response in the Grimsby, Upper Queenston, and the Lower Queenston. A comparison of the three oil fingerprints indicates differences between the three oil signatures, implying compartmentalization between the three sections. The oil in the Grimsby section was most likely not detected by conventional well logs or other geochemical techniques, indicating a by-passed pay.

As mentioned previously, the surface survey indicates heavy hydrocarbons. The Amplified Geochemical Logging indicates the heavy hydrocarbon surface expressions most likely originated from the Queenston Formation. It also implies that the ubiquitous noneconomic gas may have been coming from the Utica Shale, while the economic gas most likely came from the deeper Trenton Formation.

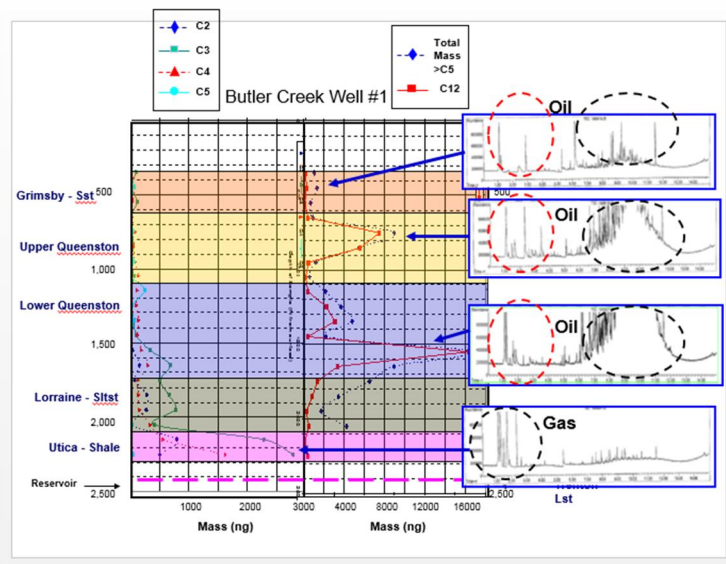
In areas of the field where there is little well control or where the stratigraphy may be uncertain, the oil hydrocarbon fingerprints of newly drilled wells can be compared to the hydrocarbon signatures of the Upper and Lower Queenston in the Butler Creek 1 to identify various stratigraphic sections. This differentiation can be invaluable for completion schemes and horizontal drilling efforts when one formation is known to be more productive and more economic than another.

Thus, the Amplified Geochemical Logging was able to demonstrate how the vertical hydrocarbon signatures can be correlated with surface expressions in providing an understanding of:

- why were there surface expressions of heavier hydrocarbons
- from which formations the liquid hydrocarbons may have originated
- from which zone the noneconomic gas may have originated
- from which zone the economic gas may have been originated

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