

## Creating a 3D Hydrocarbon Profile to Increase Production and Reduce Poor Economic Wells

Shale plays are an extremely difficult arena in which to explore. While general lessons can be translated from one play to another, there are important differences. Effective development of shale plays requires extensive evaluation and coordination of various data sources such as geology, geophysics, geomechanics, petrophysics, and engineering. (Durham, 2012). While these conventional disciplines provide a wealth of important data, one data set is often lacking – hydrocarbon data.

**Amplified Geochemical Imaging** is an ultrasensitive direct hydrocarbon detection surface technology that provides the ability to map areas of enhanced reservoir quality across the field **ahead of the drill bit** based on **enhanced porosity and net pay thickness (i.e. hydrocarbon volume)** as well as pressure.

AGI's **Downhole Geochemical Logging (DGL)** technology provides a **vertical assessment** of hydrocarbons in a well. DGL analyzes cutting samples to directly characterize the composition of hydrocarbons vertically through prospective sections. This methodology has the unique ability to look at a broad compound range from **C<sub>2</sub> to C<sub>20</sub>**, which is significantly more expansive than the limited traditional range of C<sub>1</sub>-C<sub>5</sub>. The result is a **detailed characterization of hydrocarbons contained in the stratigraphic intervals as well as addressing compartmentalization and water saturation.**

In this **Utica case study** three noneconomic wells were drilled prior to the Everhart #1 well. The Everhart #1 well was completed in the Trenton Fm and was a highly successful gas well with an IP of approximately 10 MCF/day which then leveled-off at ~3 MCF/day.

The geologic concept was that the Black River shale, see **Figure 1**, just below the Trenton Fm, charged highly porous areas in the Trenton resulting from hydrothermal dolomitization. The question became how to identify and drill these highly productive dolomitized areas.

Amplified Geochemical Imaging was utilized to generate a hydrocarbon anomaly map across the field to identify dolomitized sweet spots with superior porosity and hydrocarbon richness. The results of the survey are shown in **Figure 2**.

The red anomalies indicate high prospectivity for the economic Everhart #1 gas. Note, the Everhart #1 well falls within a red anomaly. Blue indicates areas of noneconomic gas that is different in character than the

Period	Unit	Lith.
Silurian	Grimsby	Sh, ss
	Whirlpool	Ss
Ordovician	Queenston	Sh
	Oswego	Ss
	Lorraine	Sh
	Utica	Sh
	Trenton	Ls
	Black River	Ls

Figure 1.

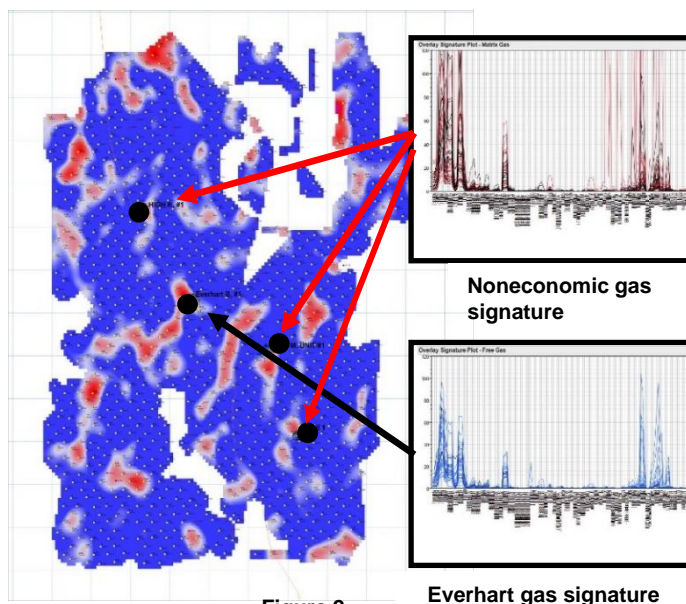


Figure 2.

Everhart gas. Notice all three noneconomic wells are in blue areas. **The data also show the Everhart gas and the noneconomic gas signatures are different suggesting a possible different source.**

Interestingly, the red Everhart anomalies essentially run NE - SW which aligned with surface lineaments. This raised the question were the Everhart anomalies actually gas-filled natural fractures? The AGI anomaly encompassing the Everhart #1 well was approximately 1.25 miles long. A subsequent pressure test on the well indicated a fracture in place that was estimated to be 1 – 2 miles in length. The client then realized the economic

# Identify Field Sweet Spots with Minimal Well Control

# Map charged natural fractures

gas was actually found, not in highly dolomitized porosity sections, but rather **natural fractures created by unloading, the release of tensional stresses in rock, caused by erosion of overlying sections during the Mesozoic period, and probably reactivated by post glacial isostatic adjustment over the past thousands of years.**

Additional geologic constructs for the play, at the time of the survey, were:

- the Utica Fm charged the Queenston formation with gas,
- there were no liquids present in these areas.

However, the AGI geochemical survey indicated otherwise. The geochemical surface data identified a liquid hydrocarbon phase in the field, as shown in **Figure 3.**

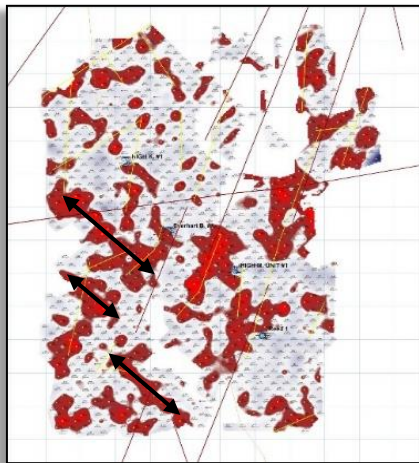


Figure 3.

The liquid anomalies trended NW – SE, unlike the gas anomalies that ran NE – SW, implying that the Everhart gas and the newly identified liquid hydrocarbons **were most likely in different formations.**

The post-survey Butler Creek 1 well **was successfully drilled based on the AGI survey.** Downhole Geochemical Logging (DGL) cutting samples were collected every 100 ft. The DGL results are shown in **Figure 4.** In the depth plot the light hydrocarbon data ( $C_2 - C_5$ ) are plotted on the left while oil hydrocarbons ( $C_6 - C_{18}$ ) are plotted on the right. The hydrocarbon signatures from each formation are shown to the right. The DGL data:

- showed the Grimsby Fm to be nonprospective for both gas and liquids.
- indicated oil in the Upper & Lower Queenston Fms,
- inferred a possible compartmental seal at the top of the Upper Queenston Fm,

- inferred the Utica Fm as the source of the noneconomic gas mapped in the surface survey.
- **clearly showed the Utica was not charging the Queenston Fm with gas, as previously thought.**
- inferred a possible compartmental seal at the top of the Utica Fm.

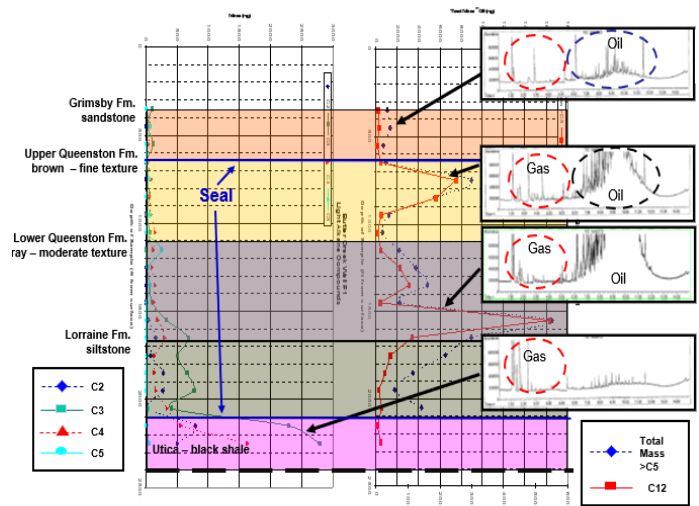


Figure 4.

**Compare the play concepts and understanding before and after the AGI survey and DGL:**

### Before:

- economic wells would be associated with highly porous dolomitized limestone,
- the Utica Fm charged the Queenston Fm with gas,
- there were no liquids present in the play.

**The AGI data showed these constructs to be incorrect.**

### After:

- economic gas accumulations were actually found in natural fractures sourced from the Black River Shale with **sweet spots mapped by the surface survey,**
- the U. Queenston shale contained oil shows from 650' – 950' while the L. Queenston contained very strong oil shows from 1450' – 1650'.
- optimal lateral landing point at 1550' with enhanced porosity and maximum hydrocarbon richness,
- high prospectivity oil areas were **mapped by the surface survey,**
- The Utica Fm was not charging the Queenston Fms,

The AGI geochemical survey, DGL data, geologic data, and drilling information **caused the client to completely change their play concept and derive a clearer and more accurate understanding of the play and its economics.**