PS Applied Organic Geochemistry and Best Practices to Address a Surface Casing Vent Flow - Lessons from Remediation Work of a Shale Gas Well in Quebec*

Jean-Yves D. Chatellier[1], Rene Rioux[1], Marianne Molgat[1], Craig Goodall[1], and Ralph Smith[1]

Search and Discovery Article #40976 (2012)**
Posted July 16, 2012

*Adapted from poster presentation at AAPG Annual Convention and Exhibition, Long Beach, California, April 22-25, 2012

[1]Talisman Energy Inc., Calgary, AB, Canada (jchatellier@talisman-energy.com)

Abstract

Organic geochemistry has proven to be an ideal tool to identify the source of and remediate a surface casing vent flow in Quebec. A large dataset of gas carbon isotopes from seven wells in the Quebec Lowlands gives well defined isotopic profiles across the 2000 meter thick shale succession. The carbon isotope signatures of ethane, propane and methane carbon are burial history dependent. Three carbon isotope domains are distinguished for both ethane and propane based on trend inversions. These unequivocal signatures are compared to carbon isotope signatures from surface casing vent (SCV) gas and used to pinpoint the source depth of gas observed at the vent. Methane carbon isotopes have proved to be much less reliable and less diagnostic except for biogenic gas.

At the Leclercville 1 well, gas from hydraulically fractured Utica shales sampled at the flowline and SCV gas were analysed for carbon isotopes. The entirely different carbon isotope signatures indicate that SCV gas does not originate from the fractured Utica interval. Bond and noise-temperature logs were also run and interpreted to identify all potential sources of gas behind the casing. The bond log was not sufficiently clear to be useful in this case.

SCVF gas at the Leclercville 1 well has an ethane carbon isotope composition that ranges from $\delta 13C$ -32.12 to -32.54 and propane from $\delta 13C$ -25.16 to -26.70; this clearly points to a gas source located within the Lorraine Formation at either a depth of 1 or 1.5 km. In contrast, the hydraulically fractured Utica shale gas, located at a depth of about 2 km, has much more negative isotopic values (ethane $\delta 13C$ -39.27, and propane $\delta 13C$ -34.85). Noise-temperature logs indicated that the most likely zone sourcing the SCV gas was located at around 1.1 km.

Following best practices, cement squeeze operations were conducted in three different zones from bottom to top: (1) in the existing Upper Utica perforations, (2) in the Lorraine at about 1500 m, and (3) at about 1000 m. Although remedial works in the first two zones were

operational successes, the flow problem remained. Significant flow reduction and pressure drop were observed at the vent after remedial operations above the 1100 metre interval outlined by both isotopes and wireline logs. Ethane and propane isotopes are vital complements to methane isotopes and can be successfully used to satisfactorily identify the depth of origin of surface casing vent gas.

Applied Organic Geochemistry and Best Practices to Address a Surface Casing Vent Flow

TALISMAN ENERGY

Lessons from Remediation Work of a Shale Gas Well in Quebec

Chatellier, J-Y., Rioux, R., Molgat, M.*, Goodall, C. and Smith, R.

Abstract

Organic geochemistry has proven to be an ideal tool to understand and remediate a casing vent flow in Quebec.

The collection of a large set of gas isotope data from the Quebec Lowlands has delivered a definite picture of the vertical change in isotope composition down a series of complete boreholes. The changes are well defined and gradual with depth. Three distinct domains are recognized for both the Ethane and Propane carbon isotopes based on trend inversions. Combining the signature of these two isotopes allows to pin-point the depth of the source of any gas coming from a surface casing vent flow (SCVF). The carbon isotopes of the Methane molecule have proved to be much less reliable and less diagnostic except for biogenic gas.

The isotopic composition of the Ethane, Propane and Methane carbon are not formation dependent but depth and paleotemperature dependent; fault reactivation post maximum burial can locally alter the isotopic profiles. To complement the analysis, produced gas from the hydraulically fracced Utica shale has been sampled via the flowline and analysed for isotopic composition. The first well that needed remediation showed that the gas collected at the SCVF was totally different from the Utica gas collected at the flowline. The SCVF gas did not come from the fracced interval.

Bond, noise and temperature logs were run to identify all possible sources of gas behind casing. The results of these were correlated with the depths derived from the isotope analyses from the same well.
The isotope data clearly indicated the source of the vent gas was from the Lorraine with two possible sources between 1 and 1.5 km, i.e. much shallower than the hydraulically fractured Utica shale (exhibiting much more negative isotopic values). Both the noise and temperature logs indicated that a zone around 1100 m was the most likely source for the vent gas. The bond log was not sufficiently clear to be useful in this case.

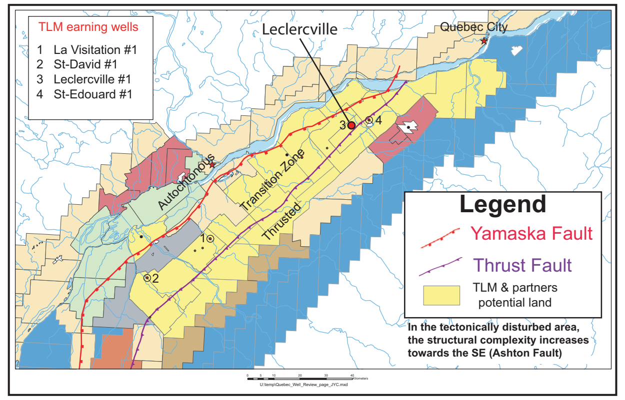
Since best engineering practices are to conduct operations at the bottom and work your way up, a first cement squeeze was attempted in the upper Utica at 1900m. Although it was an operational success, the vent flow problem remained unchanged. After re-evaluating the data, a second cement squeeze was attempted in the Lorraine at a depth of about 1350m, again with no change at the vent. A third cement squeeze was subsequently performed at ~1000m, the depth identified using gas carbon isotopes and wireline logs, at which time an almost immediate result was observed: flow rates at the vent were noticeably reduced.

Ethane and propane isotopes have been vital complements to methane isotopes and can be used to satisfactorily identify the origin of gas at a surface casing vent. Isotopic analysis in combination with standard measures such as bond, noise and temperature logs are a very powerful tool to properly identify the gas source and fix it with minimal program revisions and thus cost savings.

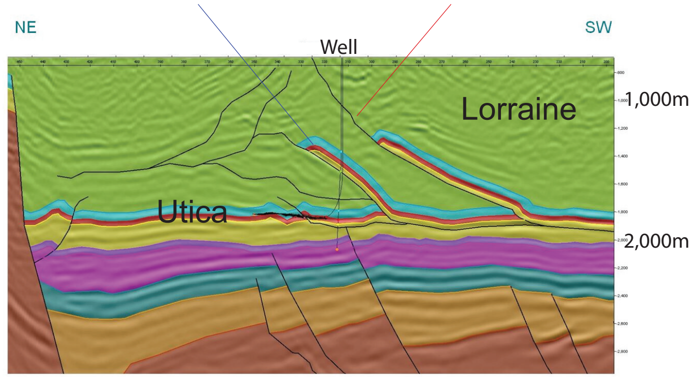
Acknowledgments

The authors would like to thank Talisman for the permission to present this material

Location and geological Setting



pre-drilling seismic interpretation



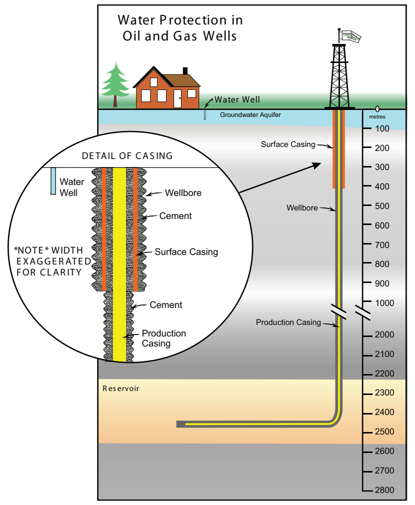
The seismic was interpreted prior to drilling the well. The faults were encountered where predicted by the seismic (depth converted). However, the Utica was not present where predicted in the hanging wall of the faults and only Lorraine was recognized.

Casing Vent Flow Identified

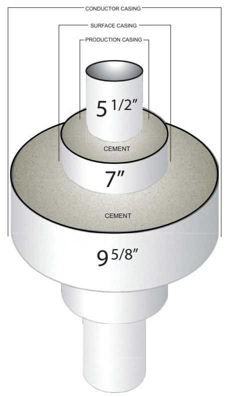
Well construction summary

General diagram

~20 times vertical exaggeration for above surface features (house, tree and derrick)

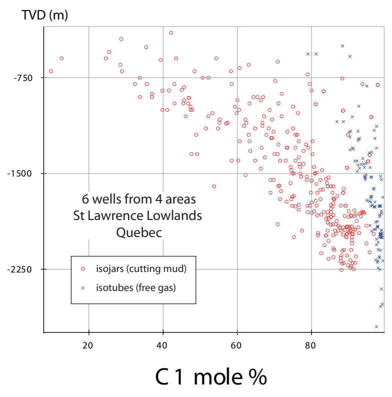


Casing Schematics



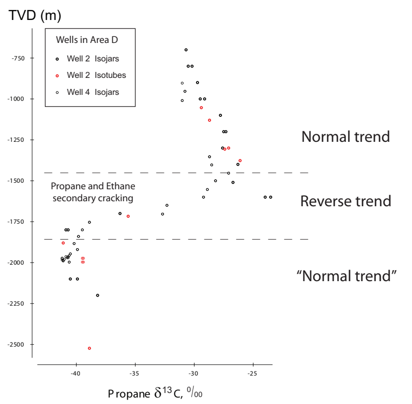
Gas Composition versus Isotopes

Sampling method greatly influence the measured gas composition **whereas** Carbon isotope values do not depend on the sampling method



At the same depth an isojar may indicate 20% methane (red circle) whereas the equivalent isotube will indicate more than 80% methane

Major differences in gas composition between Isotubes and Isojars



Propane carbon isotope ratios against depth showing similar isotope values despite different sampling techniques. The reverse trend beginning at ~1500m is called the isotope rollover (C2 or C3)

Applied Organic Geochemistry and Best Practices to Address a Surface Casing Vent Flow

TALISMAN ENERGY

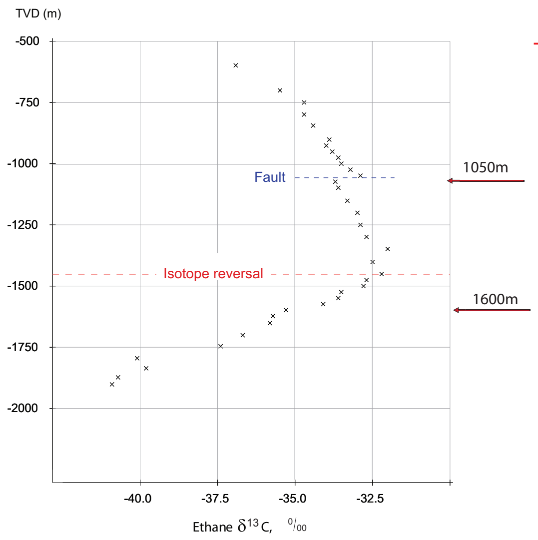
Lessons from Remediation Work of a Shale Gas Well in Quebec

Chatellier, J-Y., Rioux, R., Molgat, M.*, Goodall, C. and Smith, R.

Ethane Carbon Isotopes

samples from isojars (Cuttings)

Leclercville well



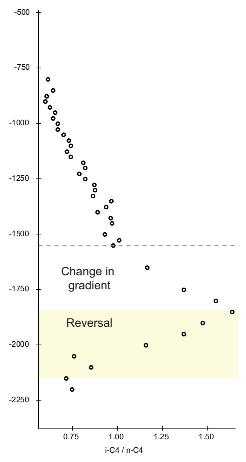
Two reverse faults
well defined on seismic

Emplacement post-maximum burial => Disruption of isotope trend

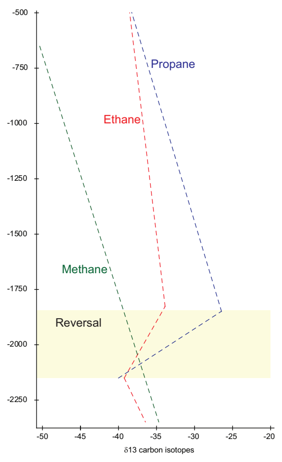
Emplacement pre-maximum burial (Late Ordovician), Isotope trend undisturbed

Other Talisman well

Butane ratios



Carbon isotope



The regression lines have been generated from one single unfaulted well

All regression line have R square > 90% except for Ethane in the lower domain

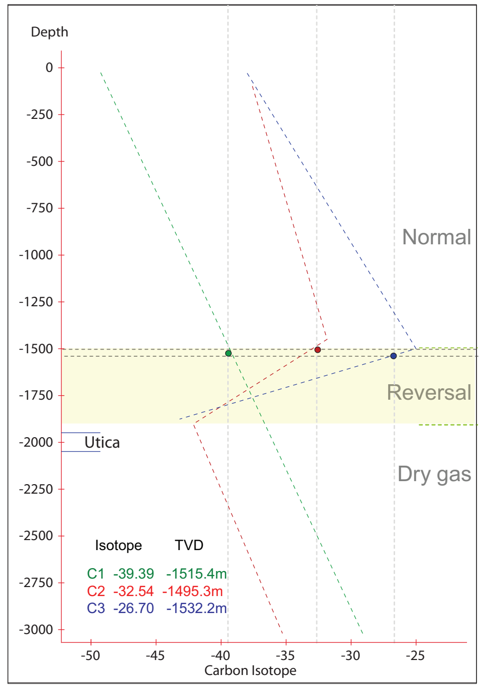
Note that the IC4/nC4 ratio exhibits a reversal at the exact same depth as the Ethane and Propane isotopes

Reversals are at the same depths (note the change in gradient in butane ratios

Depth estimates of source of gas from surface casing vents (SCV) in Leclercville

Five samples of gas sampled at the vent have been analyzed for carbon isotopes of C1, C2 and C3

The one and unique case of perfect match between C1, C2 and C3 carbon isotopes

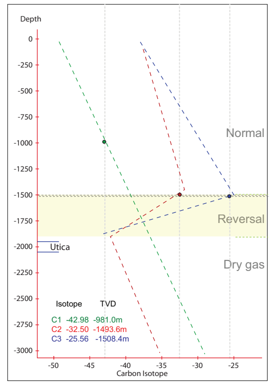


Regressions used for Leclercville are based on several neighboring wells

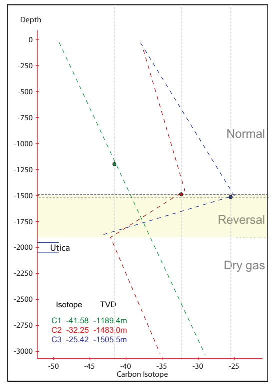
Additionally, the area has some reverse faults that disrupt the trends (see top left Ethane isotope depth profile)

That implies that the depth prediction is not as good as if ony one highly sampled well could be used

Typical SCV sample

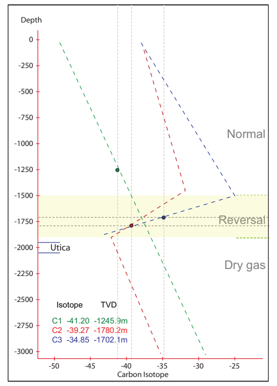


Typical SCV sample



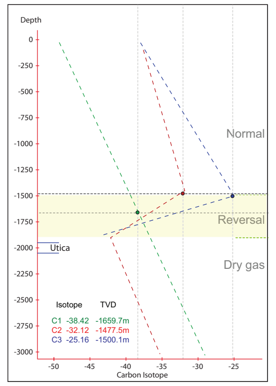
Data indicates that methane probably comes from between 1000 and 1250m
Ethane and propane isotope indicate source from top of overpressure domain

Flow line sample



Deep source estimate for Ethane and Propane, Shallow Methane source

Unusual sample



Deep Methane source Ethane and Propane from top of overpressure domain

Conclusions from Isotopes

Ethane and propane carbon isotope values of gas collected at the surface casing vents appear to be reliable as they give very similar source depth ranges.

Methane carbon isotopes generally gives a source depth estimate that is different from the ethane and propane (note, one exception was found).

The great majority of labs measure only the Methane carbon isotope ratios.

Ethane and propane isotopes NEED to be measured in order to adequately assess the source gas at the surface casing vent

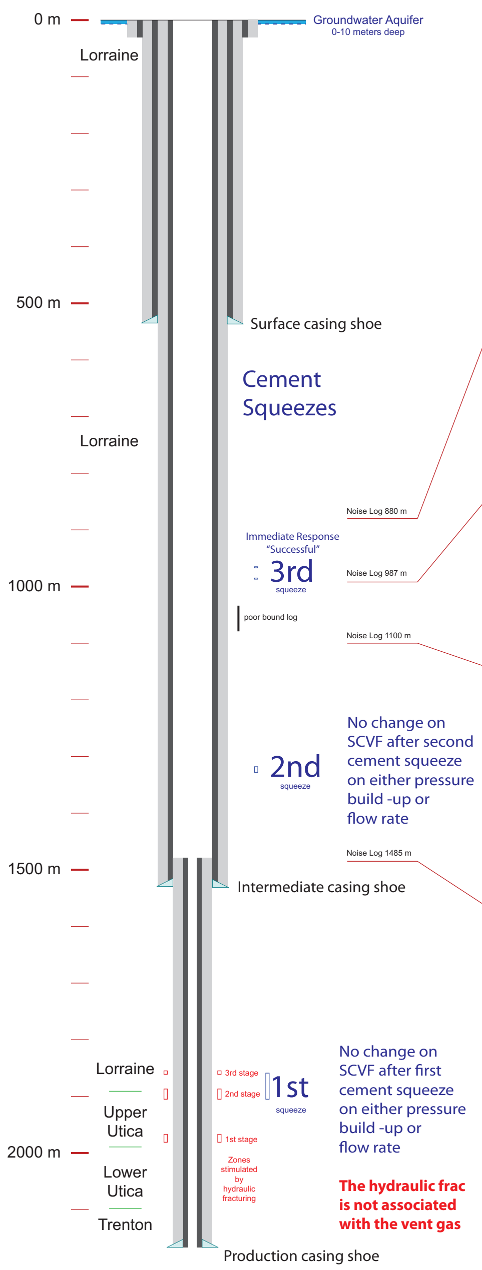
Applied Organic Geochemistry and Best Practices to Address a Surface Casing Vent Flow

TALISMAN ENERGY

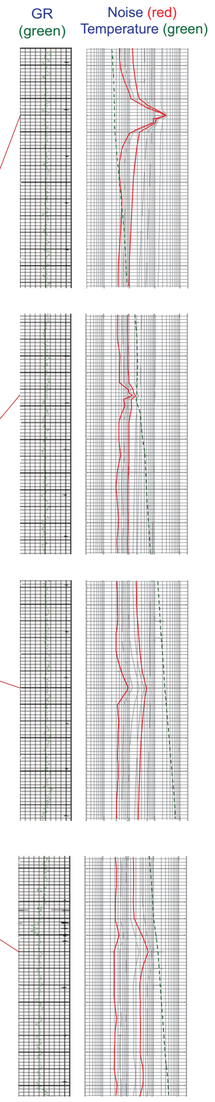
Lessons from Remediation Work of a Shale Gas Well in Quebec

Chatellier, J-Y., Rioux, R., Molgat, M.*, Goodall, C. and Smith, R.

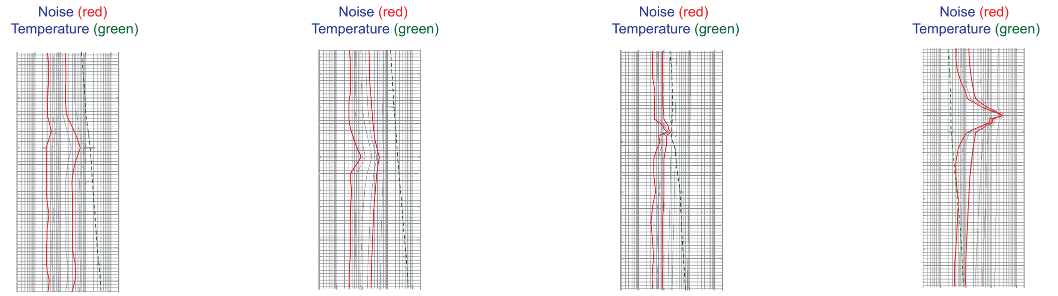
TLM Leclercville No.1



Wireline logs
(cased hole)



No noise and temperature logs below intermediate casing shoe

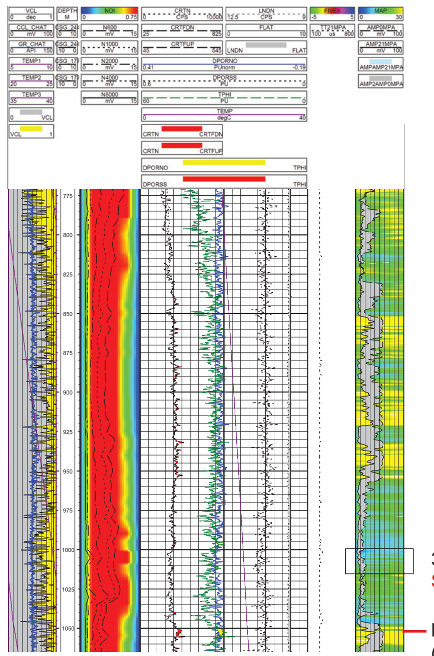


Observations

Around 1485m the Noise log shows a well defined excursion. A change in temperature gradient is noticeable around 1475m	At 1100m the noise log shows a well defined excursion	At 987m, both the noise and temperature logs exhibit a marked inflection (and possible sourcing)	The strong noise source is not associated with any temperature change.

Remarks

SCV Ethane and Propane isotope data indicate a possible source at these approximate depths.	Ethane from Isojars and Methane from one SCV sample suggest a reverse fault may be present at this depth	Methane carbon isotope from one SCV sample indicates possible sourcing at this depth	Carbon isotopes provide no diagnostic features at 800m mark

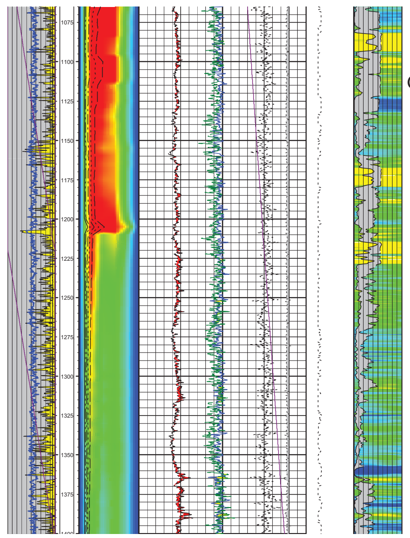


Combination
Noise log
Temperature log
Collar locator
and
Radial Bond log

3rd Squeeze
Success

Major reverse fault
(see isotope profile)

Continued from left



Interpretation:

Gas associated with open fractures from the footwall of the reverse fault

Conclusions

Hydraulic fracturing and surface casing vent flow are unrelated at Leclercville

Best practice for remediation of a SCVF is from bottom up all possible vent gas sources. This well demonstrated that the fault is the source of the vent gas

Noise and Temperature logs combined are great tools to identify the source of gas at the vent

Methane carbon isotope gave a precise location for the source of gas

Isotope profiling is an extremely powerful tool to better identify source(s) of vent or migration

Acknowledgments

The authors would like to thank Talisman for permission to present this material