



RANGE RESOURCES®

Green Valley Rd - Methane Investigation Moreland TWP, Lycoming County, PA

Mike Middlebrook

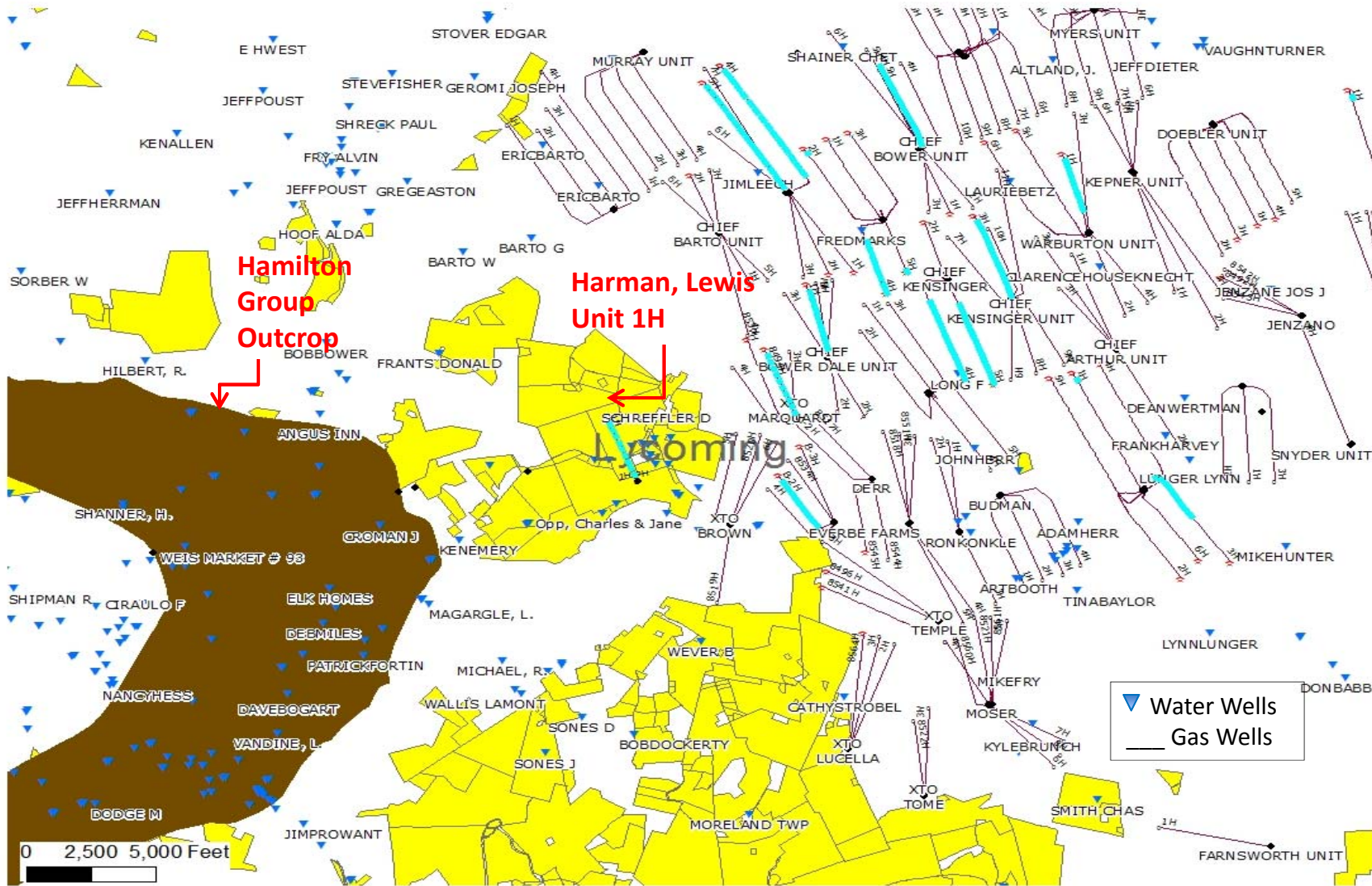
Vice President – Northern Marcellus Shale Division

October 1, 2012

Conclusions from Investigation

- **Harman, Lewis Unit 1H well integrity and hydraulic isolation was confirmed by (a) cement bond log, (b) noise survey, (c) temperature survey, (d) well construction information, and (e) pressure build-up testing.**
- **Methane was detected in area water wells PRIOR to Range's activity.**
- **Isotopic and Compositional analyses of the gas confirms that the Harman, Lewis Unit 1H well did not cause or contribute to gas in the area water wells.**

Area Development Map - Southeastern Lycoming Co, PA

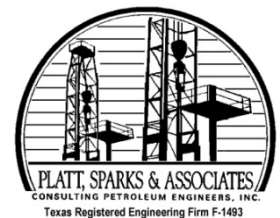


Investigation

- **Nov. 2010:** Pre-drill survey of all properties within 2500' of the Harman well, **19 water wells were sampled and methane was detected** in samples from four water wells: Bodle, Feiler 1, Feiler 3, and May (4.02 to 33.91 mg/L).
- **Jan. 2012:** In response to Bodle, Crawley, and Tironie concerns, Range:
 - Determined that there was **no** methane detected in the homes,
 - Installed methane detection alarms,
 - Vented water wells, and
 - Provided drinking water to all three homes.
- **Jan. 2012:** Conducted pressure build-up test on Harman well casing annuli.
- **Feb. 2012:** Gathered samples for isotopic testing from water wells with detected methane and from the three casing strings of the Harman well.
- **Feb. 2012:** Headspace in all water wells within 4000' of the Harman well were screened for methane. No methane was detected in any structures on 54 properties. Vents were installed on two more wells.
- **Mar. 2012:** Confirmed integrity of the Harman well with a cement bond log, noise survey and temperature survey.
- **Apr. 2012 – July 2012:** In cooperation with DEP Regional Office, conducted 5 more sample events from subject wells – two in April; two in May; and split samples in July.
- **May 2012:** Performed additional pressure build-up test on the Harman well casing annuli.

Harman, Lewis 1H Well Integrity Lycoming County, Pennsylvania

John C. McBeath, P.E.
Platt, Sparks & Associates
Austin, Texas



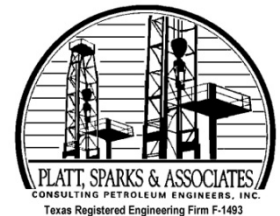
John C. McBeath, P.E.

Vice President of Platt, Sparks & Associates

Licensed P.E. in Texas, Wyoming, and California

Schlumberger 1987 - 1992 in Egypt, Kuwait, Pakistan & Oman

More than 20 years experience interpreting bond logs & other evaluation logs



Wellbore Diagram - Harman, Lewis Unit 1H

WELL NAME: Harman, Lewis Unit 1-H
FIELD: Marcellus Shale
PROJECT AREA: Williamsport Area
COUNTY/STATE: Lycoming, PA
RIG: Precision 158

SPUD DATE: 2/13/2011
COMP DATE: 6/18/2011
API#: 37-081-20292

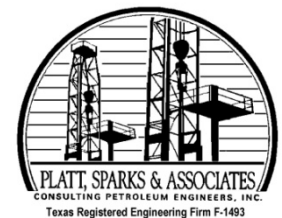
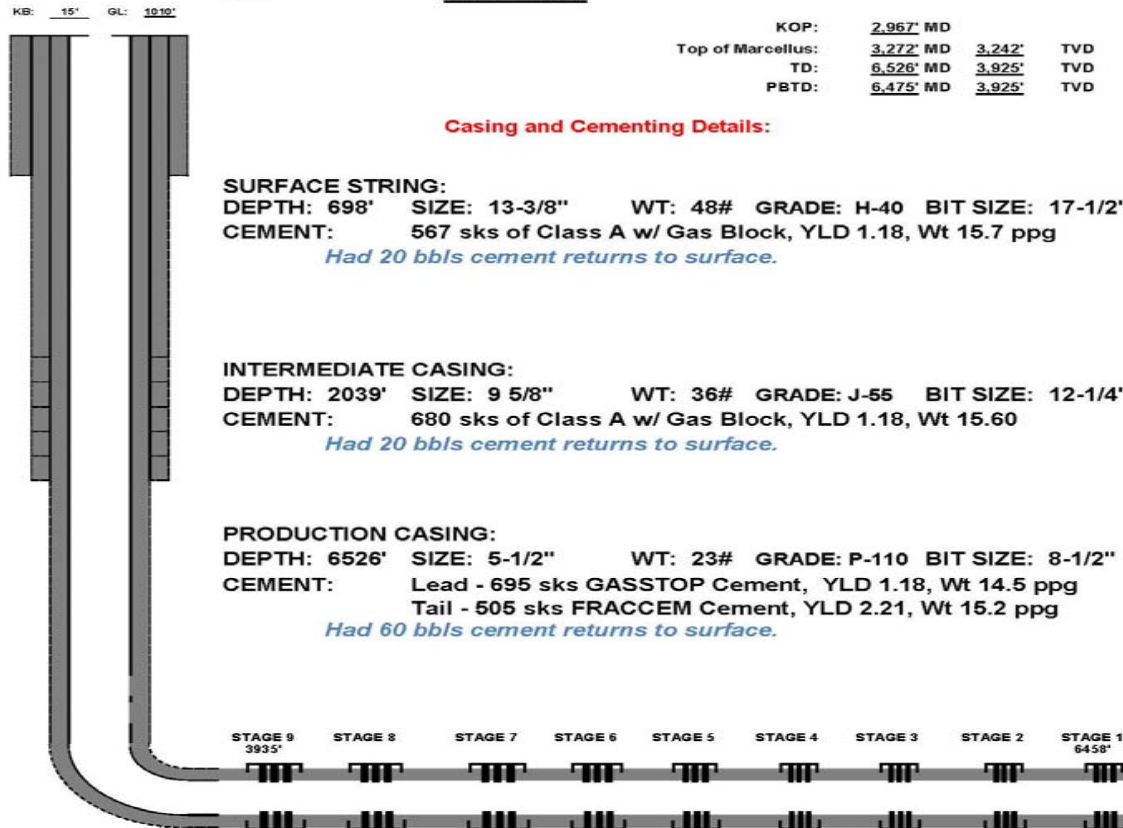
KOP: 2,967' MD
Top of Marcellus: 3,272' MD 3,242' TVD
TD: 6,526' MD 3,925' TVD
PBD: 6,475' MD 3,925' TVD

Casing and Cementing Details:

SURFACE STRING:
DEPTH: 698' **SIZE:** 13-3/8" **WT:** 48# **GRADE:** H-40 **BIT SIZE:** 17-1/2"
CEMENT: 567 sks of Class A w/ Gas Block, YLD 1.18, Wt 15.7 ppg
Had 20 bbls cement returns to surface.

INTERMEDIATE CASING:
DEPTH: 2039' **SIZE:** 9 5/8" **WT:** 36# **GRADE:** J-55 **BIT SIZE:** 12-1/4"
CEMENT: 680 sks of Class A w/ Gas Block, YLD 1.18, Wt 15.60
Had 20 bbls cement returns to surface.

PRODUCTION CASING:
DEPTH: 6526' **SIZE:** 5-1/2" **WT:** 23# **GRADE:** P-110 **BIT SIZE:** 8-1/2"
CEMENT: Lead - 695 sks GASSTOP Cement, YLD 1.18, Wt 14.5 ppg
 Tail - 505 sks FRACCEM Cement, YLD 2.21, Wt 15.2 ppg
Had 60 bbls cement returns to surface.



Cement Bond Log VDL

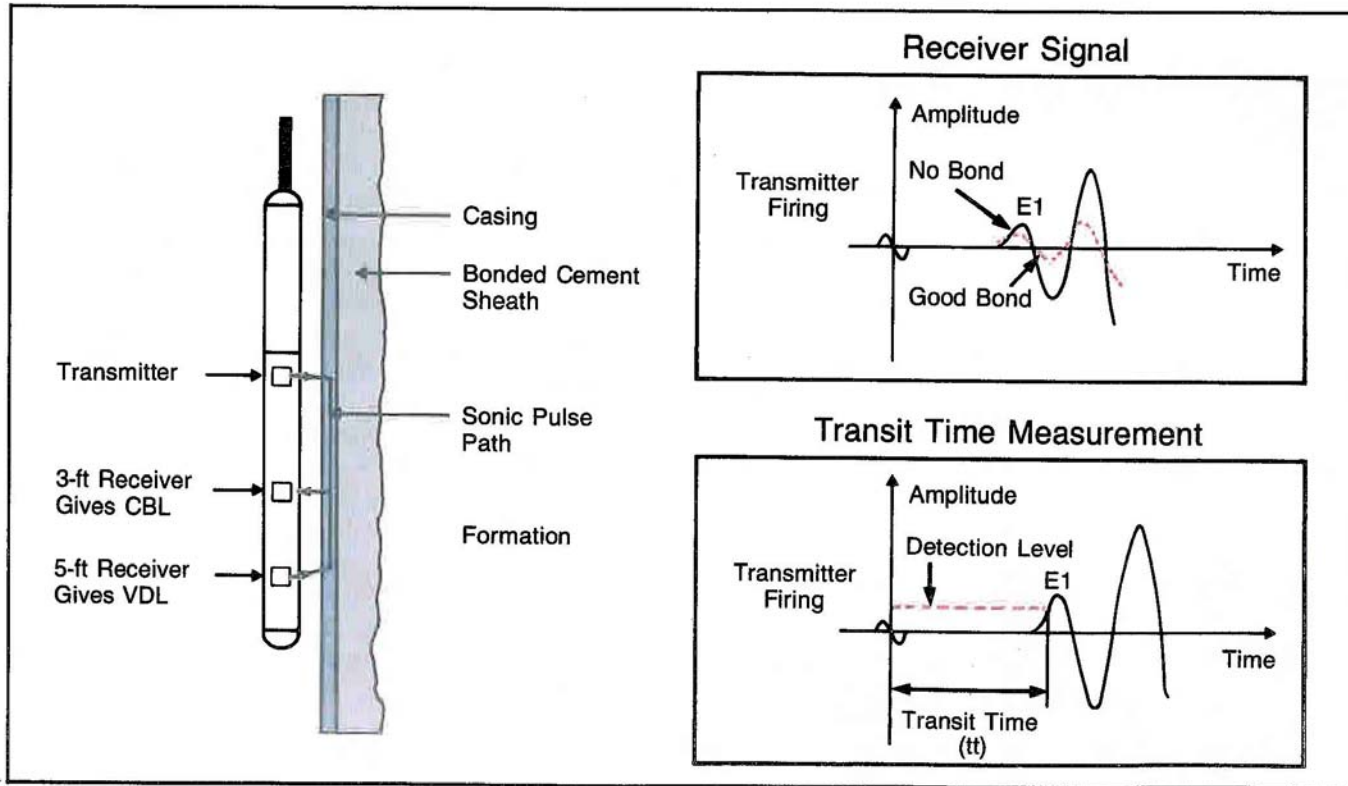
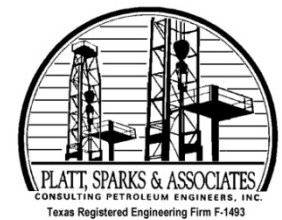
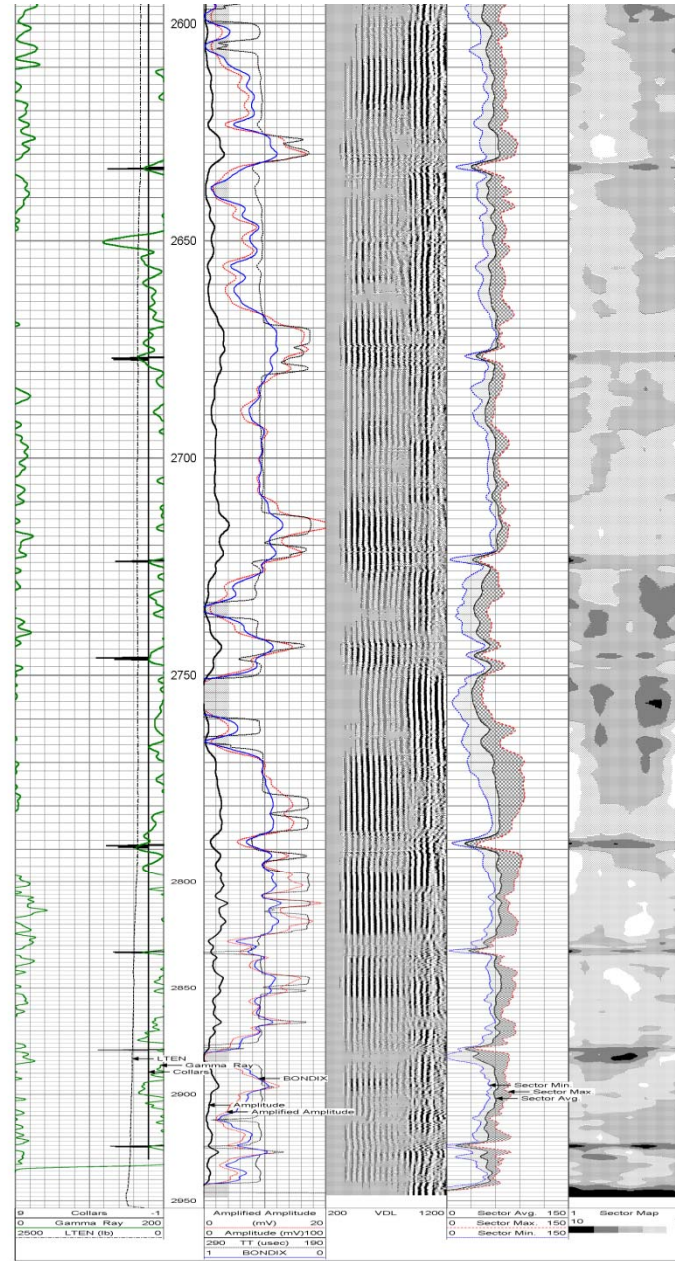
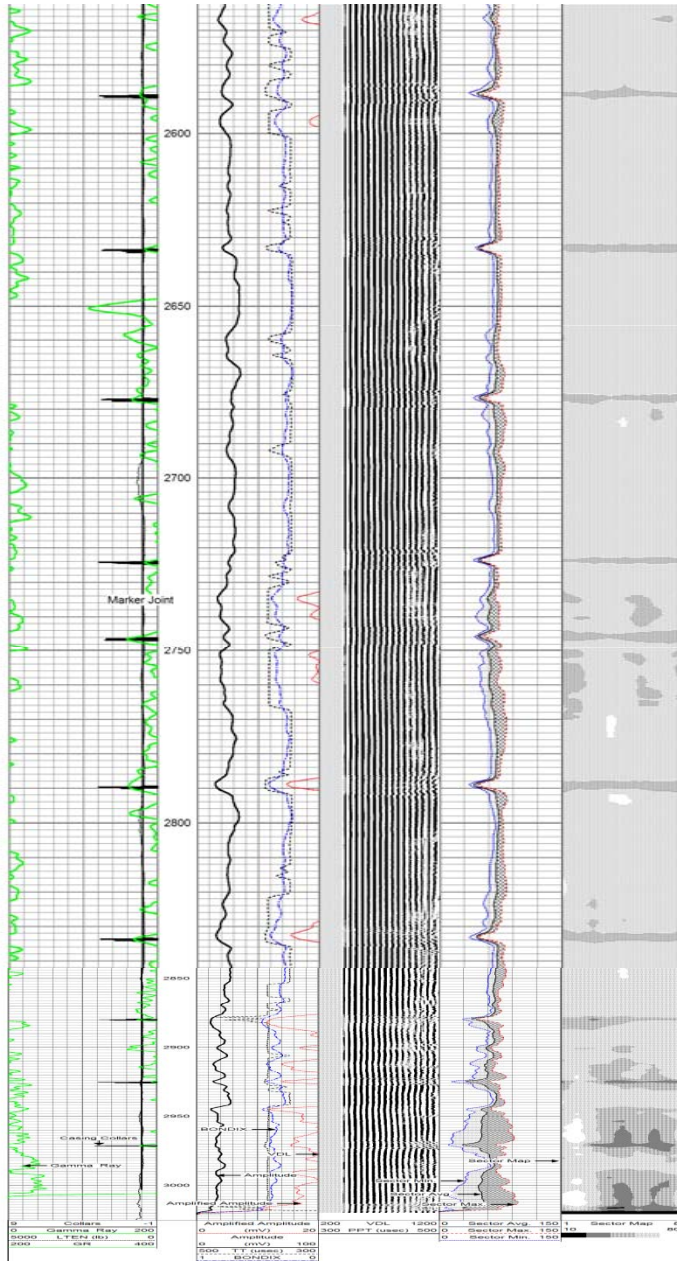


Fig. 5-3—CBL measurement

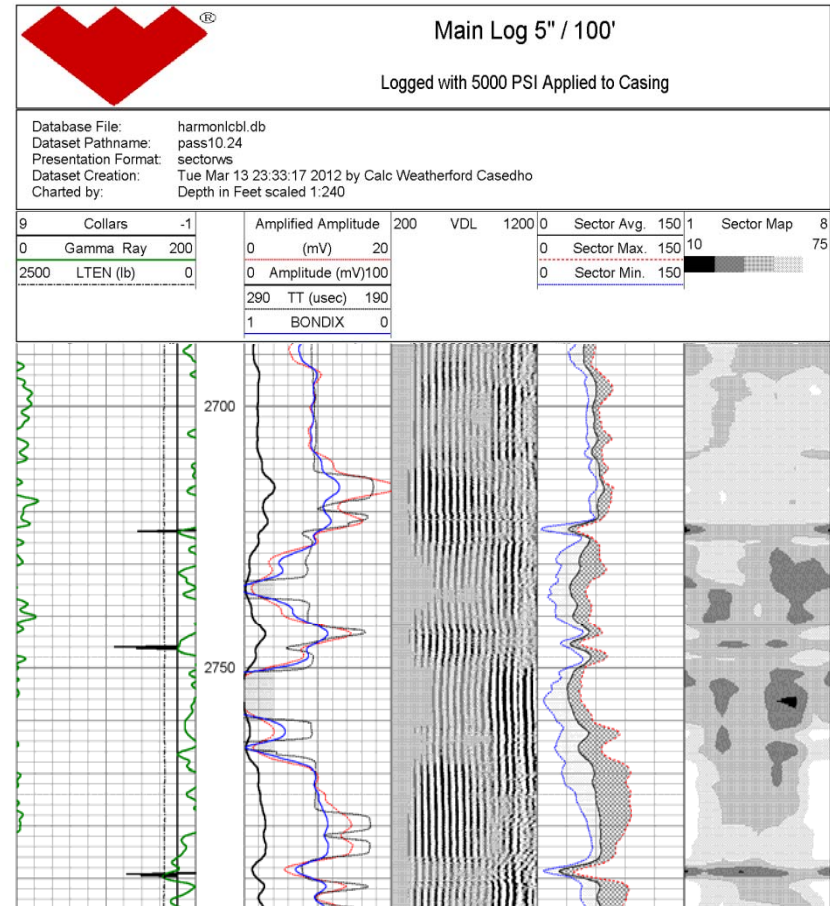
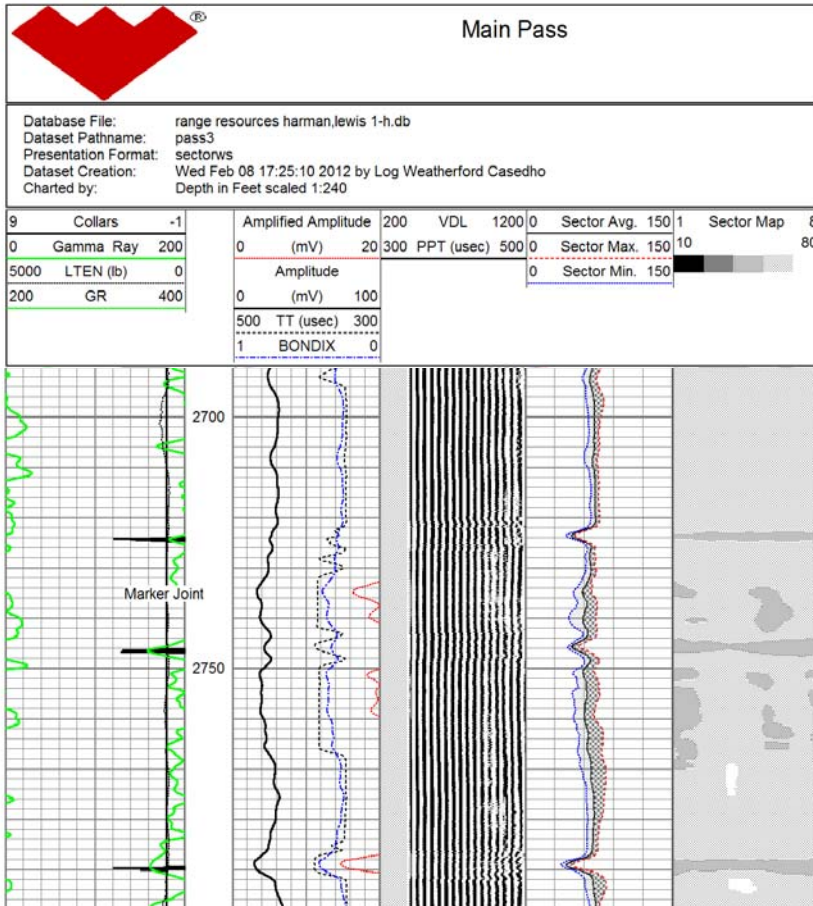
Cement Bond Logs



Cement Bond Logs

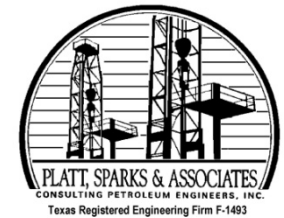
Feb 8, 2012

Mar 13, 2012



Decreased Amplitude
Higher Bond Index

Attenuated VDL
Response

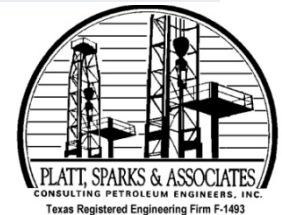


Pressure Build Up Readings

Casing Details	Size, Wt and Grade	Depth	Top of Cement – Volume Pumped	80% FW Gradient
Surface:	13-3/8" 48# H-40	698' TVD	Surface – 567 sx	242 psi
Intermediate:	9-5/8" 36# J-55	2039' TVD	Surface – 680 sx	706 psi
Production:	5-1/2" 23# P-110	6526' MD	Surface – 1200 sx	-

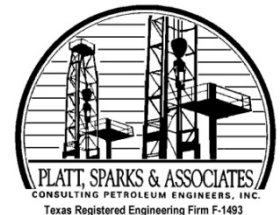
Build Up 1 – Started 1/27/12	24 hrs	48 hrs	72 hrs
9-5/8" x 13-3/8" Annulus	10 psi	13 psi	14 psi
5-1/2" x 9-5/8" Annulus	260 psi	325 psi	325 psi

Build Up 2 - Started 5/9/12	24 hrs	48 hrs	72 hrs
9-5/8" x 13-3/8" Annulus	0.9 psi	12.4 psi	39.4 psi
5-1/2" x 9-5/8" Annulus	143.5 psi	228.3 psi	288.1 psi



Conclusions

- The June 2011 and February 2012 CBLs warranted further investigation.
- The March 2012 5000 psi CBL confirmed existence of a micro-annulus, as indicated by improved amplitude and bond index readings.
- Zones with a Micro-annulus still provide hydraulic isolation.
- There are numerous bonded intervals in the Harman, Lewis Unit 1H well with adequate hydraulic isolation.
- Hydraulic isolation is confirmed by temperature and noise surveys.





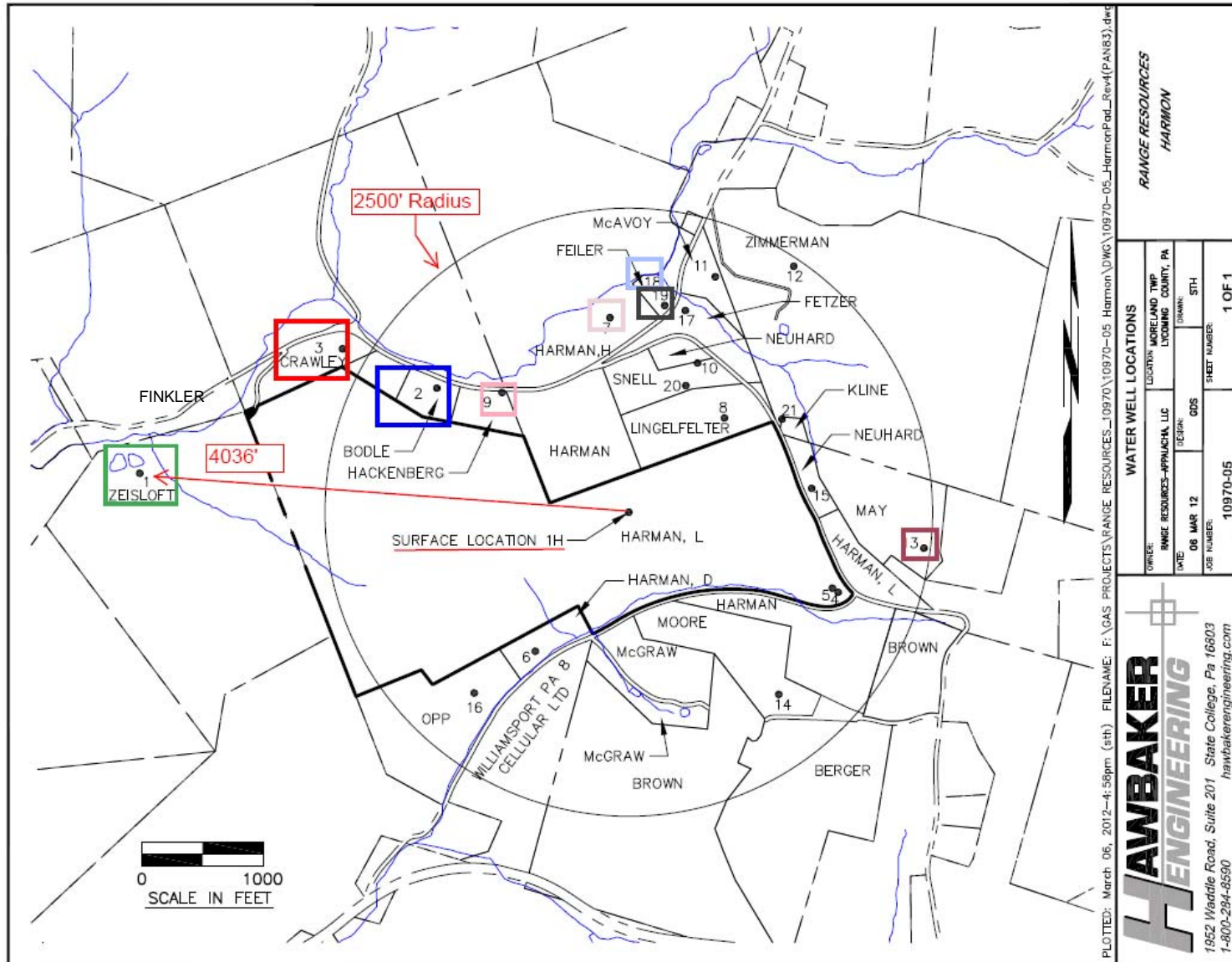
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Groundwater Sampling and Analysis

Mary Curliss Patton

Director of Regulatory - Northern Marcellus Shale Division

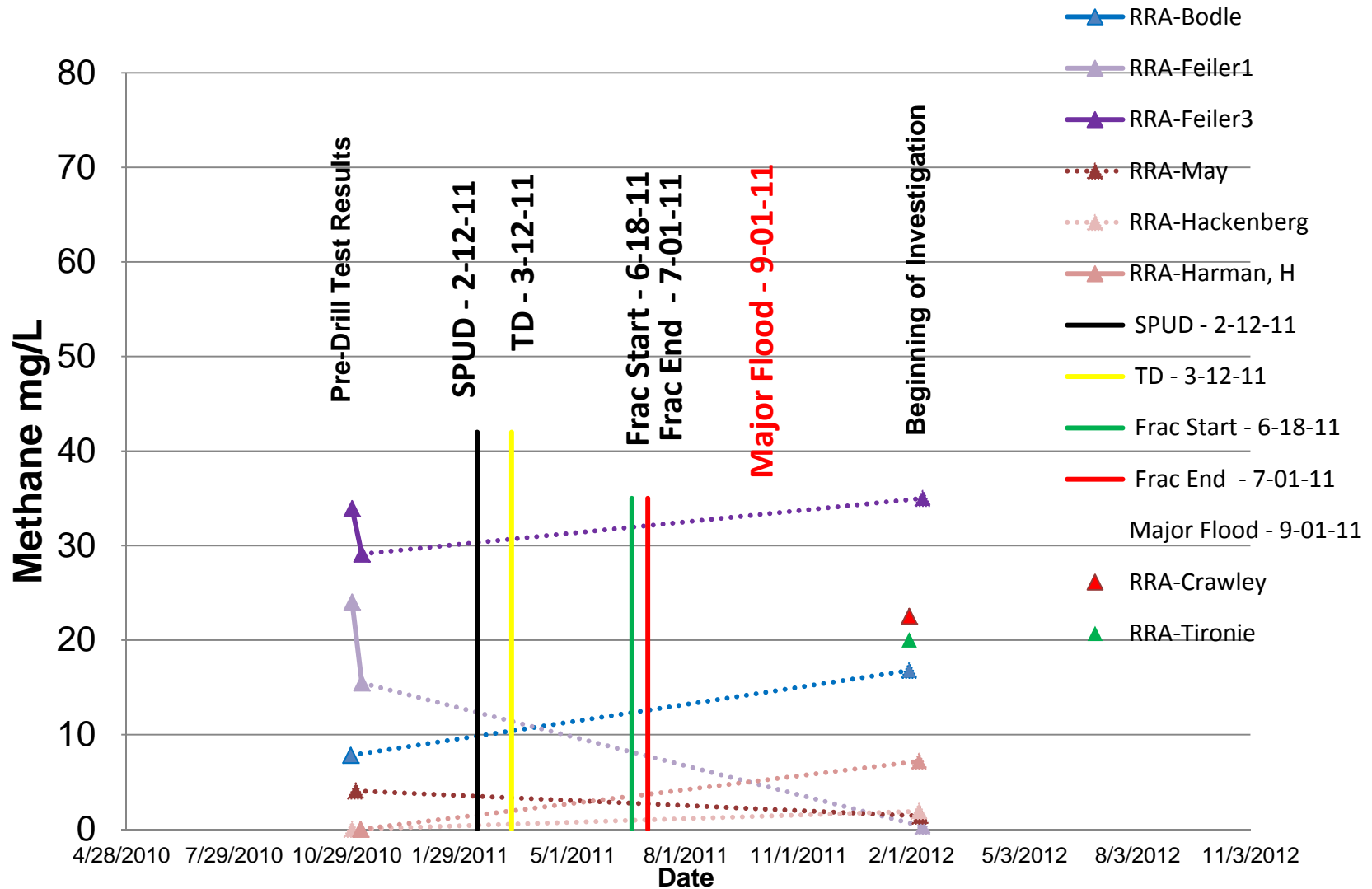
2500' Radius Map - Harman, Lewis Unit 1H Well



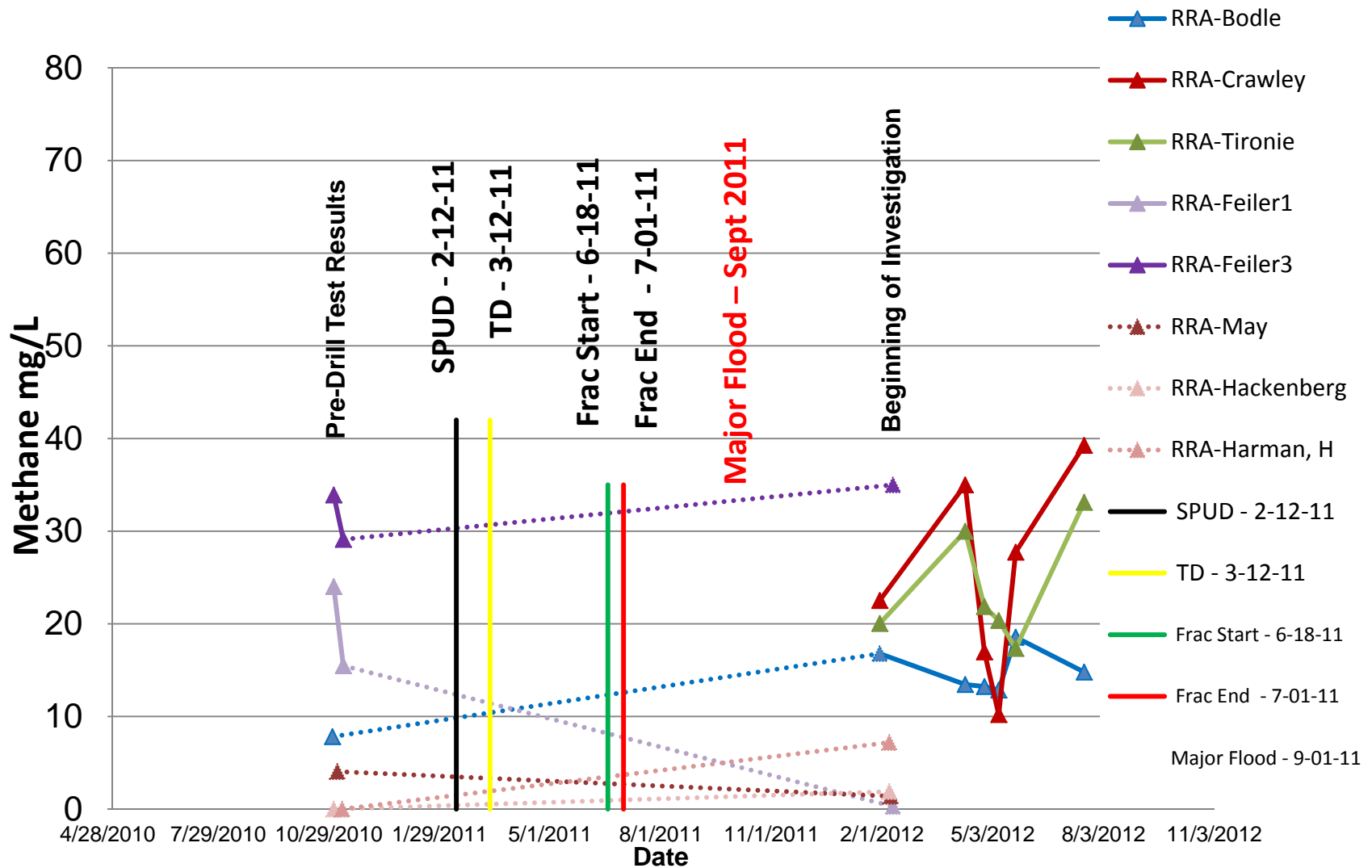
Test Results

Test Data - Methane Readings			Test Data - Methane Readings		
Test-Property	Date	Methane mg/L	Test-Property	Date	Methane mg/L
DEP-Bodle	1/18/2012	41.20	DEP-Crawley	1/24/2012	72.80
DEP-Bodle	3/08/2012	37.50	DEP-Crawley	7/18/2012	69.40
DEP-Bodle	7/18/2012	44.70			
			RRA-Crawley	1/30/2012	22.52
RRA-Bodle	11/01/2010	7.82	RRA-Crawley	4/10/2012	35.00
RRA-Bodle	1/30/2012	16.80	RRA-Crawley	4/26/2012	16.98
RRA-Bodle	4/10/2012	13.46	RRA-Crawley	5/08/2012	10.21
RRA-Bodle	4/26/2012	13.23	RRA-Crawley	5/22/2012	27.73
RRA-Bodle	5/08/2012	12.86	RRA-Crawley	7/18/2012	39.26
RRA-Bodle	5/22/2012	18.55			
RRA-Bodle	7/18/2012	14.80	RRA-Feiler1	11/02/2010	24.02
			RRA-Feiler1	11/10/2010	15.48
DEP-Tironie	1/25/2012	47.40	RRA-Feiler1	2/10/2012	0.29
DEP-Tironie	3/08/2012	21.00			
DEP-Tironie	7/18/2012	75.20	RRA-Feiler3	11/02/2010	33.91
			RRA-Feiler3	11/10/2010	29.11
RRA-Tironie	1/30/2012	20.03	RRA-Feiler3	2/10/2012	35.00
RRA-Tironie	4/10/2012	29.99			
RRA-Tironie	4/26/2012	21.87	RRA-Hackenberg	11/02/2010	0.00
RRA-Tironie	5/08/2012	20.35	RRA-Hackenberg	2/07/2012	1.90
RRA-Tironie	5/22/2012	17.35			
RRA-Tironie	7/18/2012	33.11	RRA-Harman, H	11/09/2010	0.00
			RRA-Harman, H	2/07/2012	7.20
RRA-May	11/05/2010	4.06			
RRA-May	2/08/2012	1.40			

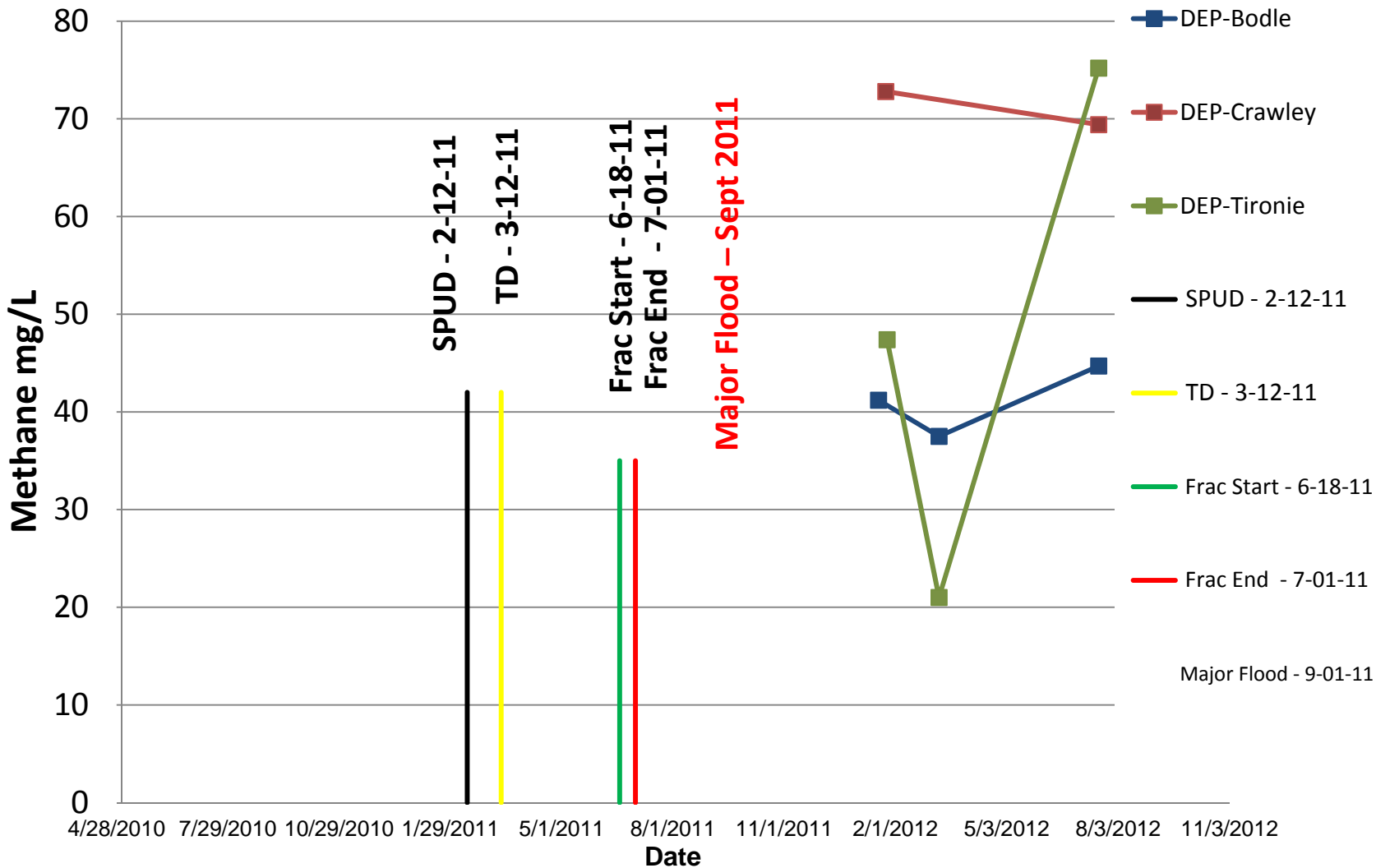
Pre-drill Results Show Methane is Present



Post-drill Results Show Methane Fluctuates



DEP Results Show Methane Fluctuates



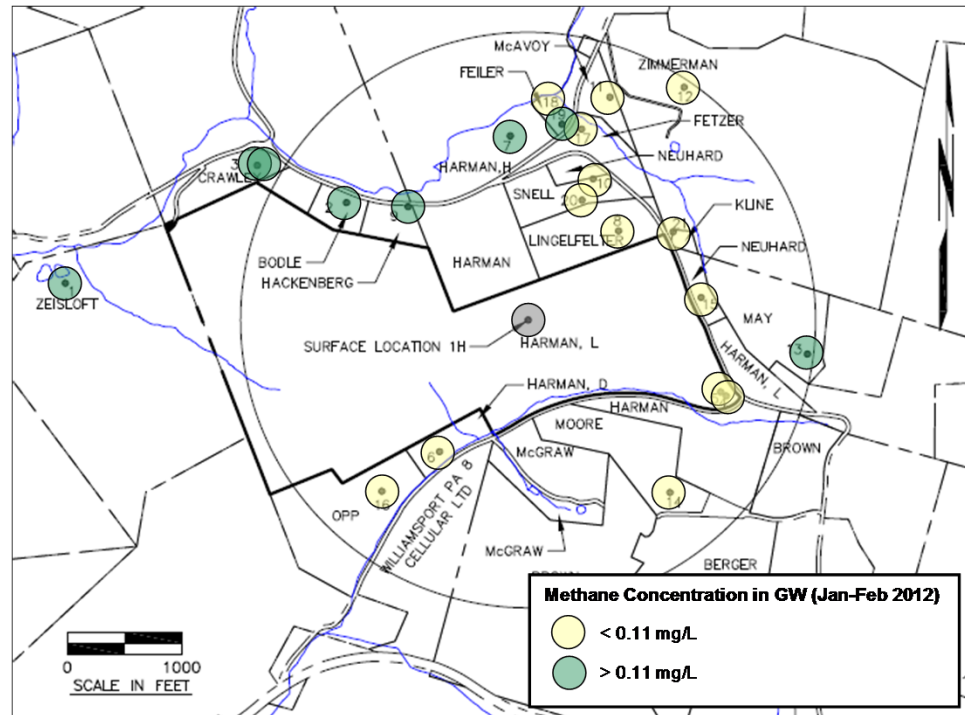
Review of Compositional and Isotopic Data Harman, Lewis 1H Well Lycoming County, Pennsylvania

Dr. Scott A. Stout, Ph.D., P.G.
Senior Consulting Geochemist
NEWFIELDS - ENVIRONMENTAL
FORENSICS PRACTICE, LLC
Rockland, Massachusetts

Gas Fingerprinting

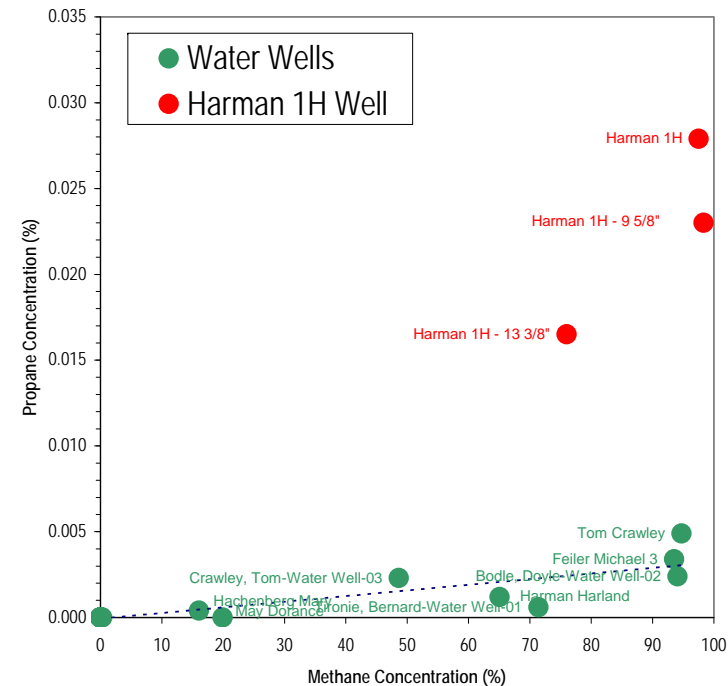
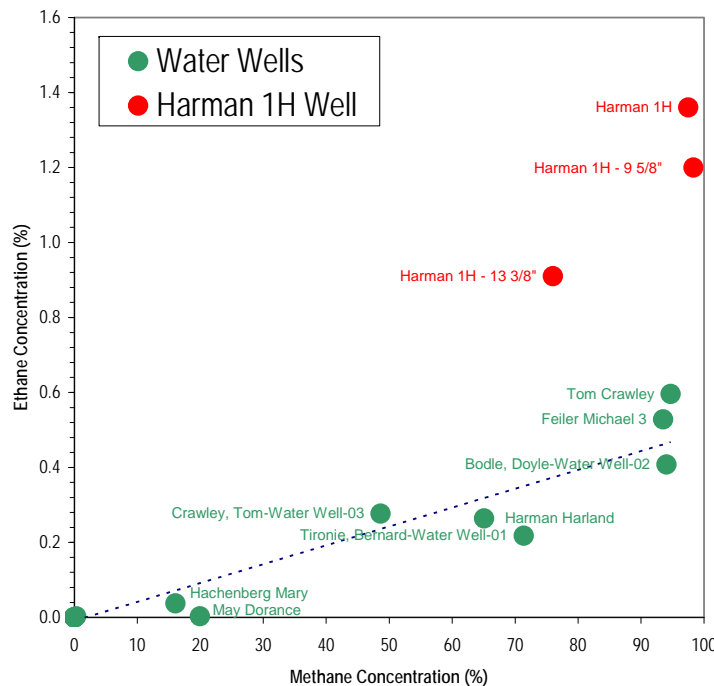
22 groundwater samples from 21 wells and 3 gas samples from the Harman well were collected:

- samples submitted to IsoTech for compositional and isotopic analysis
- gas concentrations varied in samples
- 8 groundwater samples from 7 wells contained sufficient methane for stable isotope analysis, as well as 3 Harman well gas samples



Hydrocarbon Gas Composition

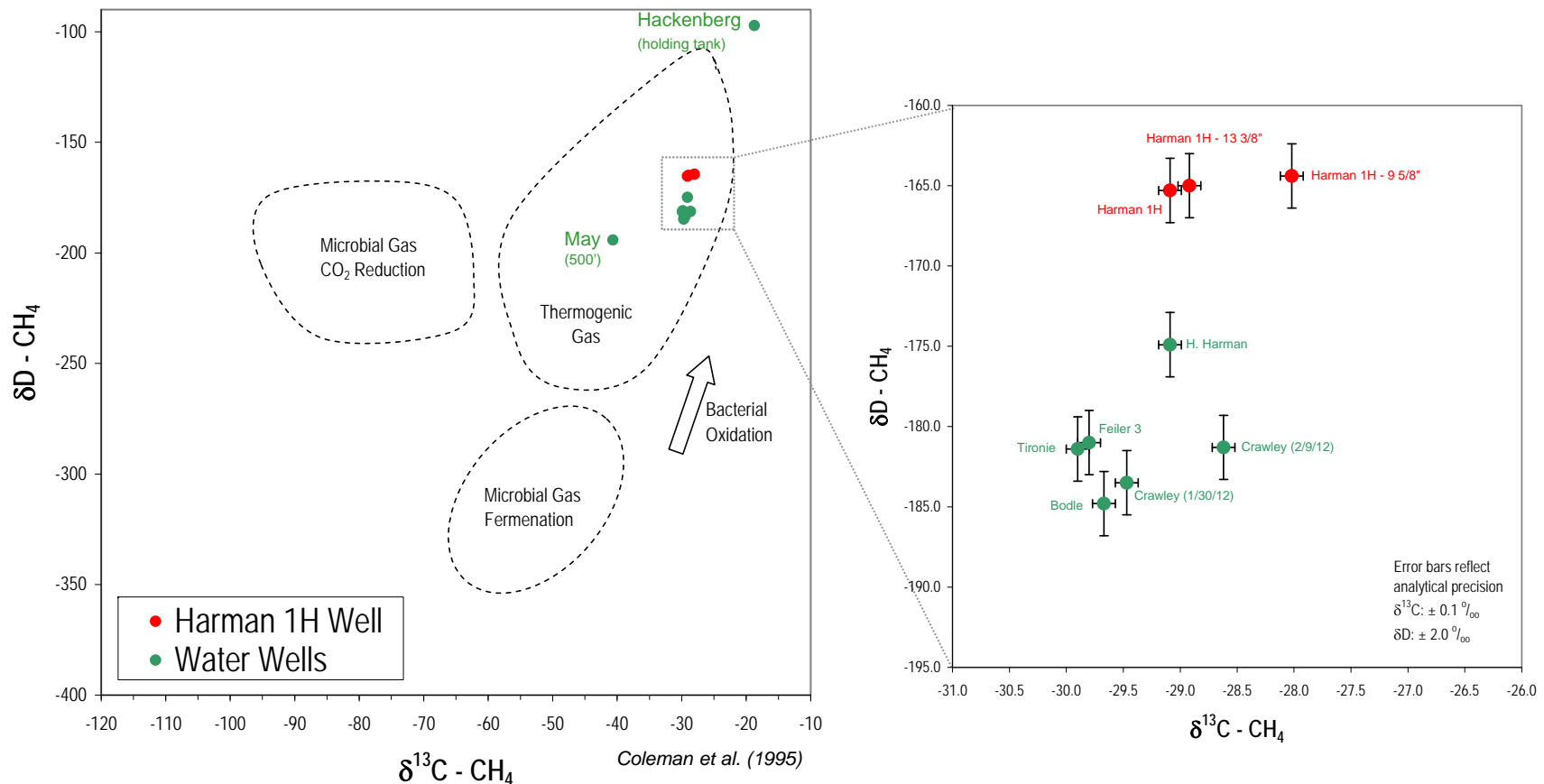
- Gases from different sources can contain different proportions of methane, ethane, propane, etc.



- Gas in area groundwaters was drier (less ethane and propane per unit methane) than the Harman well.

Methane Isotope Composition

Methane (CH_4) from different sources can contain different proportions of light (^{12}C) and heavy (^{13}C) carbon and light (^1H) and heavy (^2H) hydrogen.



Methane Isotope Composition

- Overlying strata are gas-bearing and this methane can be distinguished from Marcellus shale gas (Bradford & Susquehanna Co.).
- Lycoming Co. also commercially produces gas from Upper Devonian (Shrewsbury Gas Field <10 mi. NW of Harman well).

COMPARISON OF SUSQUEHANNA COUNTY METHANE ISOTOPIC SIGNATURES

FIG. 6

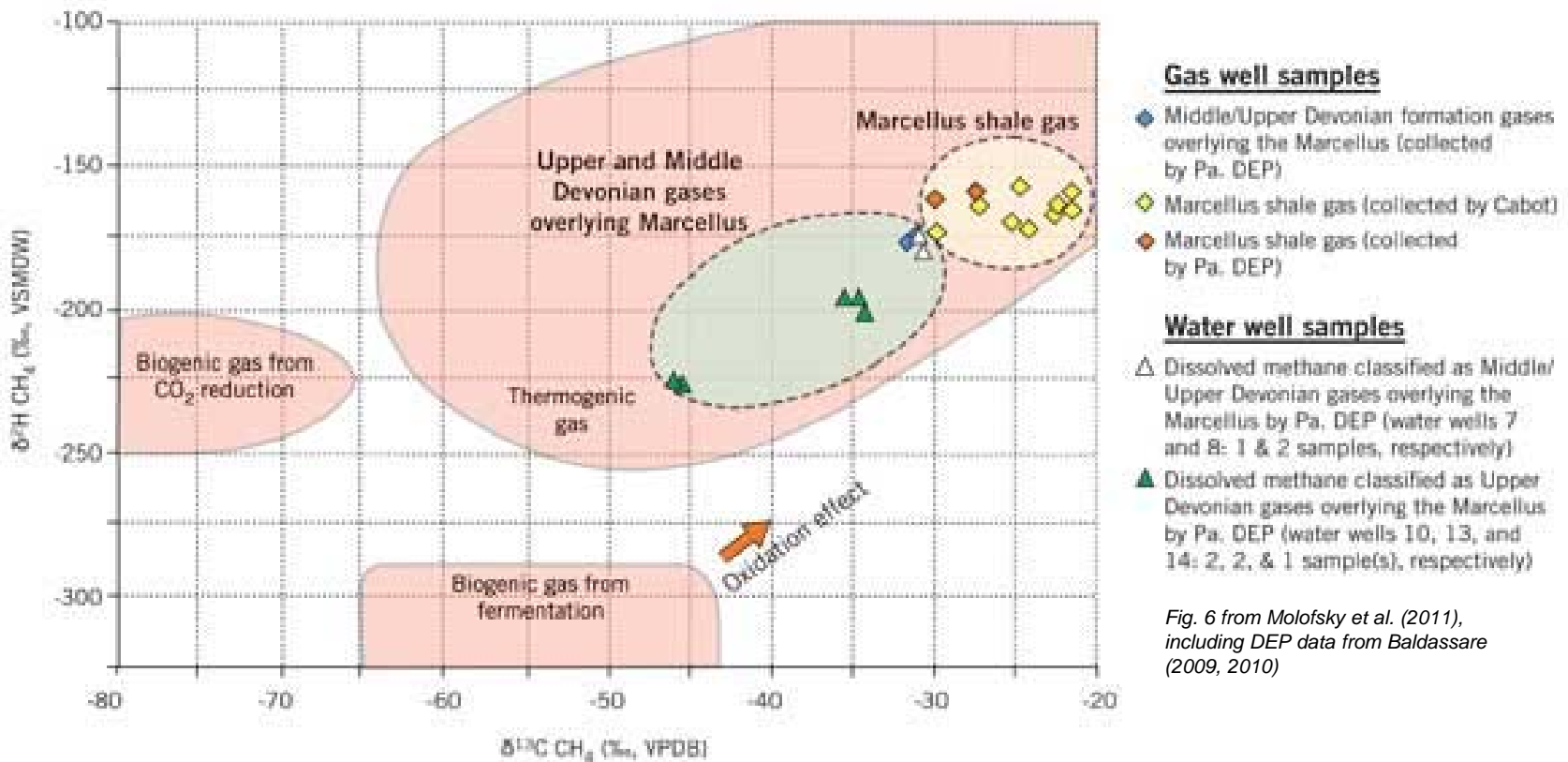
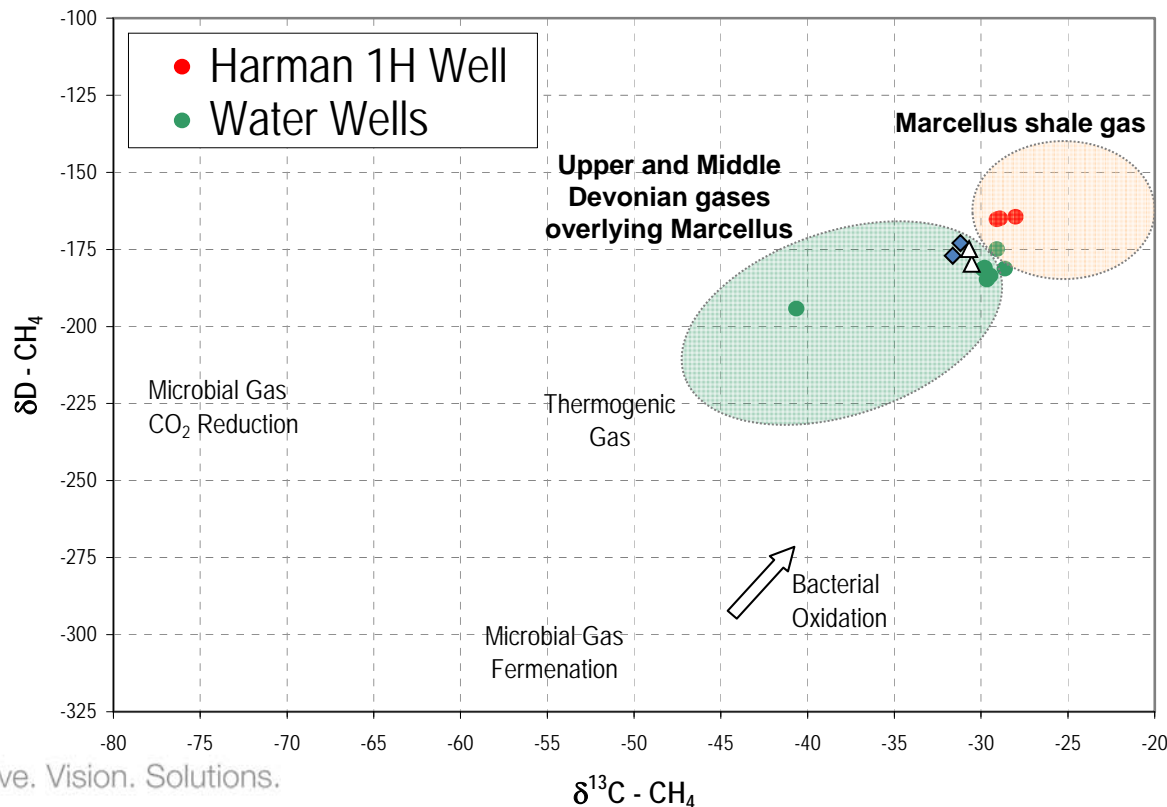


Fig. 6 from Molofsky et al. (2011), including DEP data from Baldassare (2009, 2010)

Methane Isotope Composition

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Study area gases from Harman well and groundwater wells are distinguishable isotopically. Methane in groundwater is more consistent with Middle/Upper Devonian gases.

Conclusions

- Studied gases from Harman, Lewis 1H well are distinguishable isotopically and compositionally compared to gases from the area's groundwater wells.
- Range's Harman, Lewis Unit 1H gas production well is not the source of methane gas in any of the 21 residential water wells studied.

Summary

Multiple lines of evidence demonstrate Harman, Lewis 1H well gas is not the source of gas in area groundwater:

- Integrity of the Harman, Lewis 1H well is confirmed
- Methane existed in the area's groundwater prior to drilling the Harman, Lewis 1H well
 - Overlying strata contain native gas, akin to Susquehanna Co.
- Molecular and isotopic differences exist between the Harman, Lewis 1H well gas and groundwater gases
- Even a contribution of Harman, Lewis 1H well gas to groundwater is unsupported by the data

