Agenda for meeting with EPA

RRC sampling results compared with past data and data provided by EPA.

- Dissolved methane concentrations
- Isotope ratios
- Nitrogen/CO_2
- Ethane isotope
- Thermogenic variability, biogenic, mixture

Identify possible sources of thermogenic gas

- Penetrating the Strawn Formation
  - PWS, Strawn field production, Hurst water well
- Natural migration
  - Contact between Cretaceous and Pennsylvanian
- Barnett Shale production
  - What pathway?
- Migration of Strawn gas behind production string
  - Sufficient pressure?

Discuss native geology

- Cross sections depicting depth of Perdue, Lipsky, Dawson

Discuss gas well construction and bradenhead pressure

- Teal, Butler wells
- Bradenhead pressures and gas fingerprint – not a pathway
- Carrizo well

Conclusions

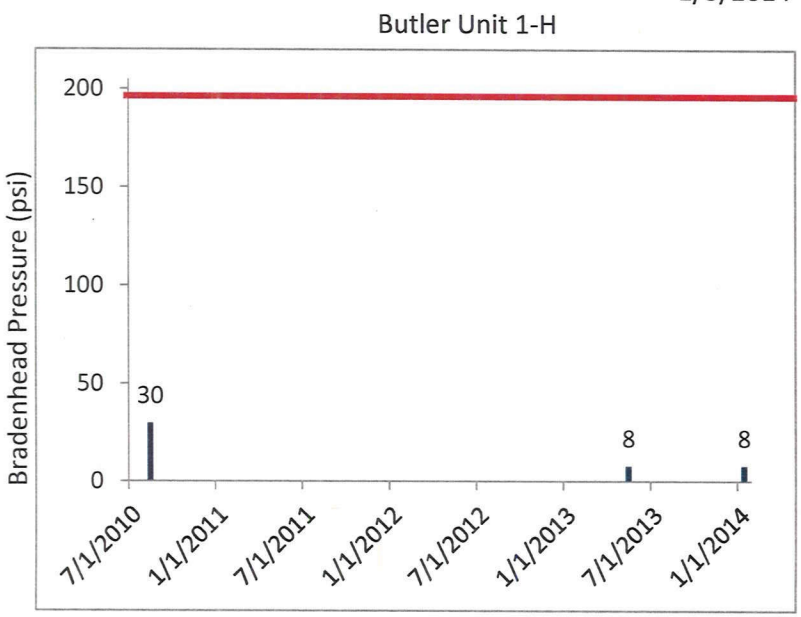
Annular Pressure Threshold compared with Bradenhead Pressures - Butler 1-H and Teal 1-H Gas Wells

APT-sc = 0.5 psi/ft x SCSD SCSD - Surface Casing Setting Depth in ftGR

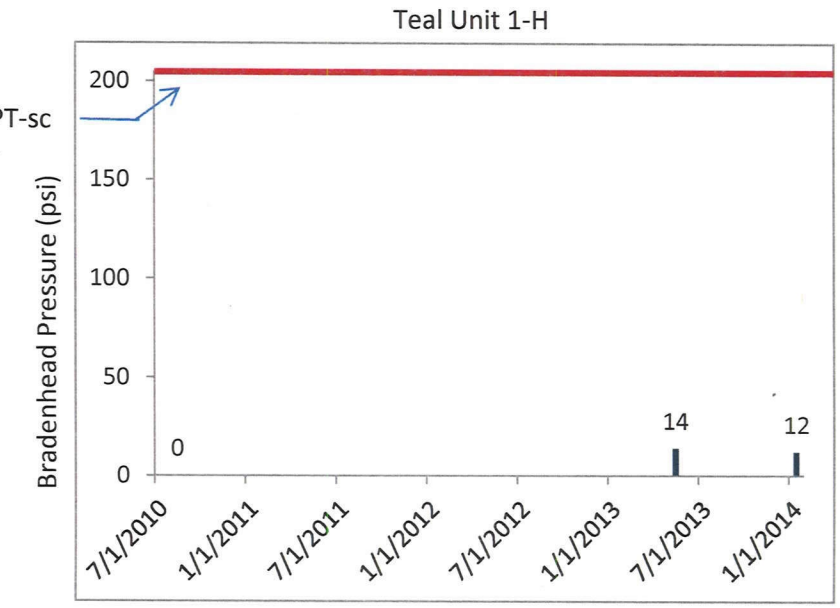
SCSD	APT-sc	
394 ftGR	197.0 psi	Butler Unit 1-H
409 ftGR	204.5 psi	Teal Unit 1-H

Butler Unit 1-H	Bradenhead Pressure (psi)
8/10/2010	30
5/21/2013	8
1/3/2014	8

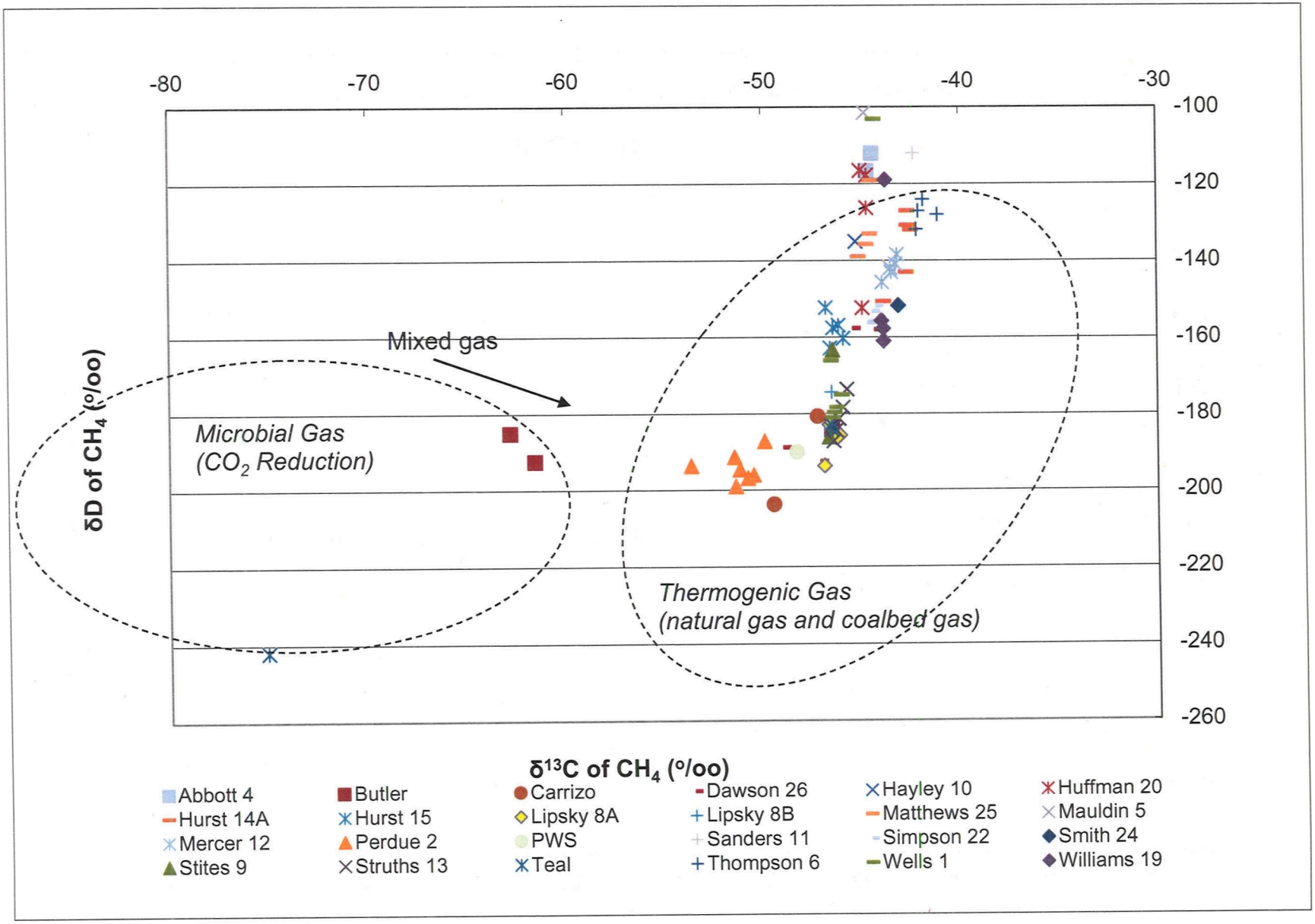
Teal Unit 1-H	Bradenhead Pressure (psi)
8/10/2010	0
5/21/2013	14
1/3/2014	12



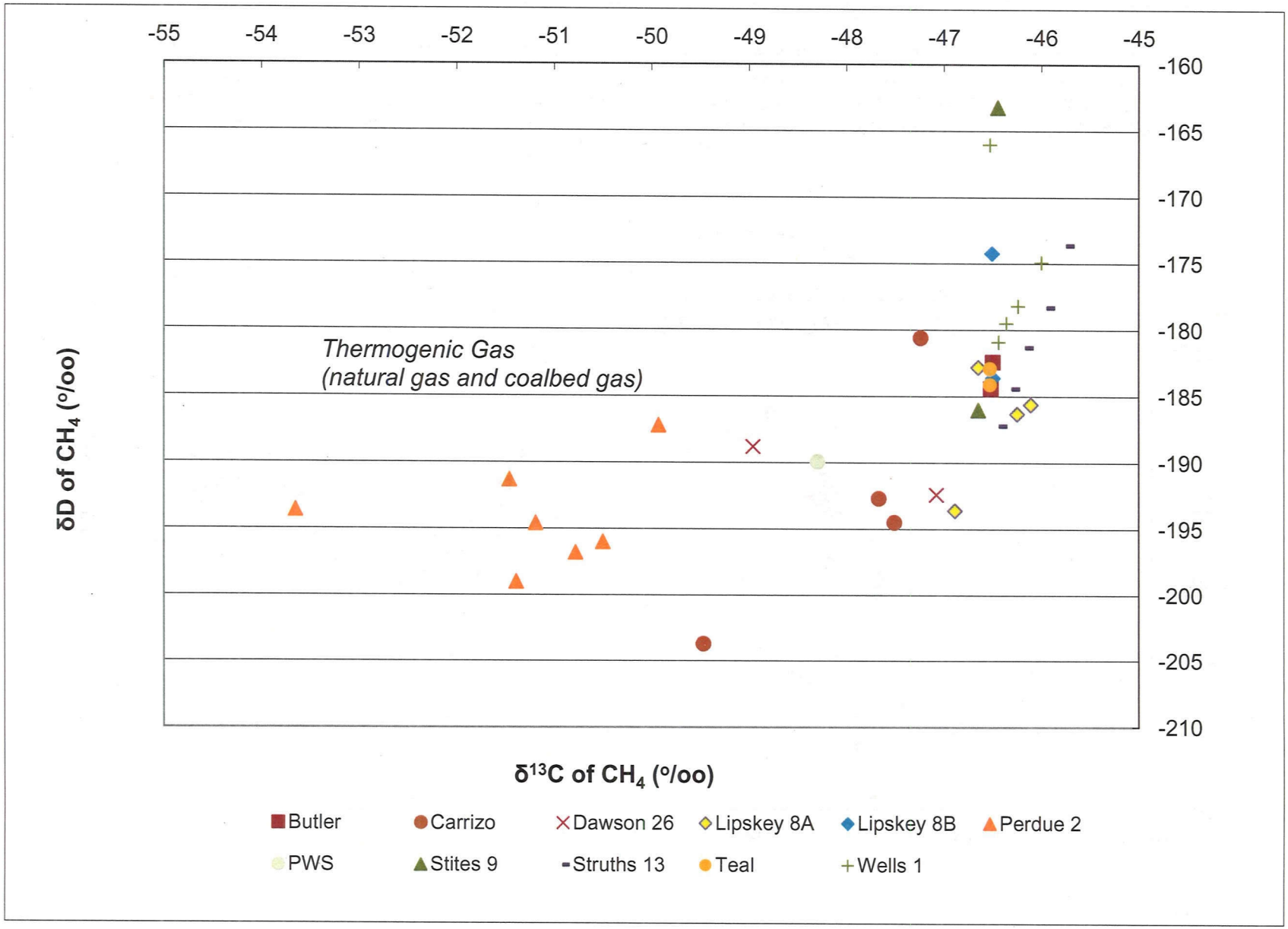
APT-sc



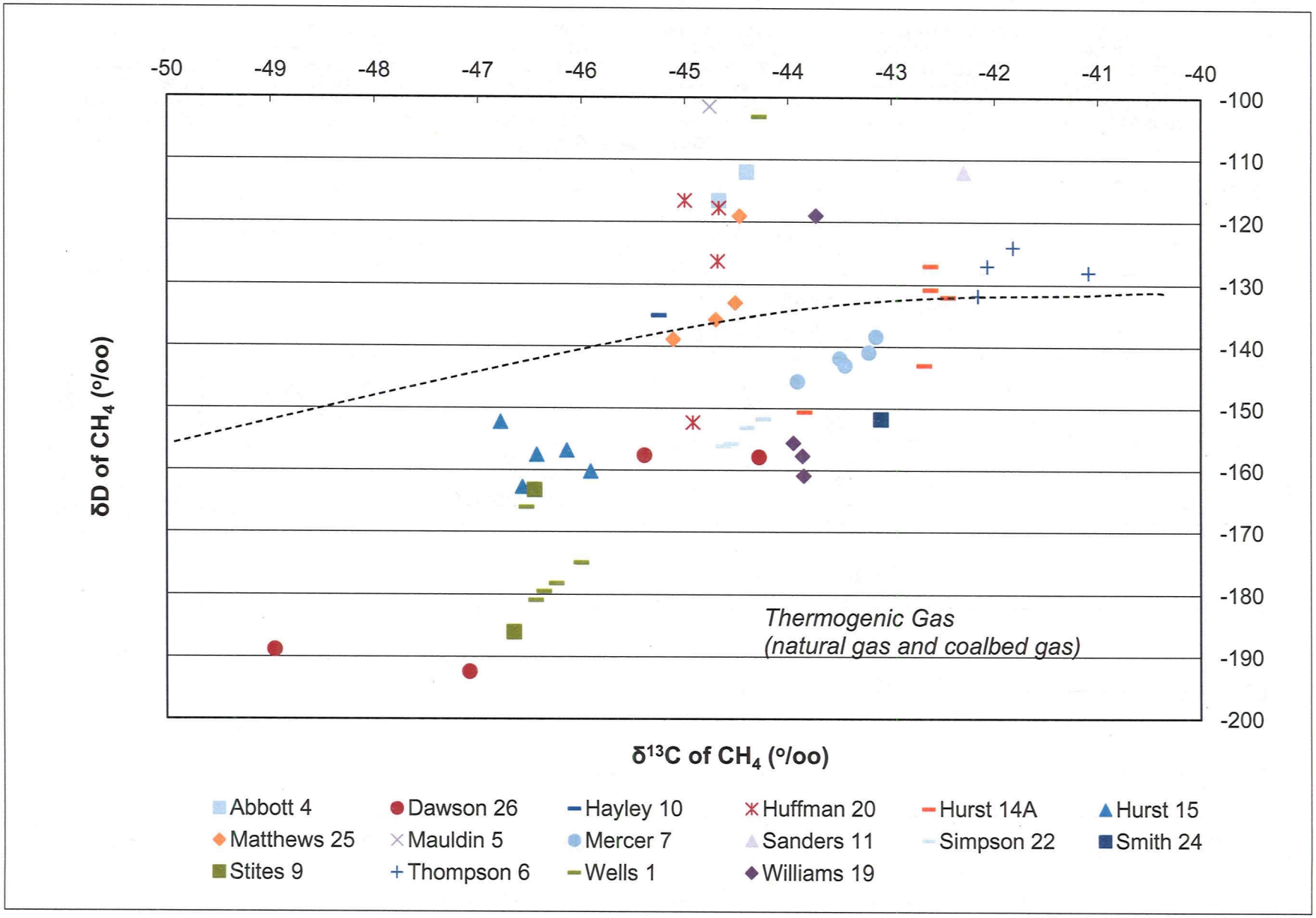
Stable Carbon and Hydrogen Isotopic Composition Ranges of Methane separated by Well Site



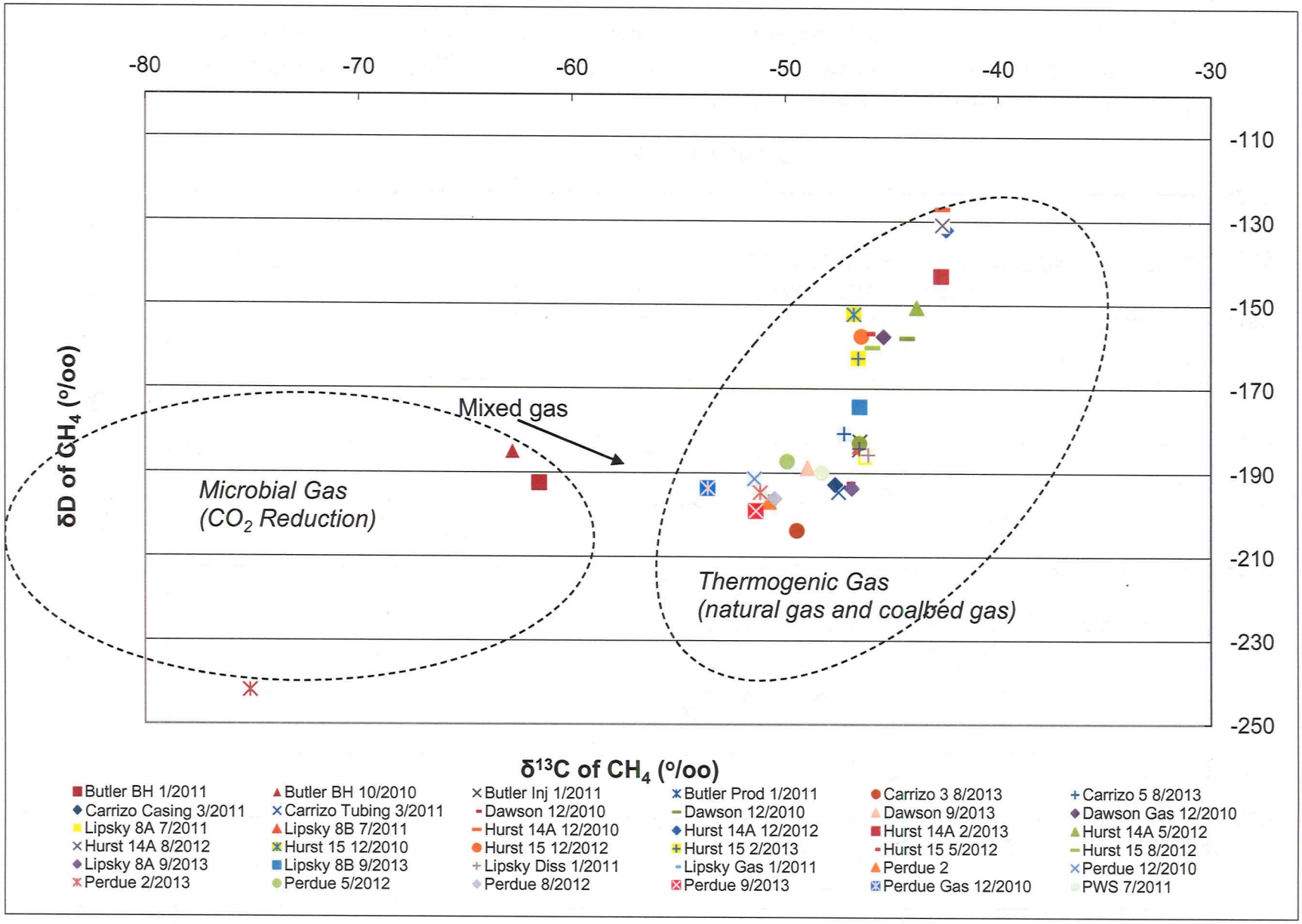
Stable Carbon and Hydrogen Isotopic Composition Ranges of Methane from Different Sources, Part 2



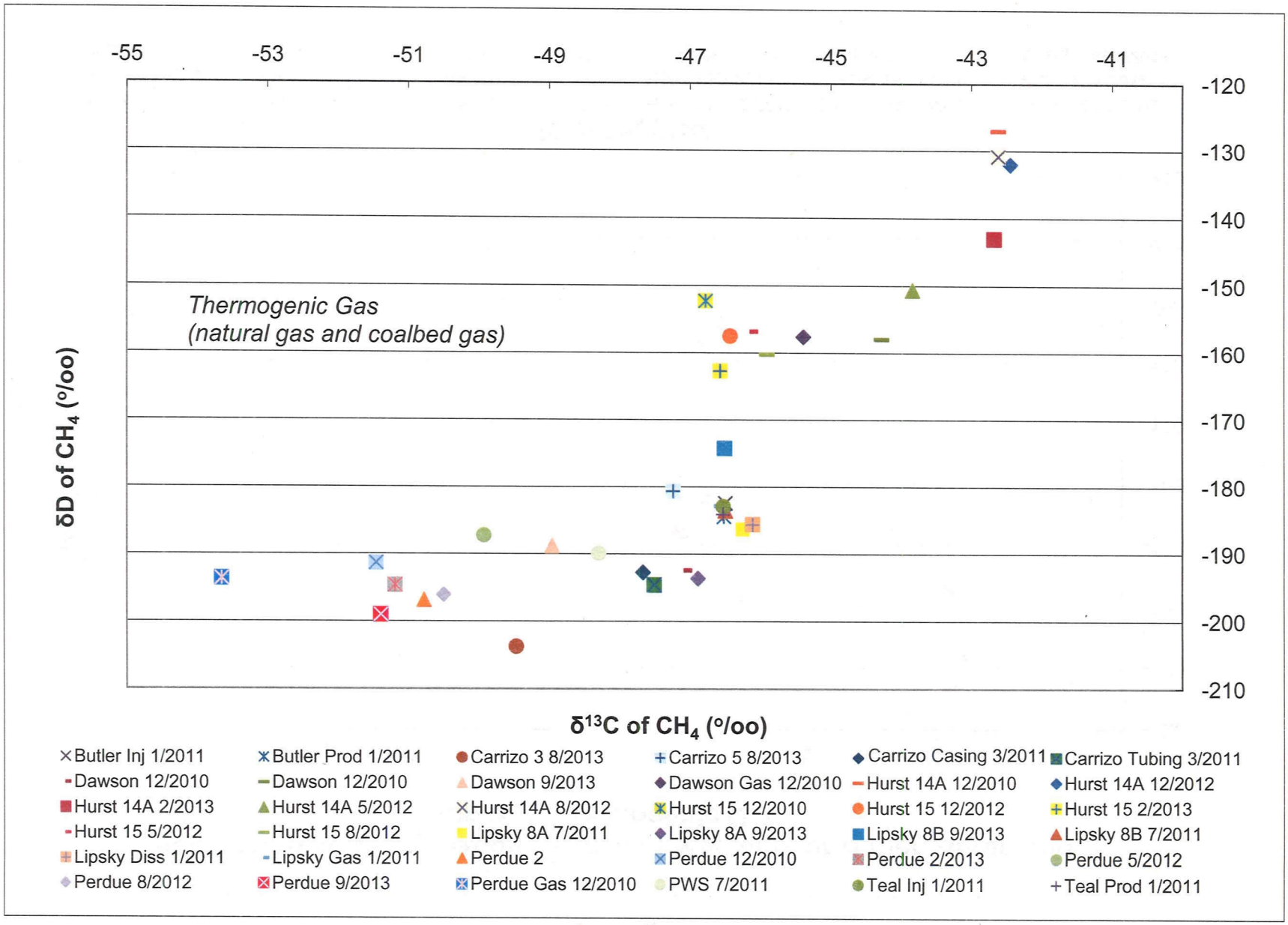
Stable Carbon and Hydrogen Isotopic Composition Ranges of Methane from Different Sources, Part 1



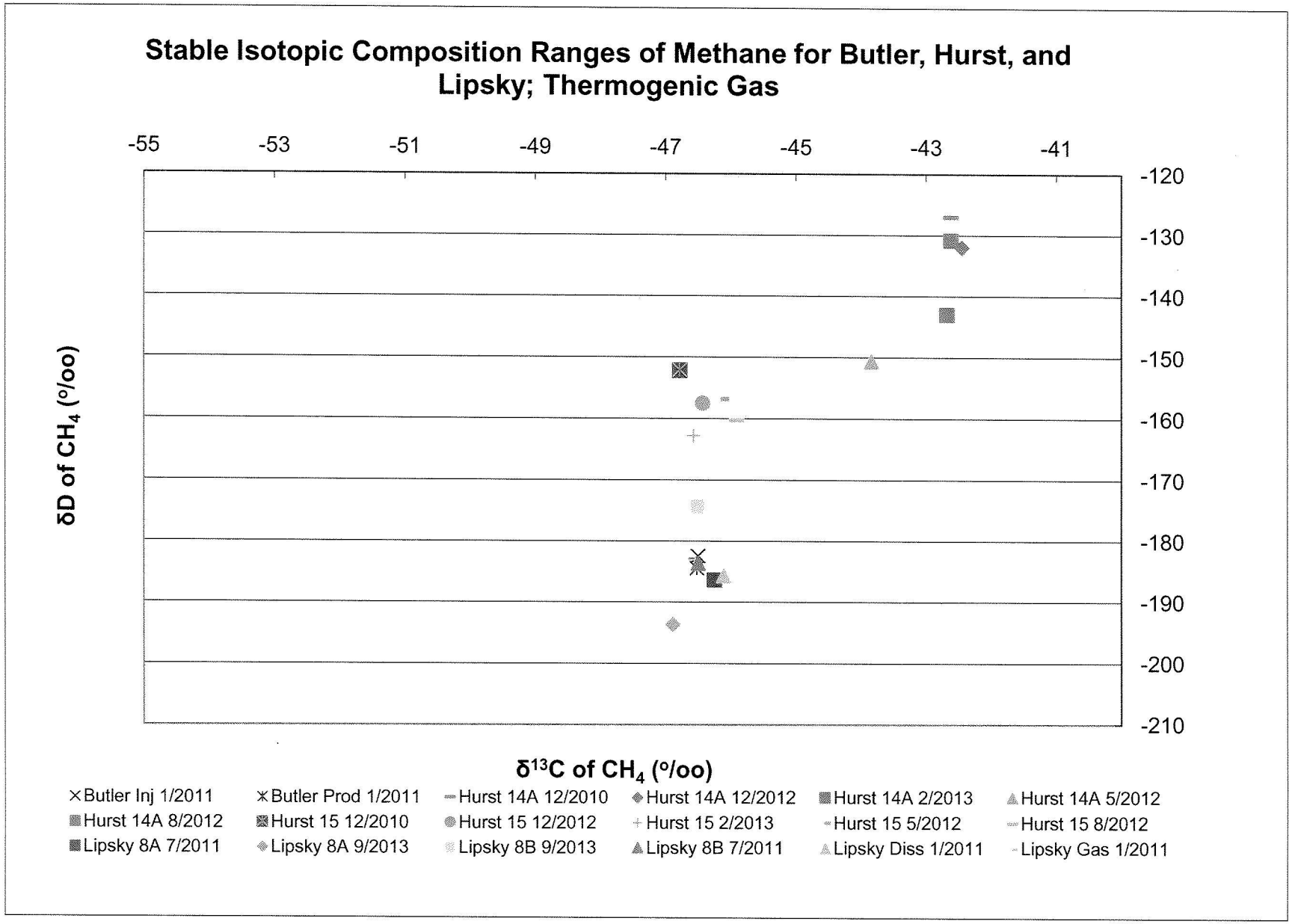
Stable Isotopic Composition Ranges of Methane for Butler, Carrizo, Dawson, Hurst, Lipsky, Perdue, Public Water Supply, and Teal; Microbial and Thermogenic Gas



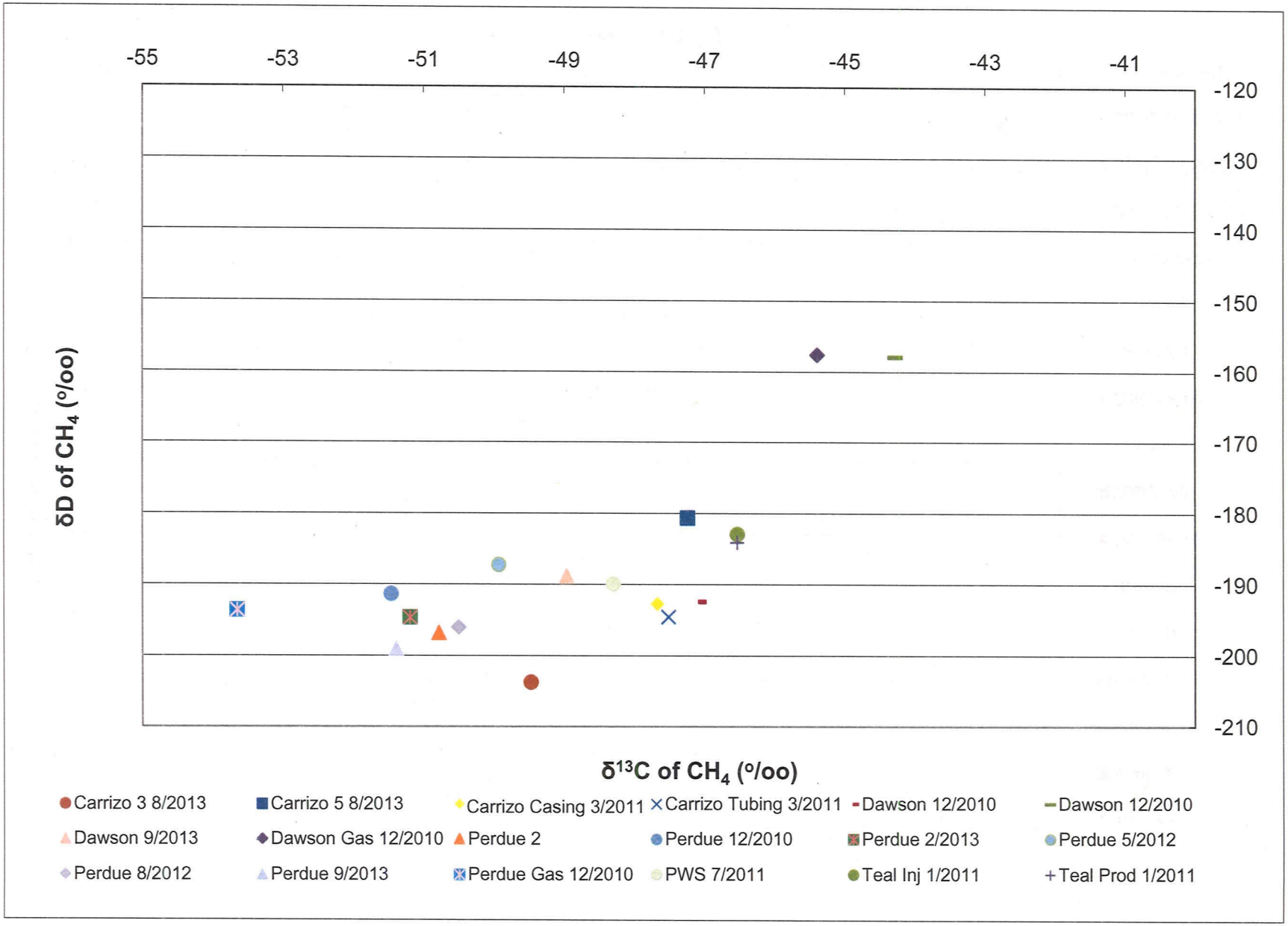
Stable Isotopic Composition Ranges of Methane for Butler, Carrizo, Dawson, Hurst, Lipsky, Perdue, Public Water Supply, and Teal; Thermogenic Gas



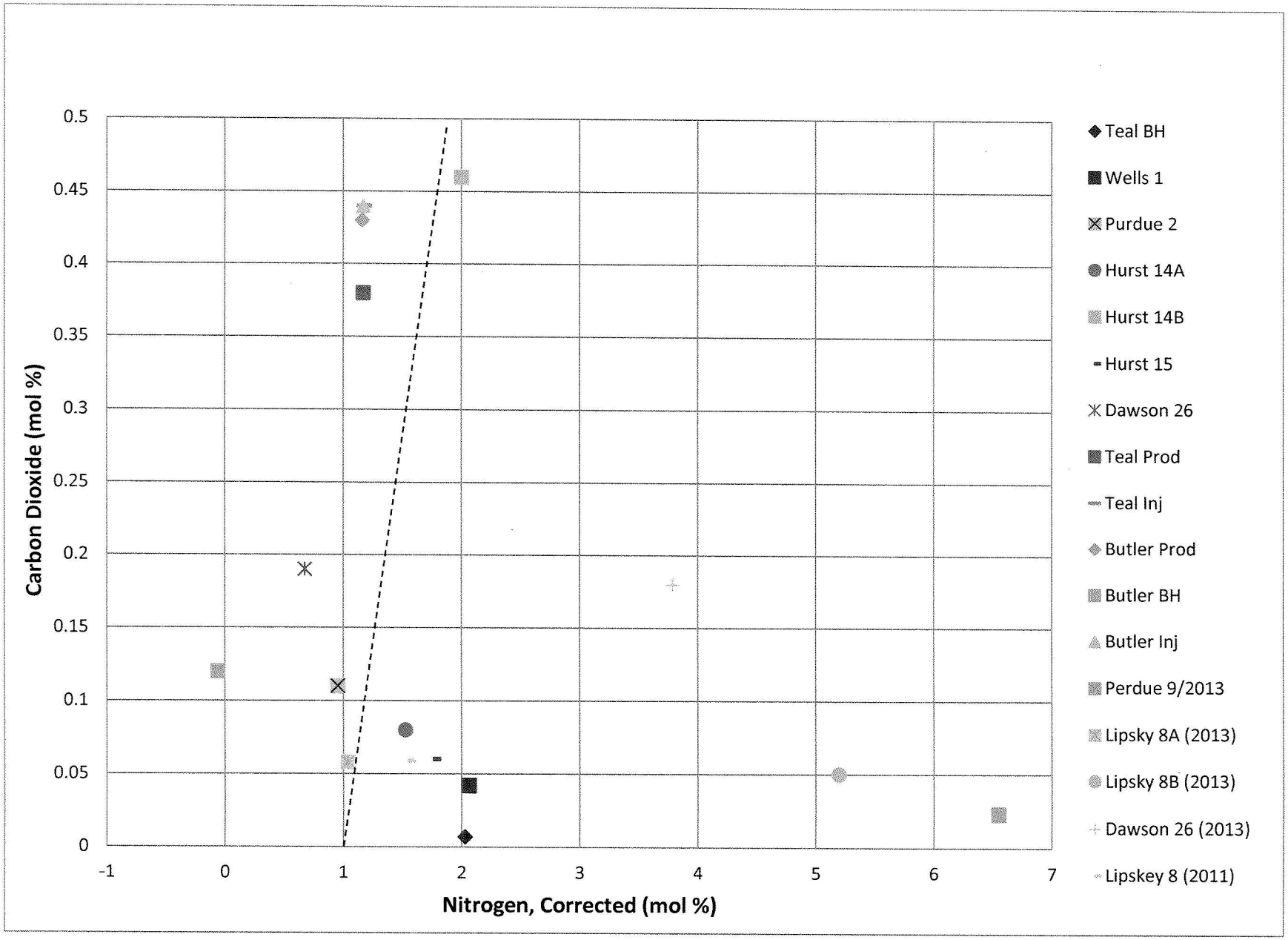
Stable Isotopic Composition Ranges of Methane for Butler, Hurst, and Lipsky; Thermogenic Gas



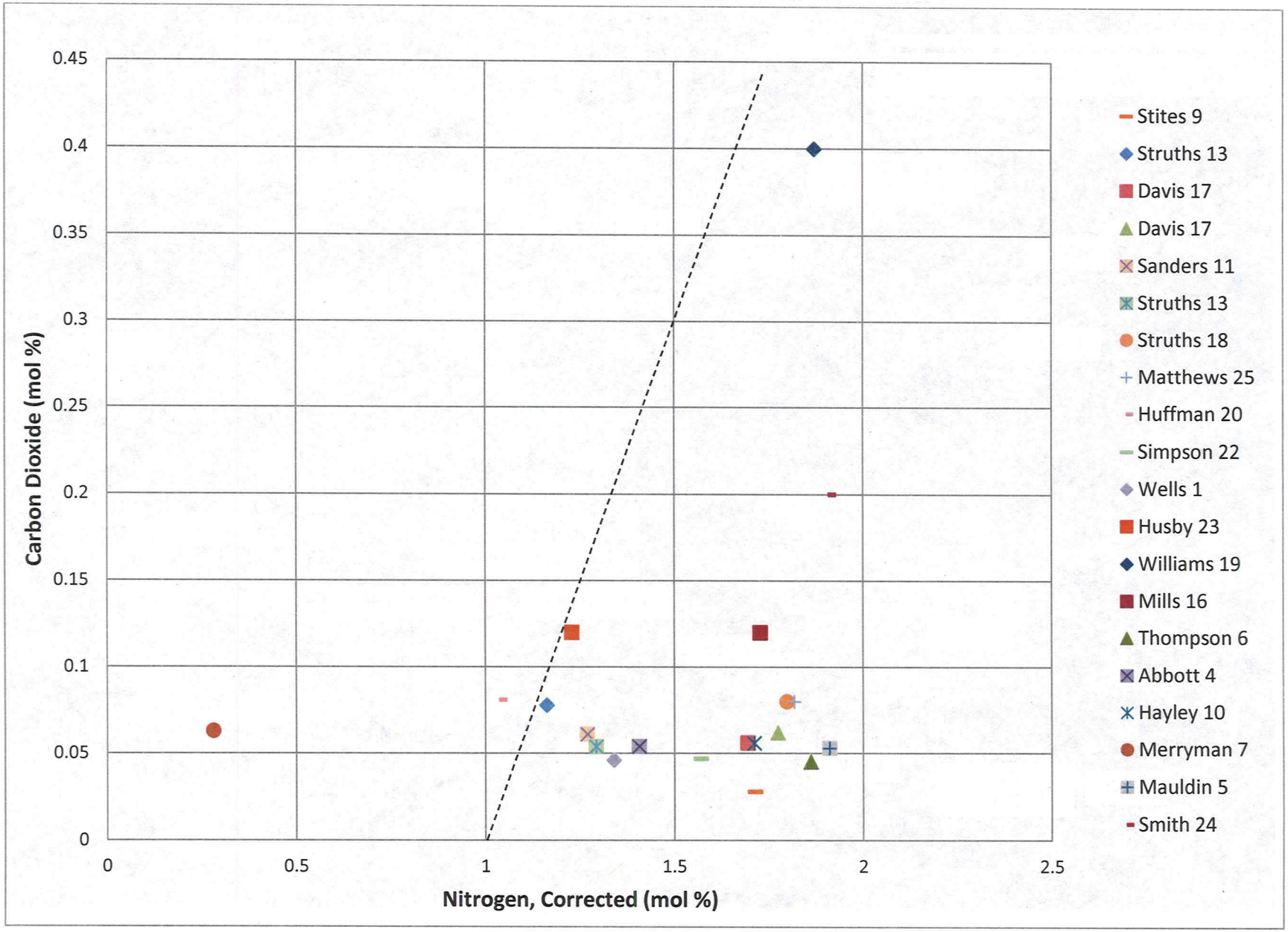
Differentiating Pennsylvanian Gas from Barnett Gas, Parker and Hood County, Part 1



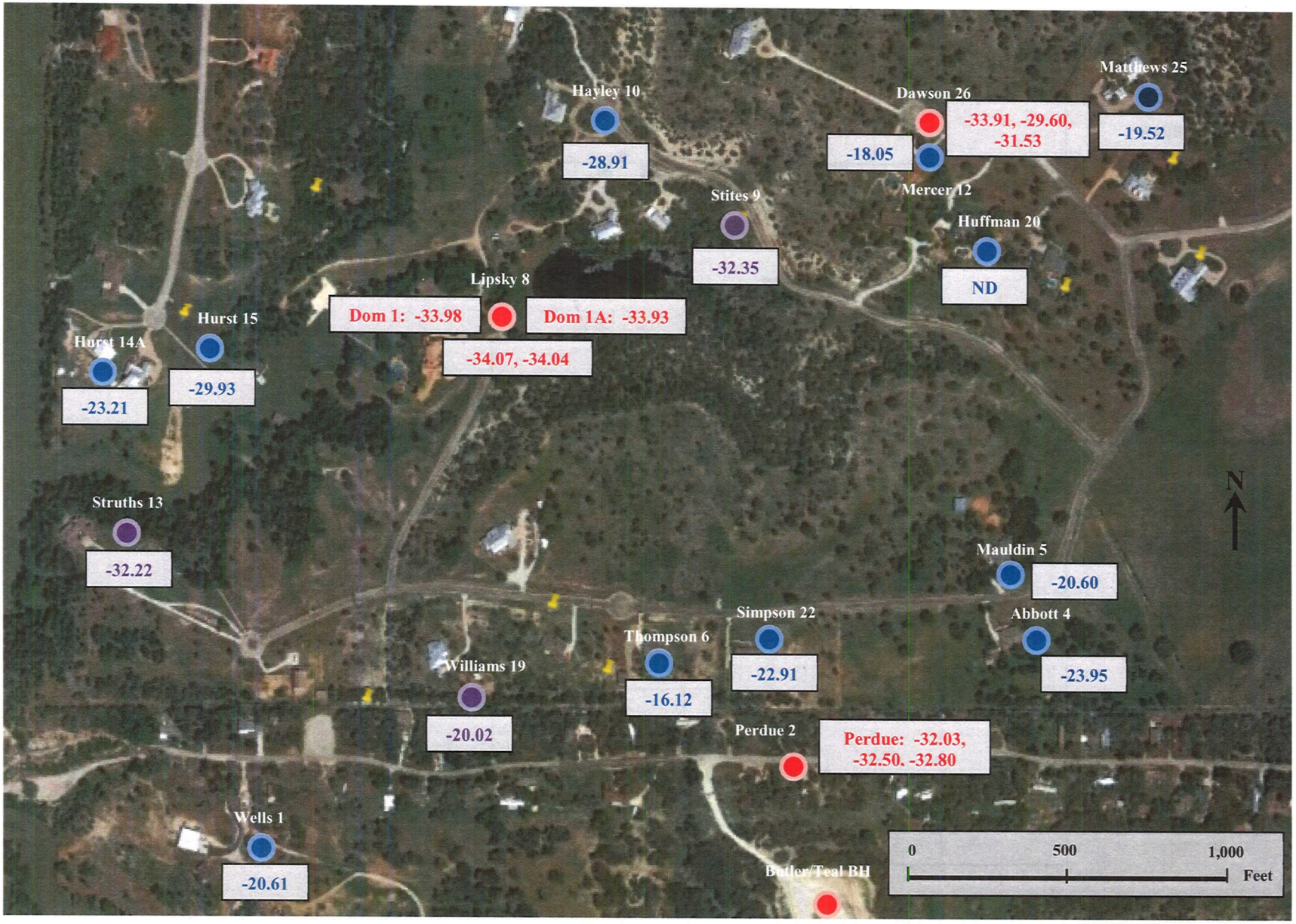
Differentiating Pennsylvanian Gas from Barnett Gas, Parker and Hood County, Part 1



Differentiating Pennsylvanian Gas from Barnett Gas, Parker and Hood County, Part 2



Distribution of Biodegraded Gas in Water Samples (2010-2011)

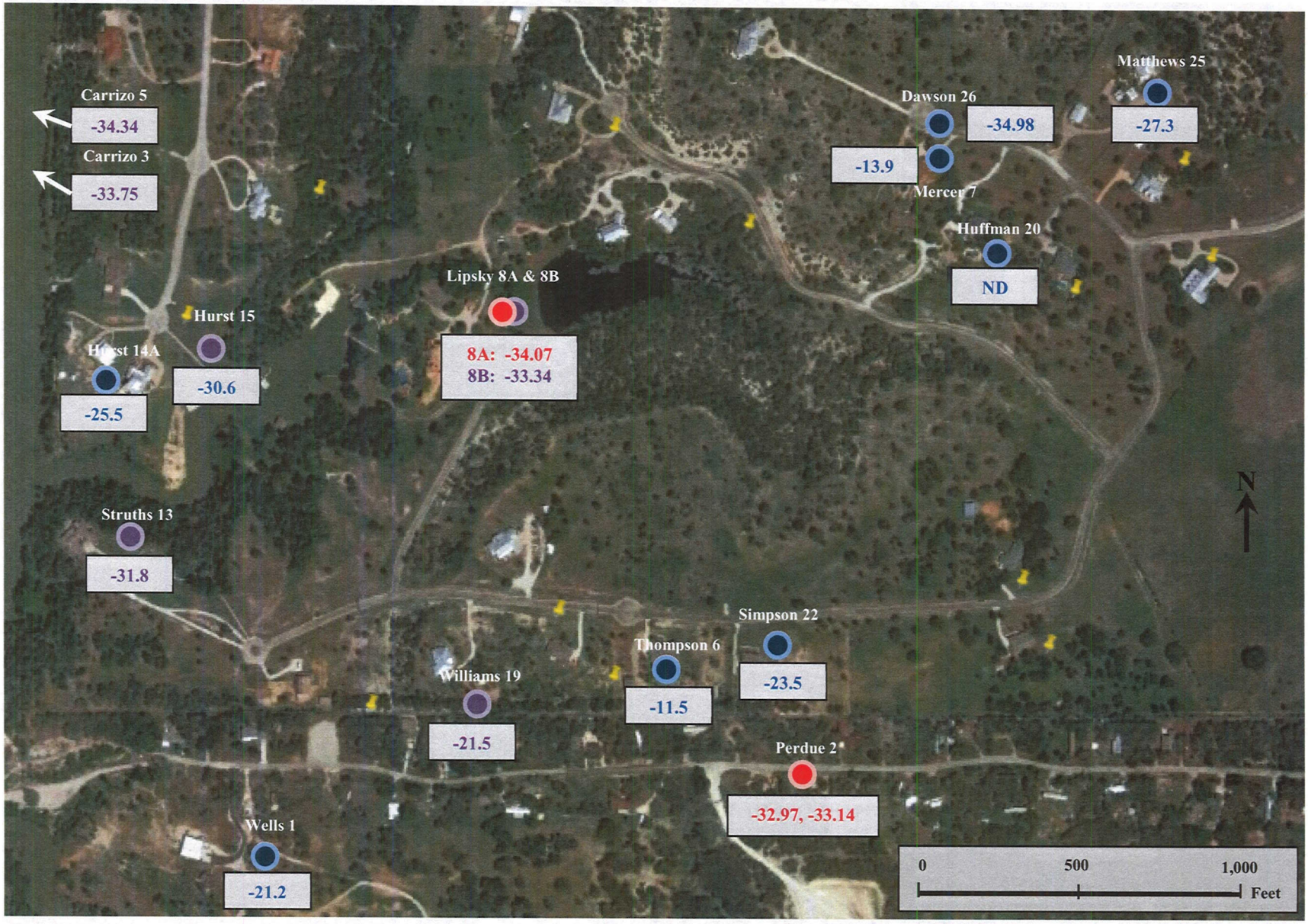


Butler
BH: -40.18
Inj: -35.15
Prod: -35.26

Teal
BH: -35.19
Inj: -35.17
Prod: -35.45

Distribution of Biodegraded Gas in Water Samples (2012)

Distribution of Biodegraded Gas in Water Samples (2013)



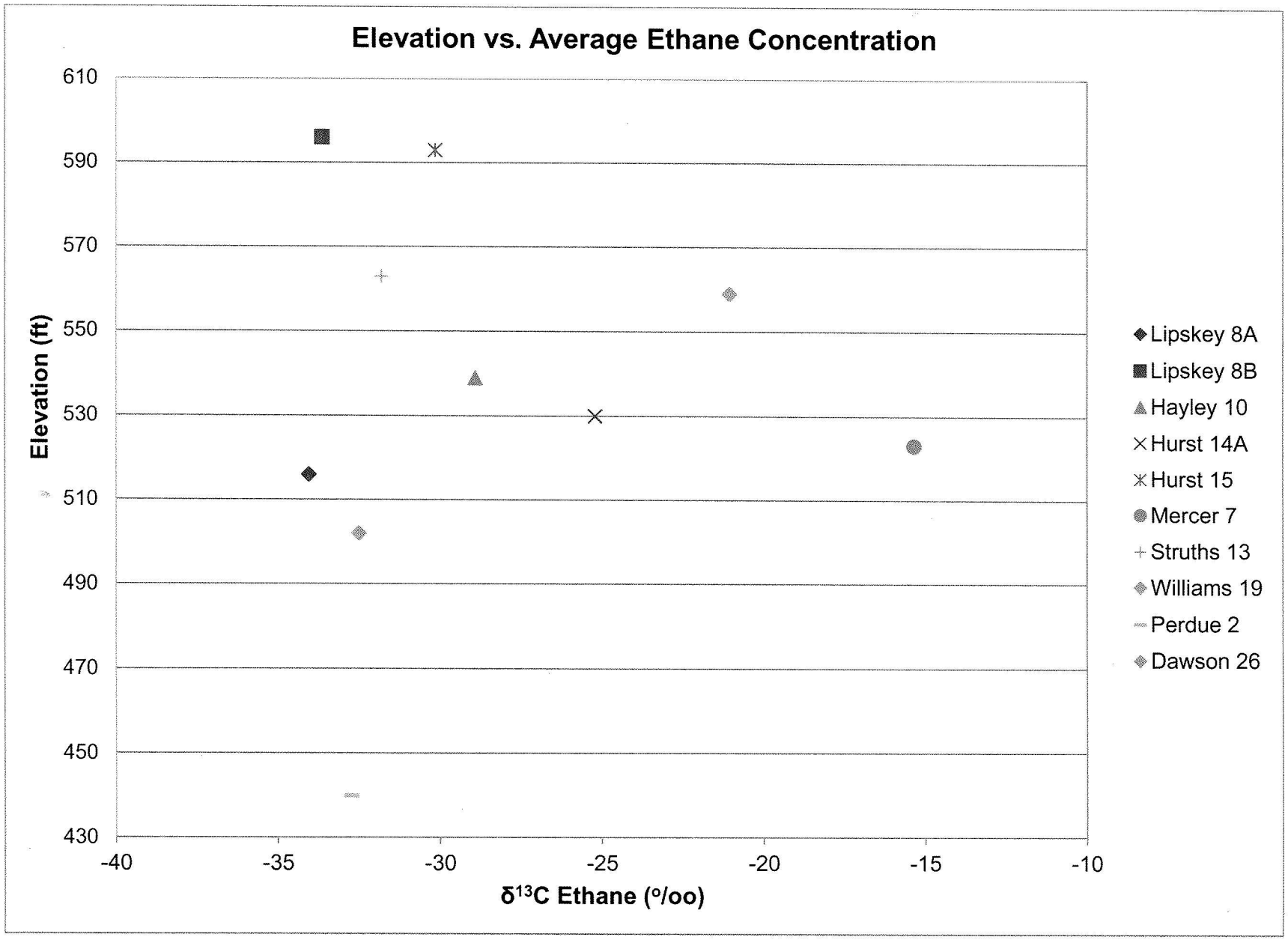
Legend for the Distribution of Biodegraded Gas

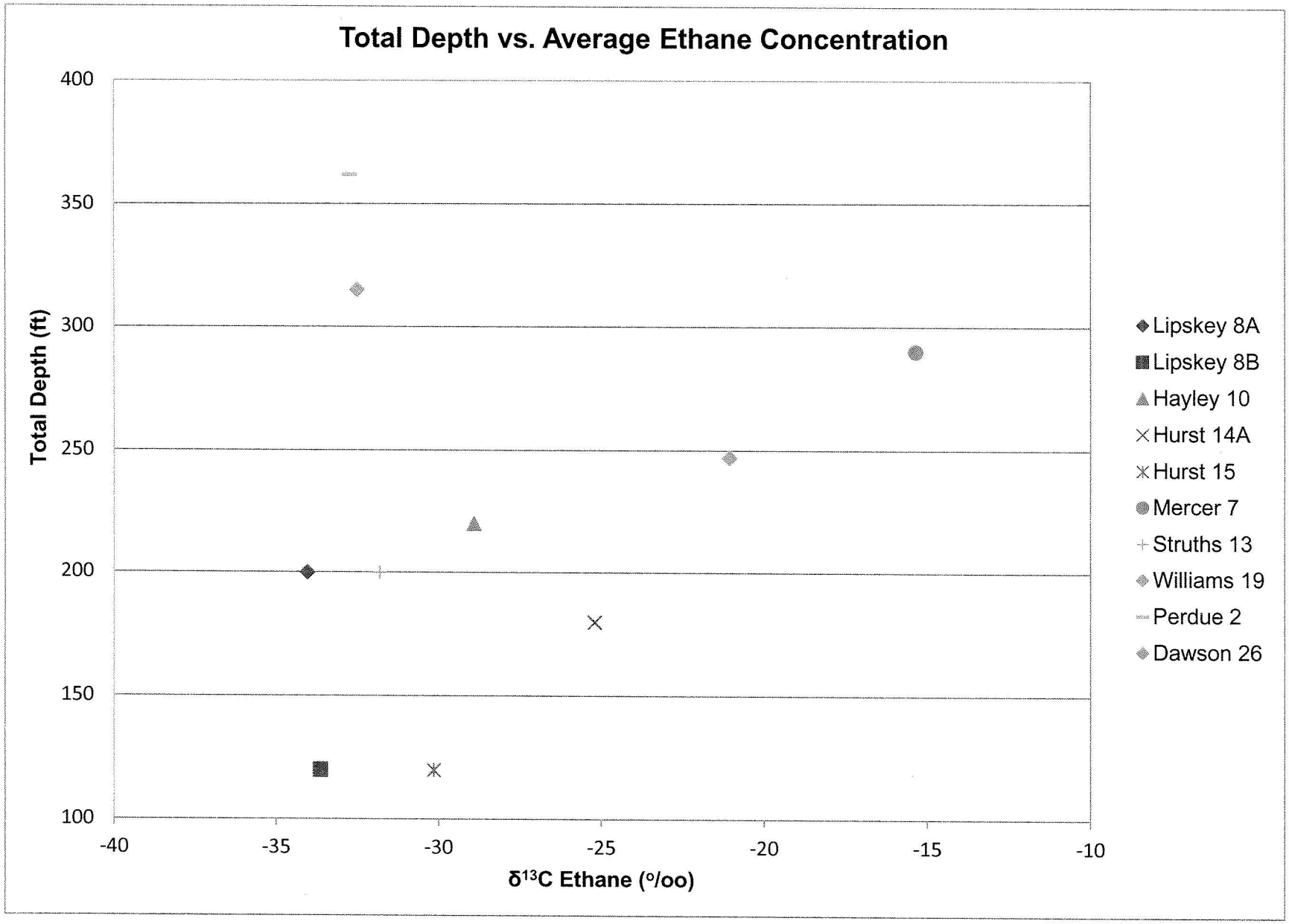
Methane in Solution Gas Sample

- Trace Methane (<0.5 mol%)
- Minor Methane (5-20 mol%)
- Moderate Methane (25-35 mol%)
- Abundant Methane (>70 mol%)

C Isotopic Composition of Ethane

- -32.97 (per mil; PDB)
- ND = Not Determined
- Additional numbers indicate well was sampled multiple times


Elevation vs. Average Ethane Concentration
610
590
570
550
530
510
490
470
450
430
Elevation (ft)
-40
-35
-30
-25
-20
-15
-10
δ13C Ethane (°/oo)
Lipskey 8A
Lipskey 8B
Hayley 10
Hurst 14A
Hurst 15
Mercer 7
Struths 13
Williams 19
Perdue 2
Dawson 26


Total Depth vs. Average Ethane Concentration
Total Depth (ft)
400
350
300
250
200
150
100
-40
-35
-30
-25
-20
-15
-10
δ13C Ethane (o/oo)
Lipskey 8A
Lipskey 8B
Hayley 10
Hurst 14A
Hurst 15
Mercer 7
Struths 13
Williams 19
Perdue 2
Dawson 26

Dissolved Methane (mg/L) Direct Fill 40ml VOA, RSK175, unless otherwise noted

	Jan-11	May-12	Aug-12	Nov-12	Dec-2012 (1)	Feb-13	May-2013(1)	Sept-2013(2)
Dawson	0.28	--(3)	--	--	28.8	--	26.8	8.08
LipskyA	2.3	--	--	--	40.2	--	41.2	8.6
LipskyB	--	--	--	--	--	--	7.0	2.98
Perdue	2.8	1.41	4.24	20.1	50.1	8.8	--	21.9

(1) Duke University Data (provided by homeowners)
(2) Data collected by RRC contractor
(3) Sample not collected or data not available.