

Evaluating a groundwater supply contamination incident attributed to Marcellus Shale gas development

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Presentation Outline

A. Case History

B. Location & Hydrogeologic Setting

C. Impacts

- **Natural Gas**
- **Foam**
- **GCxGC-TOFMS Results**

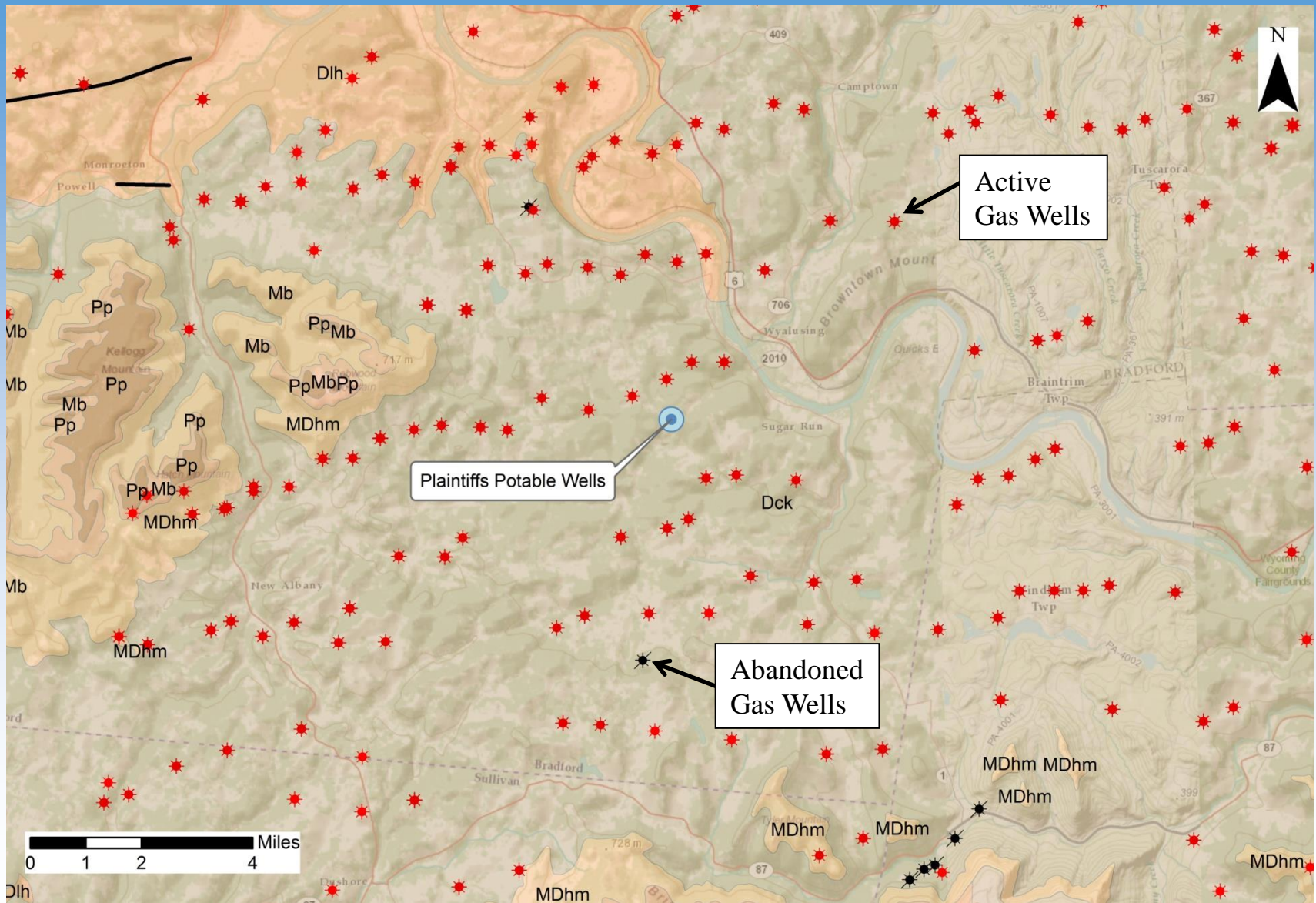
D. Mechanisms of Migration

E. Significance

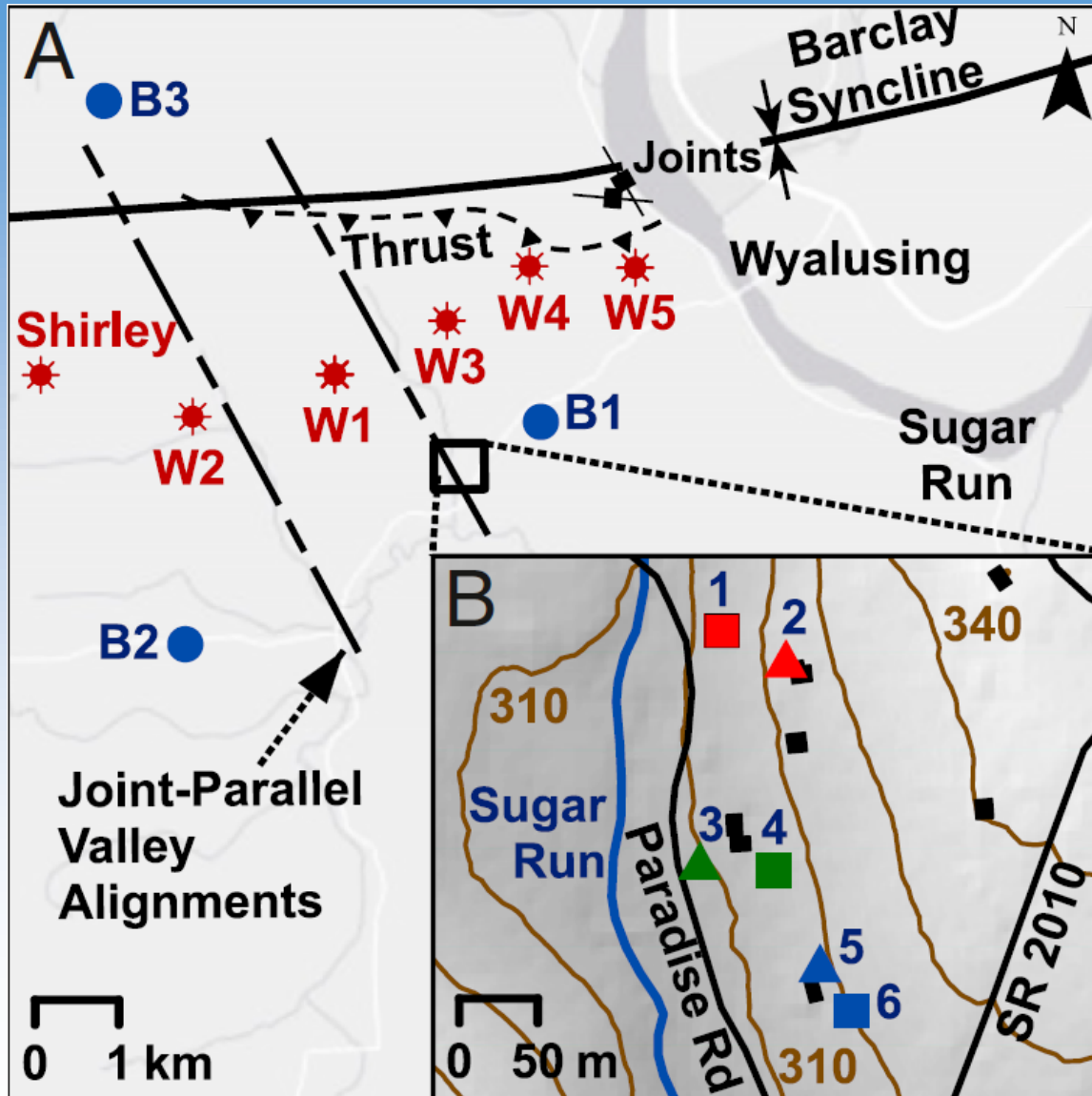
General Timeline

- **Spring - Summer 2009:** Drill Welles 1 series and pit leak.
- **Summer 2009:** Drill Welles 2 series.
- **Winter 2009 – 2010:** Drill Welles 3 series & HF Welles 1 series.
- **Winter – Spring 2010:** Drill Welles 4 – 5 series.
- **Spring – Summer 2010:** Impacts along Paradise Rd & River
- **Spring – Summer 2010:** Impacts observed along valley.
- **Late Summer 2010:** Installation of replacement groundwater wells & gas well remedial activities.
- **2010 – 2012:** PADEP/Gas Company Investigations
- **Spring 2011:** PADEP cites gas company for O&G Act & Clean Streams Law Violation.
- **Spring 2012:** Civil Suit & Settlement
- **Summer – Fall 2012:** GCxGC-TOFMS sample collection

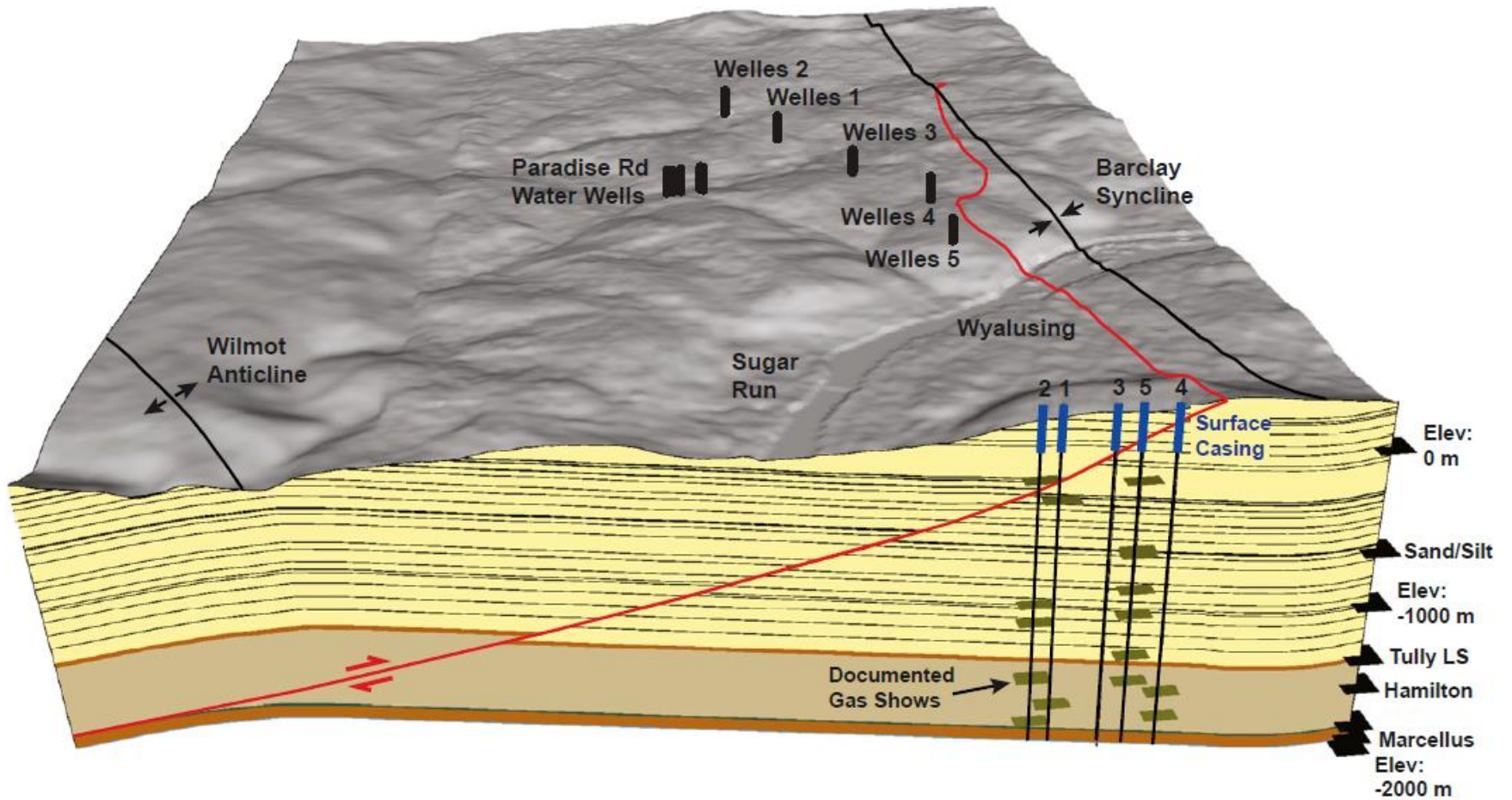
Site Location & Geology



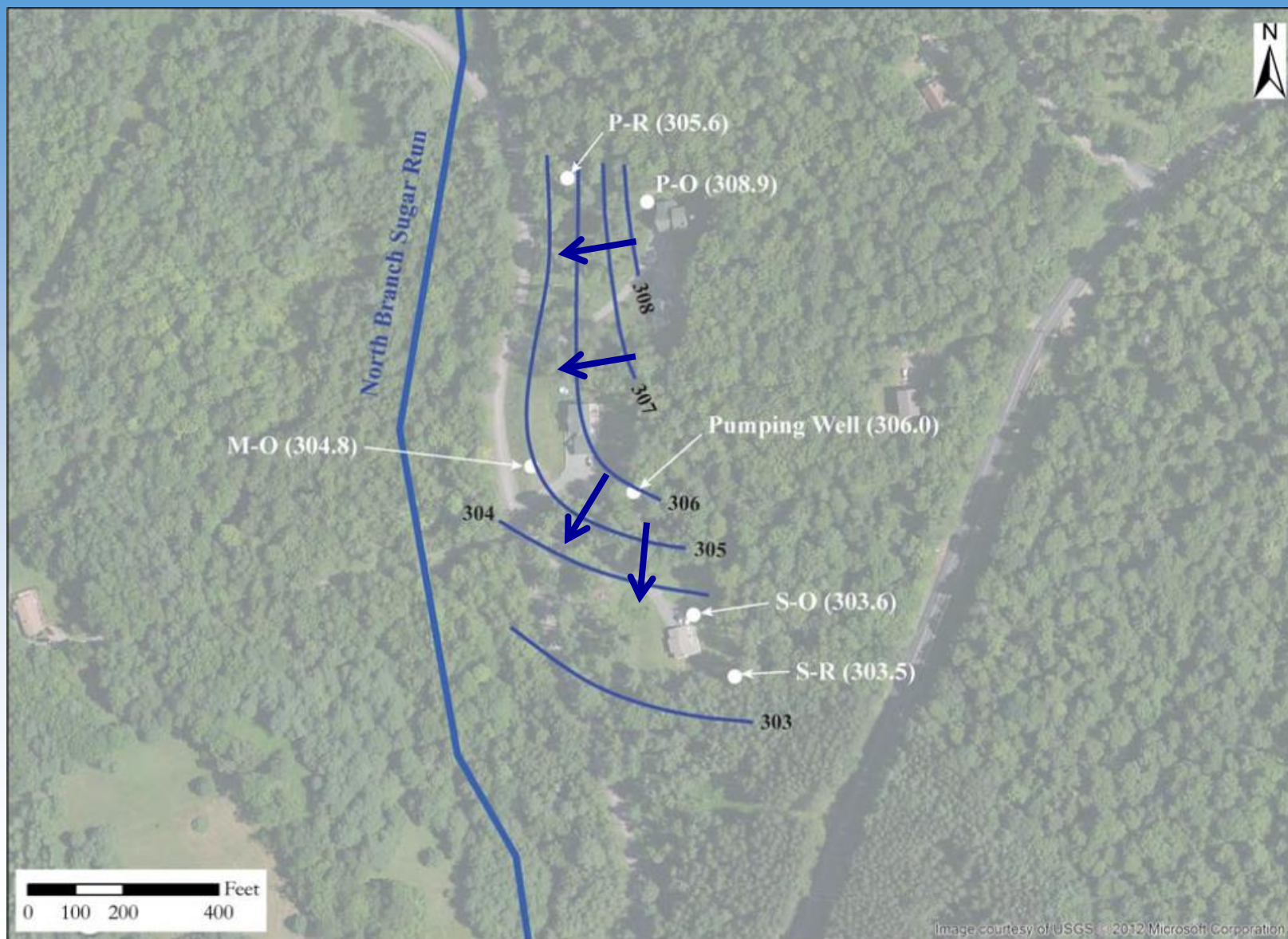
Site Location & Geology



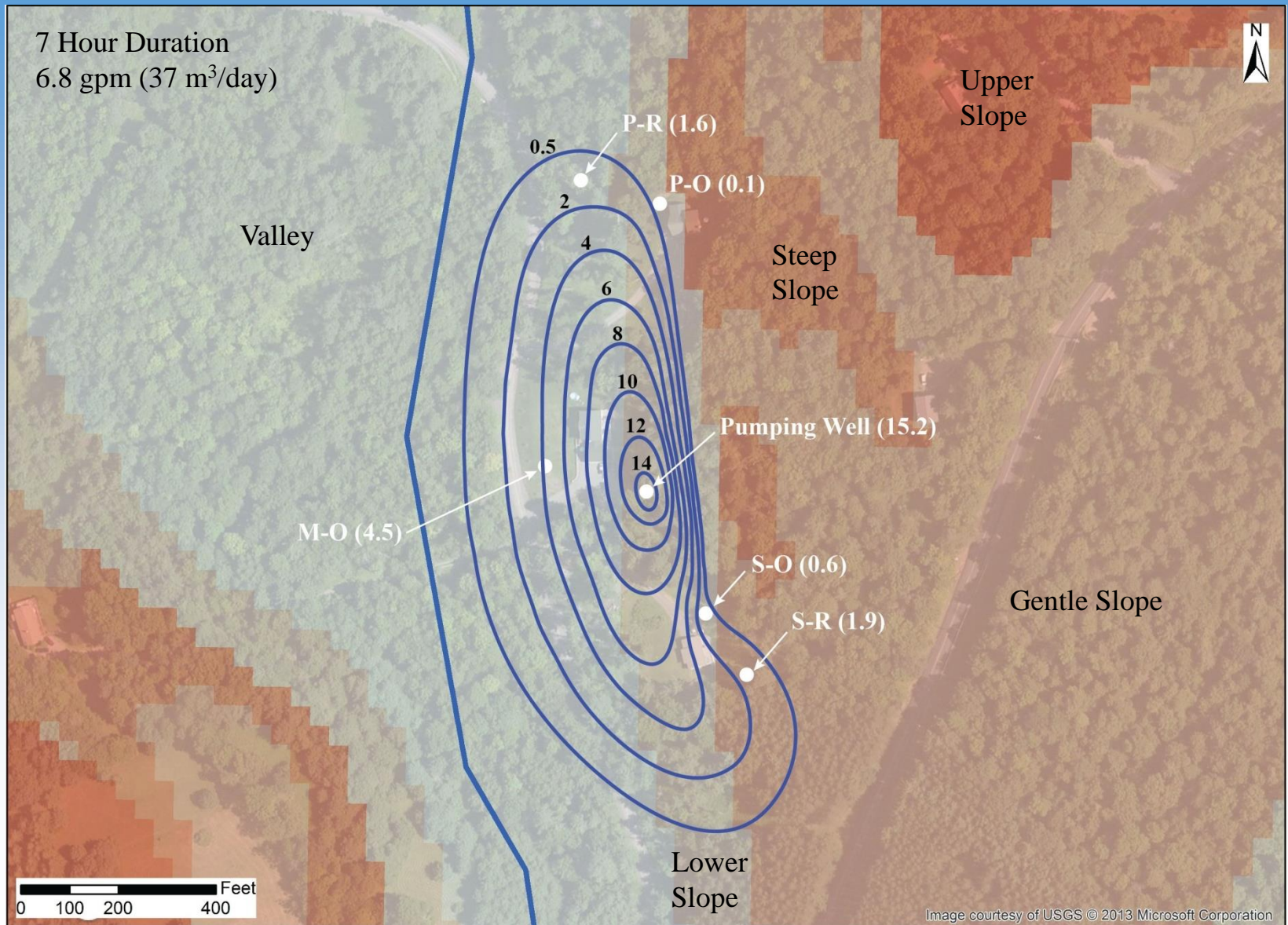
Site Location & Geology



Ambient GW Flow



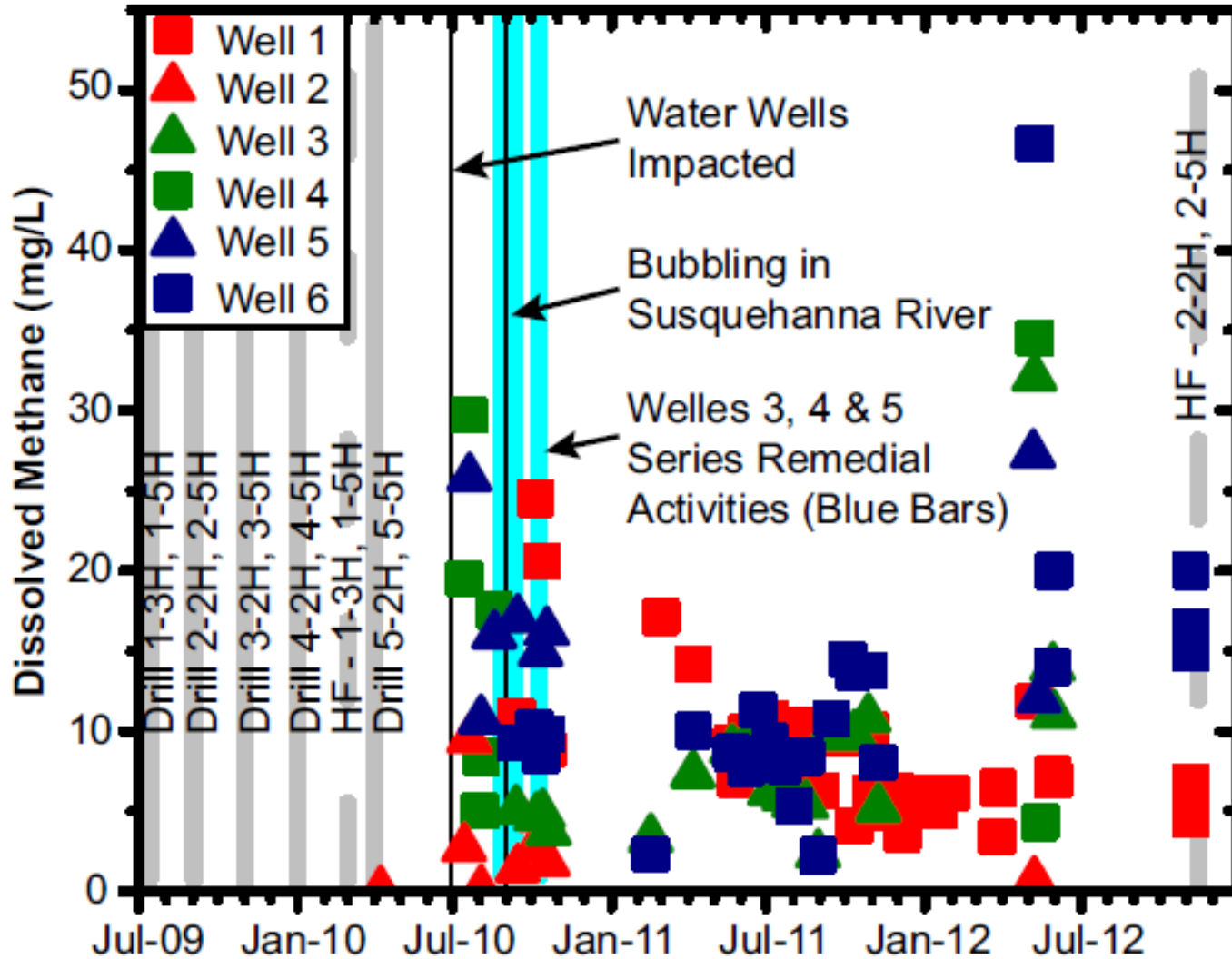
AQT Drawdown – Topographic Position Index



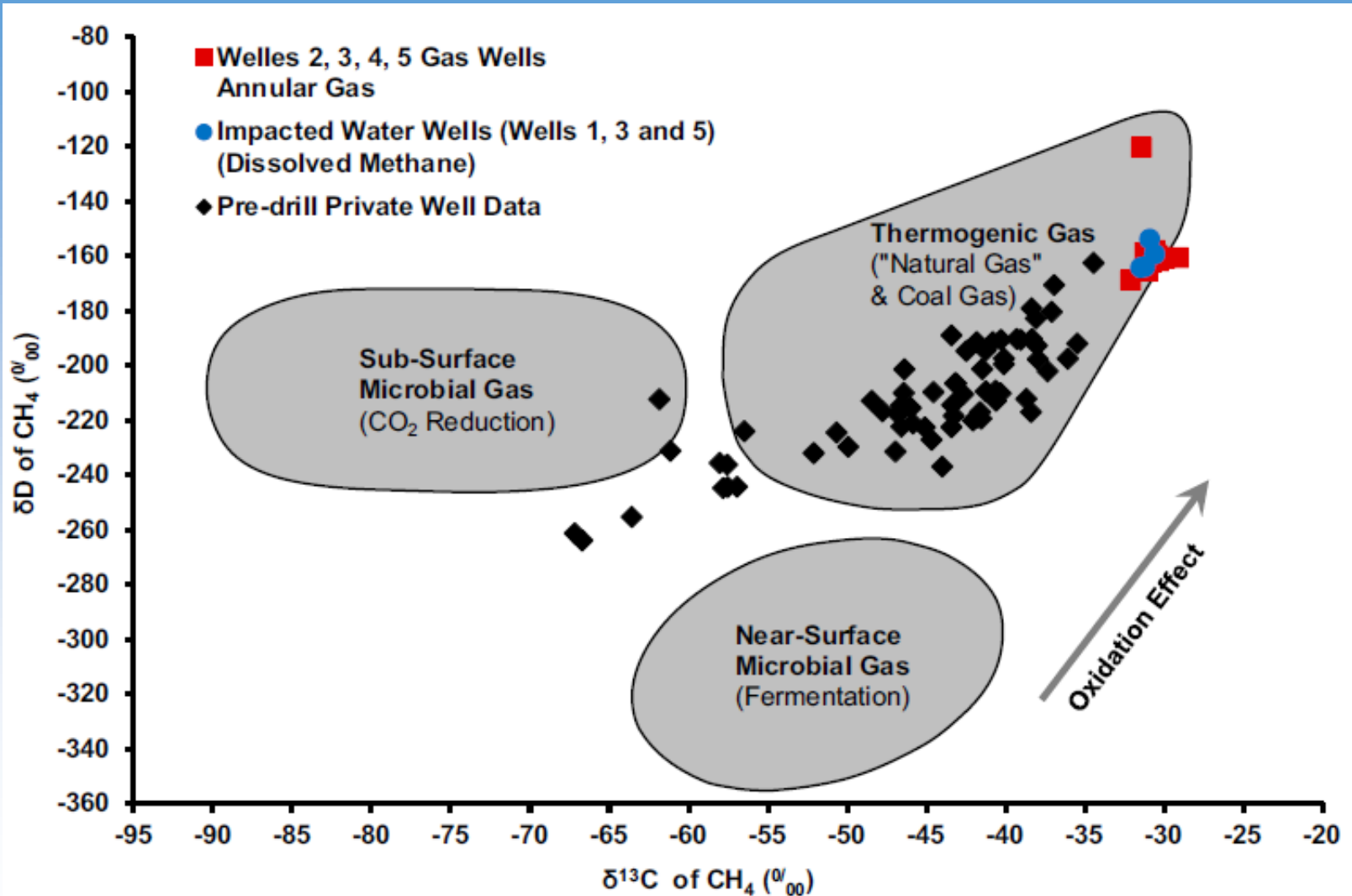
Impacts – Natural Gas



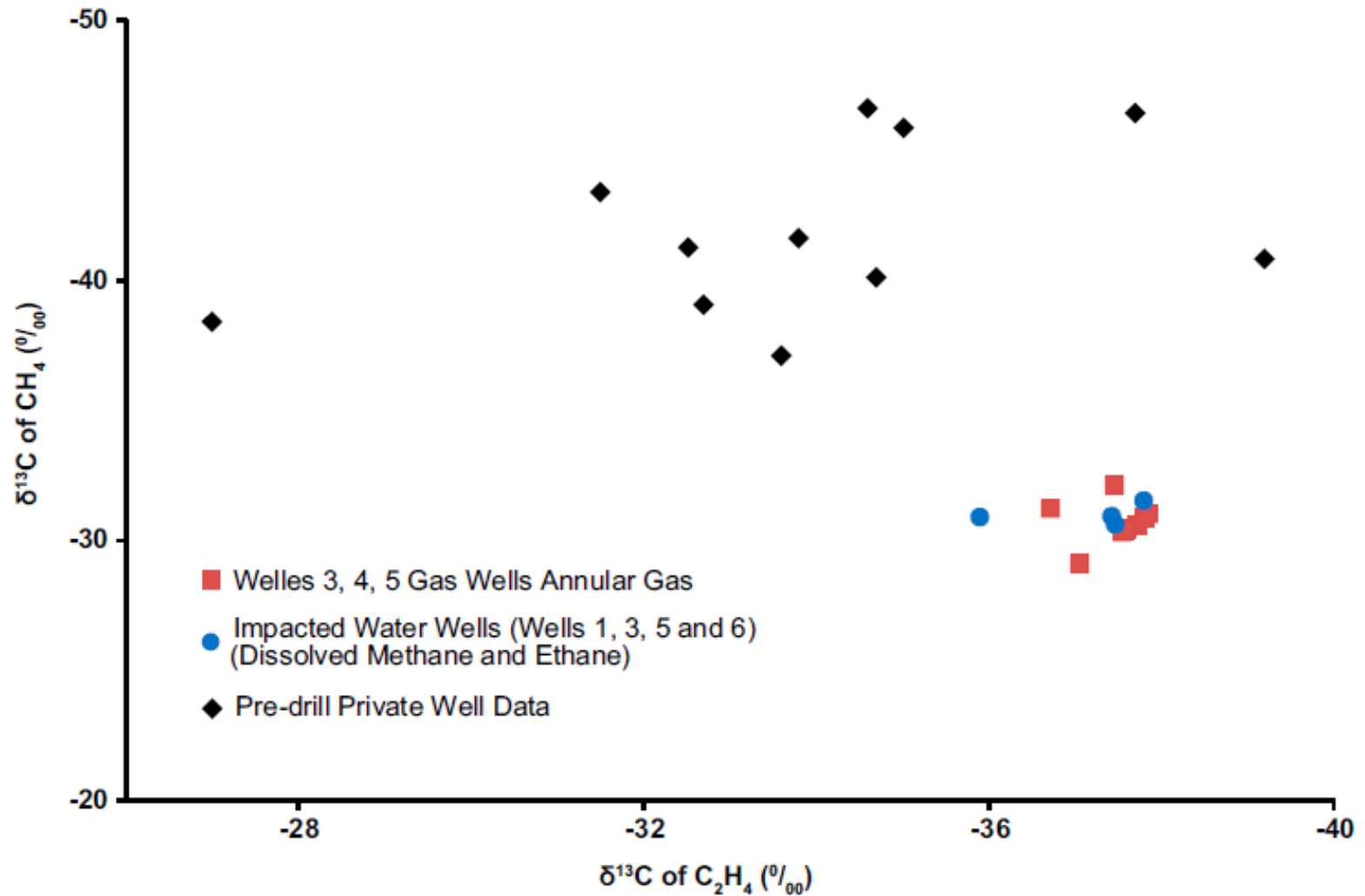
Impacts – Natural Gas



Impacts – Natural Gas



Impacts – Natural Gas



Impacts – Foam



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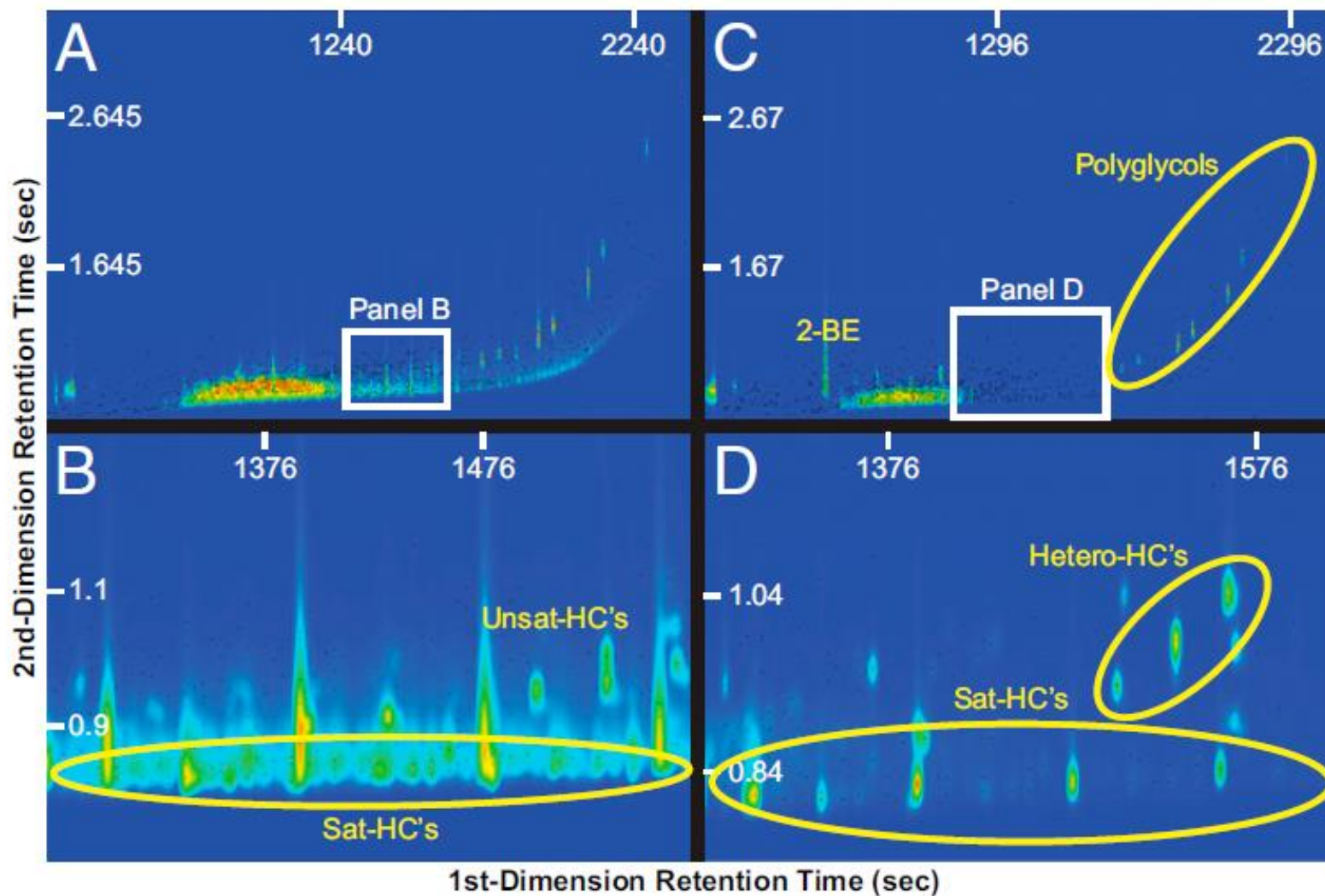
Impacts – Foam



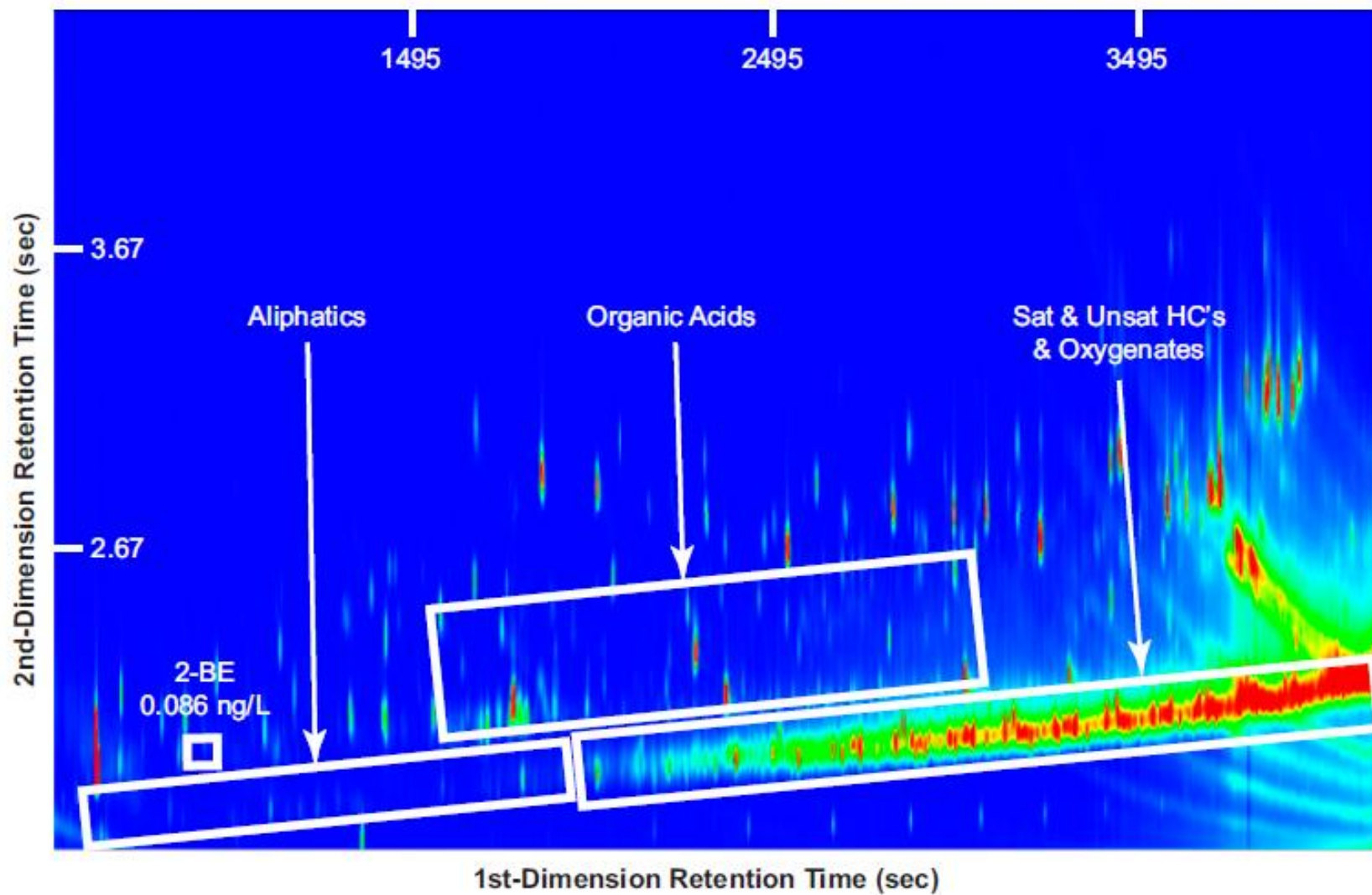
Impacts – Foam



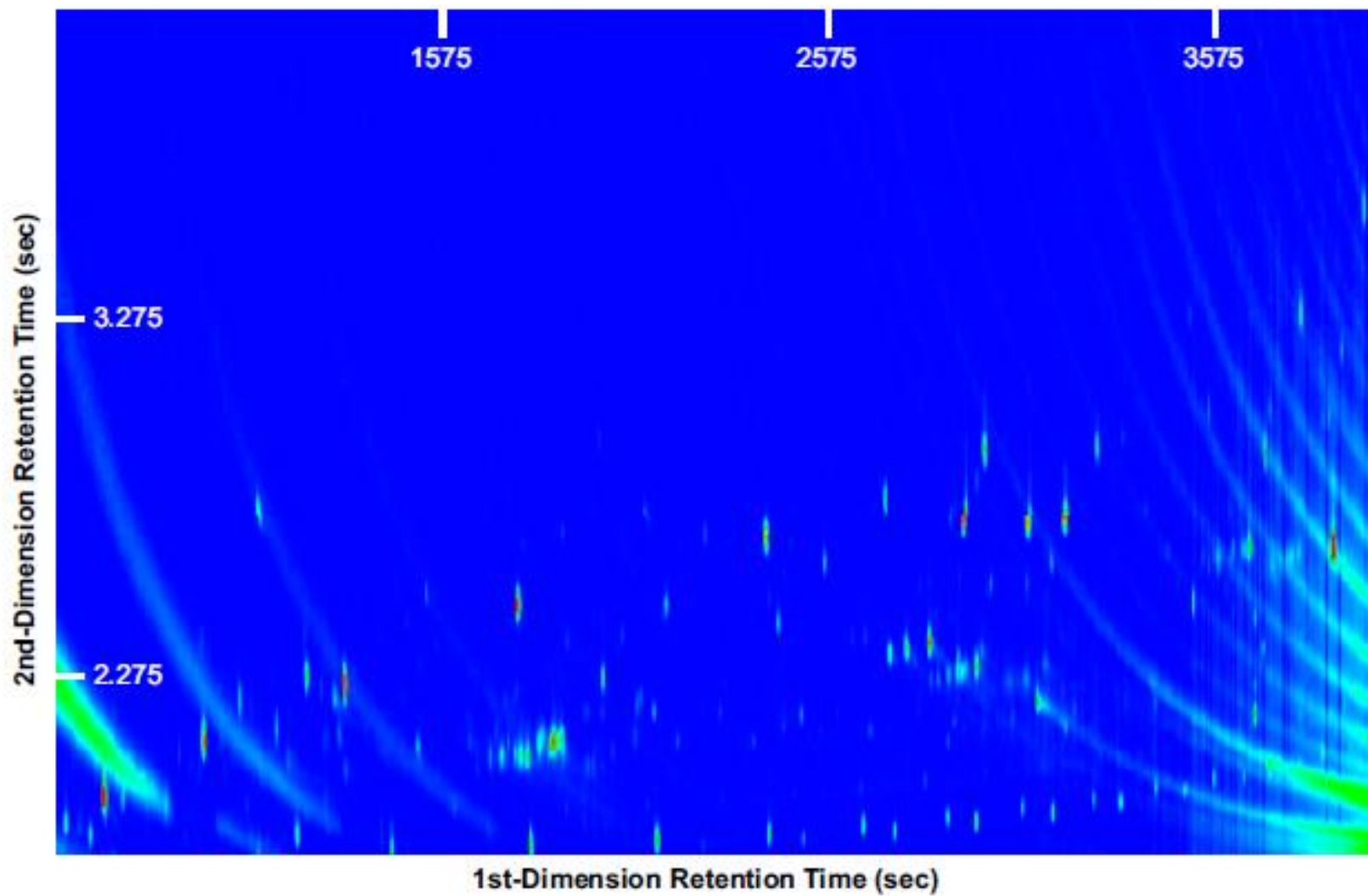
Flowback – GCxGC-TOFMS



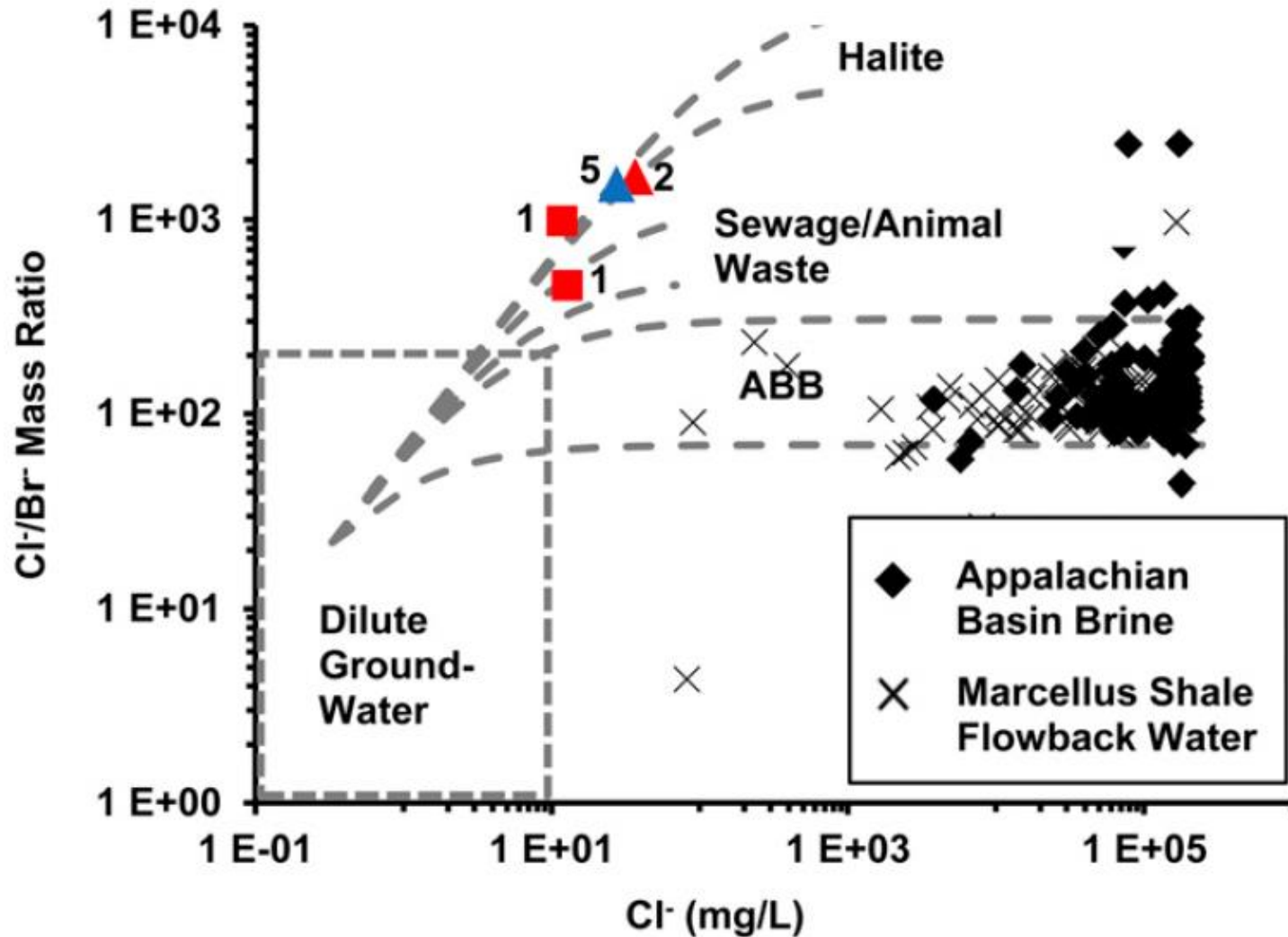
Water Well 1 - GCxGC-TOFMS



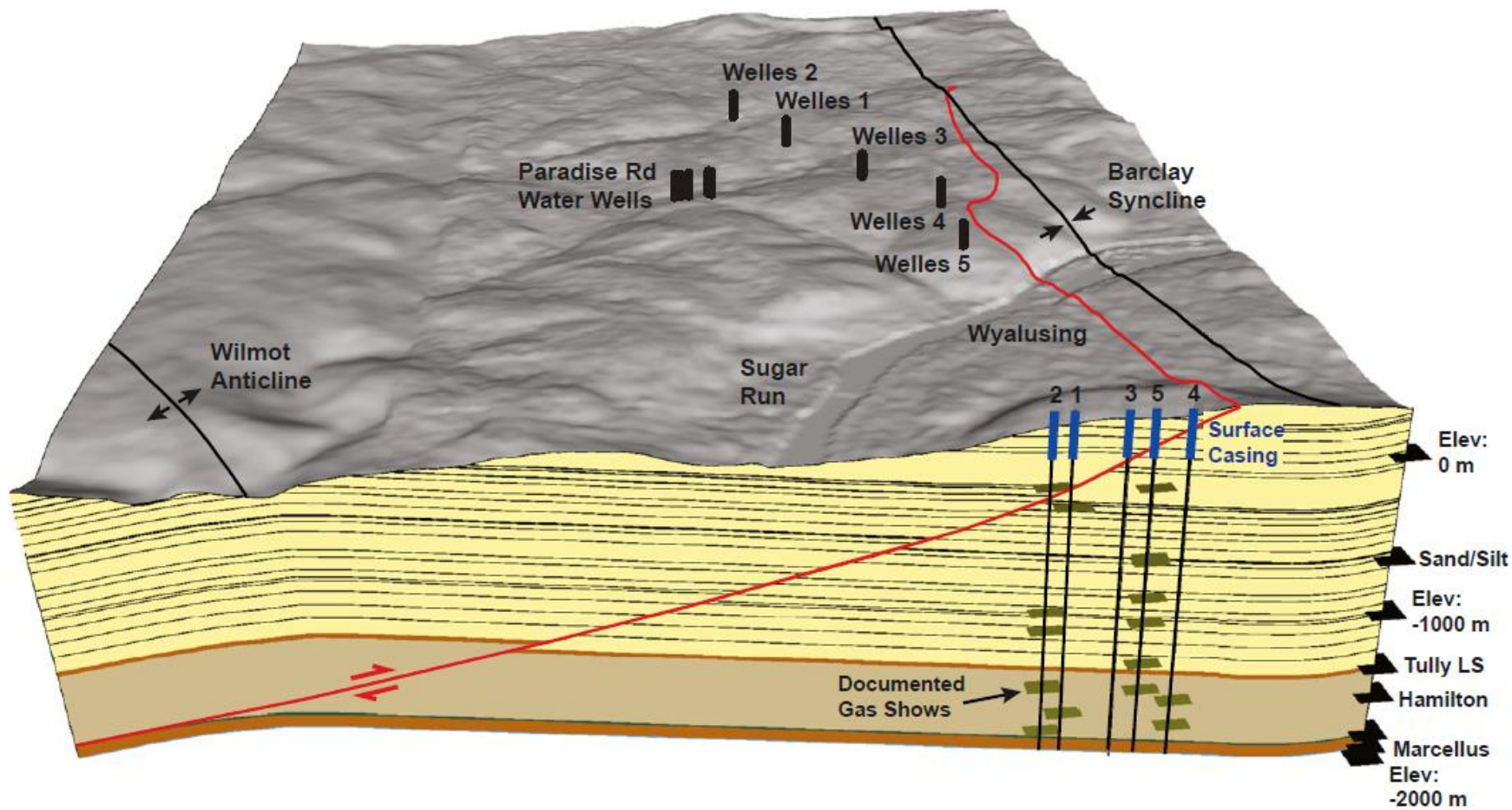
Background - GCxGC-TOFMS



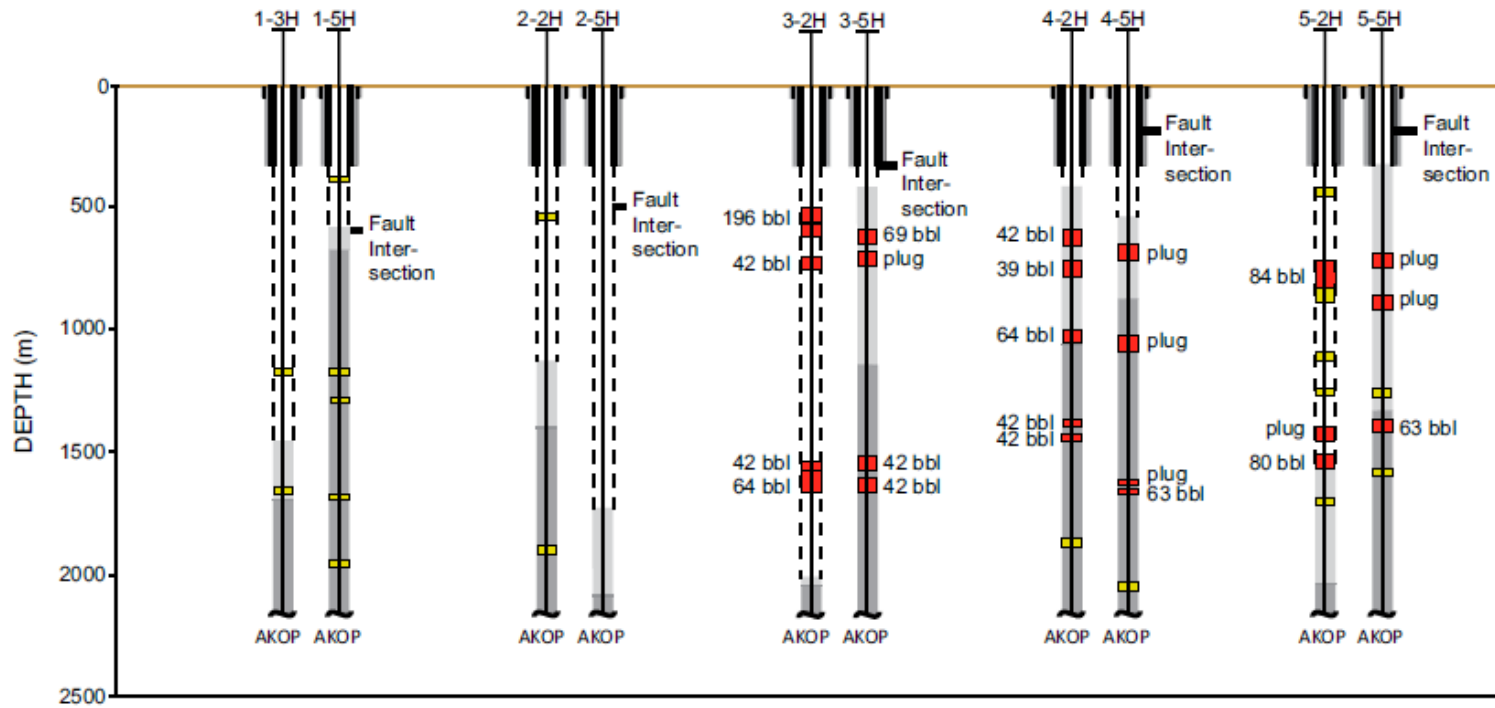
No Indication of Brine in Well Water







Mechanisms of Migration



Mechanisms of Migration



Explanation

	Documented Gas Show	AKOP: Approximate Kickoff Point (beginning of horizontal lateral turn)
	Cement Squeeze/Plug	All gas wells part of the Welles series (2 wells per pad)
	Cement (Partial Bonding)	Well construction consists of:
	Cement	1. 20" conductor casing 3. 5-1/2" production casing
		2. 9-5/8" surface casing

Highest Recorded Annular Pressures (psi) & Dates

1-3H: 19 (unknown)	3-5H: 700 (05-26-10)
1-5H: 4 (unknown)	4-2H: 490 (05-24-10)
2-2H: unknown	4-5H: 500 (05-01-10)
2-5H: unknown	5-2H: 225 (09-09-10)
3-2H: 940 (06-14-10)	5-5H: 250 (09-09-10)

Significance

- GCxGC-TOFMS application to O&G development to explore water quality impacts to water resources....or to refute them!
- Multiple lines of evidence are critical in evaluating alleged impacts
 - Baseline water quality data and time-series analysis
 - Natural gas isotopes
 - Well construction & excessive annular pressure
 - Logical timeline of events
 - Good conceptual model of geology that adequately explains contaminant migration
 - GCxGC-TOFMS!!!!
- Transparency.....Dissemination of data from gas drilling incidents to the general public is critical to gain more wide-spread acceptance and development of policies that effectively address O&G shortcomings and improve industry standards

Thank you.....Questions?