

ILLINOIS EPA INVESTIGATION OF THE THERMOGENIC NATURAL GAS RELEASE INTO THE MAHOMET AQUIFER FROM THE MANLOVE NATURAL GAS STORAGE FIELD

MAHOMET AQUIFER
TASK FORCE

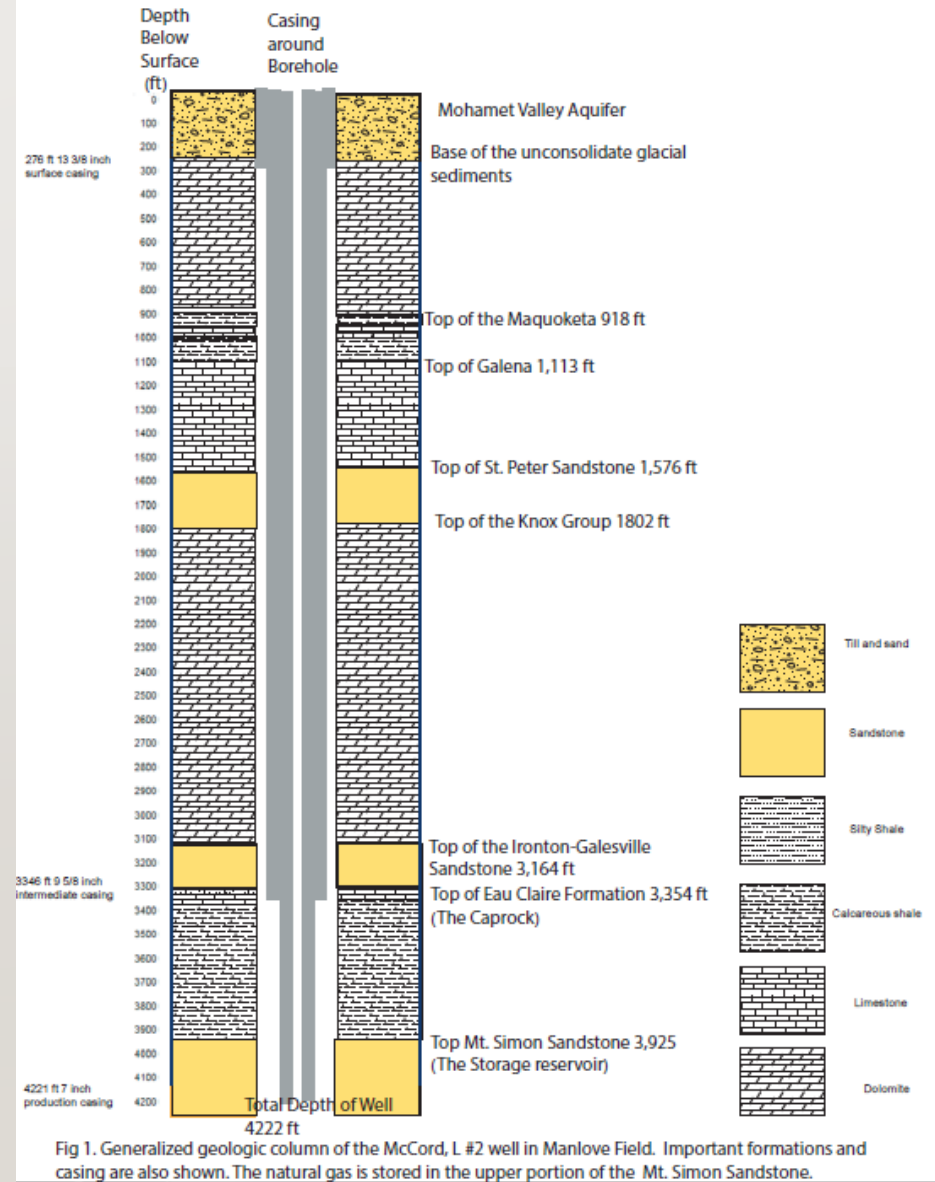
JUNE 18, 2018



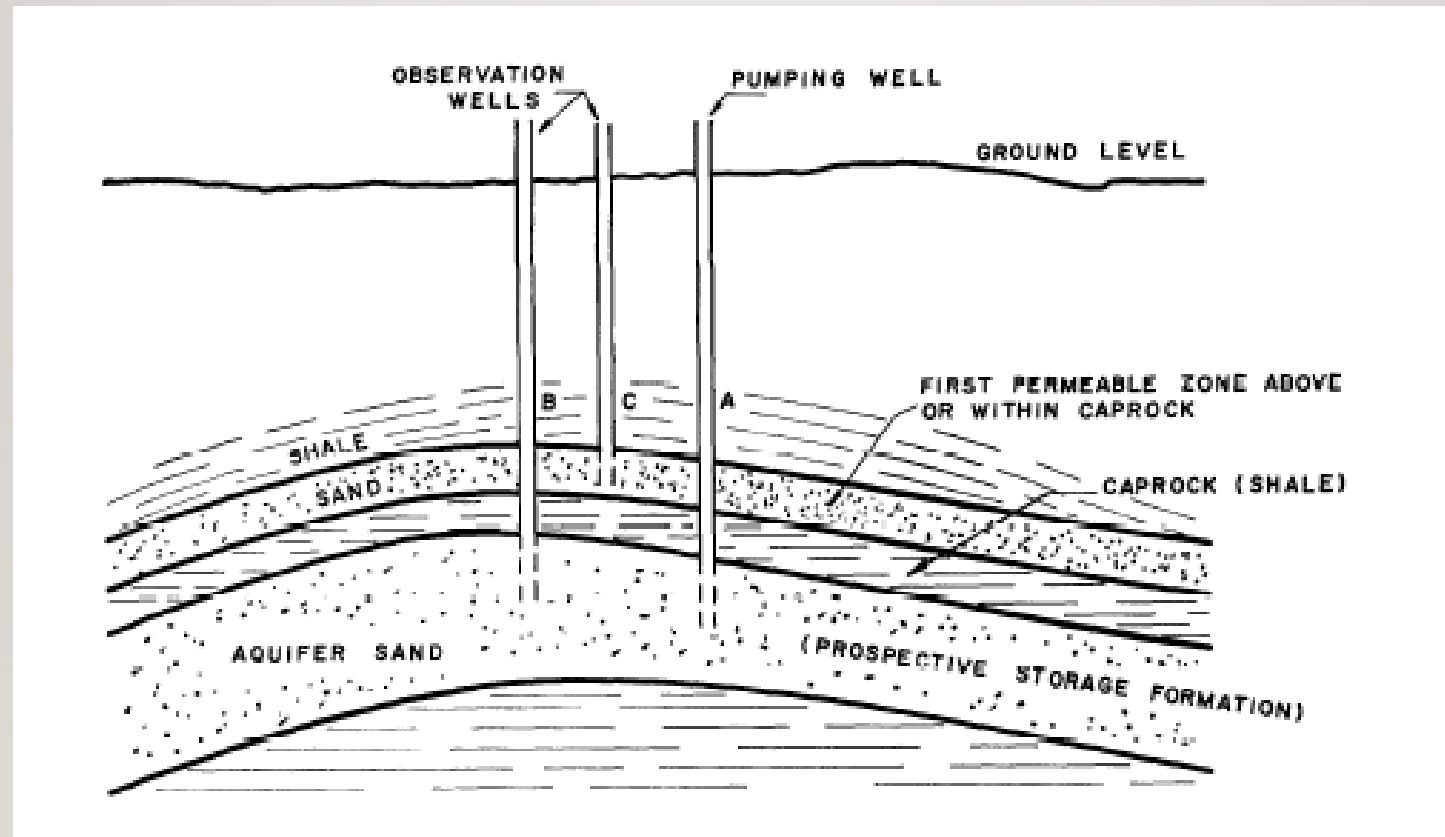
Rick Cobb, P.G., Deputy Division Manager,
Division of Public Water Supplies

BACKGROUND

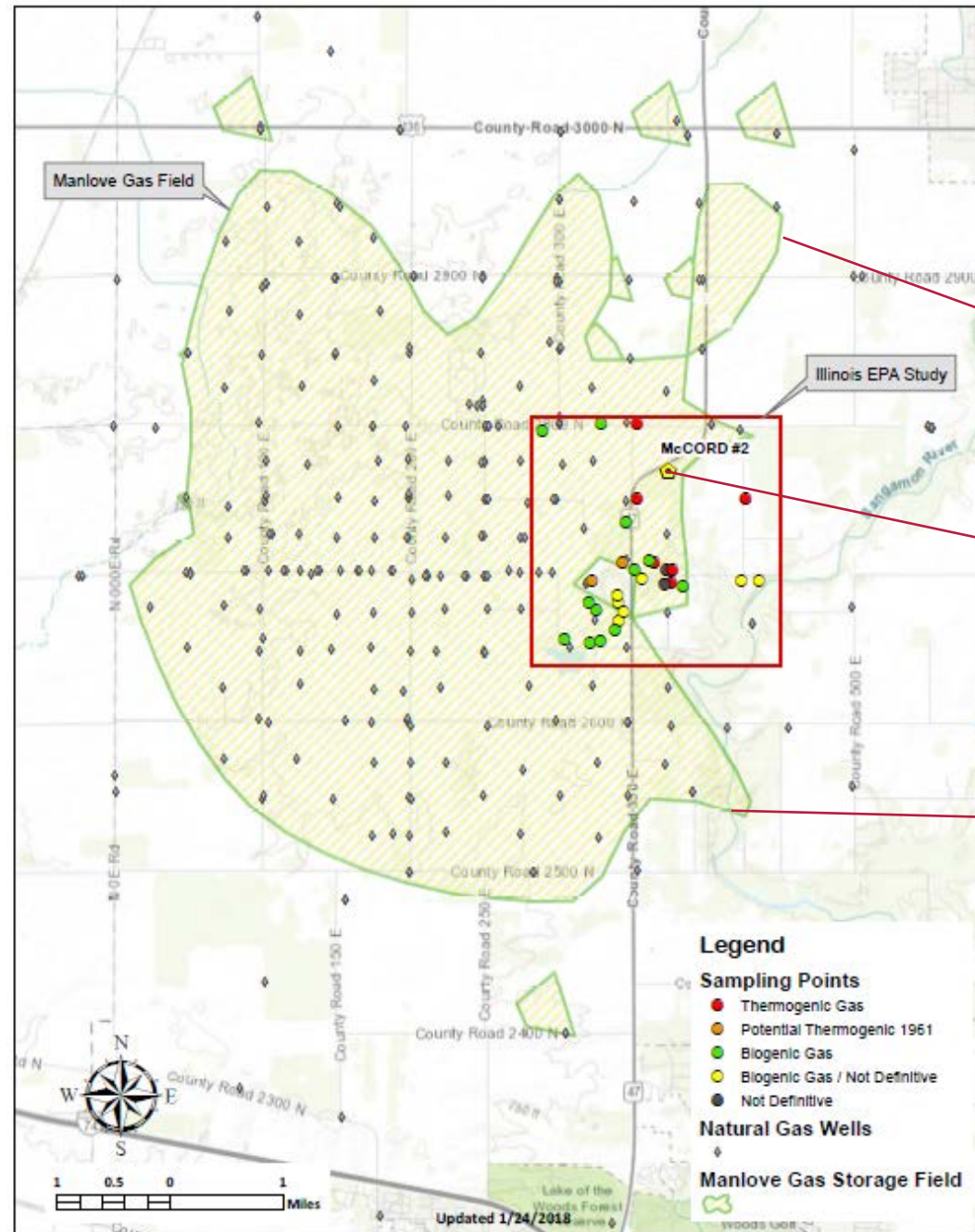
- McCord #2 (“MC2”), was injecting natural gas into the Manlove Natural Gas Storage Field at a depth of 4,000 feet below land surface into the Mt. Simon Aquifer into the Mahomet Dome structure
- A release was reported to have occurred December 19, 2016
- Bubbling was observed at the land surface near MC2



CONCEPTUAL DIAGRAM OF GAS STORAGE IN THE MT. SIMON RESERVOIR

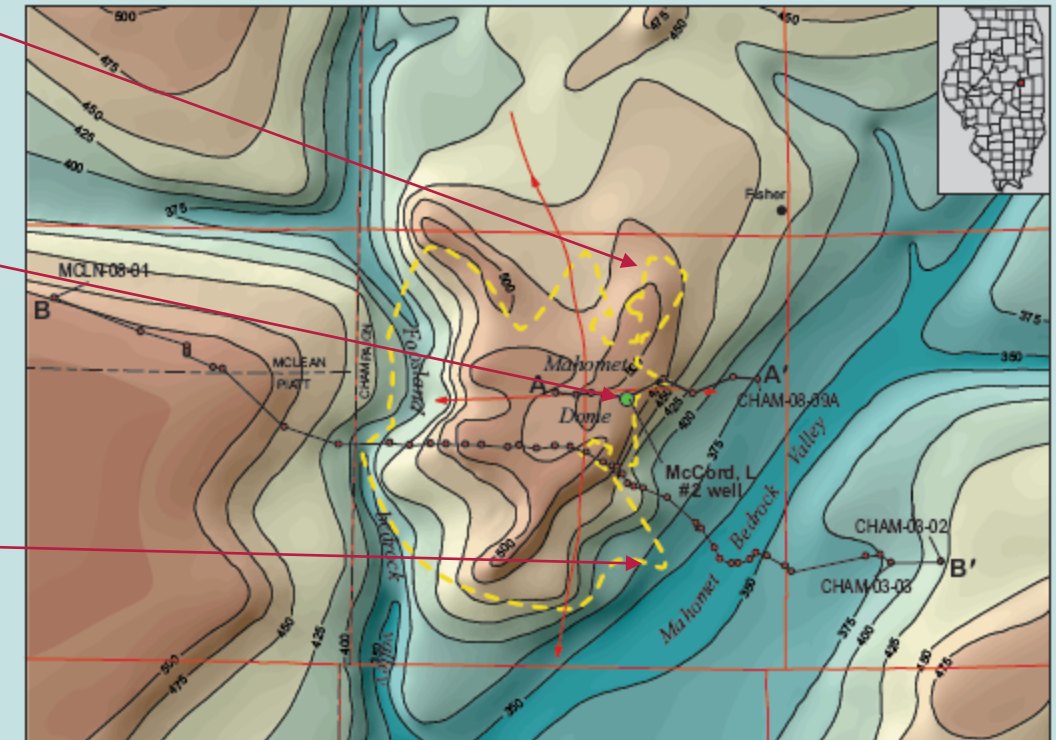


MANLOVE GAS STORAGE FIELD WITH GAS STORAGE WELLS



Geologic Cross Sections of Quaternary Deposits Across the Manlove Gas Storage Field Area, Champaign County, Illinois

Andrew J. Stumpf



Special Report 6 2018

ILLINOIS STATE GEOLOGICAL SURVEY
Prairie Research Institute
University of Illinois at Urbana-Champaign

ILLINOIS
Illinois State Geological Survey
PRAIRIE RESEARCH INSTITUTE

BACKGROUND ON NATURAL GAS – THERMOGENIC VS. BIOGENIC

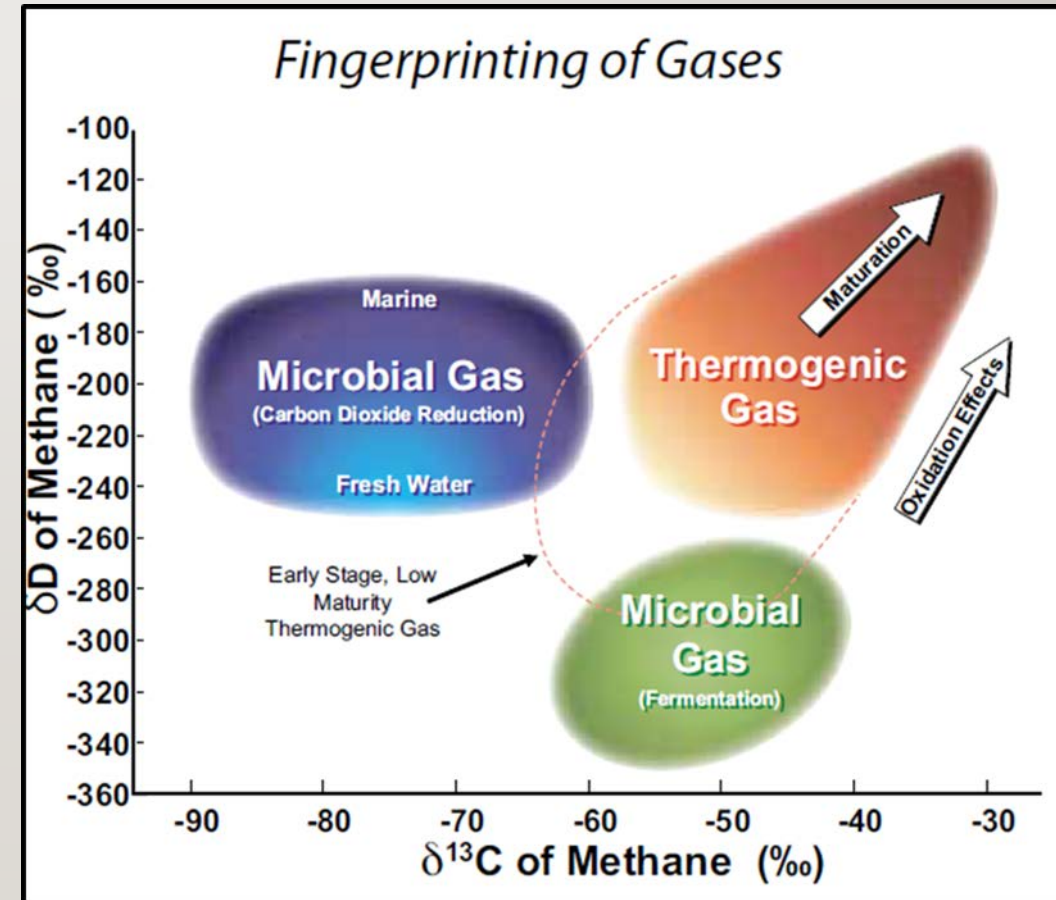
Biogenic

Methanogenesis is the formation of methane by microbes known as methanogens.

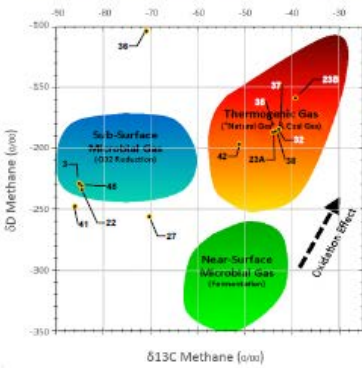
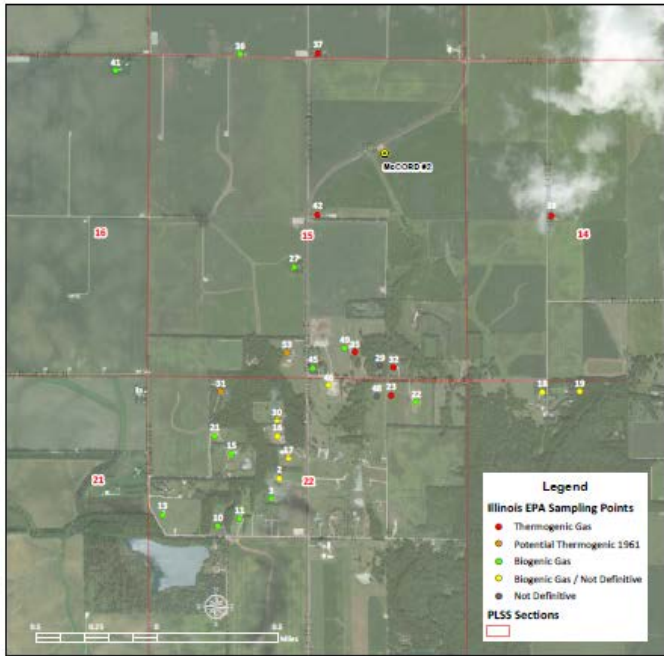
Thermogenic

Methane CH_4 (also referred to as CI), thermogenic gas can also contain heavier chain hydrocarbons such as: ethane (C_2H_6); propane (C_3H_8); iso-butane (C_4H_{10}); n-butane (C_4H_{10}); and iso-pentane (C_5H_{12}).

FINGERPRINTING OF GASES



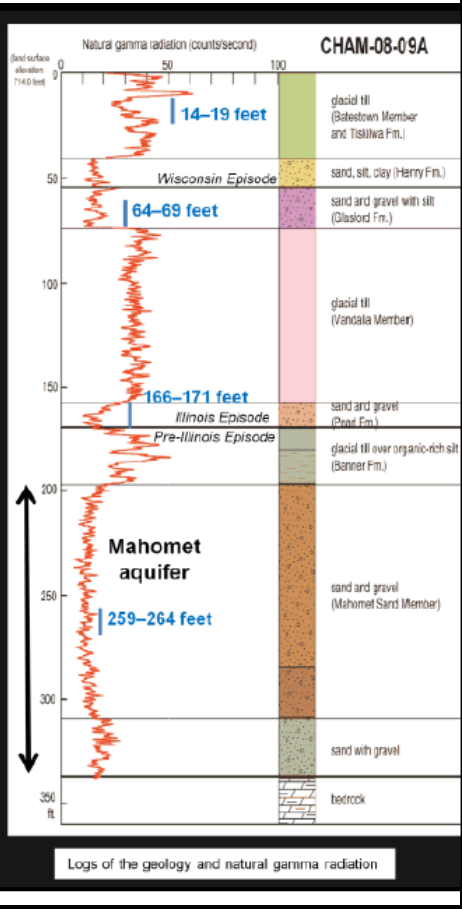
McCord #2 WITH ILLINOIS EPA SAMPLING DATA IN THE VICINITY OF MAHOMET, IL



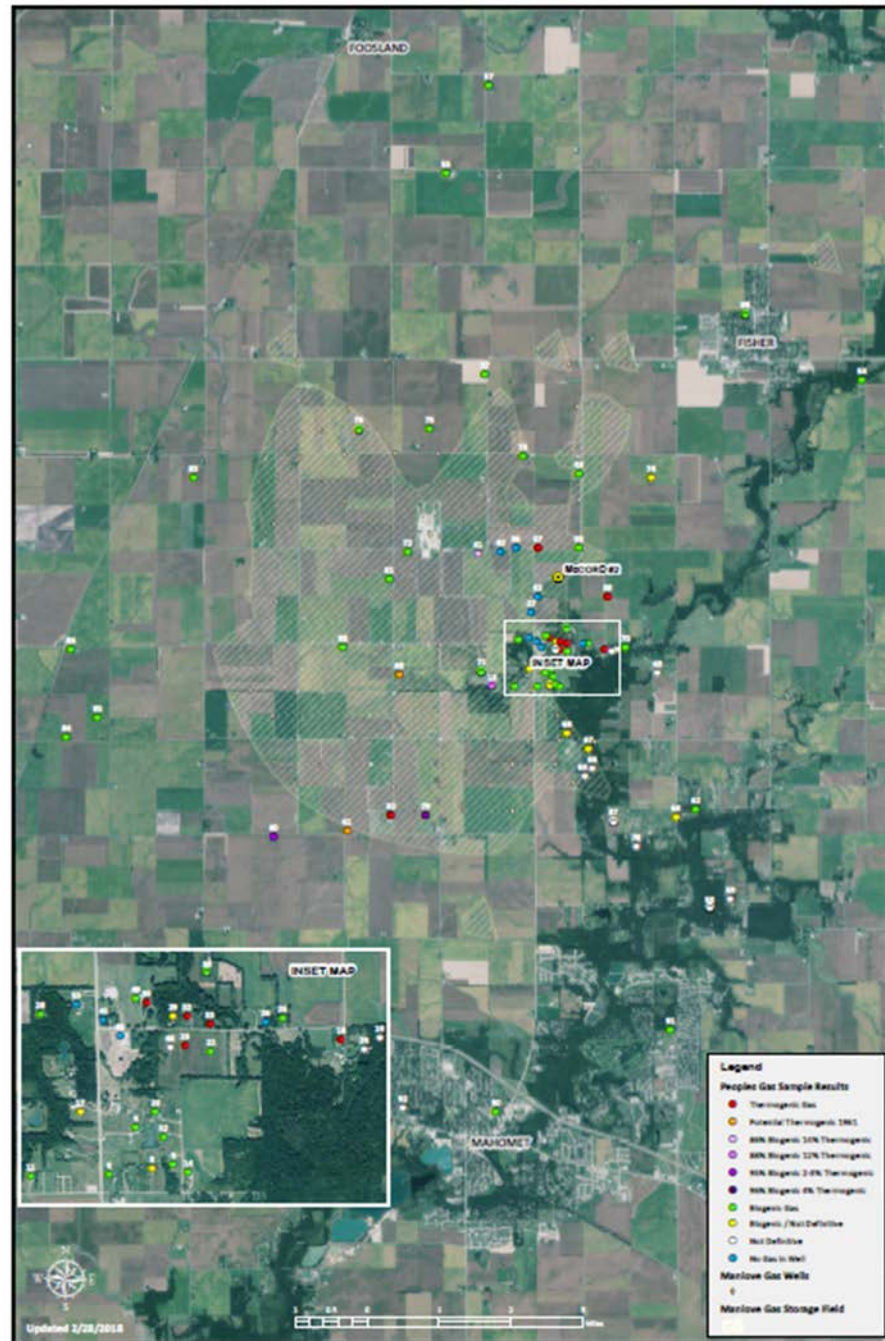
ID	TAX PAYER	ADDRESS
2		2665 COUNTY ROAD 330 E
3		2694 COUNTY ROAD 330 E
10		1814 COUNTY ROAD 2650 N
18		1356 COUNTY ROAD 2650 N
15		1610 COUNTY ROAD 2880 N
16		1610 COUNTY ROAD 2880 N
18		1678 COUNTY ROAD 330 E
17		2679 COUNTY ROAD 330 E
19		2679 COUNTY ROAD 425 E
20		2688 COUNTY ROAD 425 E
21		2679 COUNTY ROAD 330 E
22		179 E COUNTY ROAD 2780 N
23		1814 COUNTY ROAD 2780 N
27		2757 COUNTY ROAD 330 E
28		1814 COUNTY ROAD 2780 N
29		1814 COUNTY ROAD 2780 N
30		1814 COUNTY ROAD 2780 N
31		2688 COUNTY ROAD 425 E
32		179 E COUNTY ROAD 2780 N
33		1814 COUNTY ROAD 2780 N
34		1814 COUNTY ROAD 2780 N
35		1814 COUNTY ROAD 2780 N
36		1814 COUNTY ROAD 2780 N
37		1814 COUNTY ROAD 2780 N
38		1814 COUNTY ROAD 2780 N
39		1814 COUNTY ROAD 2780 N
40		1814 COUNTY ROAD 2780 N
41		1814 COUNTY ROAD 2780 N
42		1814 COUNTY ROAD 2780 N
43		1814 COUNTY ROAD 2780 N
44		1814 COUNTY ROAD 2780 N
45		1814 COUNTY ROAD 2780 N
46		1814 COUNTY ROAD 2780 N
47		1814 COUNTY ROAD 2780 N
48		1814 COUNTY ROAD 2780 N
49		1814 COUNTY ROAD 2780 N
50		1814 COUNTY ROAD 2780 N
51		1814 COUNTY ROAD 2780 N

Hydrogeology of the Private Wells Contaminated with Thermogenic Gas

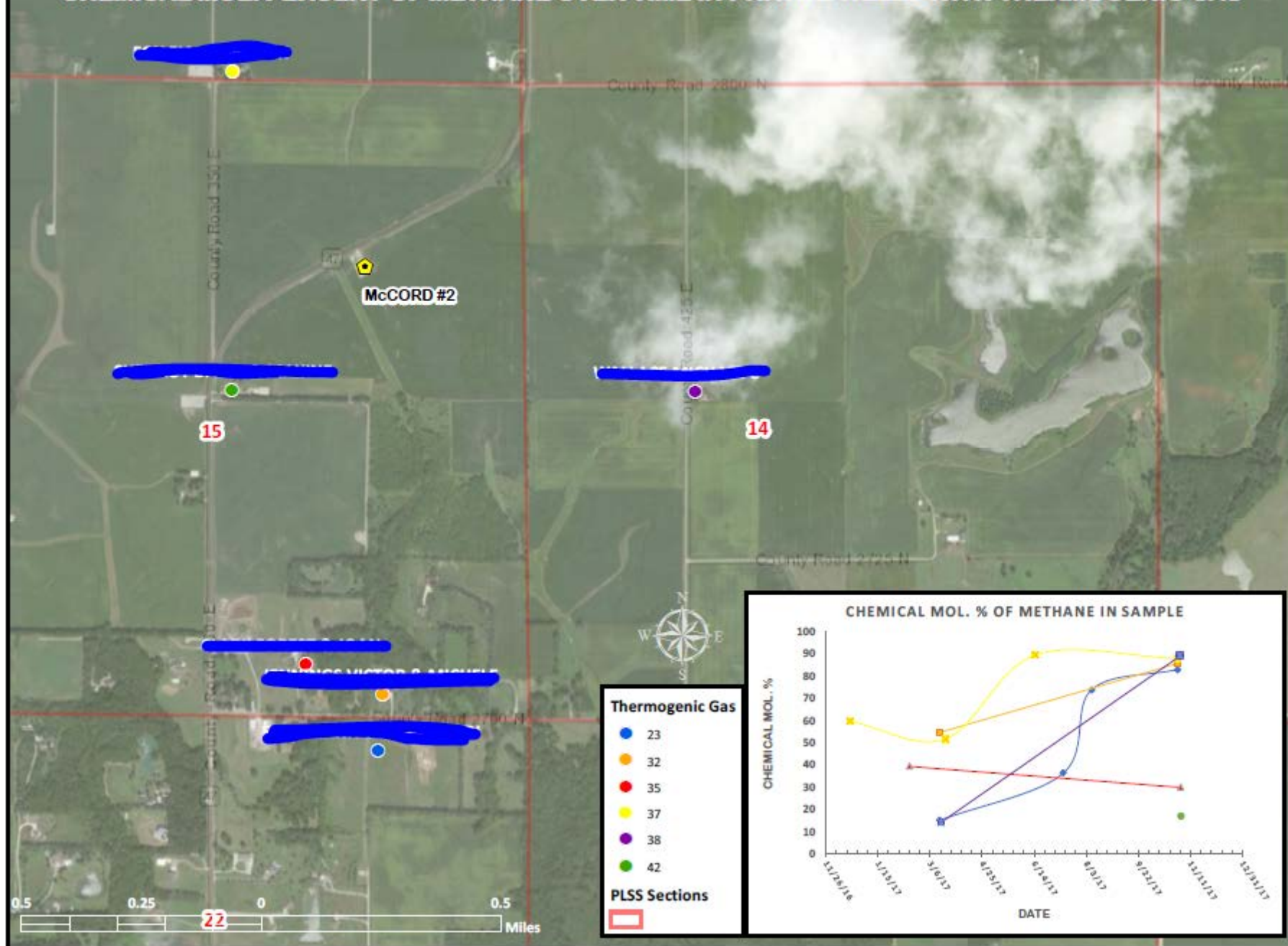
Well ID	Well Depth	Hydrostratigraphic Unit	Geologic Unit
23	150		Ashmore/Pearl
32	61	Wisconsin/Upper Glasford	Ashmore/Pearl
35	???	???	
37	220	Mahomet	
38	106 or 120	Upper Glasford	



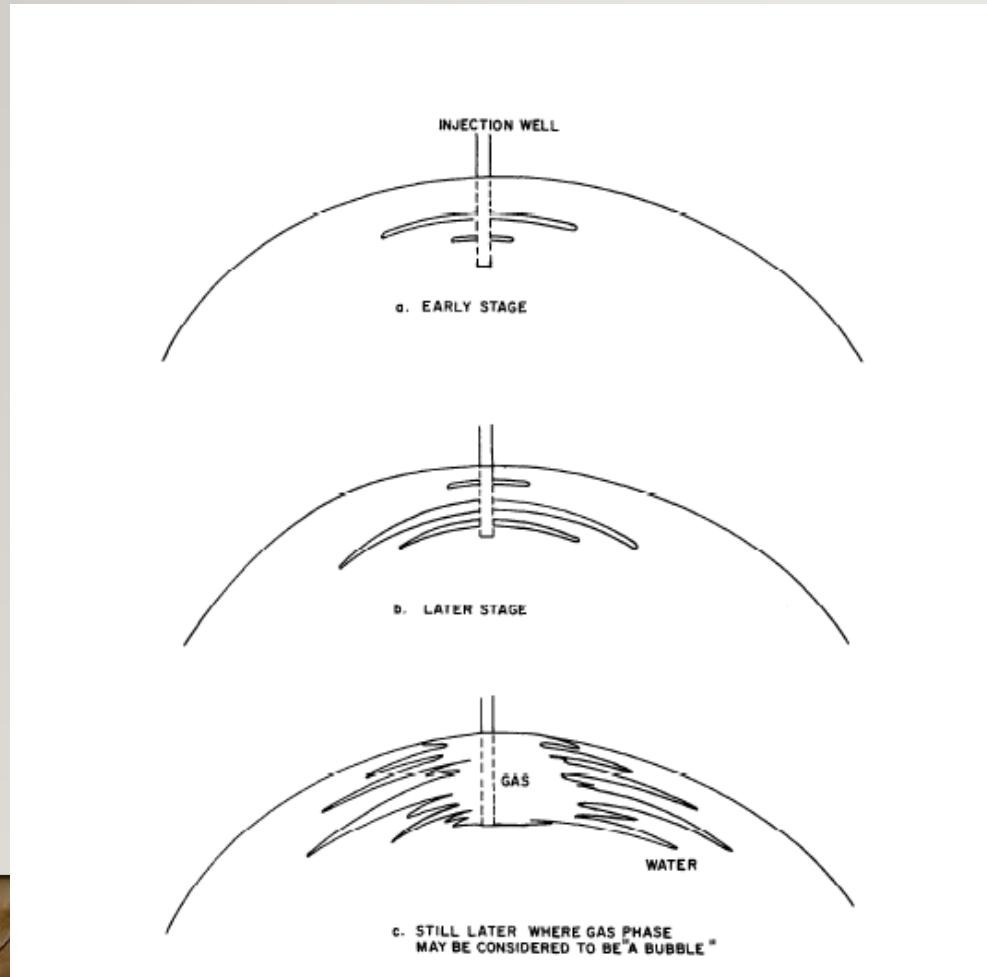
McCORD #2 WITH RESULTS FROM PEOPLES GAS SAMPLING EVENTS TO DATE



CHEMICAL MOL. PERCENT OF METHANE OVER TIME IN PRIVATE WELLS WITH THERMOGENIC GAS



MOVEMENT OF THE NATURAL GAS RELEASE



I. FREE PHASE GAS FLOW

- Moved upward vertically from the point of release in the bedrock (550' below land surface)
- Spreads out laterally in a radial pattern
- Moving faster than the velocity groundwater through permeable geologic materials (i.e. sand and gravel, sand) and possibly well casing annular seals
- Stops at impermeable zones (i.e. clay rich glacial materials)
- Movement of the bubble stabilizes and starts going into dissolved phase

MOVEMENT OF THE NATURAL GAS RELEASE CONTINUED

2. DISSOLVED PHASE OF THERMOGENIC GAS MOVEMENT

- After the free-phase gas bubble stabilizes
- The thermogenic gas starts going into a dissolved phase
- Moves down gradient at the velocity of groundwater

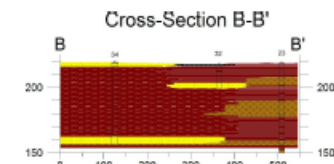
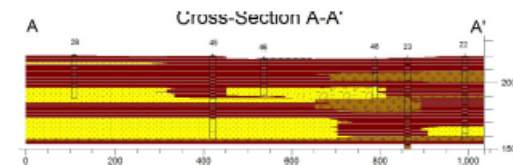
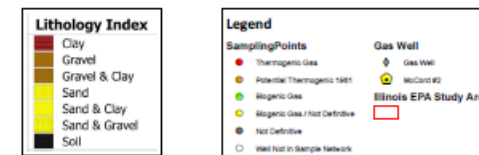
REMOVING THE THERMOGENIC NATURAL GAS FROM THE AQUIFER

- Delineate where the remaining gas bubble(s) are trapped
- Install relief wells and flare off the gas
- Thus, we need a conceptual geologic model to start the process of finding where the thermogenic gas bubble may be trapped

Table 5. Estimated Hydraulic Conductivity of Typical Geologic Materials, in ft/year (Source: Berg et al., 1984)

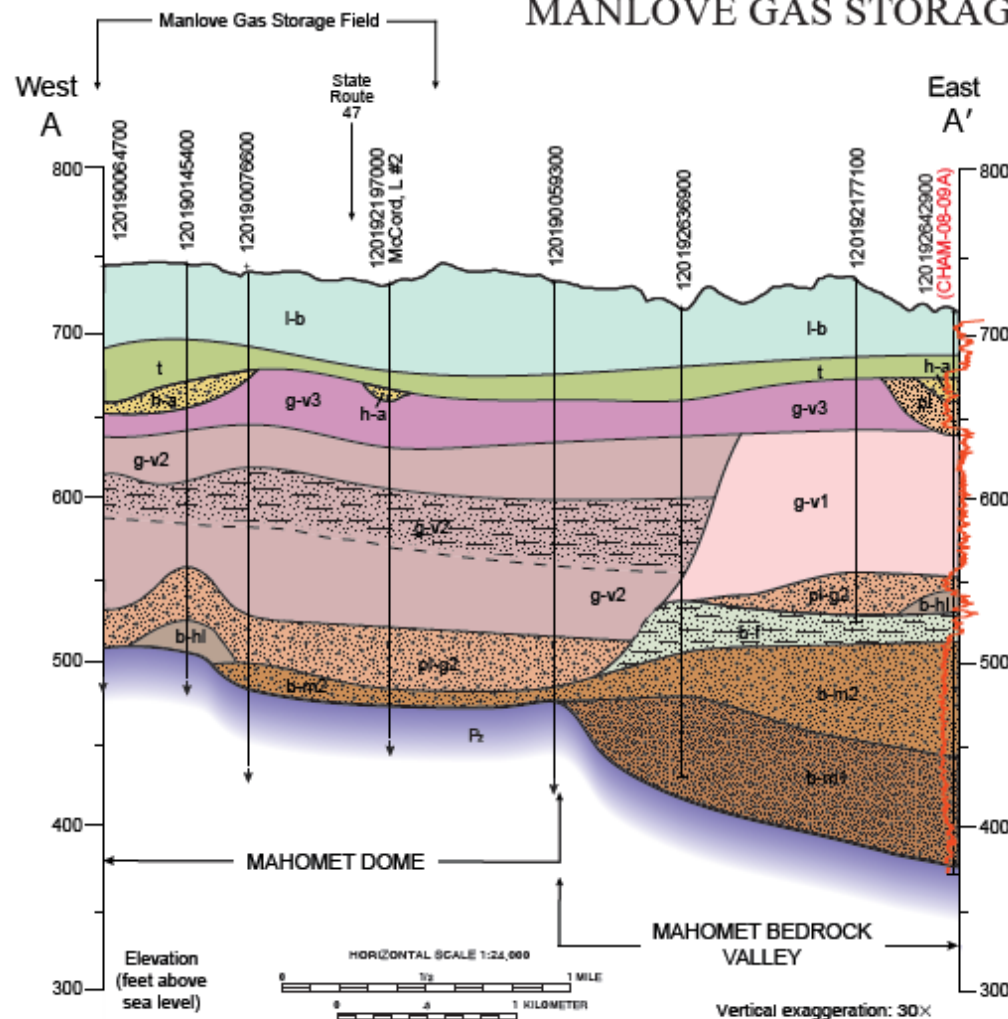
Dense limestone/dolomite	10^{-5} to 10^{-8}
Till (>25% clay)	10^{-3} to 10^{-5}
Till (<25% clay)	10^{-2} to 10^{-4}
Loess	10^{-3} to 10^{-1}
Sandstone	$>10^{-1}$
Limestone	$>10^{-1}$
Silty sand	10^{-2} to 10
Clean sand and gravel	10

**McCord #2 WITH IEPA SAMPLING DATA
WITH GEOLOGIC CROSS SECTIONS**



GEOLOGIC CROSS SECTIONS OF QUATERNARY DEPOSITS ACROSS THE MANLOVE GAS STORAGE FIELD AREA, CHAMPAIGN COUNTY, ILLINOIS

Andrew J. Stumpf



Legend for Cross Sections

Geologic materials

- Sand and gravel, pebbly
- Sand and gravel
- Mainly sand; may contain some gravel or silt
- Fine sand, silt, and clay
- Diamicton

Unit contacts

- Contact
- Contact (inferred)

Borehole Information

- county identification number → 120190145400 ← project field identification number (CHAM-08-09A)
- entire depth shown → only upper part shown
- Log of natural gamma radiation measured in borehole
- 0 150 CPS = counts per second

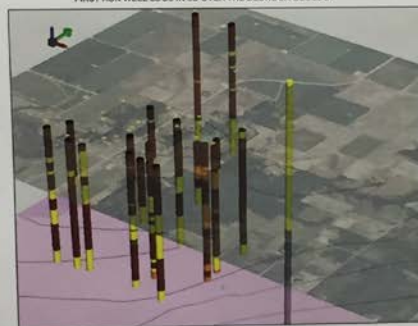
Note:

The locations of cross sections A-A' and B-B' are shown in Figure 1. The borings on the cross sections are labelled with the API number or county identification number, and field identification number (in parentheses). The 12-digit API number on file at ISGS Geological Records Unit references records in the ISGS wells and borings database. The geologic and geophysical logs are available from ISGS websites ILWATER (<http://www.isgs.illinois.edu/ilwater>) and ILOIL (<http://www.isgs.illinois.edu/illinois-oil-and-gas-resources-interactive-map>).

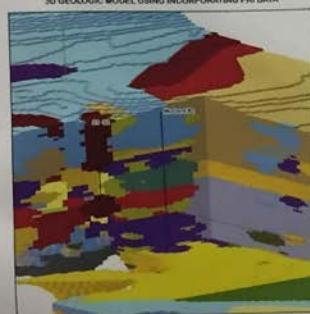
This aerial photograph shows a study area with various sampling locations. A blue oval labeled 'A' is located in the lower-left quadrant. A cluster of yellow circles labeled 'A'' is in the lower-right quadrant. A yellow circle labeled 'B' is in the upper-right quadrant. A yellow circle labeled 'B'' is in the lower-right quadrant. A north arrow is in the top right corner.

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FIRST RUN WELL LOGS IN 3D OVER THE BEDROCK GEOLOGY



3D GEOLOGIC MODEL USING INCORPORATING PRI DATA

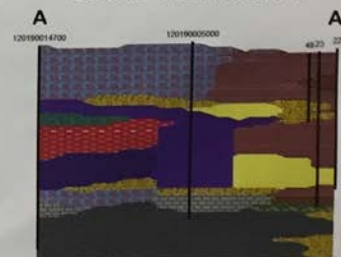


Lithology Index

	Clay
	Clay & Gravel
	Clay & Sand
	Clay with Sand & Gravel
	Granulation
	Granulation with Sand & Gravel
	Gneisslike
	Gravel
	Gravel & Clay
	Laminarlike
	Sand
	Sand & Clay
	Sand & Gravel
	Scallopedlike
	Sandy Clay
	Shale
	Silt & Clay
	Silt & Gravel
	Silt & Sand
	Siltaceous
	Silty Clay
	Silty Sand
	Silt

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Cross-Section A-A'



Cross-Section B-B'



NEXT STEPS

We don't have all the answers



More detailed hydrogeologic characterization may be required



Negotiation with the RP and AGO