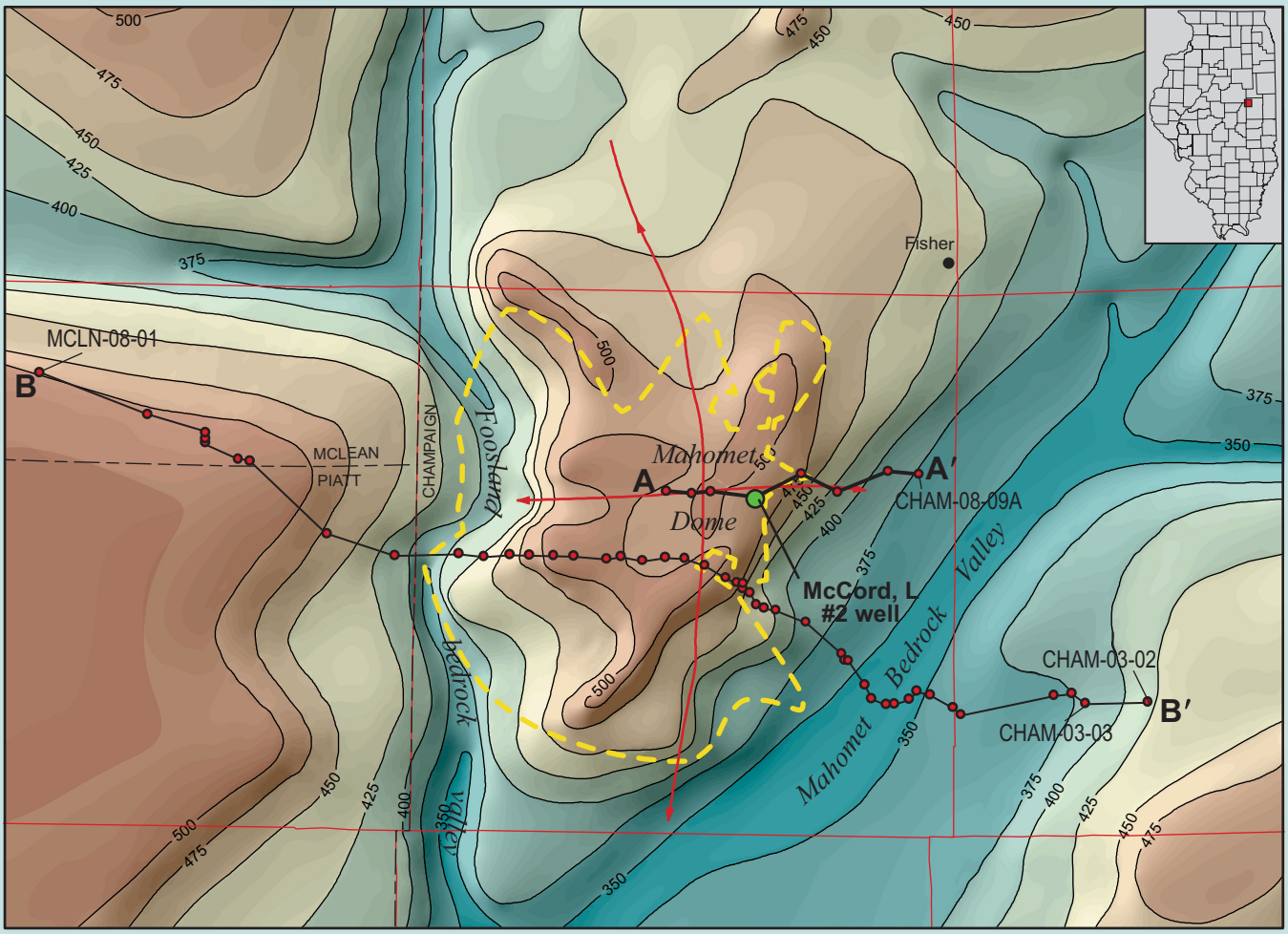
Geologic Cross Sections of Quaternary Deposits Across the Manlove Gas Storage Field Area, Champaign County, Illinois

Andrew J. Stumpf



Special Report 6 2018

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Front cover: *Area of northwest Champaign County depicting the topography of the bedrock surface across the Mahomet Dome, Mahomet Bedrock Valley, tributary bedrock valleys, and adjacent bedrock uplands. Also shown is the extent of the Manlove gas storage field area (dashed yellow line) and lines of geologic cross sections (see Figure 1 in text).*

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Contents

OVERVIEW

This report was written by the Illinois State Geological Survey (ISGS) to assist the Prairie Research Institute's Natural Gas Working Group (NGWG), the Illinois Environment Protection Agency (IEPA), and other stakeholder groups involved in studying the Manlove gas storage field gain a better understanding of the shallow subsurface geology in northwestern Champaign County. Interpretations made about the surface and subsurface geology are based on a conceptual geological model developed by Stumpf and Atkinson (2015) and Stumpf and Dey (2012). Their model is based on new studies of the Mahomet aquifer in the Champaign County area between 2007 and 2012 and previous lithostratigraphic classifications published by Hansel and Johnson (1996), Kempton et al. (1991), Willman and Frye (1970), and Willman et al. (1975).

The cross sections depict the geologic materials encountered between the land surface and the buried bedrock surface along transects A–A′ and B–B′ (Plates 1 and 2). Limited detailed information exists on sequences of Quaternary clayey till and deposits of glacial sand, gravel, and silt across the gas storage field area that were formed during multiple periods of glacial and postglacial deposition and erosion. These cross sections are the first detailed representations of the Quaternary deposits across the Mahomet Dome, the structure in which the Manlove gas storage field is developed.

The cross sections were made by correlating lithologic units interpreted from the geologic and geophysical logs

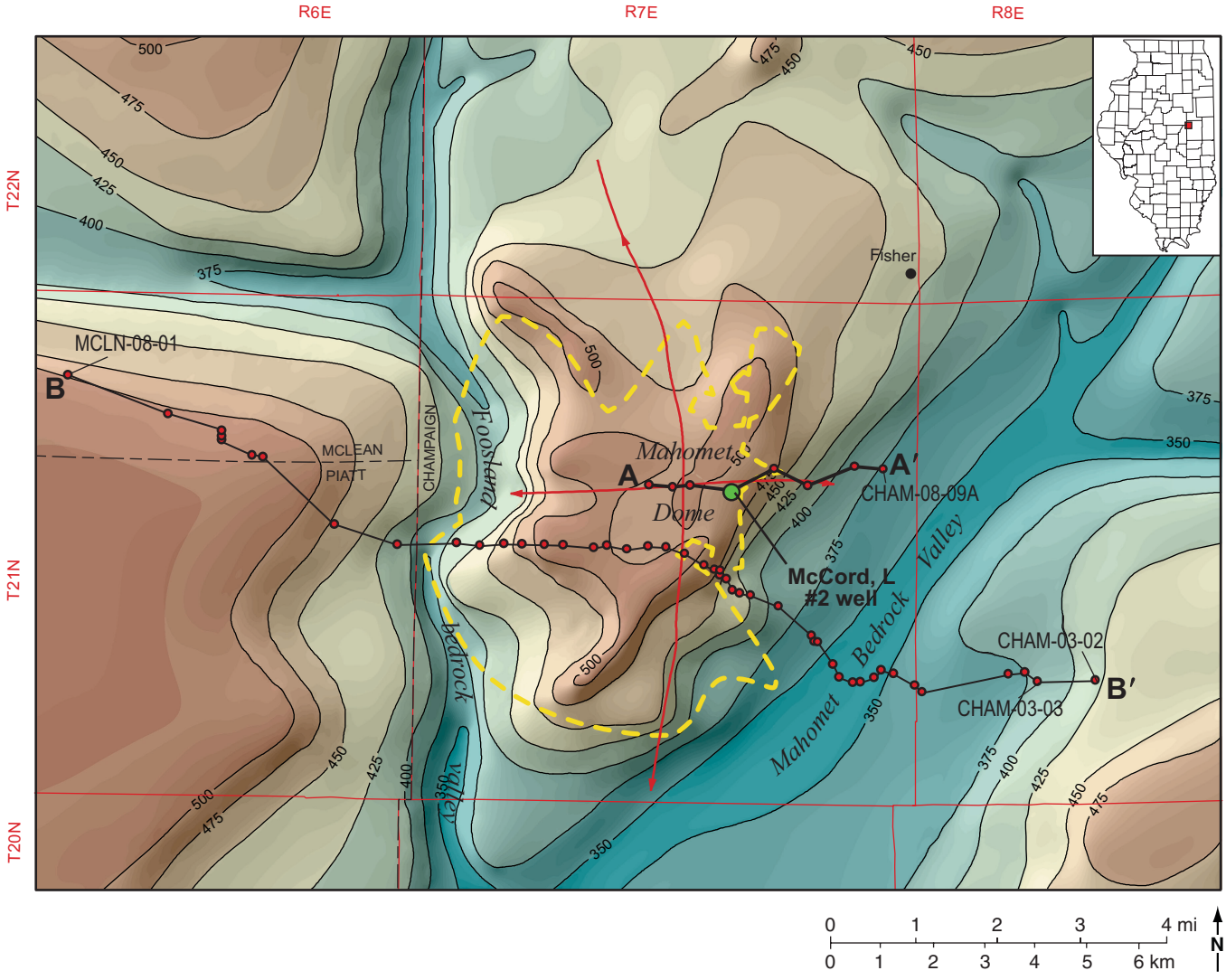

Figure 1 Location of geologic cross sections across the Manlove gas storage field area. The cross section lines lie over a shaded relief map depicting the topography of the bedrock surface (data from Nelson, Bedrock geology of Champaign County, Illinois, ISGS Bulletin in preparation). Borehole locations are shown by the red dots, and those drilled by the ISGS are labeled (e.g., CHAM-03-03). The McCord, L #2 injection well (green dot) is also labeled. The Manlove gas storage field area is delineated by the dashed yellow line. The extent of the Mahomet Dome is delineated by the red arrows.

for water wells, natural gas injection/extraction wells, and coal and petroleum exploration test borings. These data are correlated with the geology and geophysical logs from four continuously cored stratigraphic borings completed by the ISGS and geophysical logs from two other water wells. These boreholes are located between 1 and 5 miles of the Manlove gas storage field (Plates 1 and 2). A customized tool for the ESRI ArcMap software programmed by the ISGS (Carrell 2015) was used to generate georeferenced cross sections from the lithologic data. Polygons for each geologic unit were outlined in ArcMap, but shapefiles of the cross sections were later imported into Adobe Illustrator (version CC 2015.3.1) for graphical editing using the MAPublisher plug-in by Avenza Systems Inc. (version 9.8). In Adobe Illustrator, the polygons were closed and symbolized, line segments smoothed, and surrounding elements added to create a standardized layout for publication.

In assembling the cross sections, it was necessary to undertake additional analysis to move point locations closer to the corresponding wellhead, specifically water wells located without a global positioning system (GPS). Prior to 2012, water wells were typically located by township, range, and section, the legal location, using the Illinois Public Land Survey System (PLSS). For constructing the cross sections, county tax parcel data (e.g., Champaign County GIS Consortium (http://www.maps.ccgisc.org) and public aerial and ground-based photography (e.g., Google Maps, https://www.google.com/maps) were used to obtain the most accurate point locations. The updated coordinates were added to the ISGS wells and borings database, which contains the records of wells drilled in the State of Illinois.

The boreholes labeled on the cross sections are cataloged in the ISGS wells and borings database by the API well number, which is a "unique, permanent, numeric identifier assigned for identification purposes to a well" (American Petroleum Institute 1979). The ISGS also assigns the API number to geological data collected at point locations (e.g., field outcrops, geophysical soundings, shallow excavations, etc.). The 12-digit number consists of four parts (in this order): the state code (2 numeric digits), the county code (3 numeric digits), the unique well code (5 numeric digits), and whether the original hole has been redrilled, sidetracked, or directionally extended. The county code is sequentially assigned to borings as they are added to the repository. On the ILWATER (http://www.isgs.illinois.edu/ilwater) and ILOIL (http://maps.isgs.illinois.edu/ILOIL/) websites, the API well number can be searched under the FIND tab.

GUIDANCE FOR USE

1. General Information/Citation

- **a. Title—**Geologic cross sections of Quaternary deposits across the Manlove gas storage field area
- **b. Project Citation—**Data request from the Prairie Research Institute's Natural Gas Working Group (NGWG) and the Illinois Environmental Protection Agency (IEPA), and provided to other stakeholder groups involved in studying the Manlove gas storage field.
- **c. Suggested Citation—**Stumpf, A.J., 2018, Geologic cross sections of Quaternary deposits across the Manlove gas storage field area, Champaign County, Illinois: Illinois State Geological Survey, Special Report 6, 7 p.; 2 plates.
- **d. Overview—**See Overview section beginning on page 1.
- **e. Topic—**Geologic mapping, Quaternary geology
- **f. Keywords—**Glacial geology, Quaternary, Mahomet aquifer, Manlove gas storage field
- **g. Publication—**April 9, 2018
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2. Metadata

- **a. Contacts—**
  - i. Same as author noted above
- **b. Constraints—**Nondisclosure
  - i. **Terms of Use**—The ISGS should be contacted in advance to arrange ISGS review of planned presentations and publications using these data. Data usage must be approved in advance of presentation and publication. As appropriate, at least one ISGS project member should be included as a co-author in the publication(s) that use these data.
  - ii. **Disclaimer**—This information was prepared as an account of work conducted by a unit of the University of Illinois. Neither the University of Illinois nor any unit thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. The views and opinions of authors expressed herein do not necessarily state or reflect those of the University of Illinois or any agency thereof.
  - iii. **Status**—Final analysis of the data has not been published, and as such, this data set is provisional and subject to change. Data have undergone standard project quality control review.

3. Resource

- **a. Format** (digital/Adobe Systems Portable Document Format [PDF] file)
- **b. Start Date—**March 8, 2018

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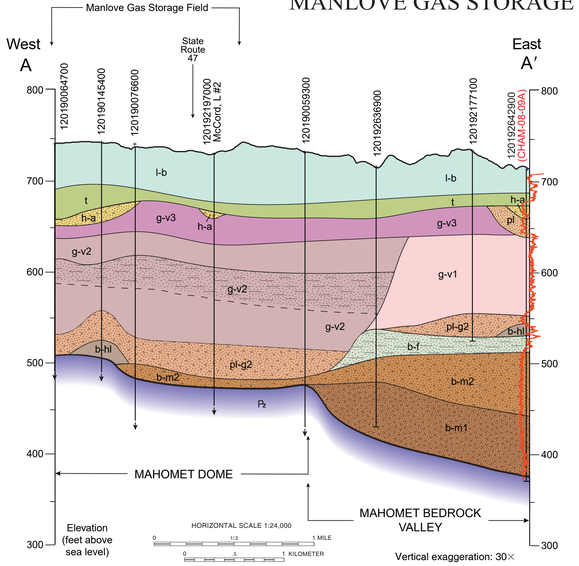
GEOLOGIC CROSS SECTIONS OF QUATERNARY DEPOSITS ACROSS THE MANLOVE GAS STORAGE FIELD AREA, CHAMPAIGN COUNTY, ILLINOIS

Andrew J. Stumpf



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Legend for Cross Sections

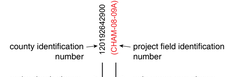
Geologic materials

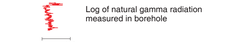
- Sand and gravel, pebbly
- Sand and gravel
- Mainly sand; may contain some gravel or silt
- Fine sand, silt, and clay
- Diamicton

Unit contacts

- Contact
- Contact (inferred)

Borehole Information





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).

QUATERNARY DEPOSITS

Description[1,2]	Unit	Interpretation
HUDSON EPISODE (~14,600 years before present (B.P.) to today)		
Sand, silt, clay, and gravel; massive to stratified; locally oxidized; poorly sorted; contains beds of organic material; up to 15 feet thick	Cahokia Formation c	**Alluvium (stream deposits)** mapped in floodplains along creeks and drainageways and in fan-shaped deposits where streams emerge from the moraines onto lower gradient slopes
WISCONSIN EPISODE (~23,000–14,600 years B.P.)		
Sand and gravel; contains some beds of silt and pebbles; brown to yellowish brown; calcareous; well to poorly sorted; up to 25 feet thick	Henry Formation h	**Glaciofluvial sediment (outwash)** deposited by glacial meltwater in streams and rivers that flowed from ice margins
Diamicton; sandy loam to silt loam; gray to brown; calcareous; contains beds of sand, silt, and gravel; 30 to 100 feet thick	Batestown Member, Lemont Formation l-b	**Till and associated sediment** derived directly from glacial ice
Diamicton; loam; grayish brown to reddish gray; calcareous; very stiff; 10 to 65 feet thick	Tiskilwa Formation t	**Till and associated sediment** derived directly from glacial ice; in the subsurface directly underlies the Batestown Member
Sand and gravel with silt; contains pebbles and cobbles; brown to grayish brown; calcareous; well to poorly sorted; 5 to 35 feet thick	Ashmore Tongue, Henry Formation h-a	**Glaciofluvial sediment (outwash)** deposited by glacial meltwater in streams and rivers that flowed from an advancing ice margin; not consistently differentiable from underlying sand and gravel correlated to the Pearl Formation
ILLINOIS EPISODE (~190,000–130,000 years B.P.)		
Fine to coarse sand with gravel; yellowish brown to grayish brown; calcite-cemented in places; incised into the Vandalia Member and older units; upper part contains weathered sand and gravel with silt and clay assigned to the Sangamon Geosol; 5 to 80 feet thick	Pearl Formation pl	**Glaciofluvial sediment (outwash)** deposited by glacial meltwater in streams and rivers that flowed from ice margins; inset into the Vandalia Member (upper unit), Glasford Formation; contains the Sangamon Geosol in the upper part except where eroded
Diamicton, sand and gravel, and silt and clay; interstratified; includes sediments previously assigned to the Berry Clay, Hagerstown, Radnor and Toulon Members, or Roby Silt Member; upper part contains weathered silty to clayey materials assigned to the Sangamon Geosol; 10 to 70 feet thick	Vandalia Member, Glasford Formation upper unit g-v3	**Proglacial and ice-contact sediment** deposited by glacial meltwater or sediment gravity flows (debris flows) along ice margins; contains the Sangamon Geosol in the upper part except where eroded
Diamicton, with layers of sand and gravel and silt and clay; diamicton is loam textured and is less compacted than lower unit (g-v1); includes sediments previously assigned to the Berry Clay, Radnor, Toulon Members, or Roby Silt Member; 25 to 175 feet thick	Vandalia Member, Glasford Formation middle unit g-v2	**Subglacial and ice-contact sediment** derived directly from glacial ice or deposited by glacial meltwater; deposition is interpreted to have occurred within an area of fast-flowing ice, possibly an ice stream and associated with the deglacial phase of the Illinois Episode glaciation
Diamicton; silt loam to loam; grayish brown; calcareous; contains beds of sand, silt, and gravel; hard; 10 to 100 feet thick	Vandalia Member, Glasford Formation lower unit g-v1	**Till and associated sediment** derived directly from glacial ice; overlain by deposits that accumulated along ice margins; nearly continuous deposit
Sand and gravel; pebbly; grayish brown; contains some beds of silt or diamicton; calcareous; well to moderately well sorted; 5 to 70 feet thick	Pearl Formation Grigg Tongue upper / lower units pl-g2 pl-g1	**Glaciofluvial sediment** deposited in front of advancing ice margins; include sediment deposited by outflows from lakes ponded behind ice margins; over the Mahomet Bedrock Valley (MBV), units are difficult to distinguish from the Mahomet Sand Member when intervening older till and lake sediment are absent; includes deposits of sand and gravel (pl-g1) outside the MBV
PRE-ILLINOIS EPISODE (~1,200,000–430,000 years B.P)		
Diamicton; loam; reddish brown to grayish brown; calcareous; contains beds of sand, silt, or gravel; hard; upper part weathered in profile of Yarmouth Geosol; 5 to 45 feet thick	Hillery Member, Banner Formation b-hl	**Till and associated sediment** derived directly from glacial ice; may contain Yarmouth Geosol weathering profile in the upper 10 feet (typically truncated)
Diamicton; loam to silt loam; grayish brown to light olive brown; calcareous; contains beds of sand, silt, or gravel; contains numerous clasts of the local bedrock; hard; ~20 feet thick	Harmattan Member, Banner Formation b-hm	**Till and associated sediment** derived directly from glacial ice
Sand, diamicton, and silt; sandy loam to silty clay loam; very dark gray to greenish gray; leached to weakly calcareous; may contain humus, peat, wood, and/or fossil snails; hard; 5 to 30 feet thick	Fisher member, Banner Formation b-f	**Fluvial or lacustrine sediment** deposited on a former floodplain of a river flowing in the MBV; the land surface was poorly drained and occasionally covered by overbank deposits or slope wash
Sand and gravel; brown to grayish brown; contains some beds of silt; calcareous; well to moderately well sorted; 10 to 90 feet thick	Mahomet Sand Member, Banner Formation, upper unit b-m2	**Glaciofluvial sediment (outwash)** deposited in the MBV by glacial meltwater flowing from a retreating ice margin located northeast of the area
Diamicton; sandy loam to clay loam; brown to pinkish gray; calcareous; contains intervals of sand and gravel or silt and clay; hard; ~40 feet thick	West Lebanon Member Banner Formation b-wl	**Till and associated sediment** derived directly from glacial ice flowing into the area from a northern or eastern ice source
Sand and gravel; pebbly to cobbly; brown; locally contains beds of silt or diamicton; calcareous; well to moderately well sorted; 5 to 100 feet thick	Mahomet Sand Member, Banner Formation, lower unit b-m1	**Glaciofluvial sediment (outwash)** deposited in the MBV by glacial meltwater flowing from an advancing ice margin located northeast of the area
PRE-ILLINOIS EPISODE AND OLDER		
Shale, siltstone, limestone and dolomite; upper part is soft, fissile, and fractured; locally contains siderite nodules, plant macrofossils, and slickensides	Pennsylvanian, Mississippian, Devonian, Silurian bedrock Pz	**Bedrock;** includes strata having a marine or terrestrial origin; its upper surface is undulating or irregular (including valleys and uplands) shaped by multiple cycles of erosion

[1] The materials mapped at the land surface may be overlain by 1 to 5 feet of wind-deposited silt (loess).
[2] The lithostratigraphy is modified after Stumpf and Atkinson (2015) and Stumpf and Dey (2012) and includes units from classification systems published by Hansel and Johnson (1996), Kempton et al. (1991), Willman and Frye (1970), and Willman et al. (1975).

Geology by Andrew J. Stumpf, Illinois State Geological Survey.

Digital cartography by Jennifer E. Carrell, Illinois State Geological Survey.

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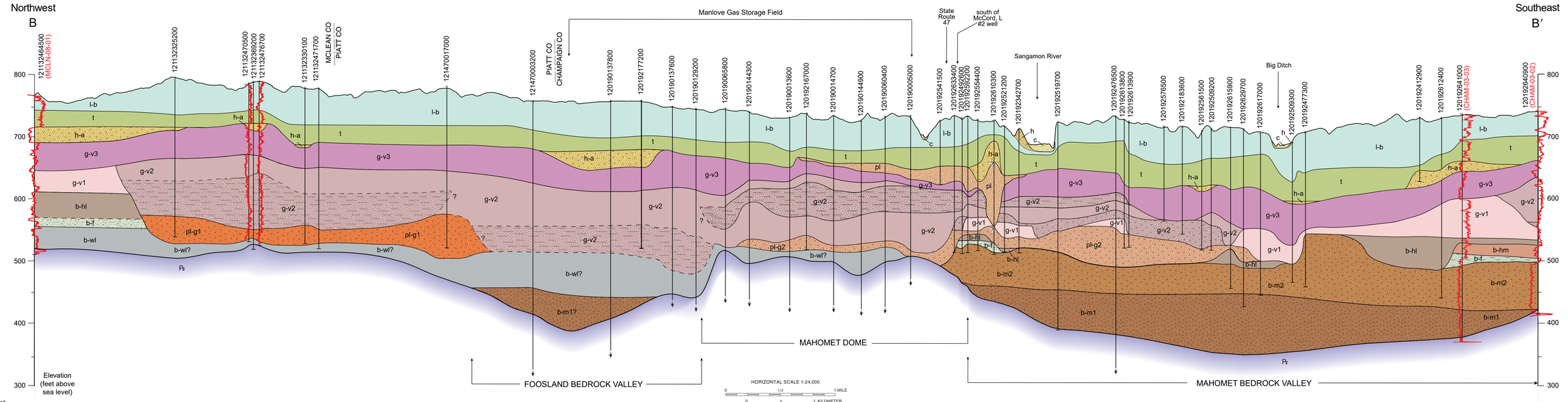

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