UNIVERSITY OF MINNESOTA

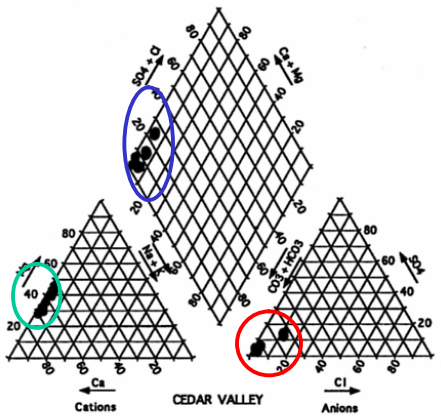
Using Geochemistry to Sort Out Bedrock Aquifer Frameworks

MGWA Fall Conference 2007

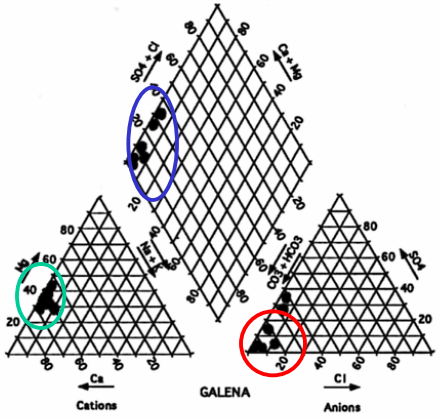
Bob Tipping

Minnesota Geological Survey

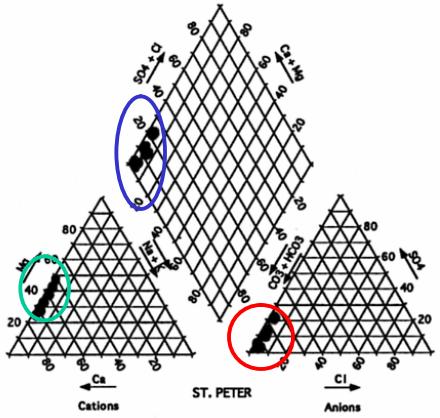
University of Minnesota



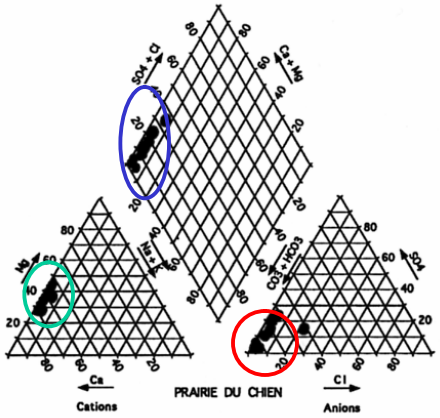
CEDAR VALLEY



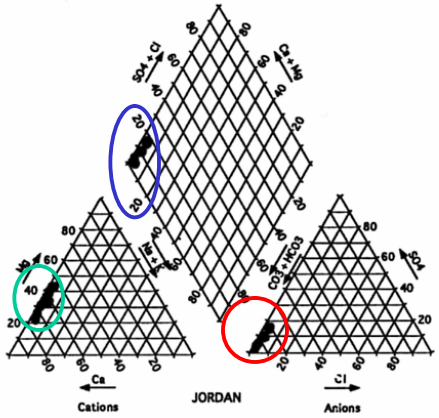
GALENA



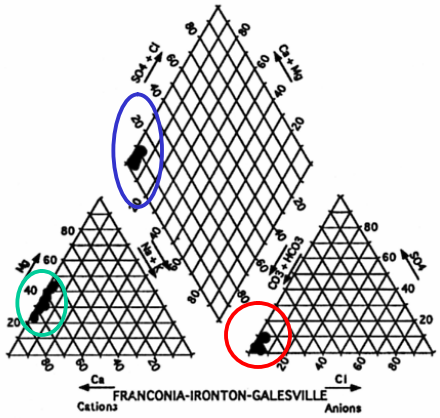
ST. PETER



PRAIRIE DU CHIEN



JORDAN



FRANCONIA-IRONTON-GALESVILLE

•Chemical data provide a valuable tool for tracing ground-water flow paths

•Deviations from background concentrations help identify zones of preferential flow within bedrock aquifers

•Recognizing regional patterns in chemical data help refine conceptual models of ground-water flow

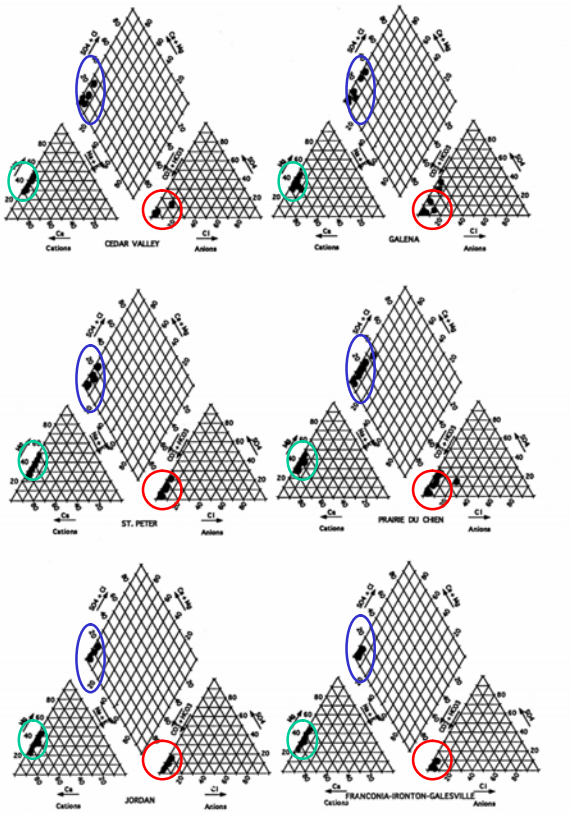
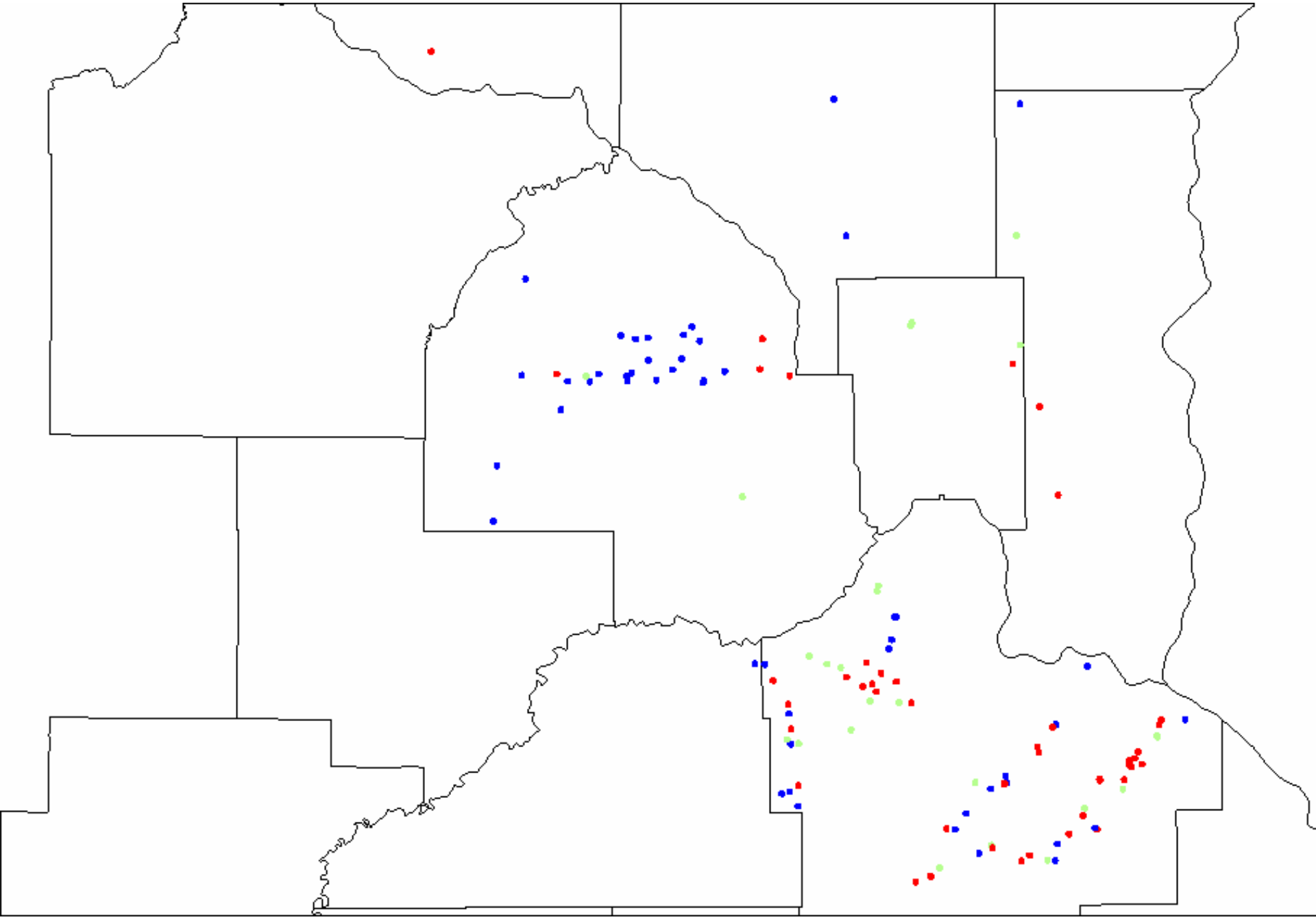
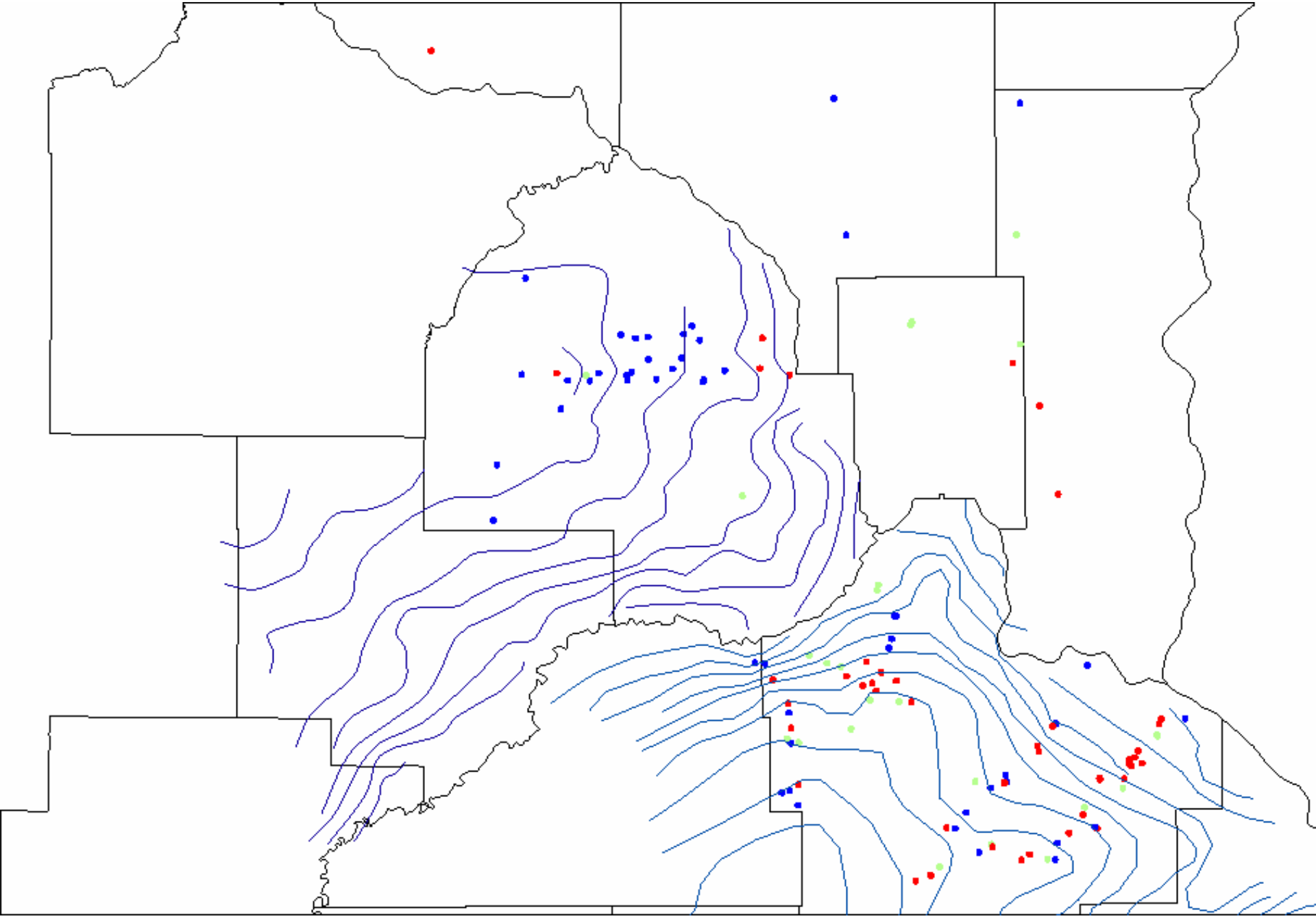
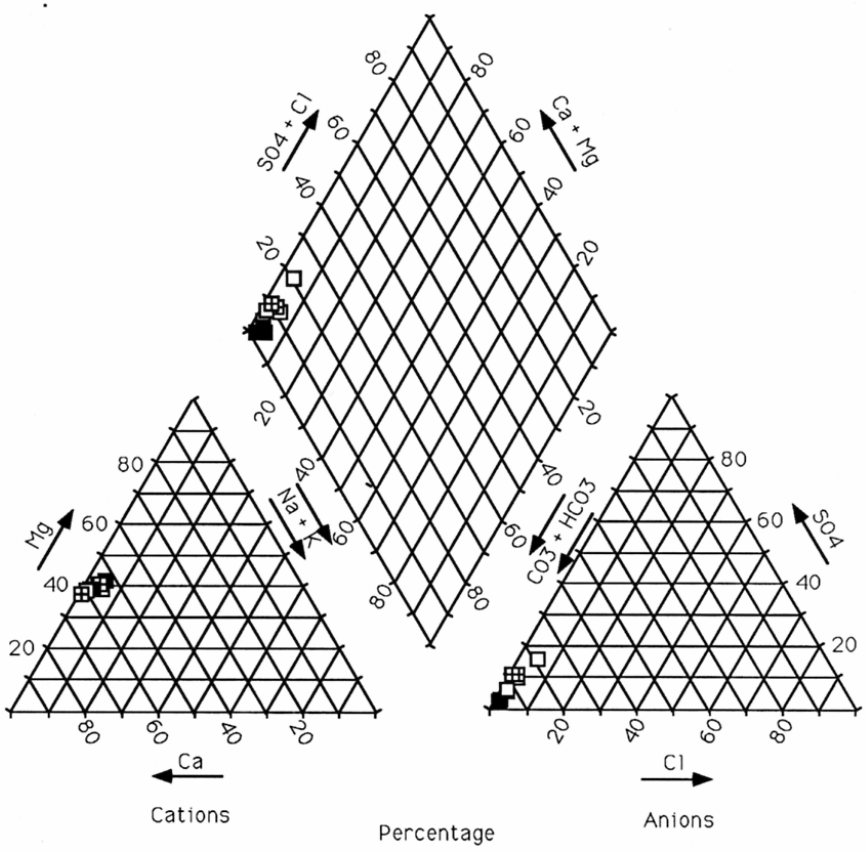


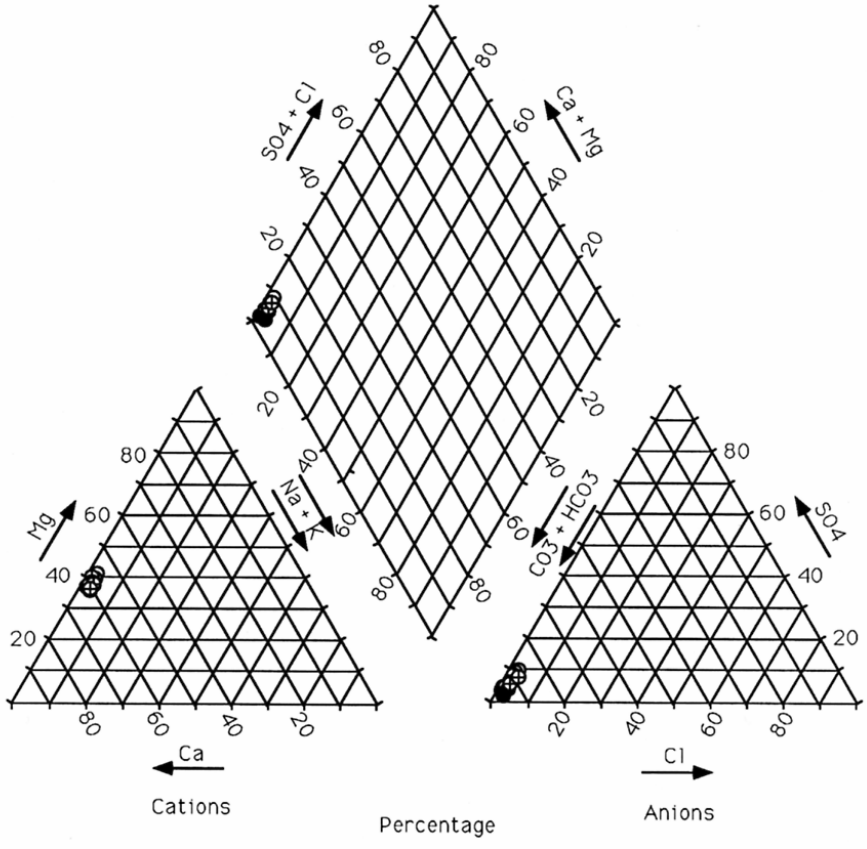
Figure 10. Piper Diagrams for water-chemistry samples from the Cedar Valley, Galena, St. Peter, Prairie du Chien, Jordan, and Franconia-Ironton-Galesville formations.







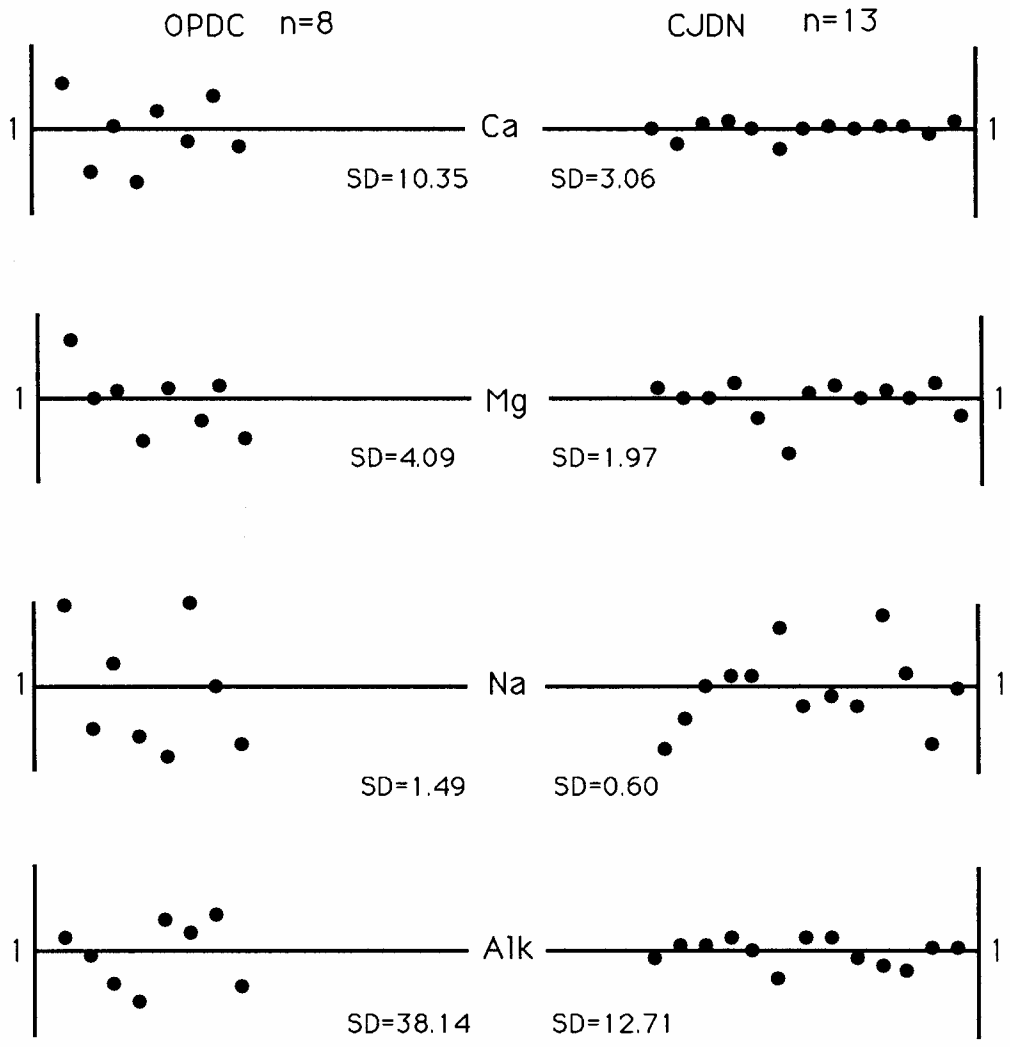
Prairie du Chien Wells

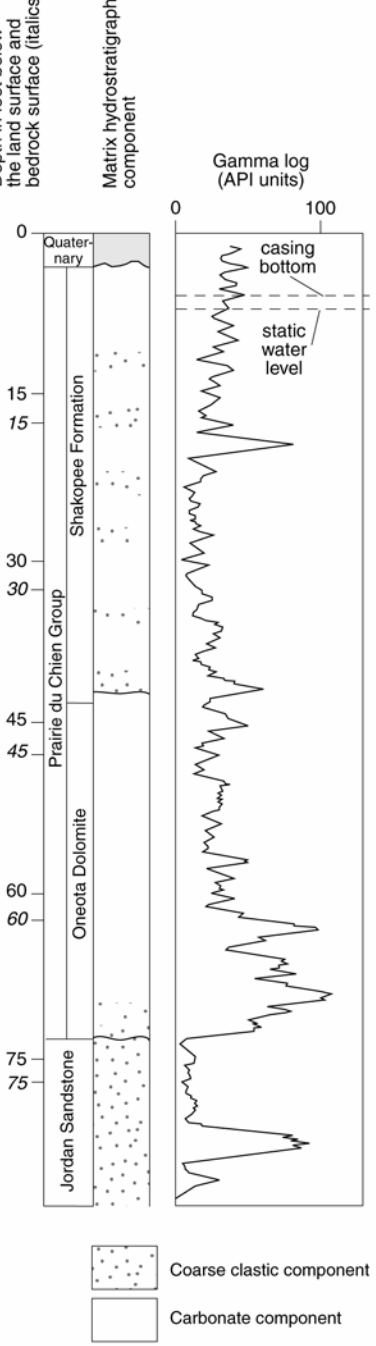


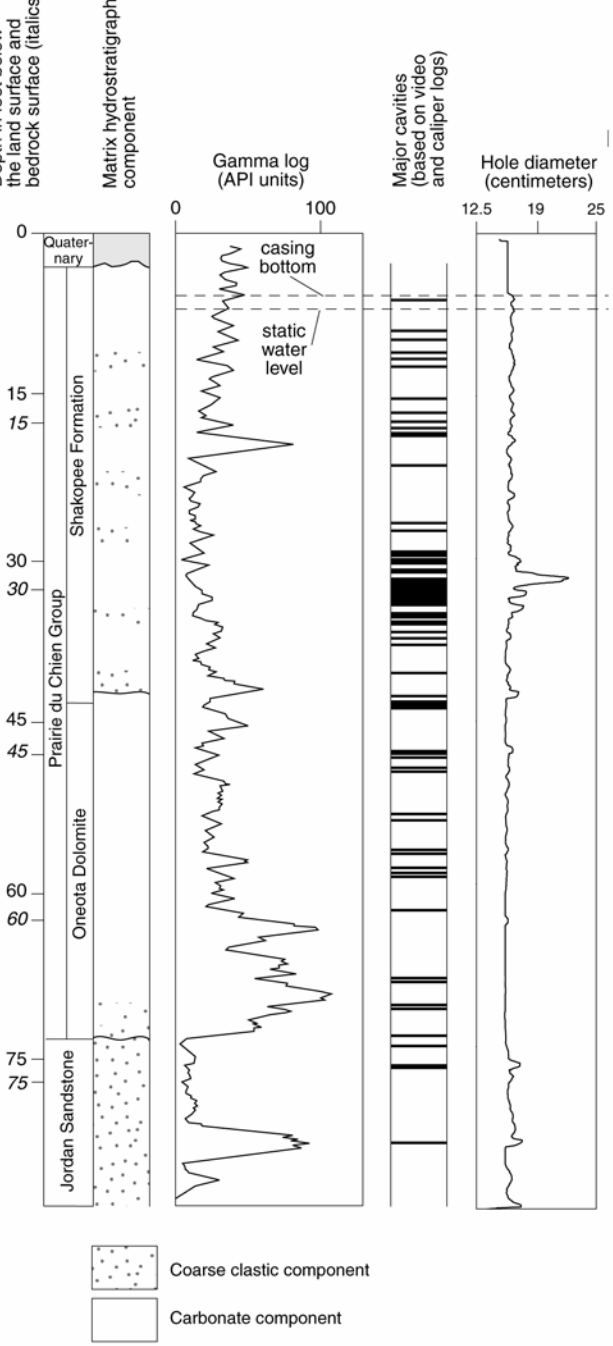
Jordan Wells

Normalization plots of analytes

Prairie du Chien vs. Jordan wells

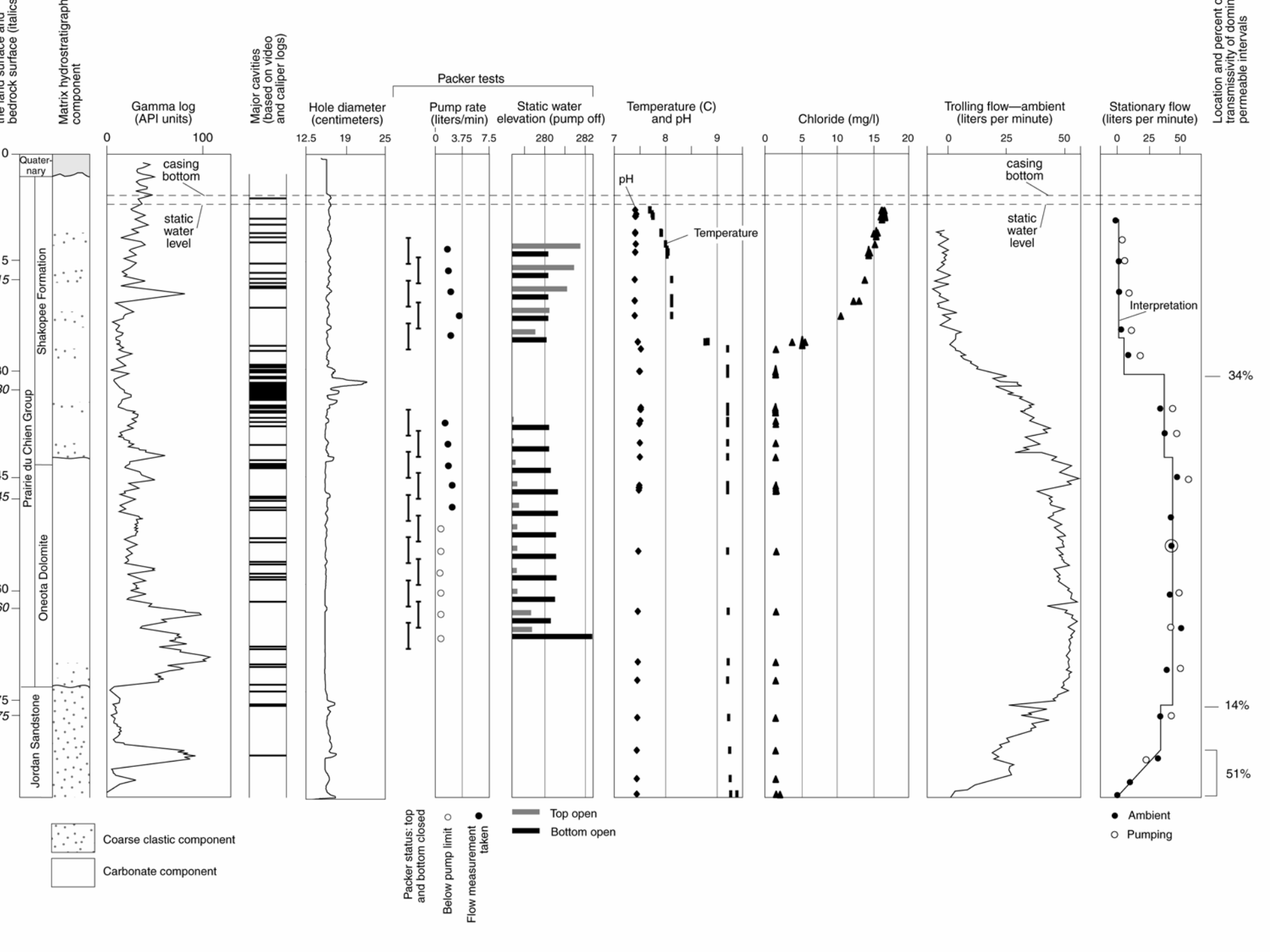


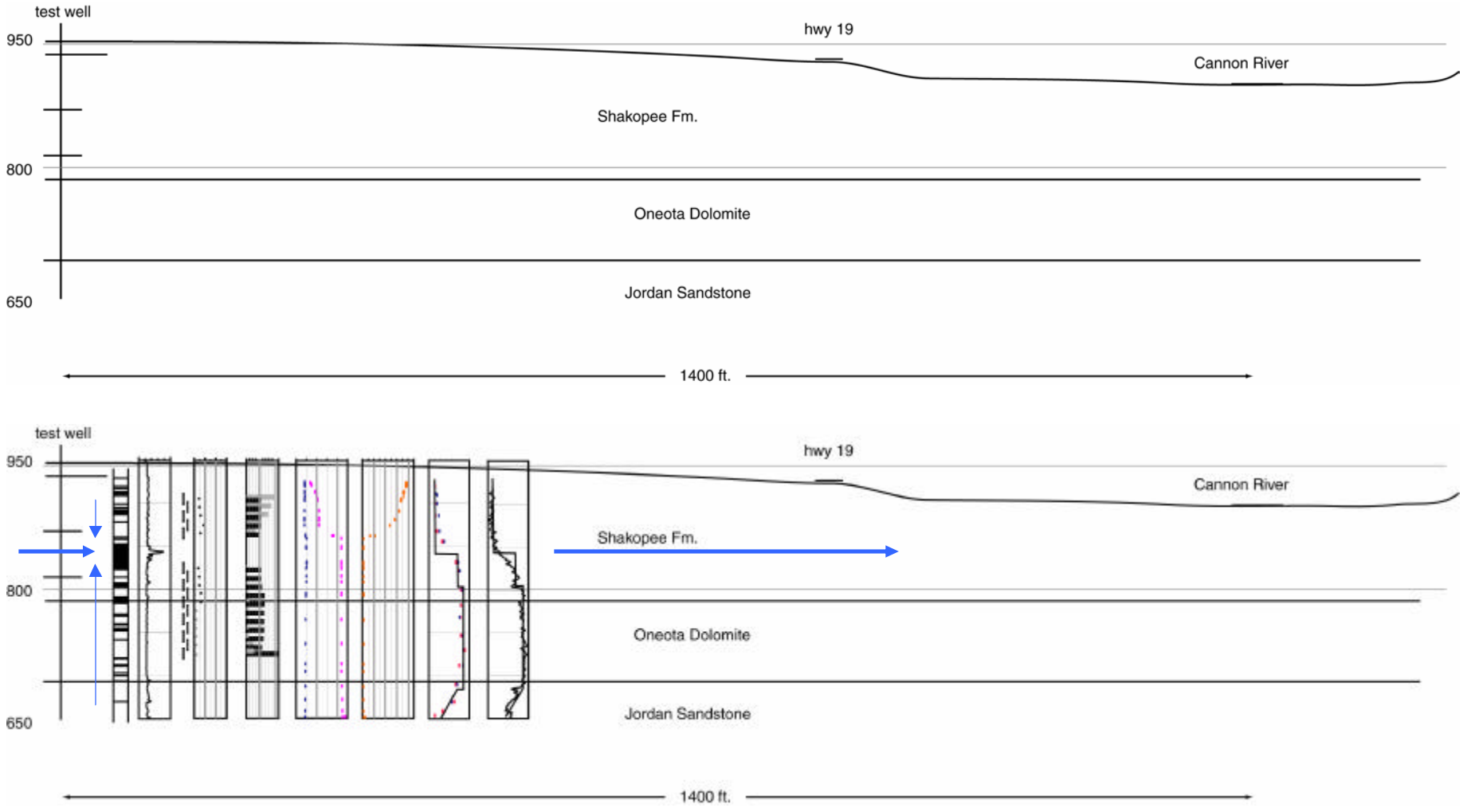

the land surface and bedrock surface (italics)
Matrix hydrostratigraphic component
Gamma log (API units)
0
100
0
15
15
30
30
45
45
60
60
75
75
Quater-nary
Prairie du Chien Group
Shakopee Formation
Oneota Dolomite
Jordan Sandstone
casing bottom
static water level
Coarse clastic component
Carbonate component

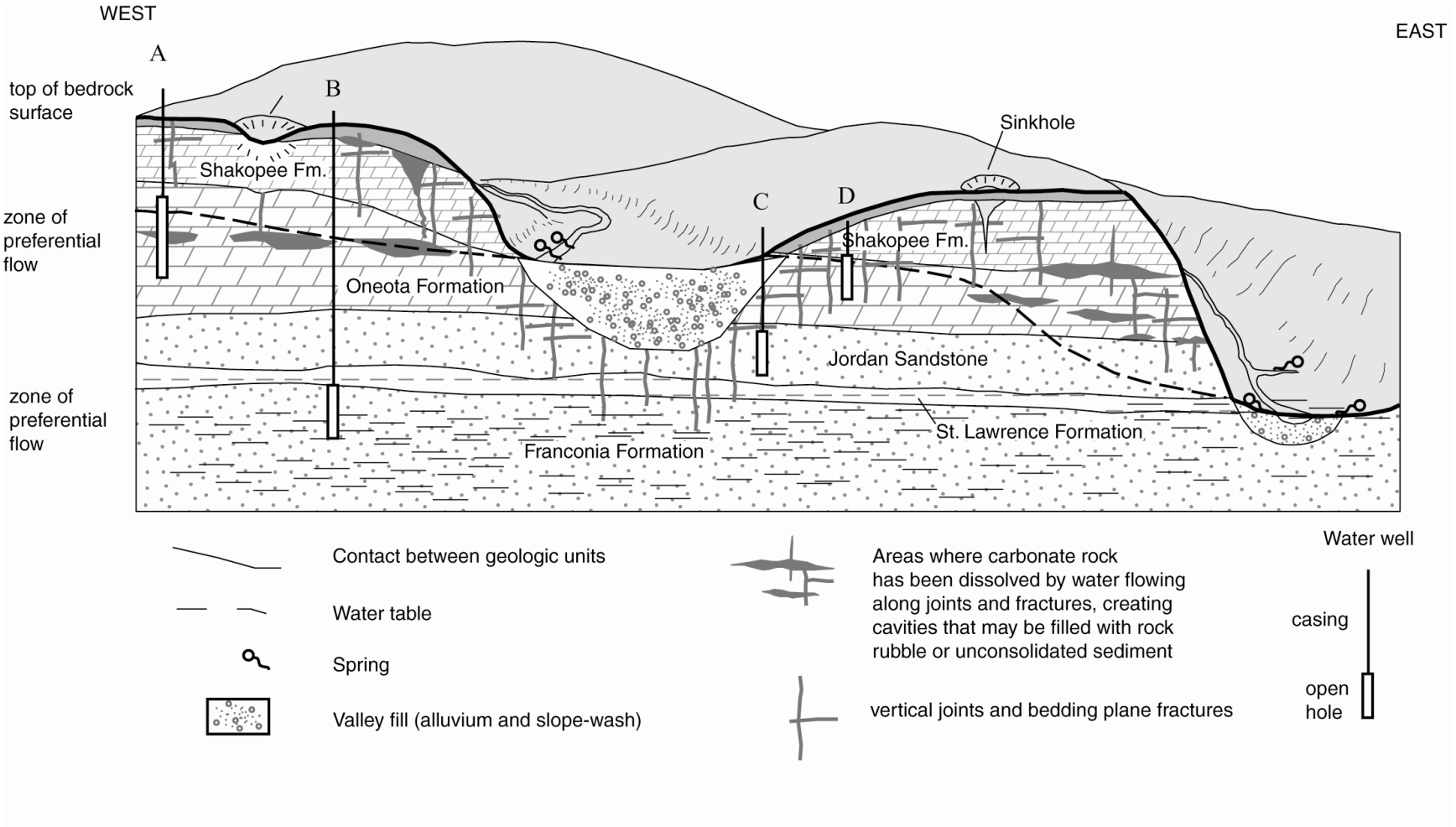

the land surface and bedrock surface (italics)
Matrix hydrostratigraphic component
Gamma log (API units)
Major cavities (based on video and caliper logs)
Hole diameter (centimeters)
0
100
12.5
19
25
0
15
15
30
30
45
45
60
60
75
75
Quater-nary
Shakopee Formation
Prairie du Chien Group
Oneota Dolomite
Jordan Sandstone
casing bottom
static water level
Coarse clastic component
Carbonate component

the land surface and
bedrock surface (italics
Matrix hydrostratigraphic
component
Gamma log
(API units)
Major cavities
(based on video
and caliper logs)
Hole diameter
(centimeters)
Packer tests
Pump rate
(liters/min)
Static water
elevation (pump off)
0
100
12.5
19
25
0
3.75
7.5
280
282
Quater-
nary
Shakopee Formation
Prairie du Chien Group
Oneota Dolomite
Jordan Sandstone
casing
bottom
static
water
level
0
15
15
30
30
45
45
60
60
75
75
Coarse clastic component
Carbonate component
Packer status: top
and bottom closed
Below pump limit
Flow measurement
taken
Top open
Bottom open

the land surface and
bedrock surface (italics
Matrix hydrostratigraphic
component
Gamma log
(API units)
Major cavities
(based on video
and caliper logs)
Hole diameter
(centimeters)
Packer tests
Pump rate
(liters/min)
Static water
elevation (pump off)
Temperature (C)
and pH
Chloride (mg/l)
0
100
12.5
19
25
0
3.75
7.5
280
282
7
8
9
0
5
10
15
20
Quater-
nary
Shakopee Formation
Prairie du Chien Group
Oneota Dolomite
Jordan Sandstone
casing
bottom
static
water
level
pH
Temperature
0
15
15
30
30
45
45
60
60
75
75
Coarse clastic component
Carbonate component
Packer status: top
and bottom closed
Below pump limit
Flow measurement
taken
Top open
Bottom open


Matrix hydrostratigraphic component
Gamma log (API units)
Major cavities (based on video and caliper logs)
Hole diameter (centimeters)
Packer tests
Pump rate (liters/min)
Static water elevation (pump off)
Temperature (C) and pH
Chloride (mg/l)
Trolling flow—ambient (liters per minute)
Stationary flow (liters per minute)
Location and percent of transmissivity of dominant permeable intervals
Quaternary
Shakopee Formation
Prairie du Chien Group
Oneota Dolomite
Jordan Sandstone
casing bottom
static water level
pH
Temperature
Interpretation
34%
14%
51%
Coarse clastic component
Carbonate component
Packer status: top and bottom closed
Below pump limit
Flow measurement taken
Top open
Bottom open
Ambient
Pumping


test well
950
800
650
hwy 19
Cannon River
Shakopee Fm.
Oneota Dolomite
Jordan Sandstone
1400 ft.
test well
950
800
650
hwy 19
Cannon River
Shakopee Fm.
Oneota Dolomite
Jordan Sandstone
1400 ft.

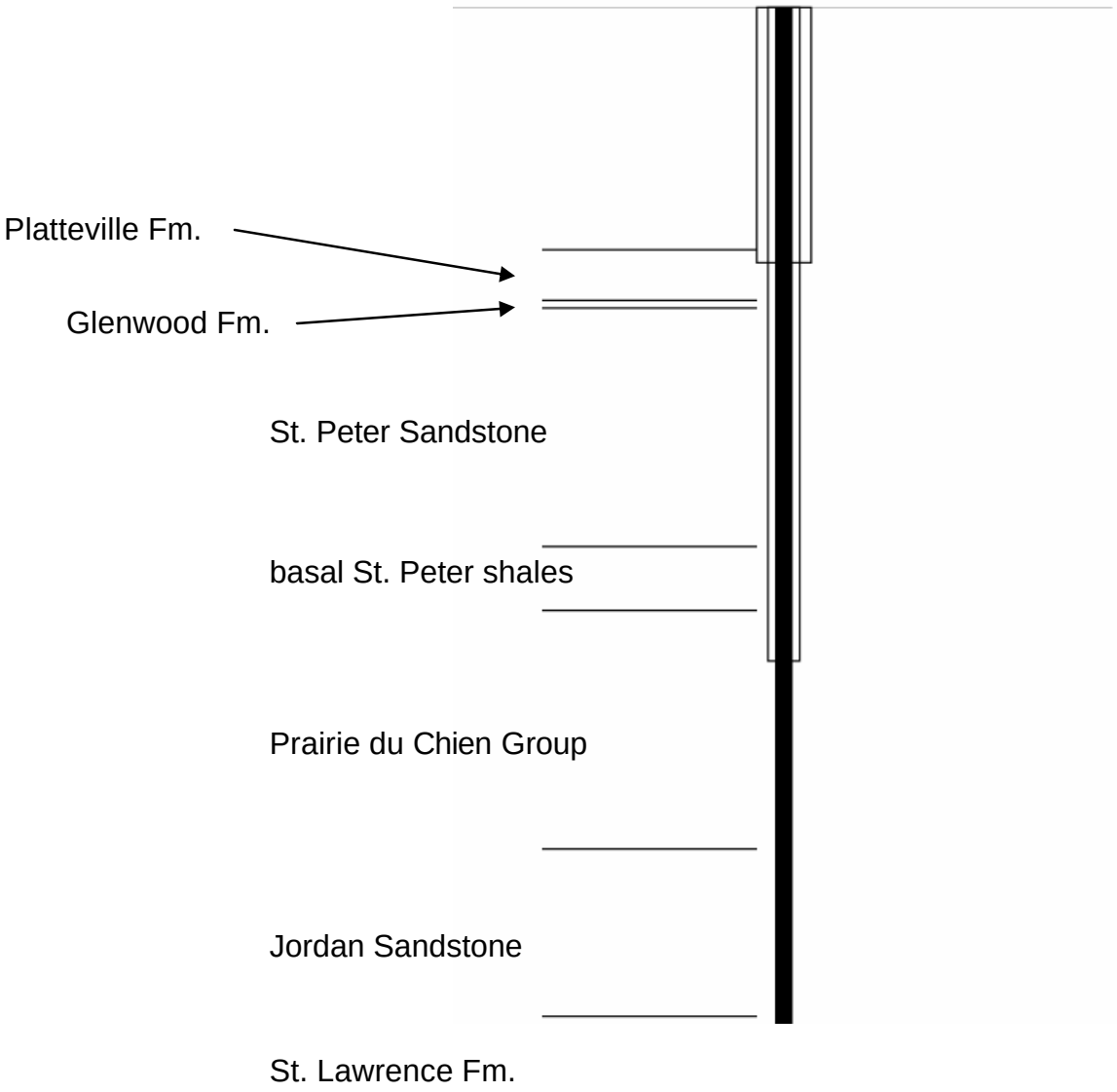


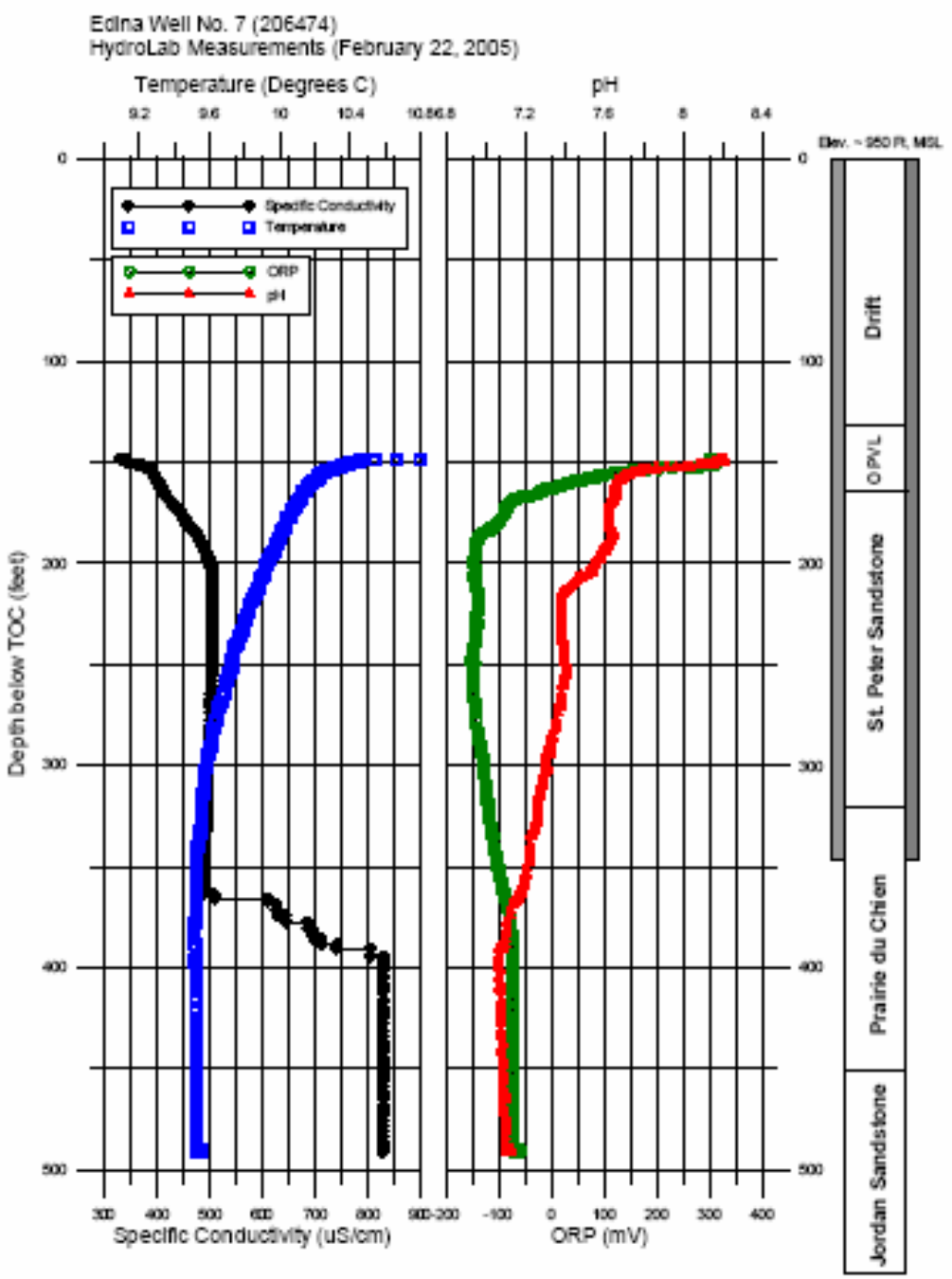
A, B - zones of preferential flow

C - bedrock valley conditions

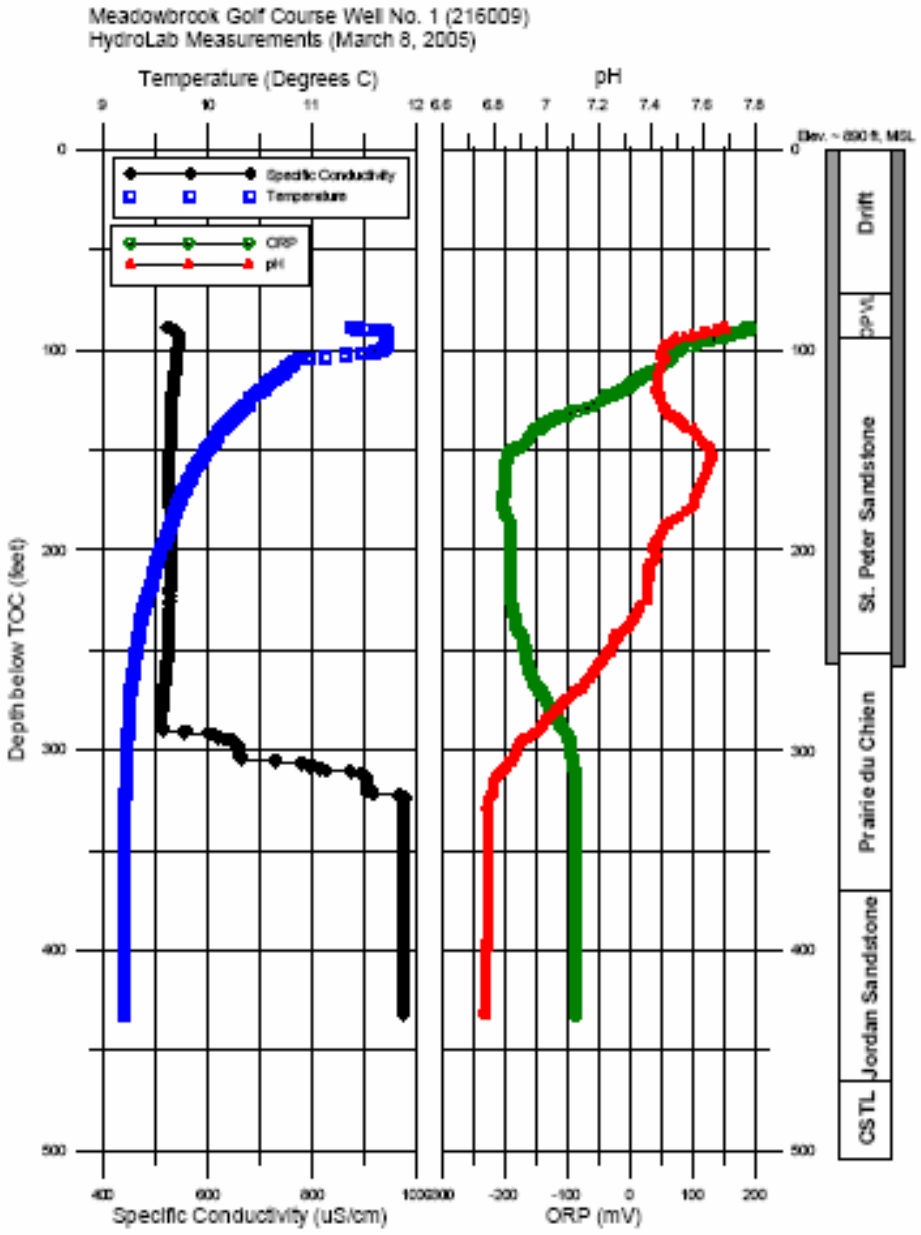
D - bedrock surface conditions

Edina Well 7


Platteville Fm.
Glenwood Fm.
St. Peter Sandstone
basal St. Peter shales
Prairie du Chien Group
Jordan Sandstone
St. Lawrence Fm.



Steve Robertson, MN Dept. of Health



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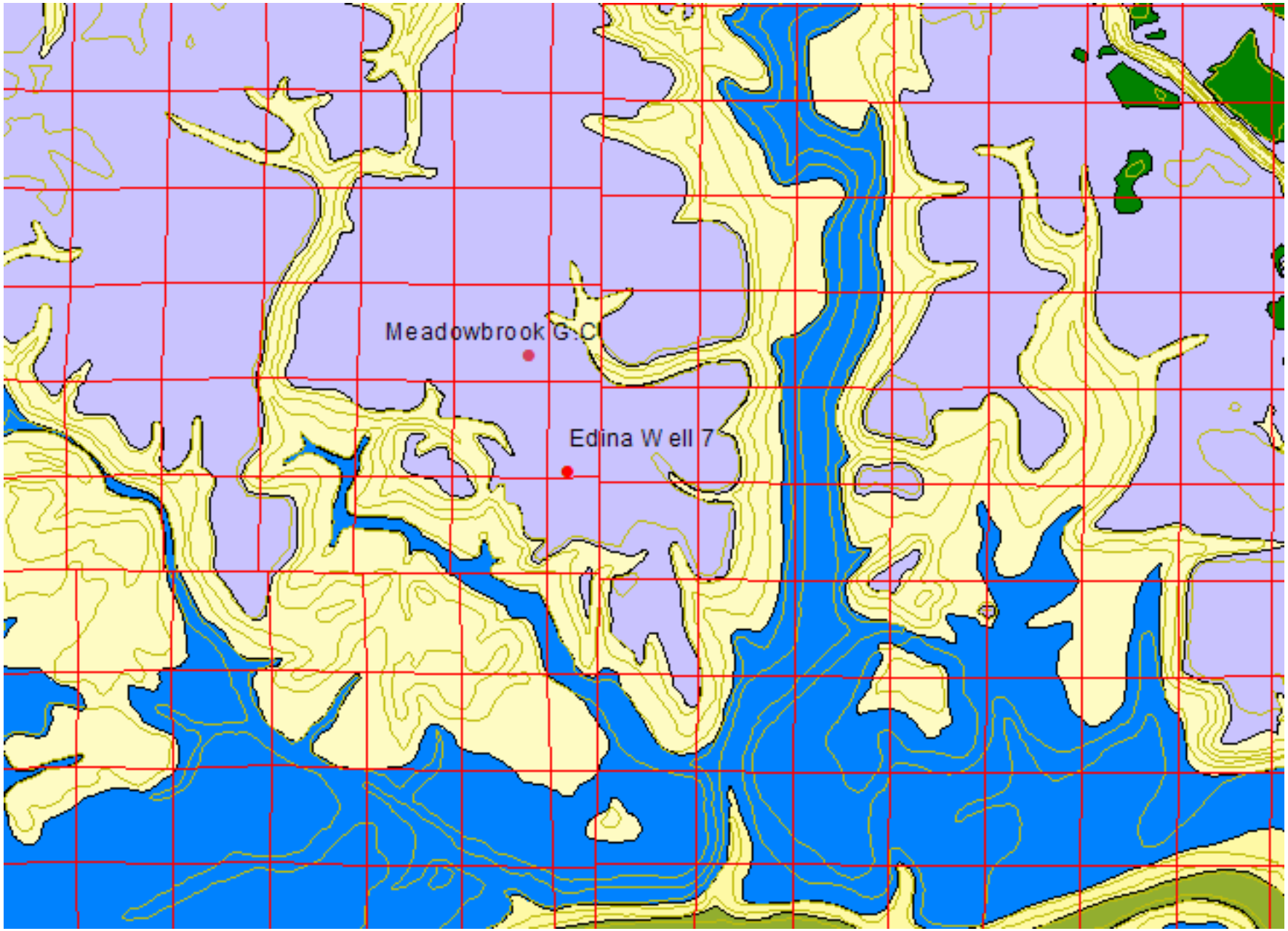
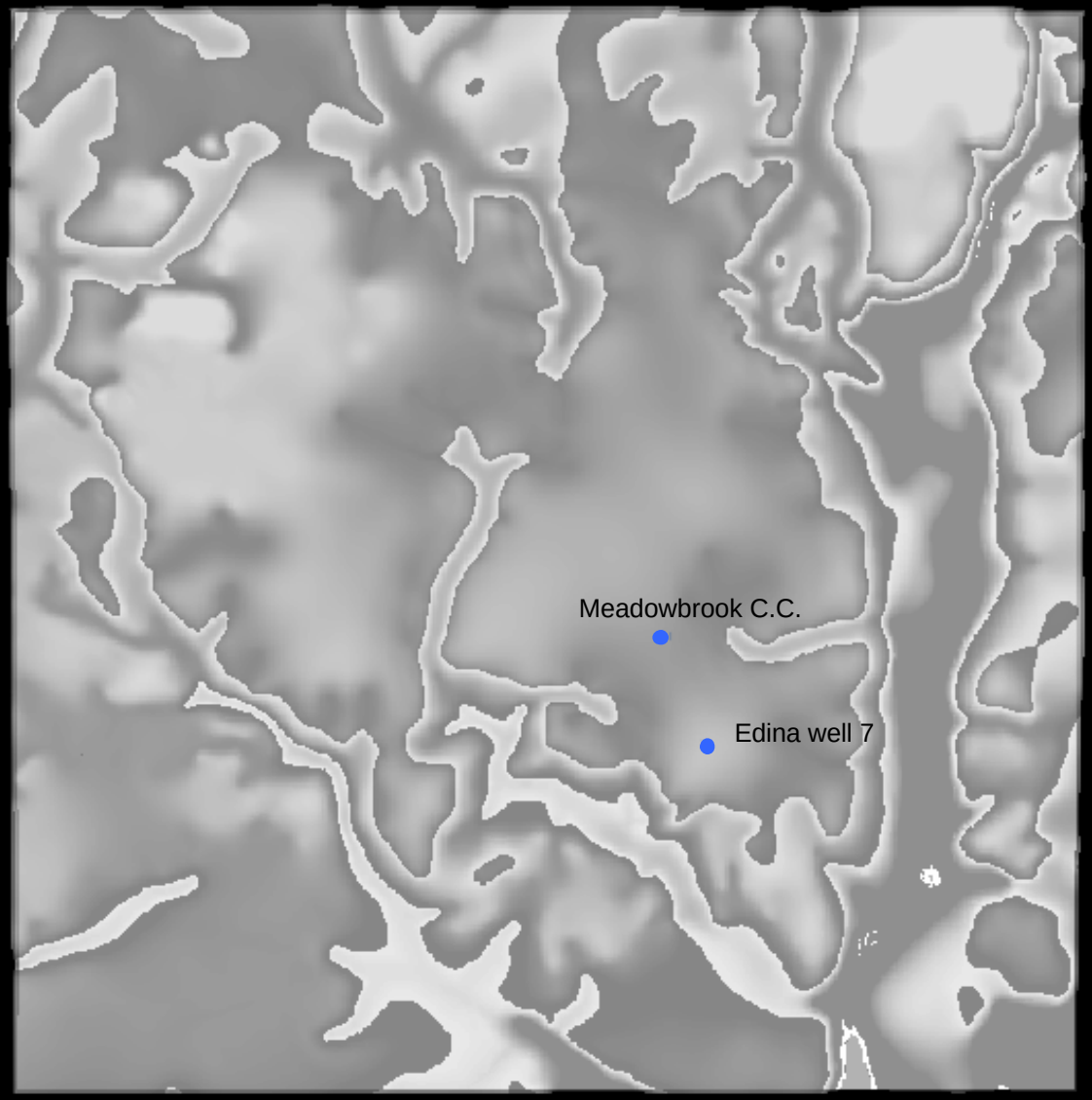
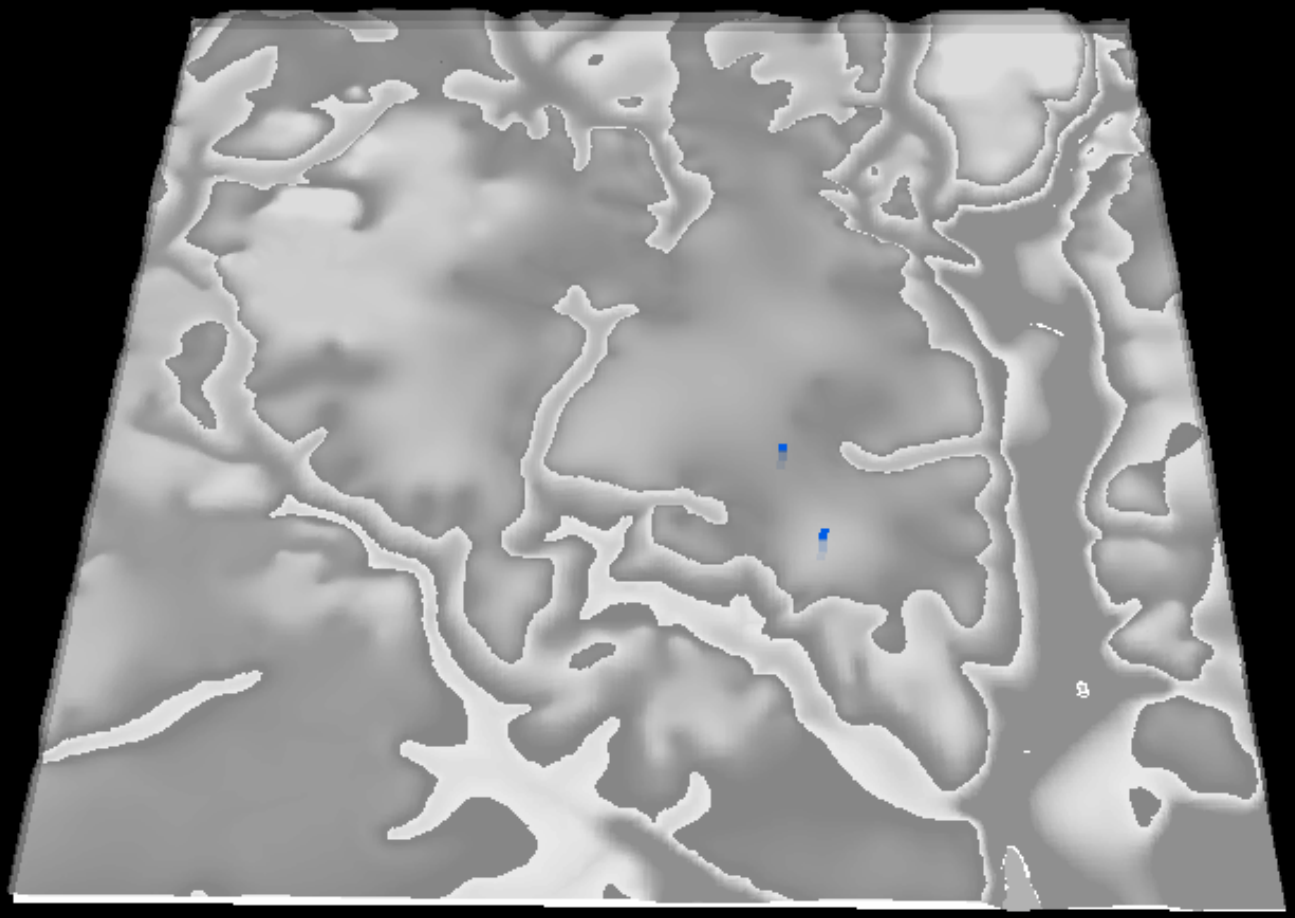
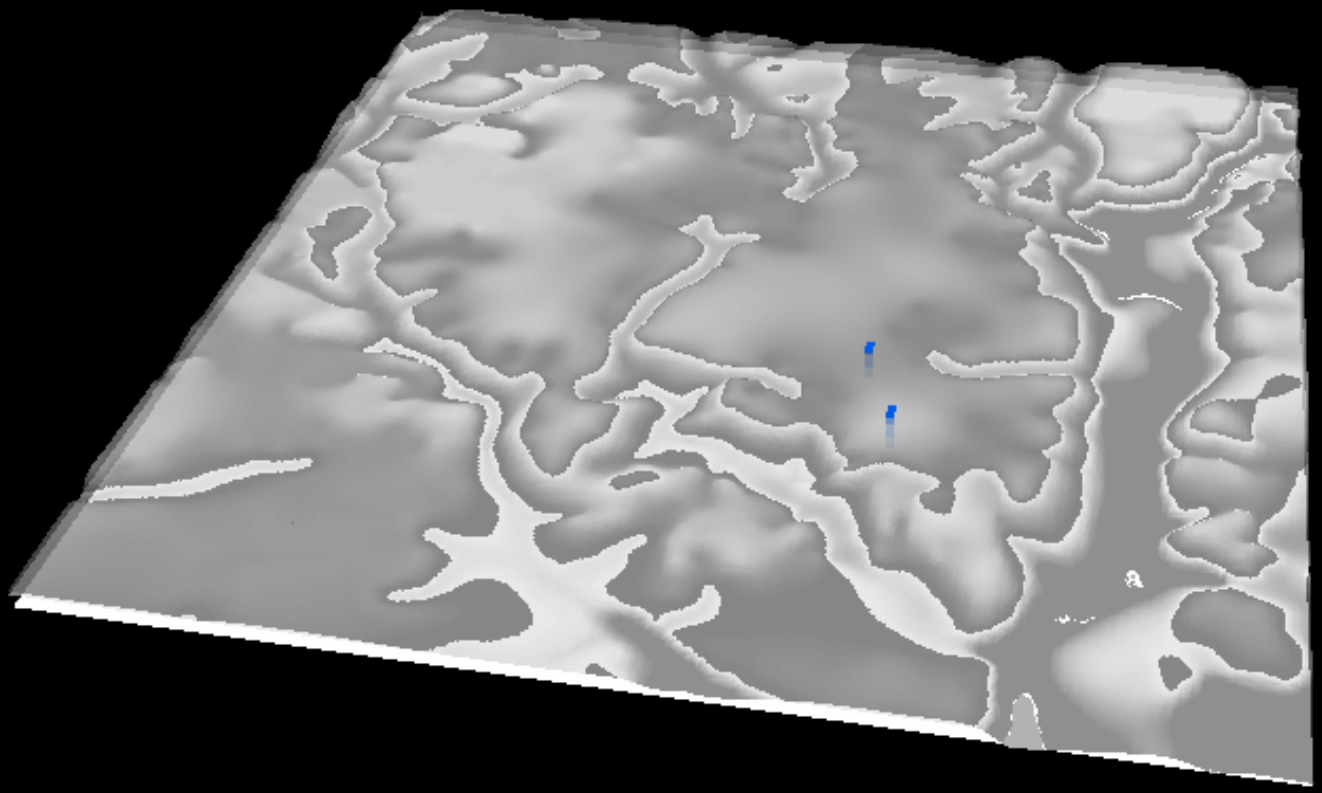
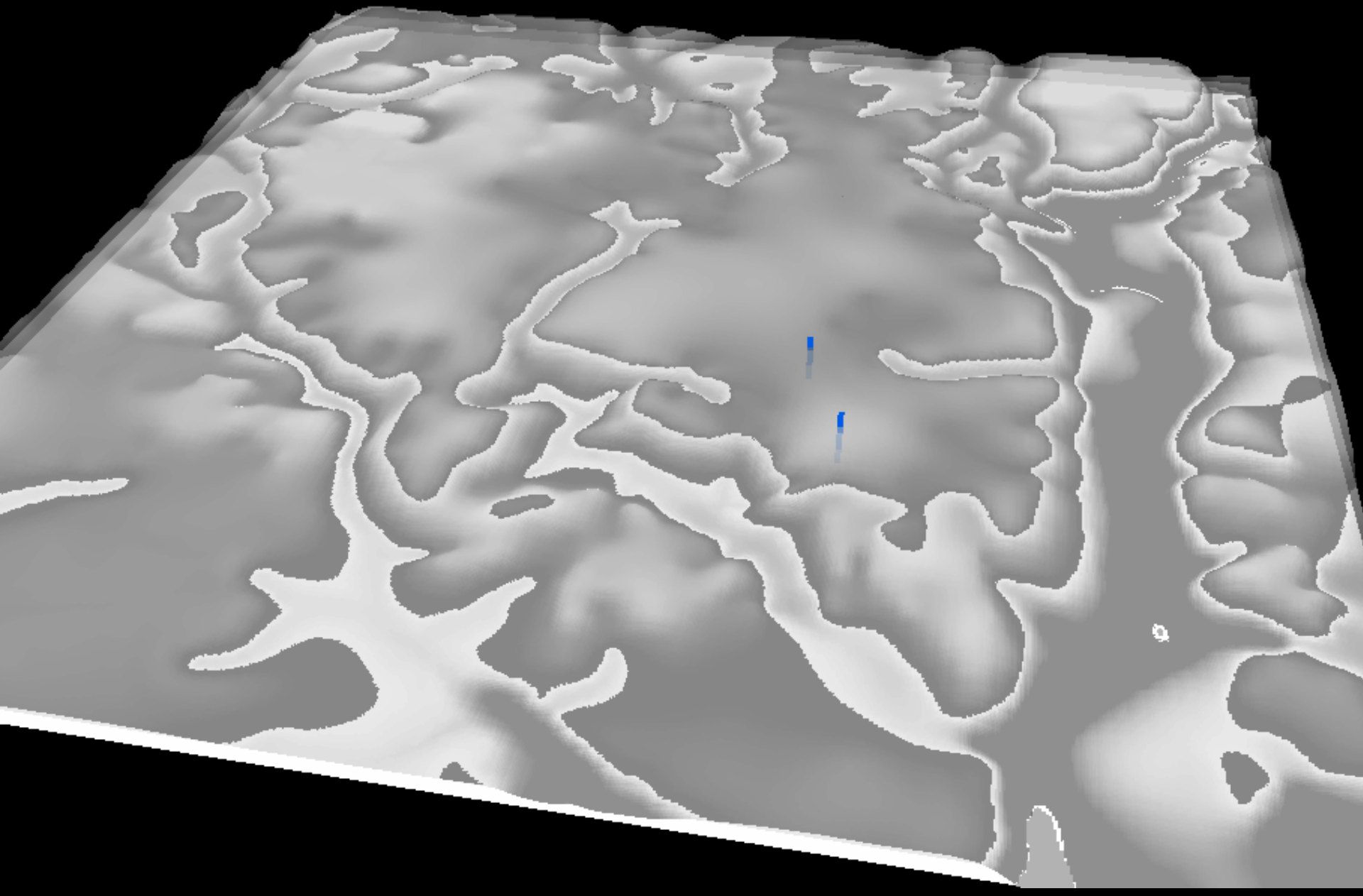
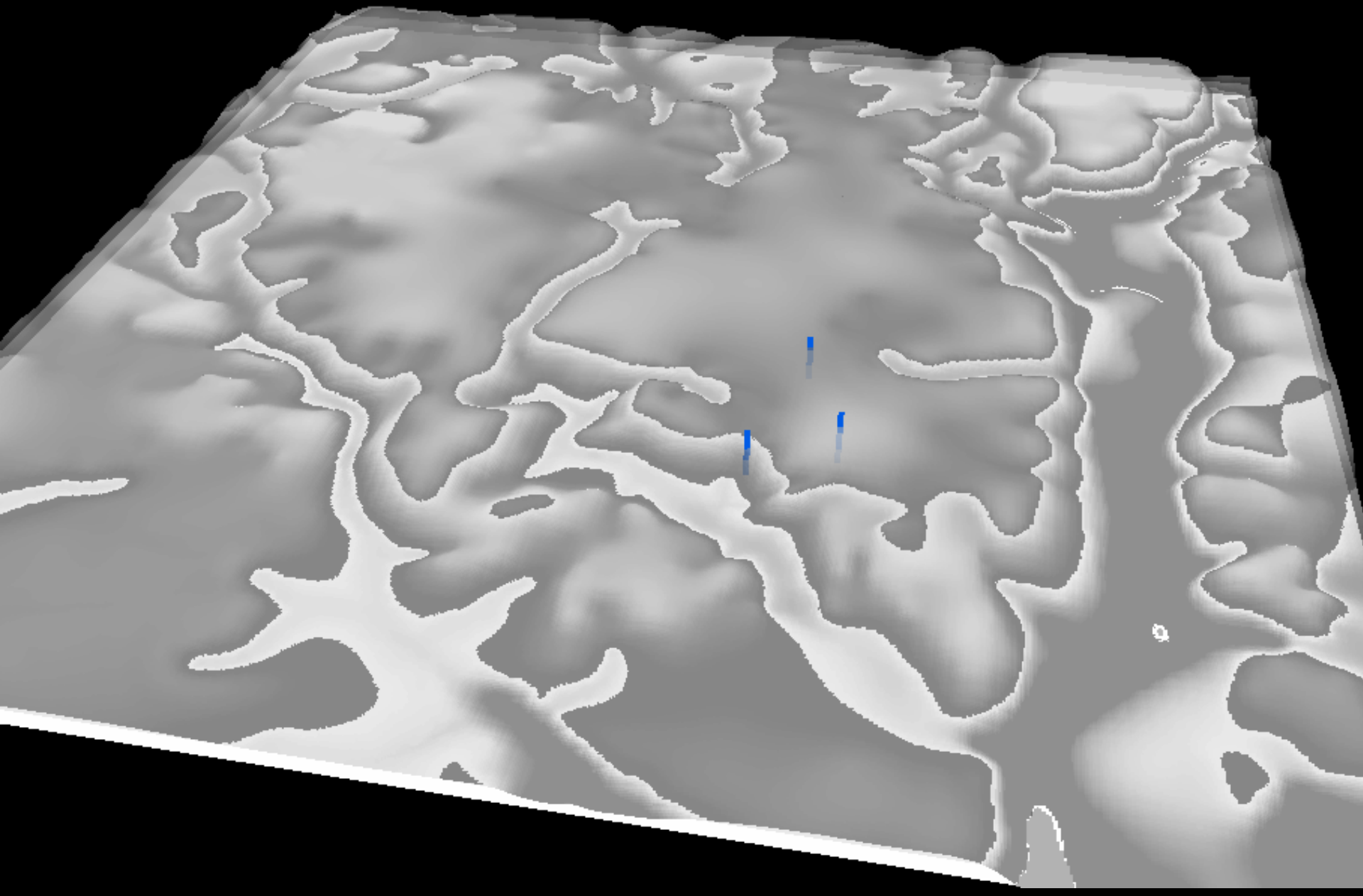

Meadowbrook G.C.
Edina Well 7


Meadowbrook C.C.
Edina well 7

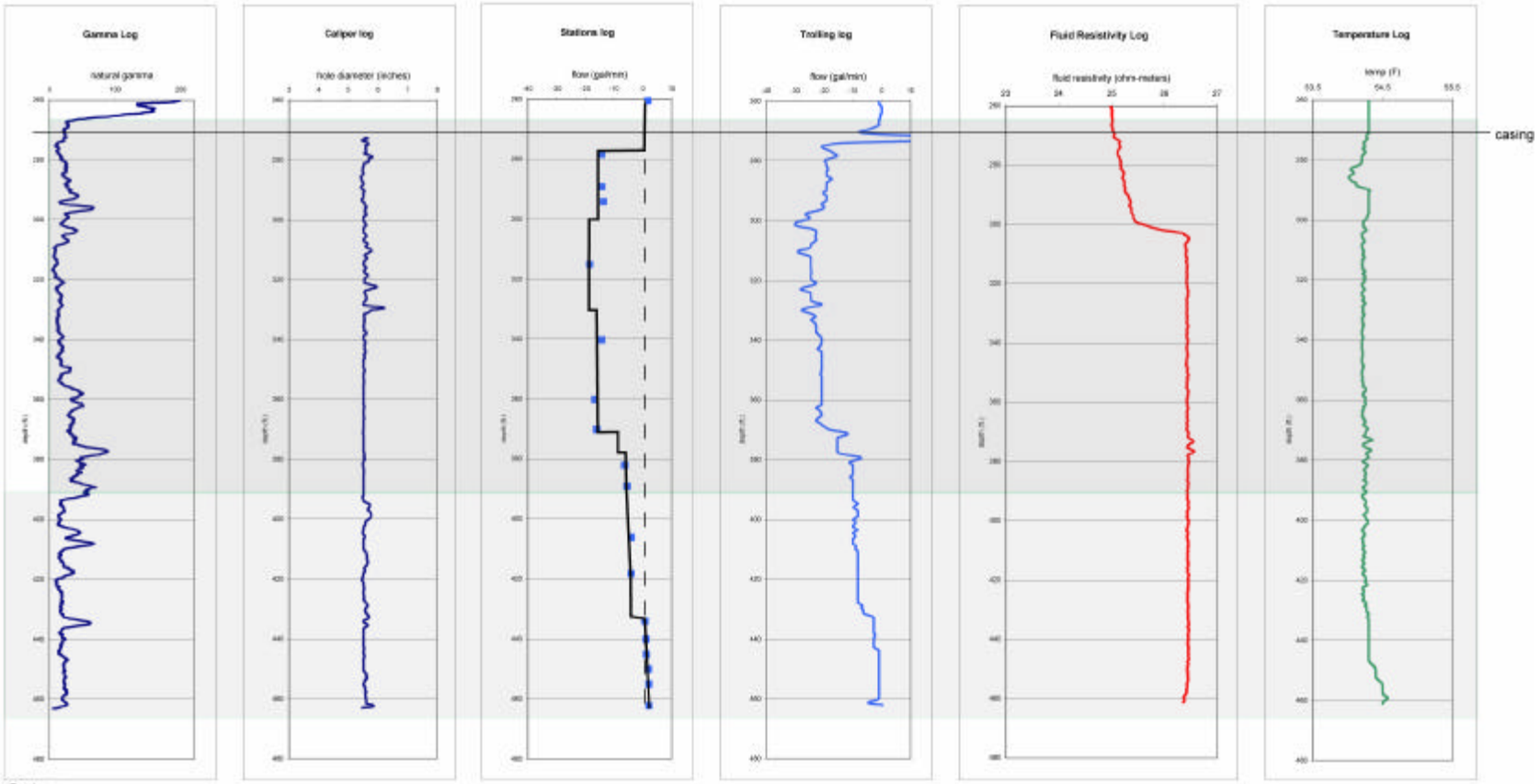








Edina test well 1 Edina, Minnesota
Unique Well Number 748656
T 117 R 21 Section 32 BDAABA



Geology:

DRIFT	0-125'
OSTP	125'-266'
OPDC	266'-393'
CJDN	393'+

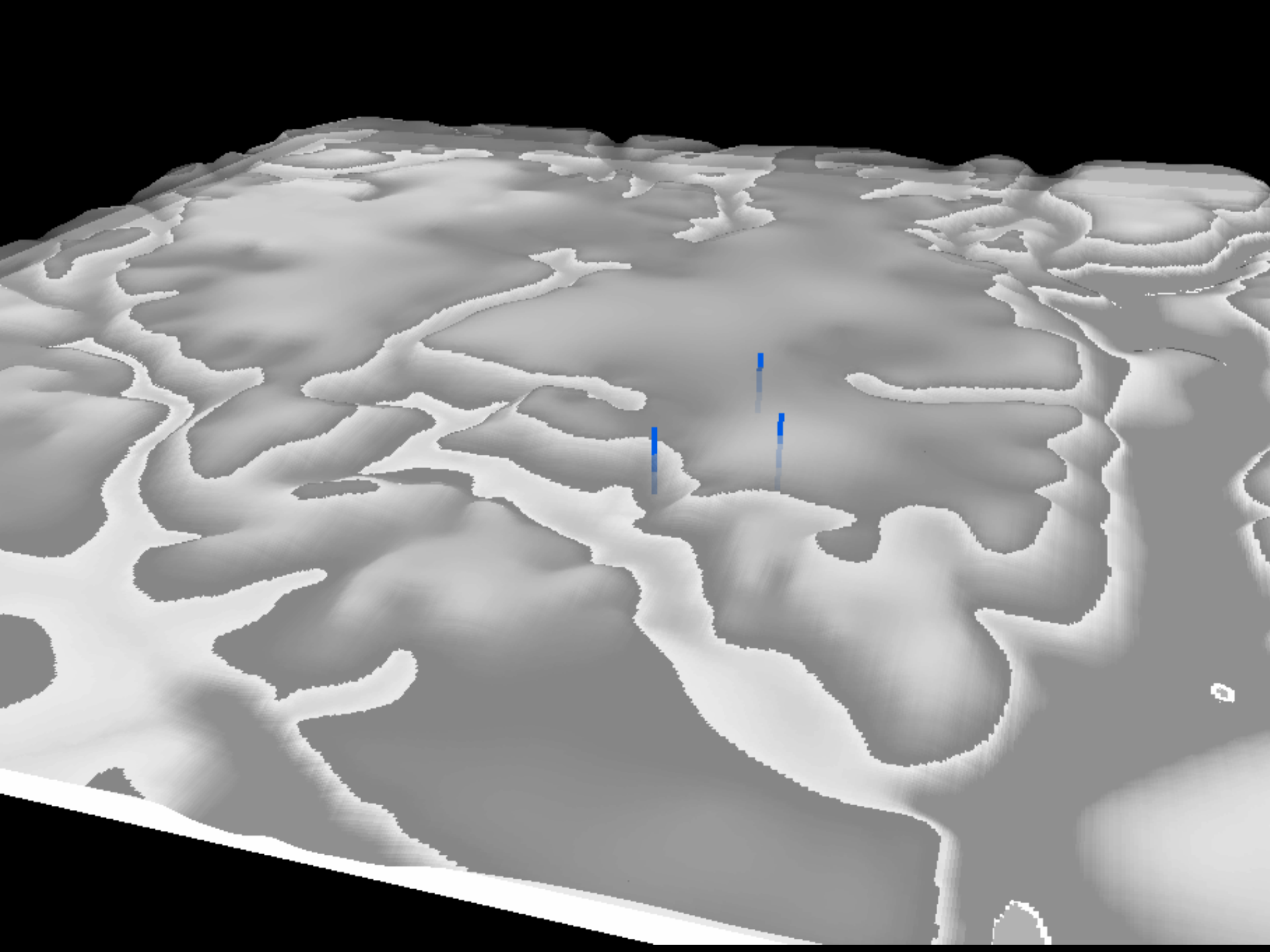
ambient ambient ambient ambient

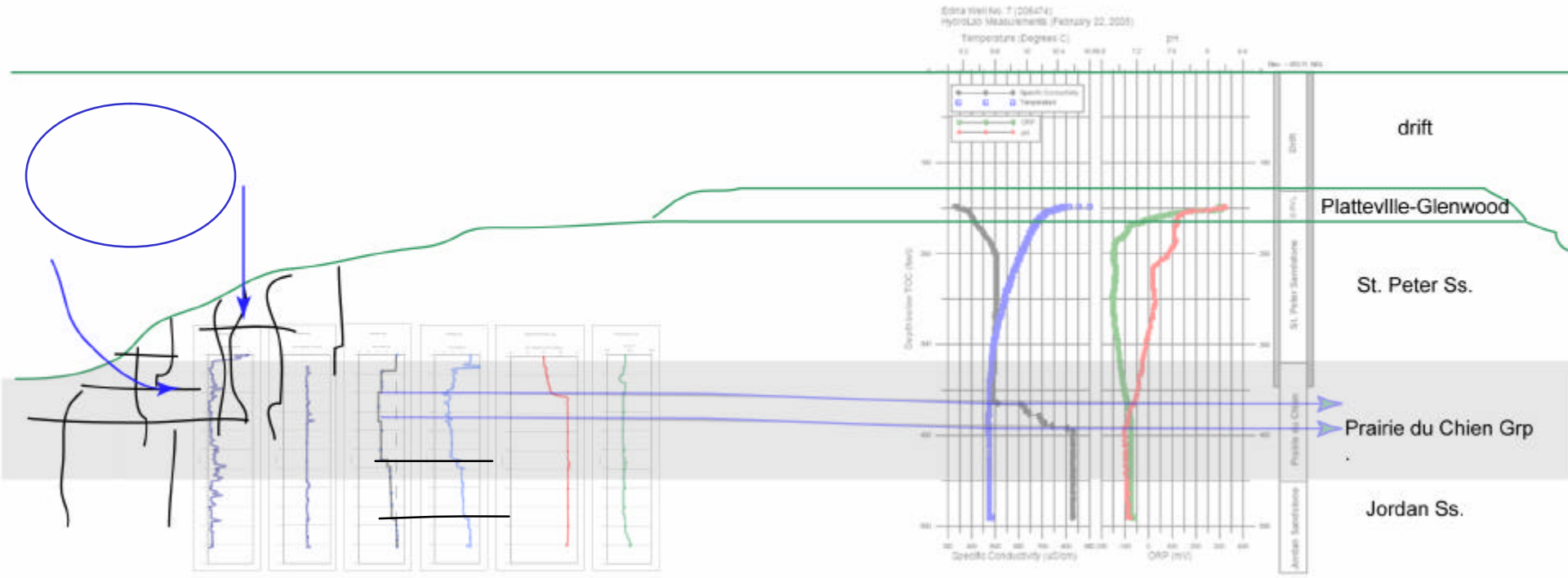
Ambient measurements made without a skirt on the tool
Measured flow estimated and plotted to be 5.5% of actual value

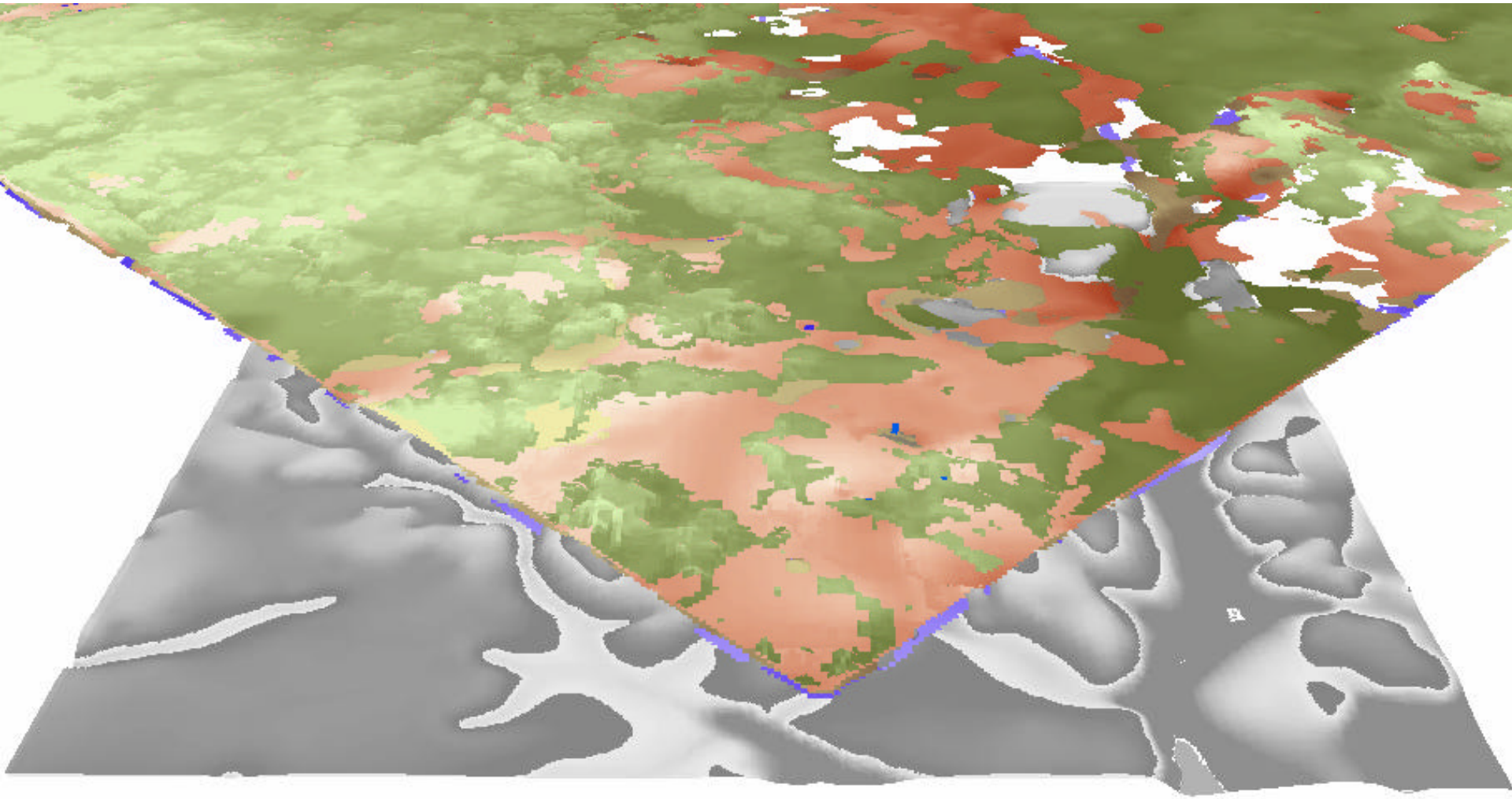
Logged by Minnesota Geological Survey
January 8, 2007

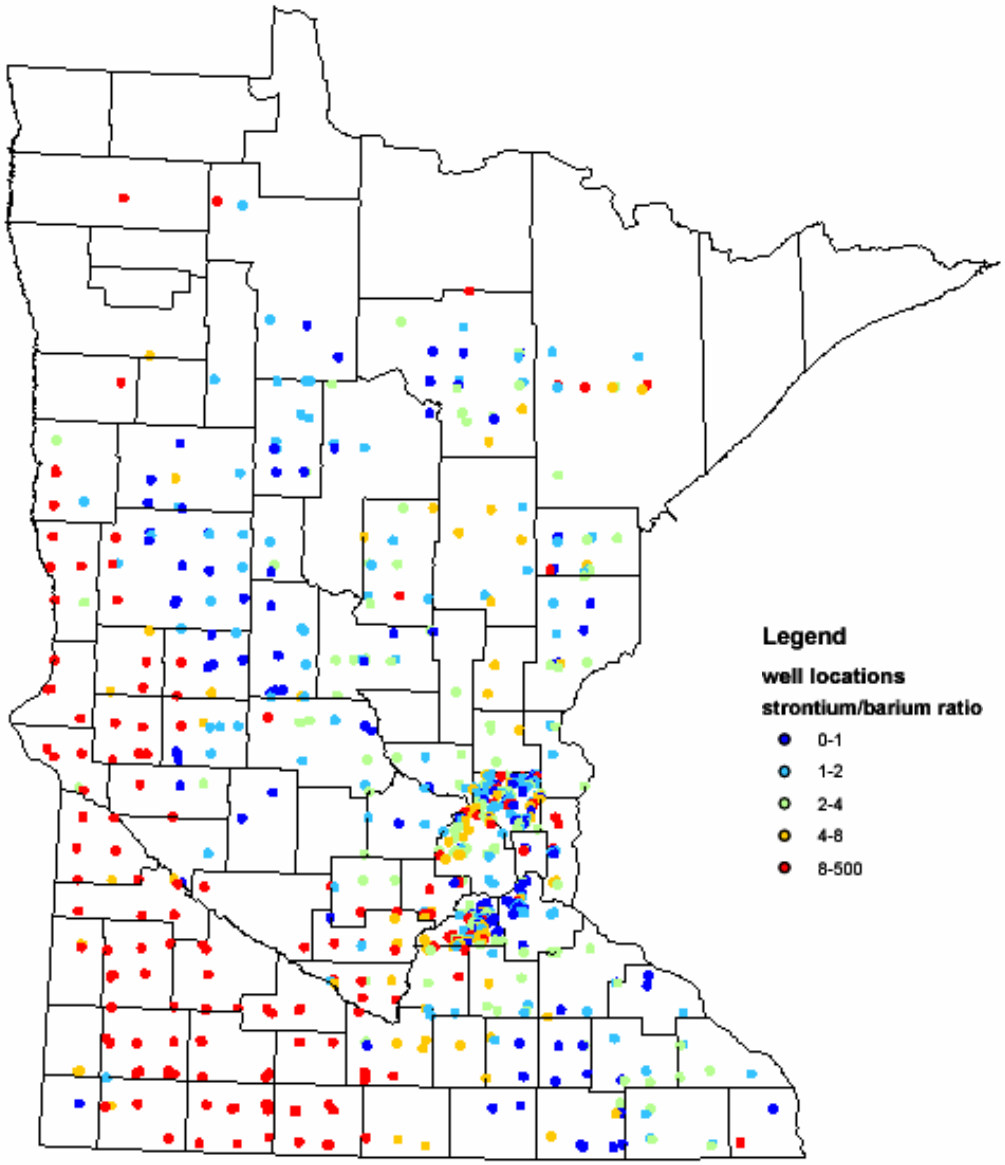
Hydraulically active zones:

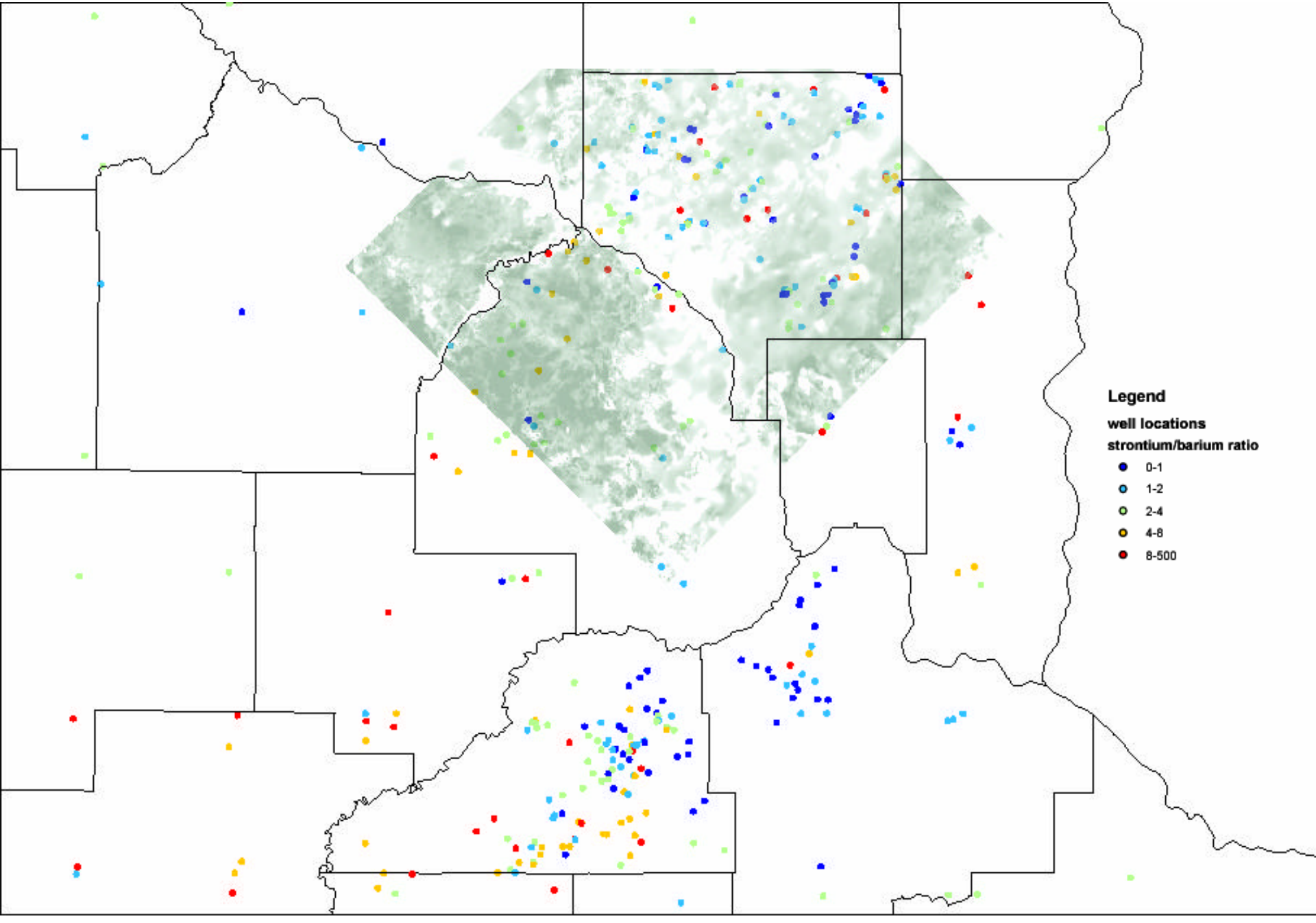
Average injection rate:
Change in water level due to injection:




drift
Platteville-Glenwood
St. Peter Ss.
Prairie du Chien Grp
Jordan Ss.




Legend
well locations
strontium/barium ratio
0-1
1-2
2-4
4-8
8-500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0-1
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4-8
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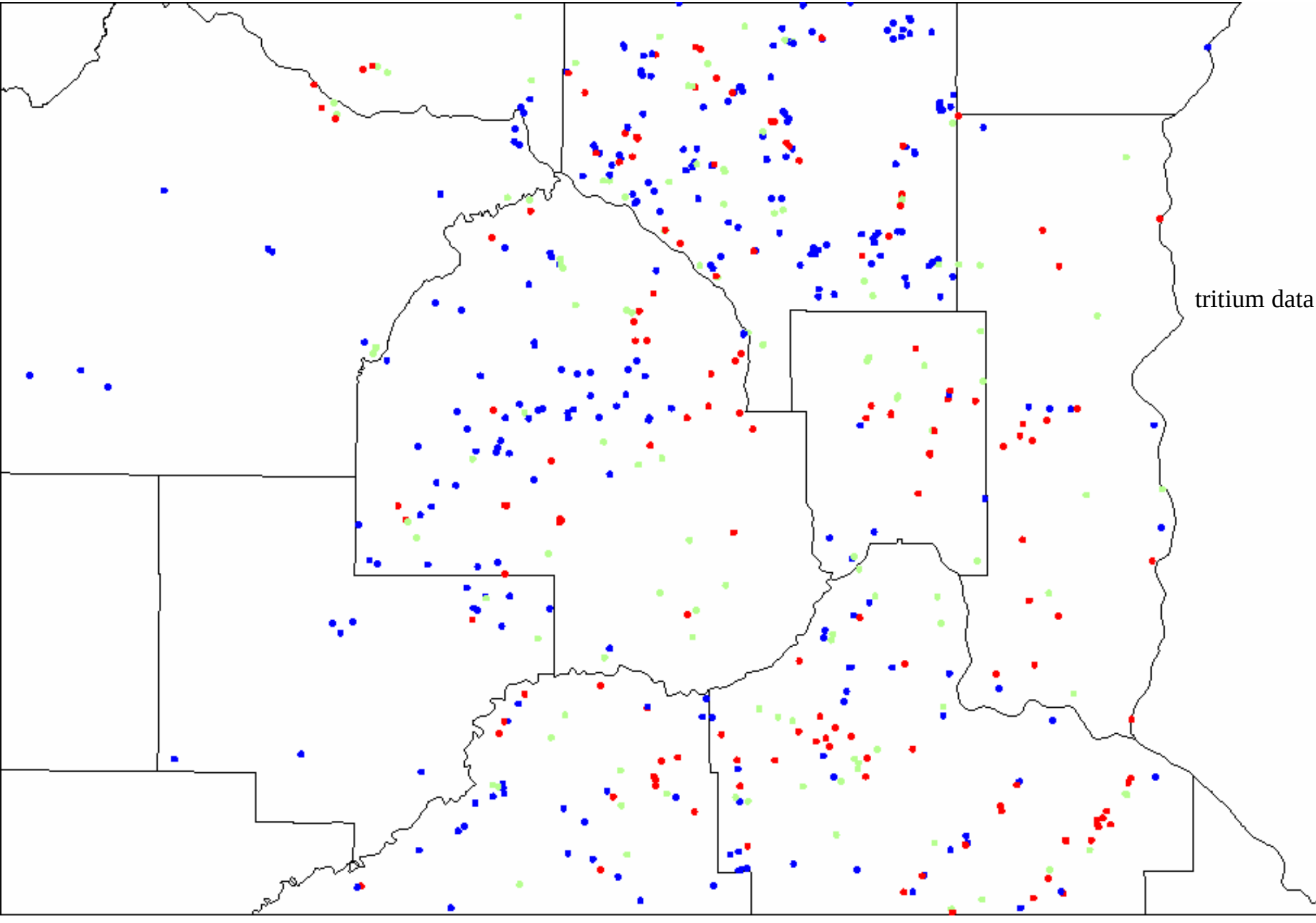
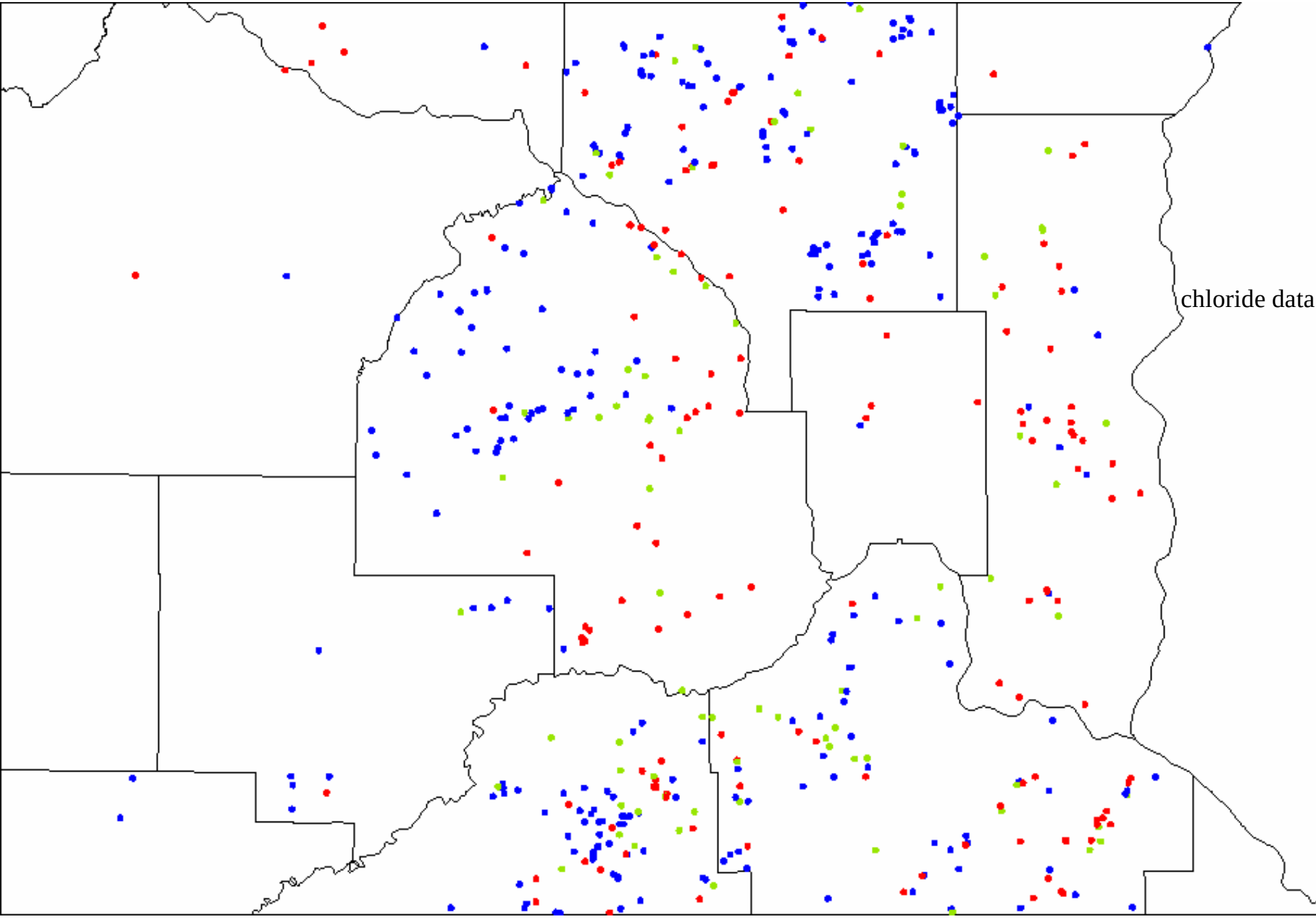
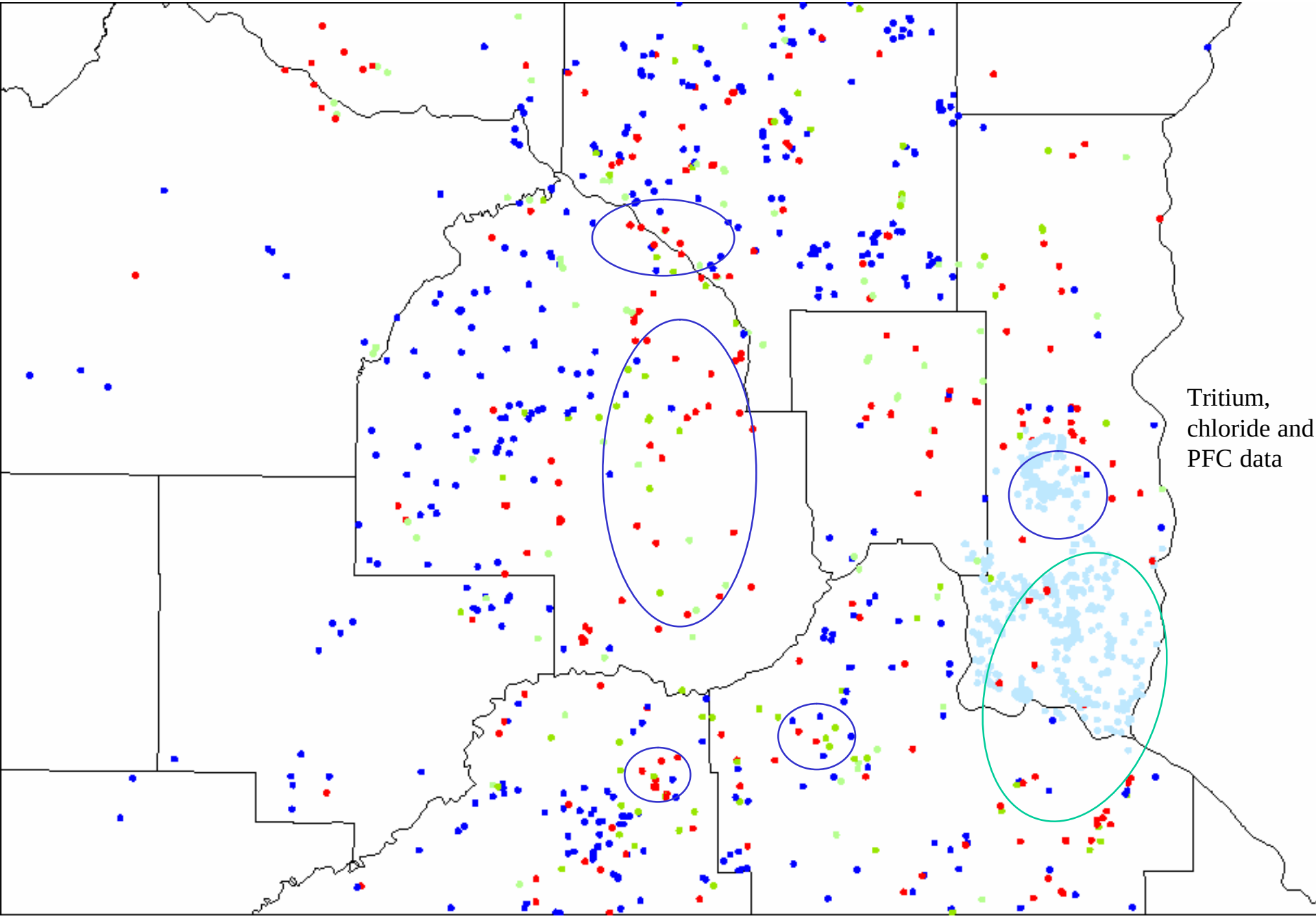
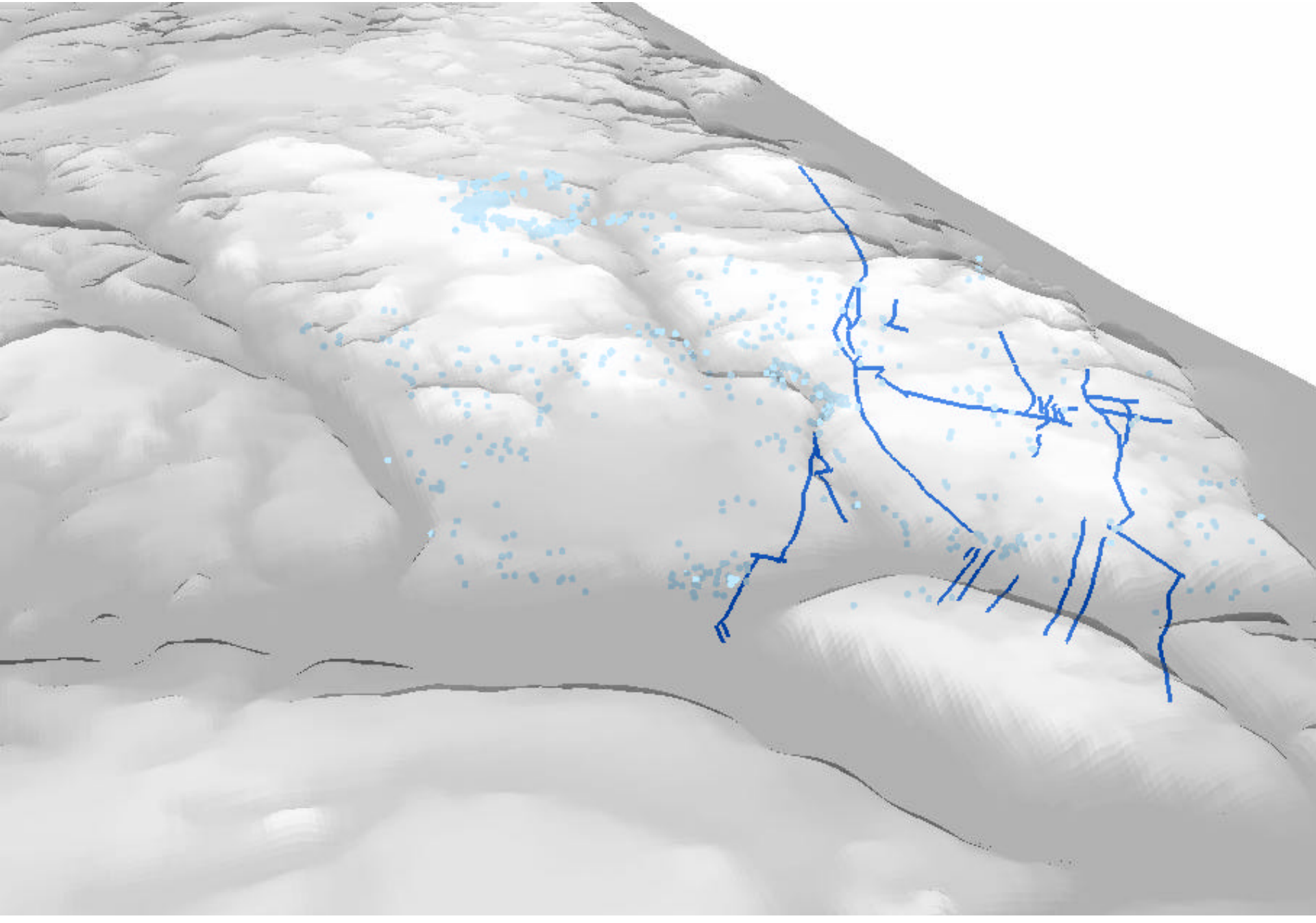

tritium data


chloride data


Tritium,
chloride and
PFC data



- Chemical data provide a valuable tool for tracing ground-water flow paths
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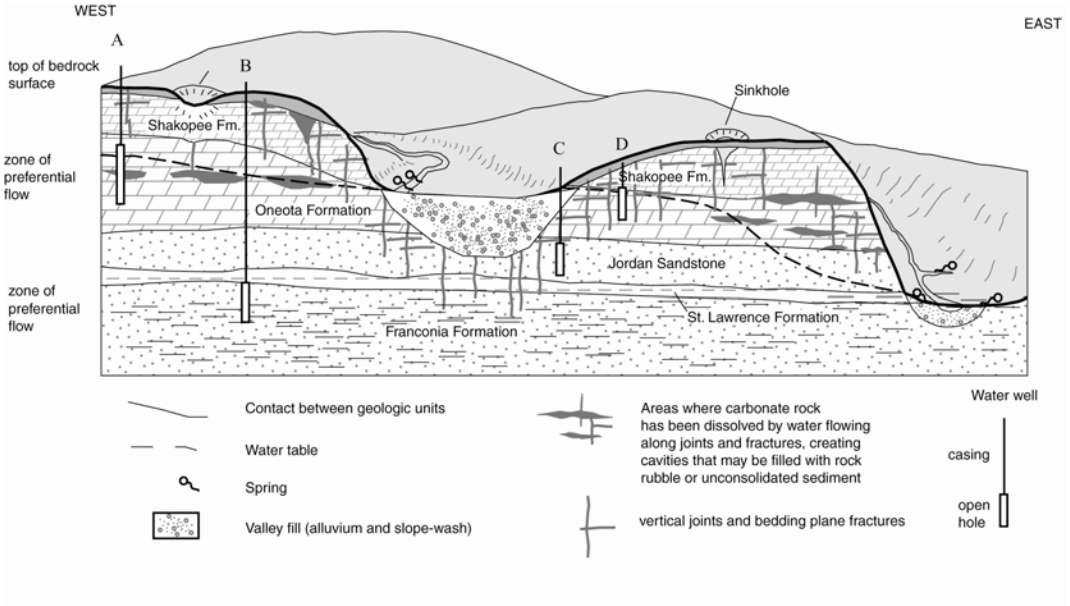
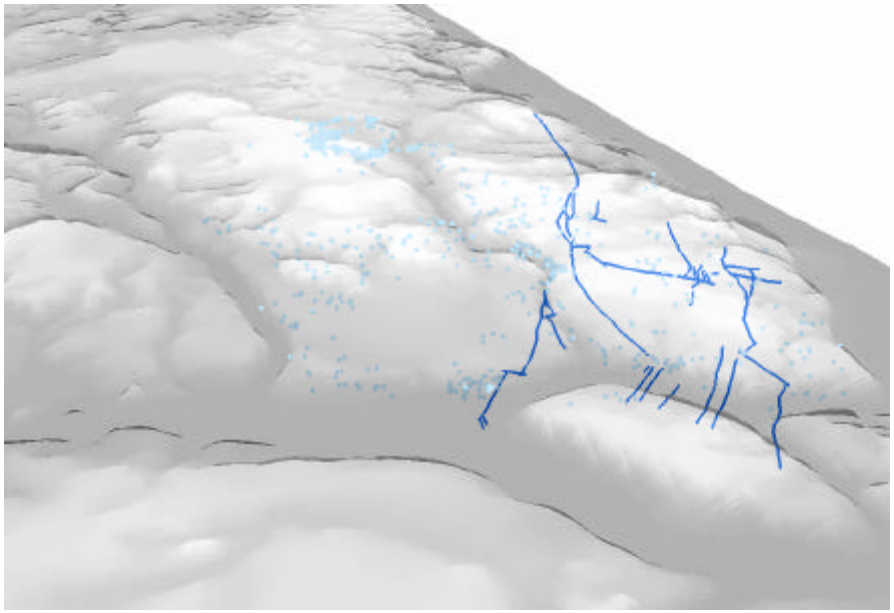
- Recognizing regional patterns in chemical data help refine conceptual models of ground-water flow





Sources of historic data presented in this talk:

- The United States Geological Survey NAQWA program along with additional data from the National Water Inventory System (NWIS)
- The Minnesota Department of Health
- The Minnesota Pollution Control Agency GWMAP program – both ambient ground-water monitoring and land-use studies
- University of Minnesota graduate studies (Tipping, 1992; Nemetz, 1993; Burman, 1995)
- Anoka County Community Health and Environmental Services (Marsh, 1996; Marsh 2001).

Metropolitan Council