Mapping Hydrologic Systems

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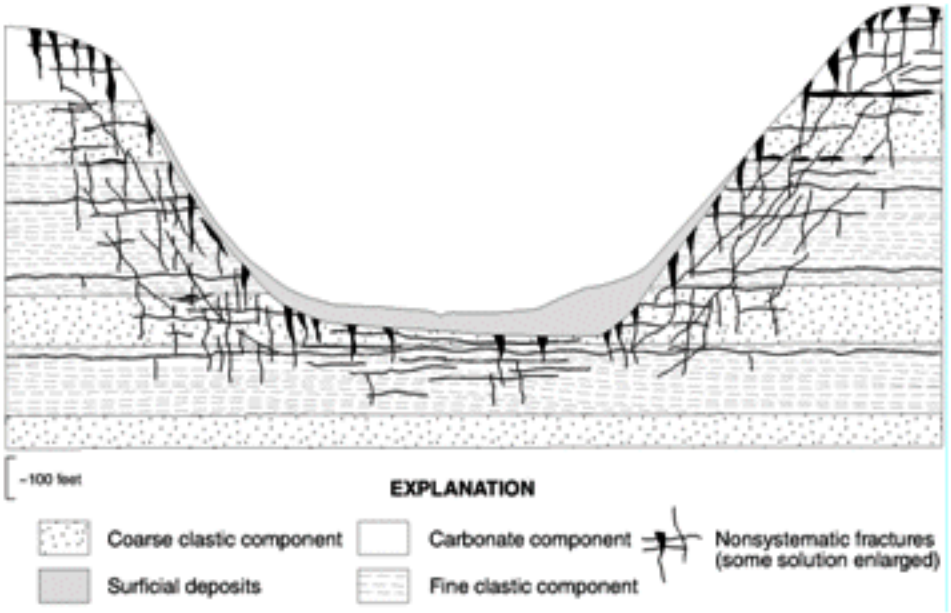
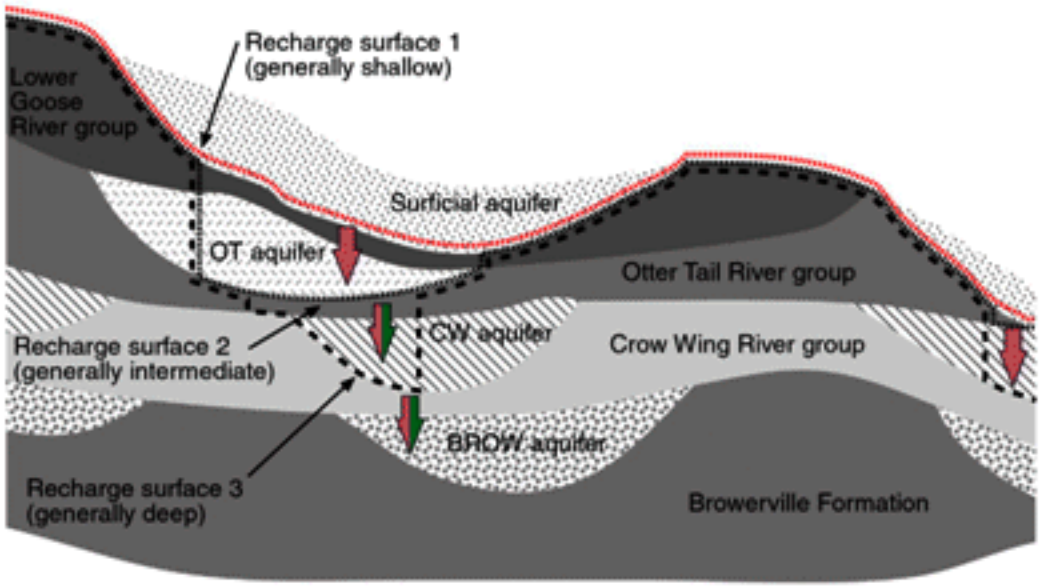
November 2006

Aquifer mapping innovations

Bedrock hydrostratigraphic revisions



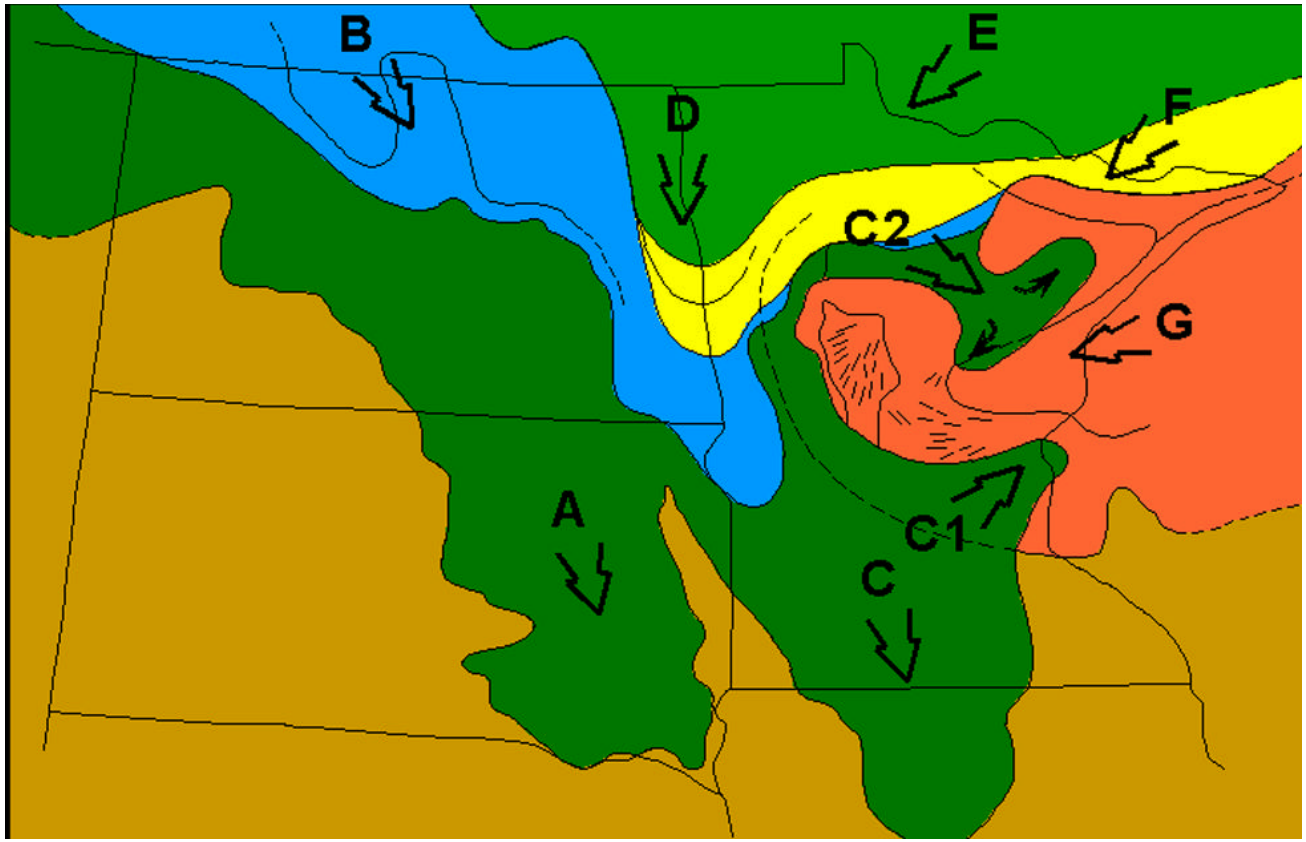
Buried sand and gravel aquifer mapping



Buried sand and gravel mapping information and data requirements

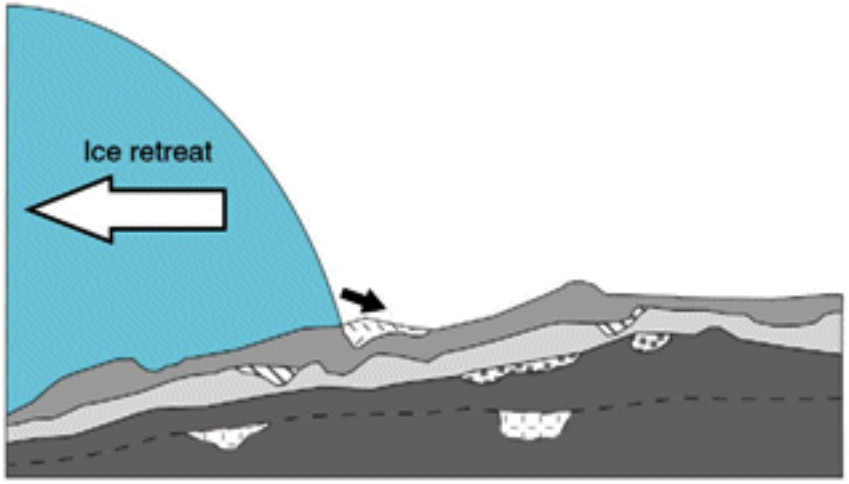
Information: Surficial geologic map

(Geologic Atlas of Pope County, Part A, 2003)

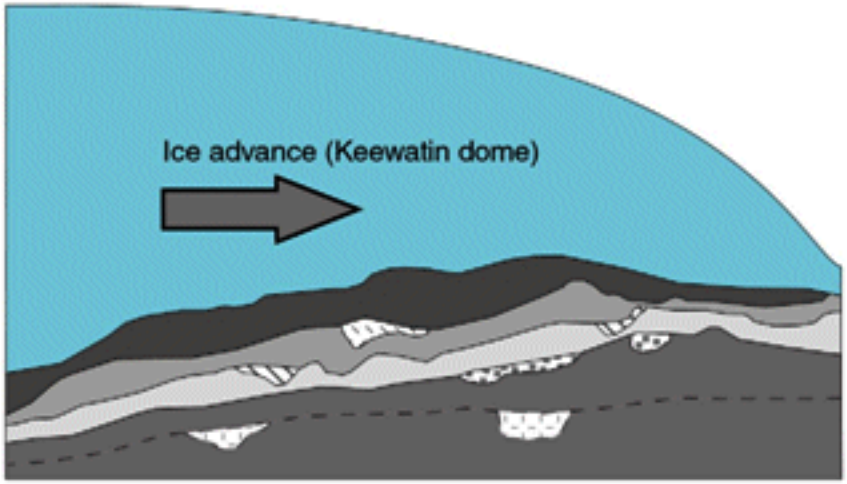


Information: Stratigraphy and depositional history

(Geologic Atlas of Pope County, Part B, 2006)

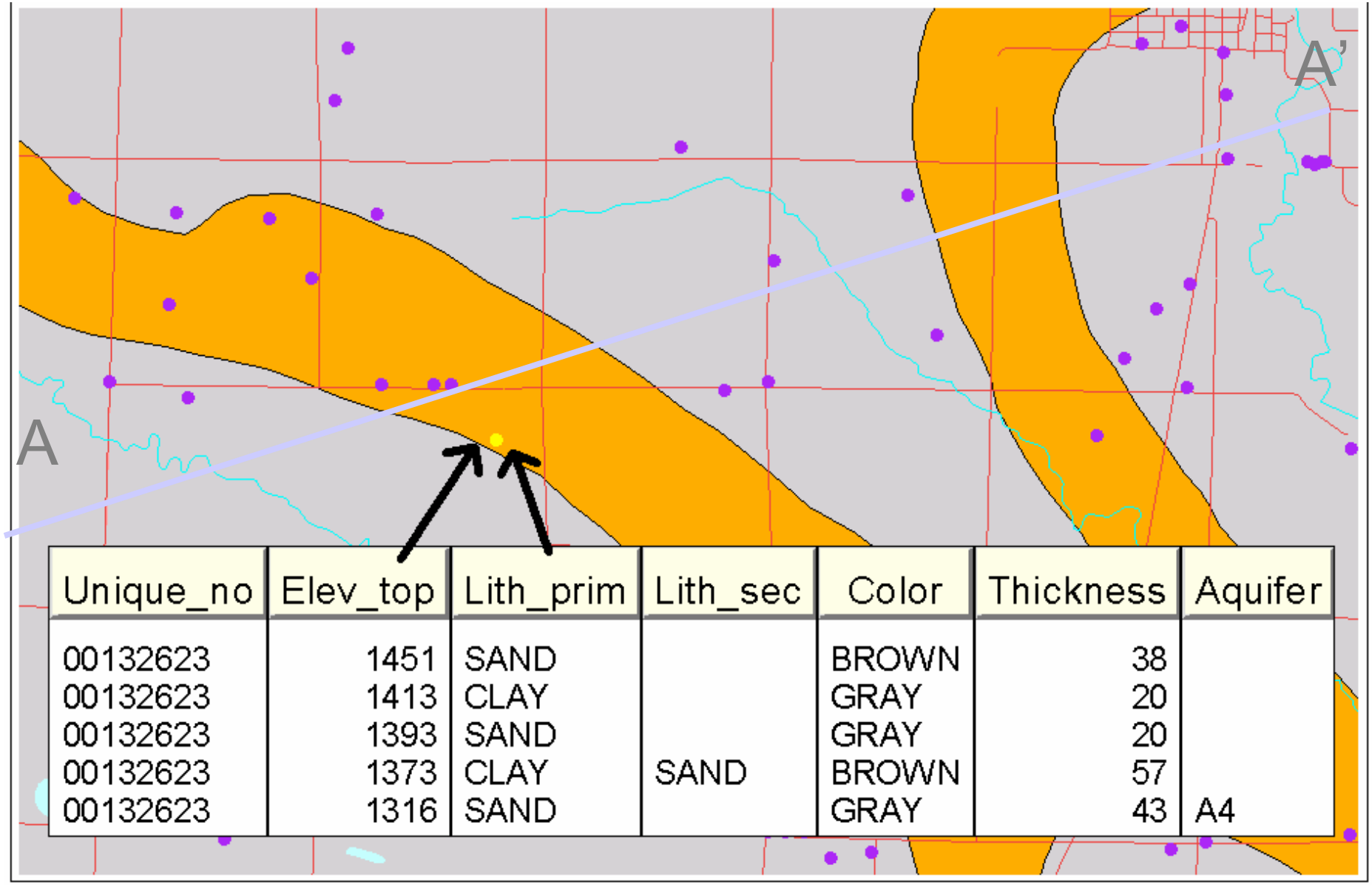


2e. Sand deposition (OT aquifer) on the Otter Tail River group.



2f. Till deposition—Lower Goose River group.

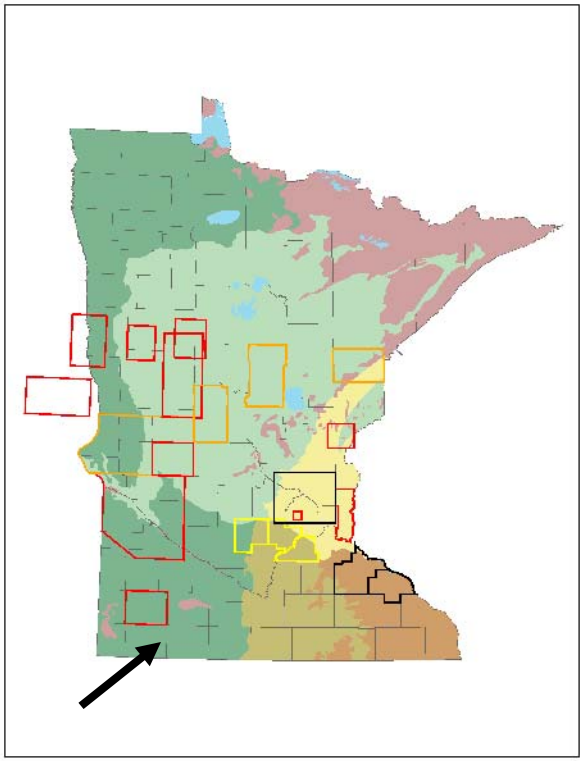
Data: Located and interpreted well logs in a database

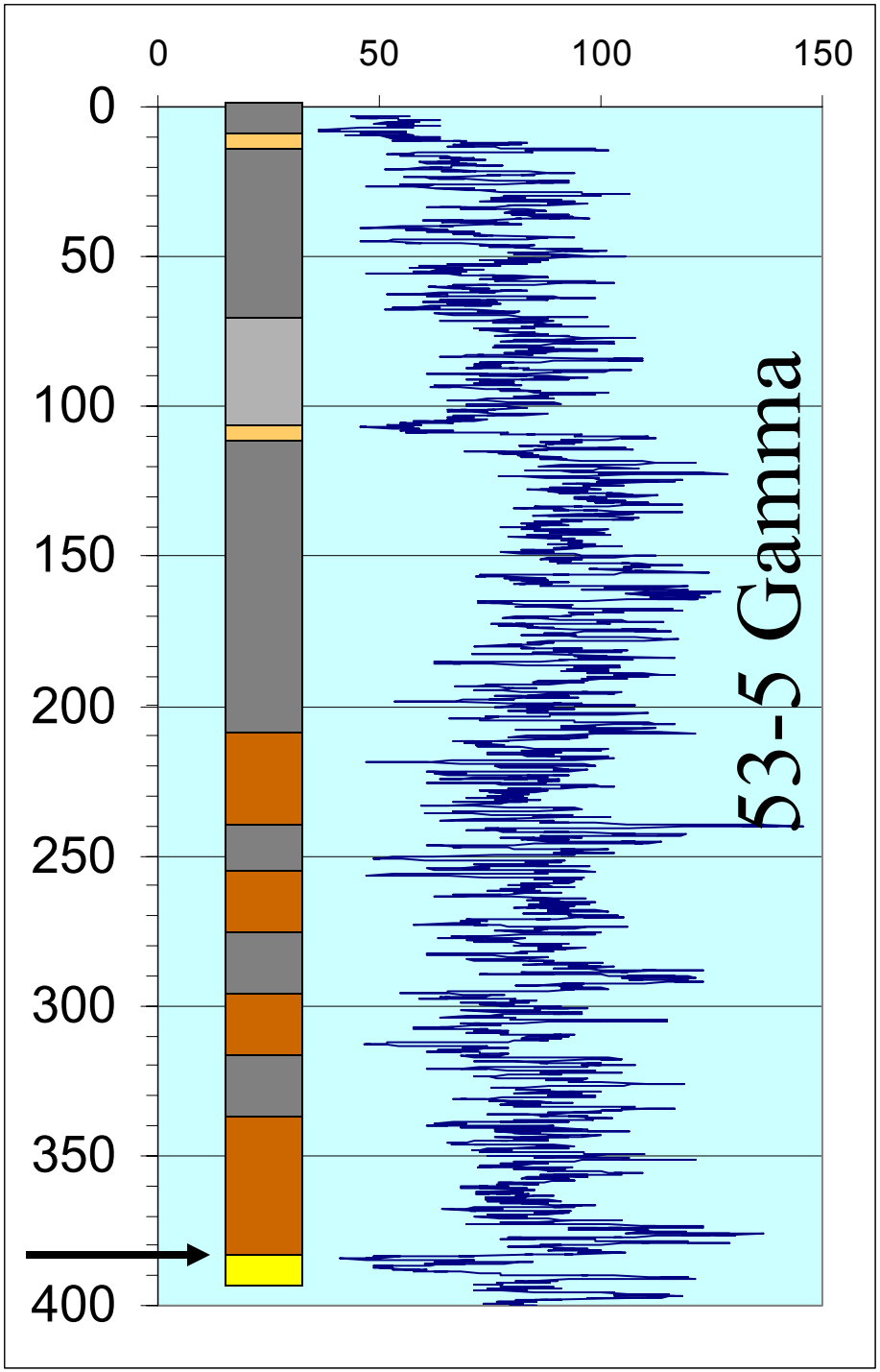


Unique_no	Elev_top	Lith_prim	Lith_sec	Color	Thickness	Aquifer
00132623	1451	SAND		BROWN	38	
00132623	1413	CLAY		GRAY	20	
00132623	1393	SAND		GRAY	20	
00132623	1373	CLAY	SAND	BROWN	57	
00132623	1316	SAND		GRAY	43	A4

Data: Scientific test boring

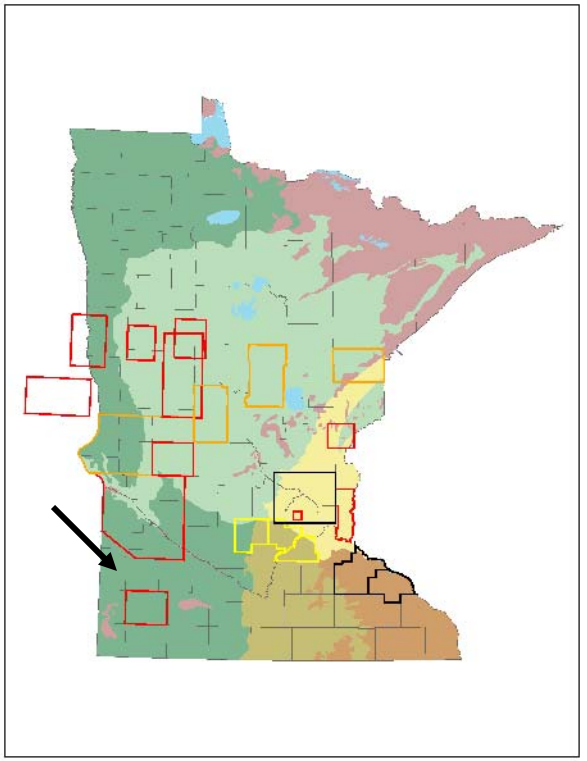
(Unpublished DNR data, 1999)





Data: Rotosonic core

(Regional Hydrogeologic Assessment
Southwestern Minnesota, Part A, 1995)



SWRA-3 (SE¼SE¼ sec. 8, T. 107 N., R. 46 W., Pipestone County)

Coarse Sand Grain Counts
Crystalline-
Carbonate-Shale

Matrix Texture

Gamma Log

Lithologic Log

Elevation (feet above sea level)

1700
1650
1600
1550
1500
1450

Sand
Silt
Clay

46-46-8
69-25-6
57-17-26
68-21-11
57-34-9
30-17-53
57-35-8
71-22-7
61-35-4
55-40-5
56-40-4

End of casing

0 50 100
Cumulative %

0 50 100
API gamma units

Depth (in feet)

0
50
100
150
200
250

1 Pebbly silty clay l

Silt and clay; very
laminated. *Lake s*

2 Pebbly silty clay; l

3 Pebbly clay loam
mottles and secon
gypsum below 113

Clay and silt; dark gray to black; calcareous; organic rich. *Lake sediment.*

4 Pebbly clay; light olive brown to olive brown. Oxidized glacial sediment in upper 10–15 ft; inclusion of other glacial sediment at 175 ft. *Glacial sediment.*

Fine to medium sand with some coarser zones; light olive brown; calcareous. *Stream sediment.*

Silt, fine sand, and clay; light olive brown; calcareous. *Lake or overbank-stream sediment*

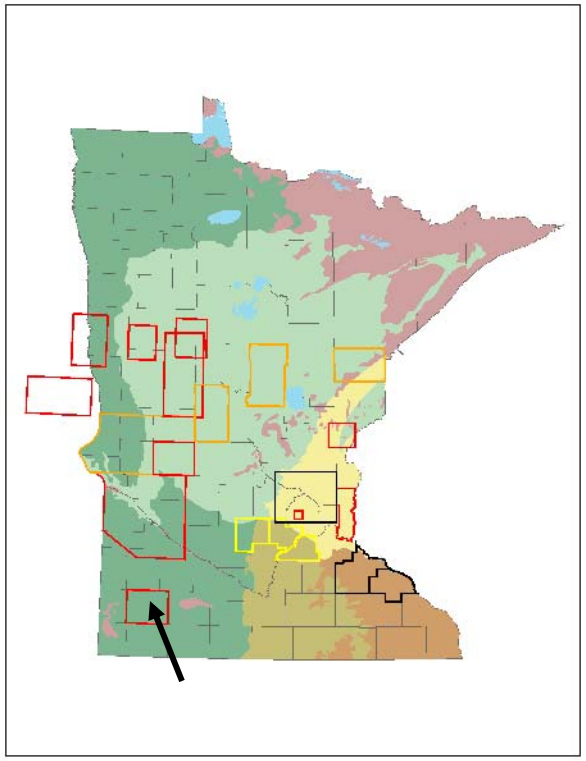
Pebbly clay loam; very dark grayish brown; calcareous. *Glacial sediment.*

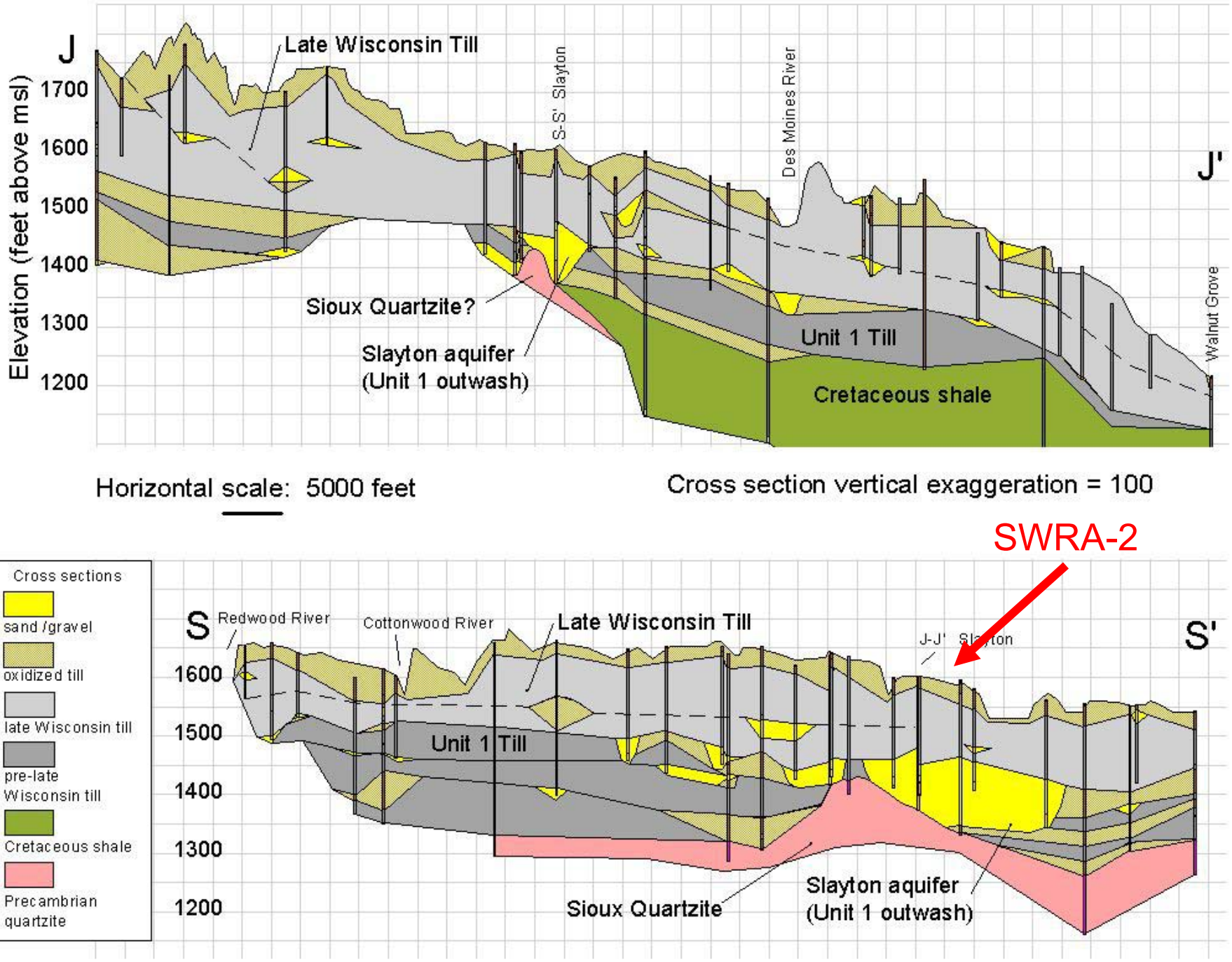
Fine sandy clay loam; pebbly loam (medium to coarse sand); layered; variable sorting; clasts of glacial sediment; light olive brown to grayish brown; calcareous. *Stream sediment and lake sediment.*

5 *250–270 ft:* pebbly clay loam; light olive brown to very dark gray; calcareous; layered with sand and sandy clay loam. *Below 270 ft:* more homogeneous. *Glacial sediment.*

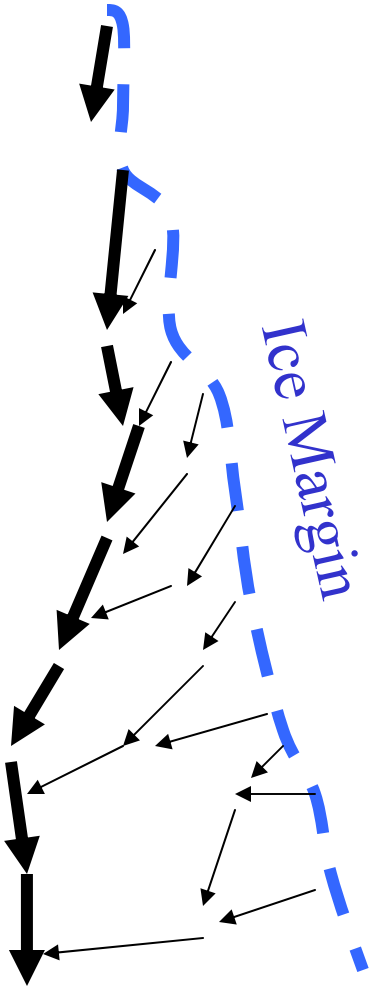
Data: Rotosonic core

(Regional Hydrogeologic Assessment
Southwestern Minnesota, Part A, 1995)

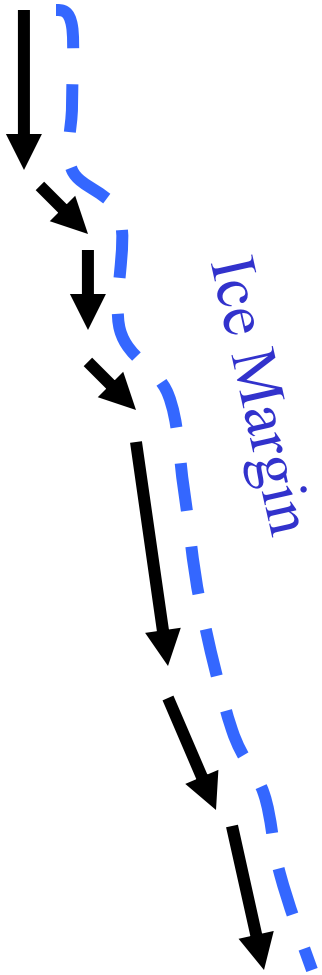



J
J'
Late Wisconsin Till
S-S' Slayton
Des Moines River
Walnut Grove
Elevation (feet above msl)
1700
1600
1500
1400
1300
1200
Sioux Quartzite?
Slayton aquifer
(Unit 1 outwash)
Unit 1 Till
Cretaceous shale
Horizontal scale: 5000 feet
Cross section vertical exaggeration = 100
SWRA-2
Cross sections
sand /gravel
oxidized till
late Wisconsin till
pre-late Wisconsin till
Cretaceous shale
Precambrian quartzite
S
S'
Redwood River
Cottonwood River
Late Wisconsin Till
J-J' Slayton
1600
1500
1400
1300
1200
Unit 1 Till
Sioux Quartzite
Slayton aquifer
(Unit 1 outwash)

Depositional Models



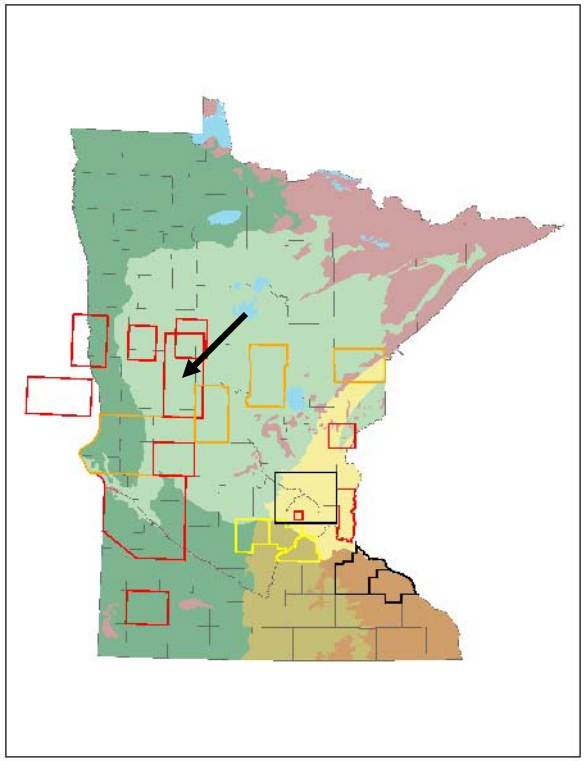
Sub-parallel (Rock River)

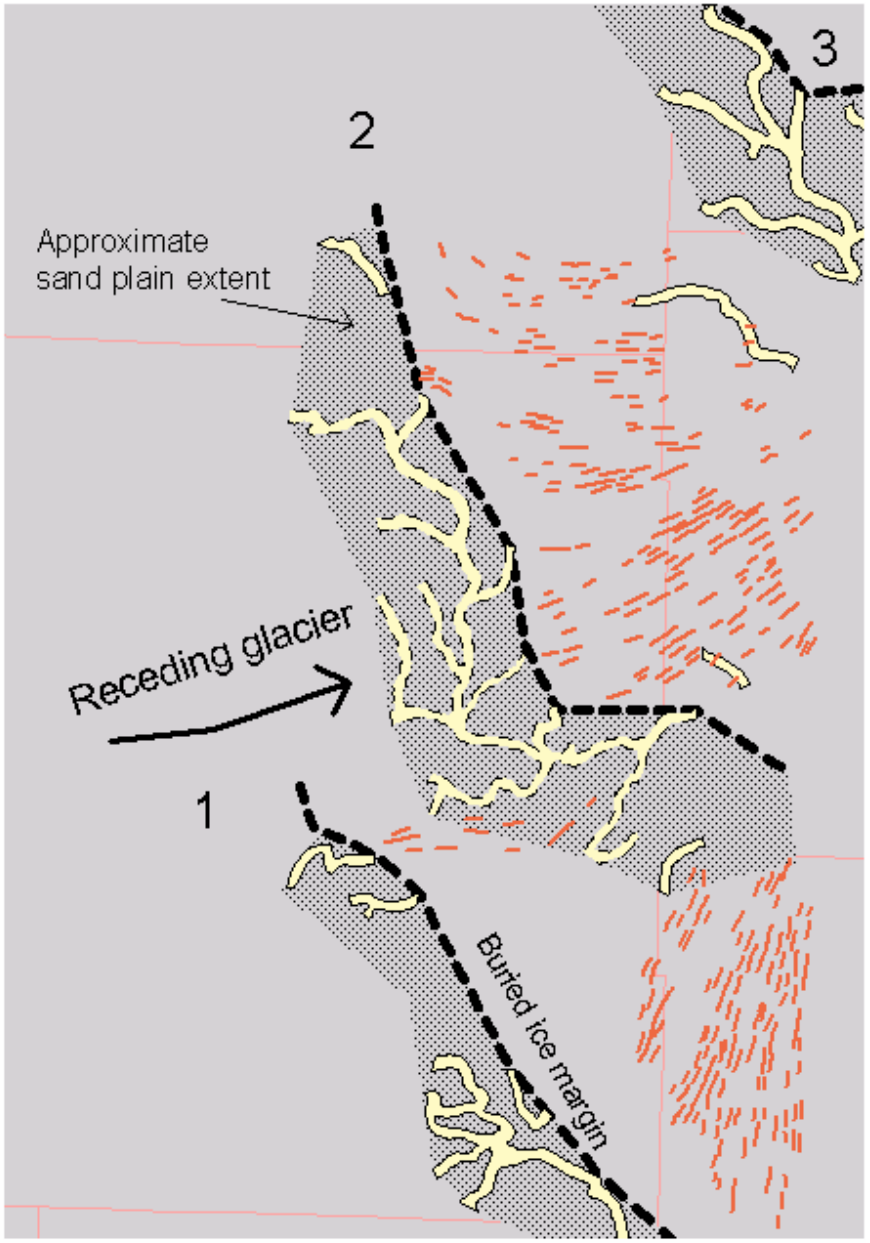


Parallel

Depositional Model: Parallel/sub-parallel to ice margin

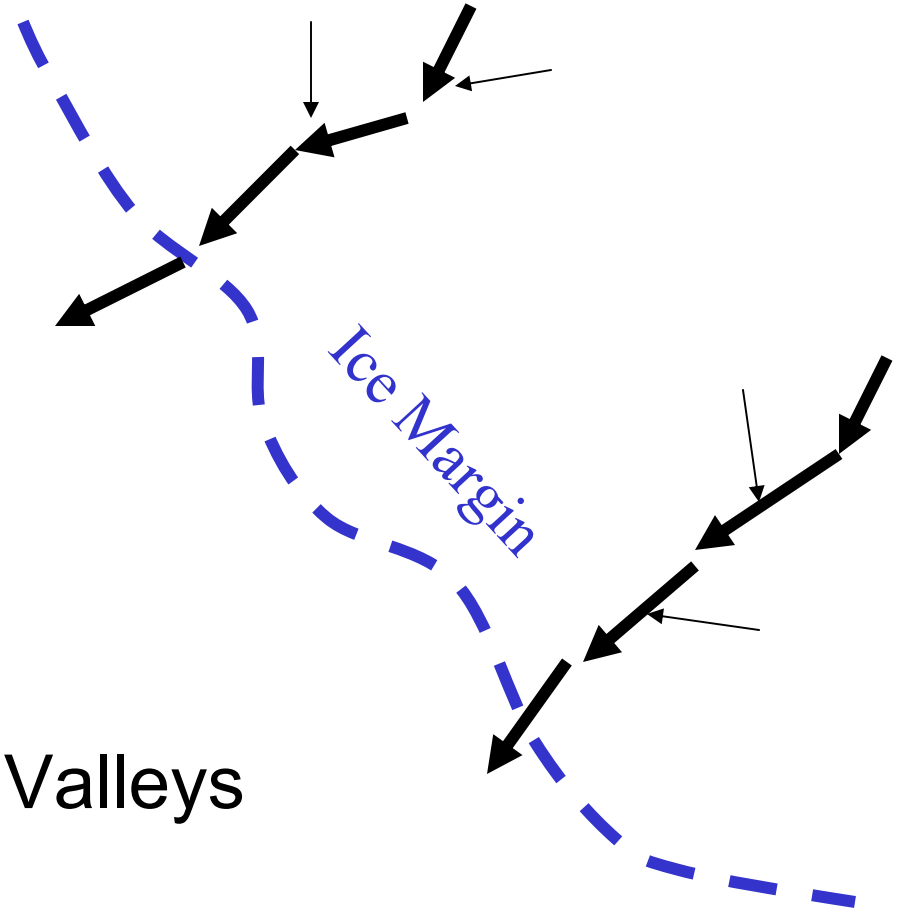
(Regional Hydrogeologic Assessment, Otter Tail Area, Parts A and B, 1999 and 2002)





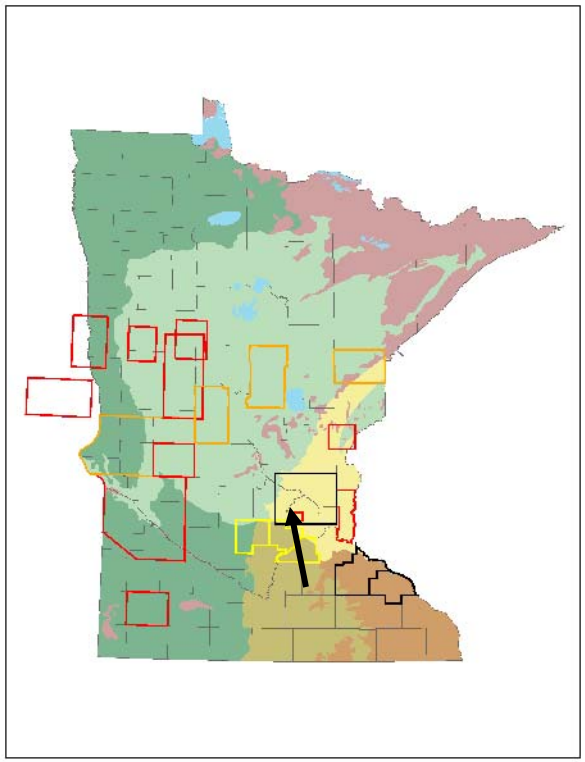
Sand plains and receding ice margins

Depositional Models

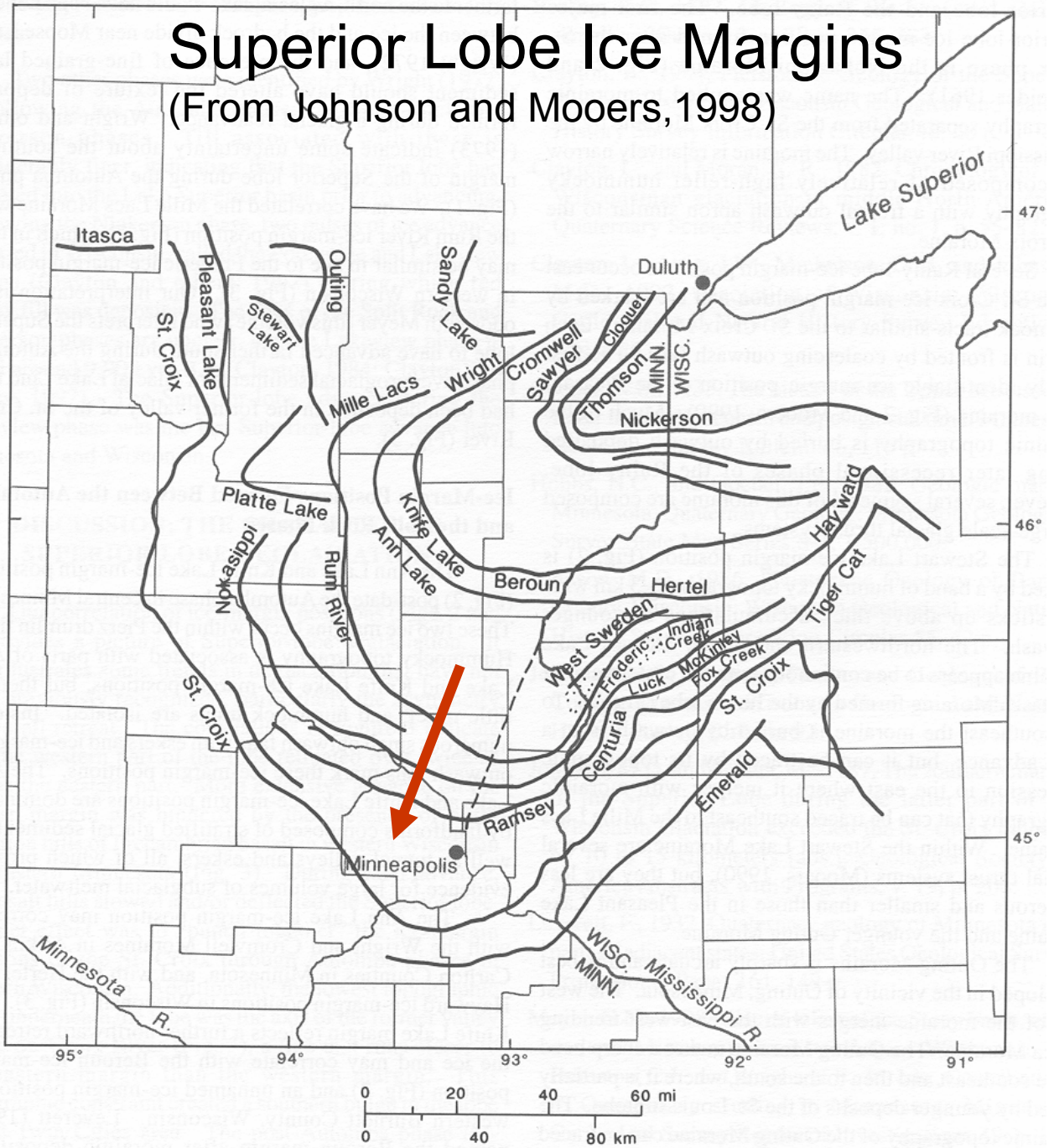


Tunnel Valleys

Depositional Model:
Tunnel valley

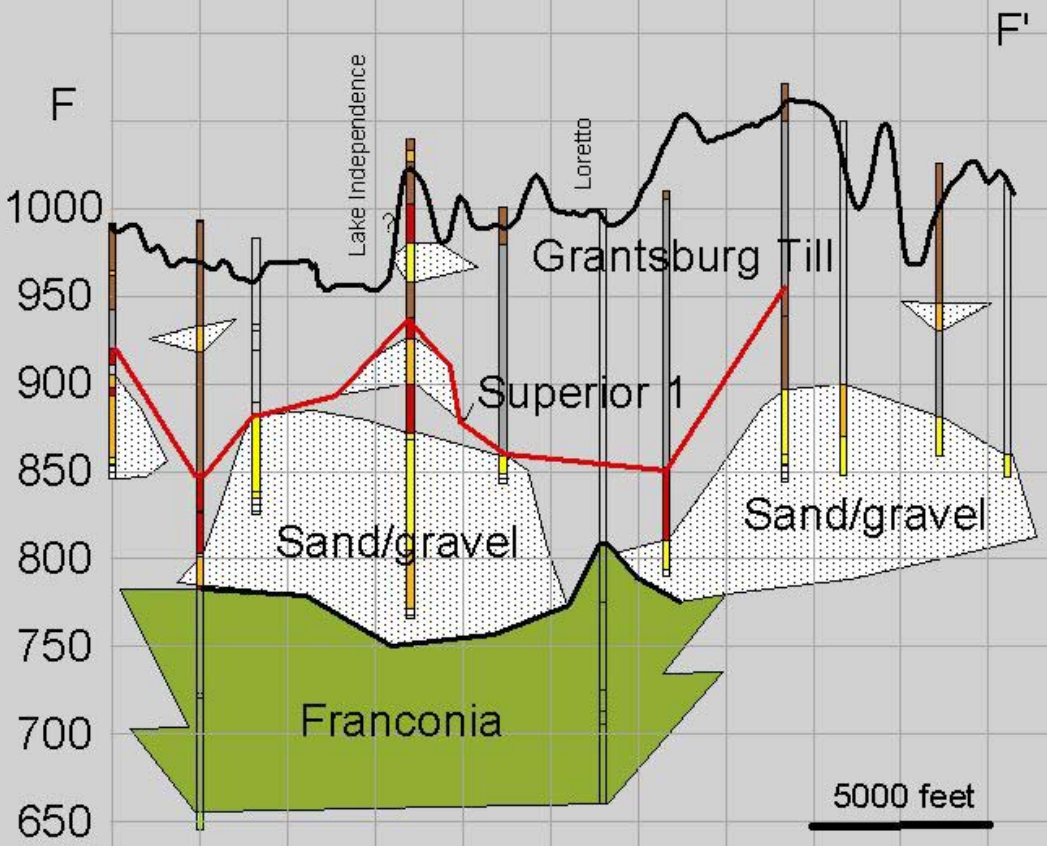


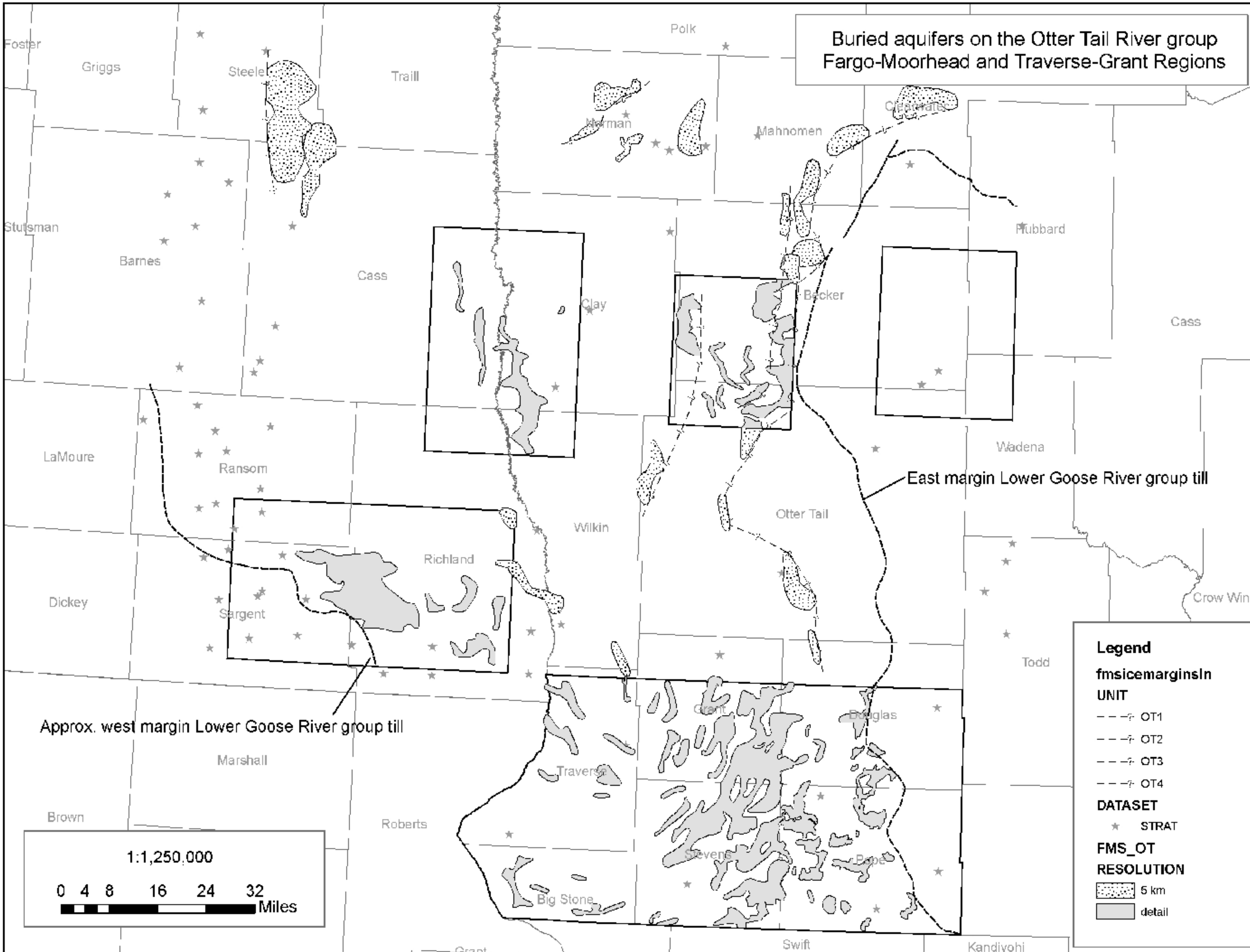
Superior Lobe Ice Margins
(From Johnson and Mooers,1998)



Depositional Model: Tunnel valley

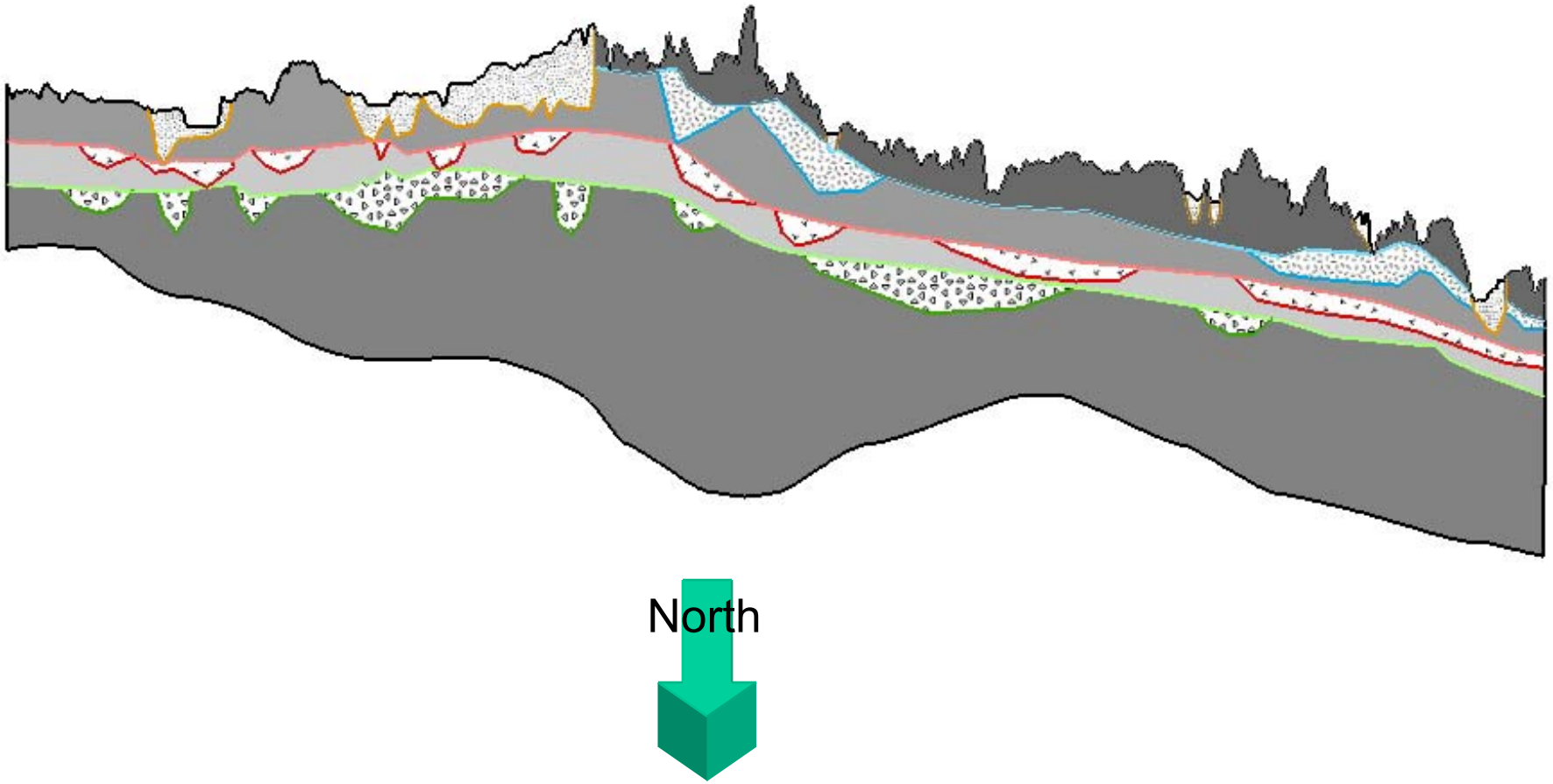
(Buried glacial outwash aquifers,
Medina township, unpublished DNR report, 2002)



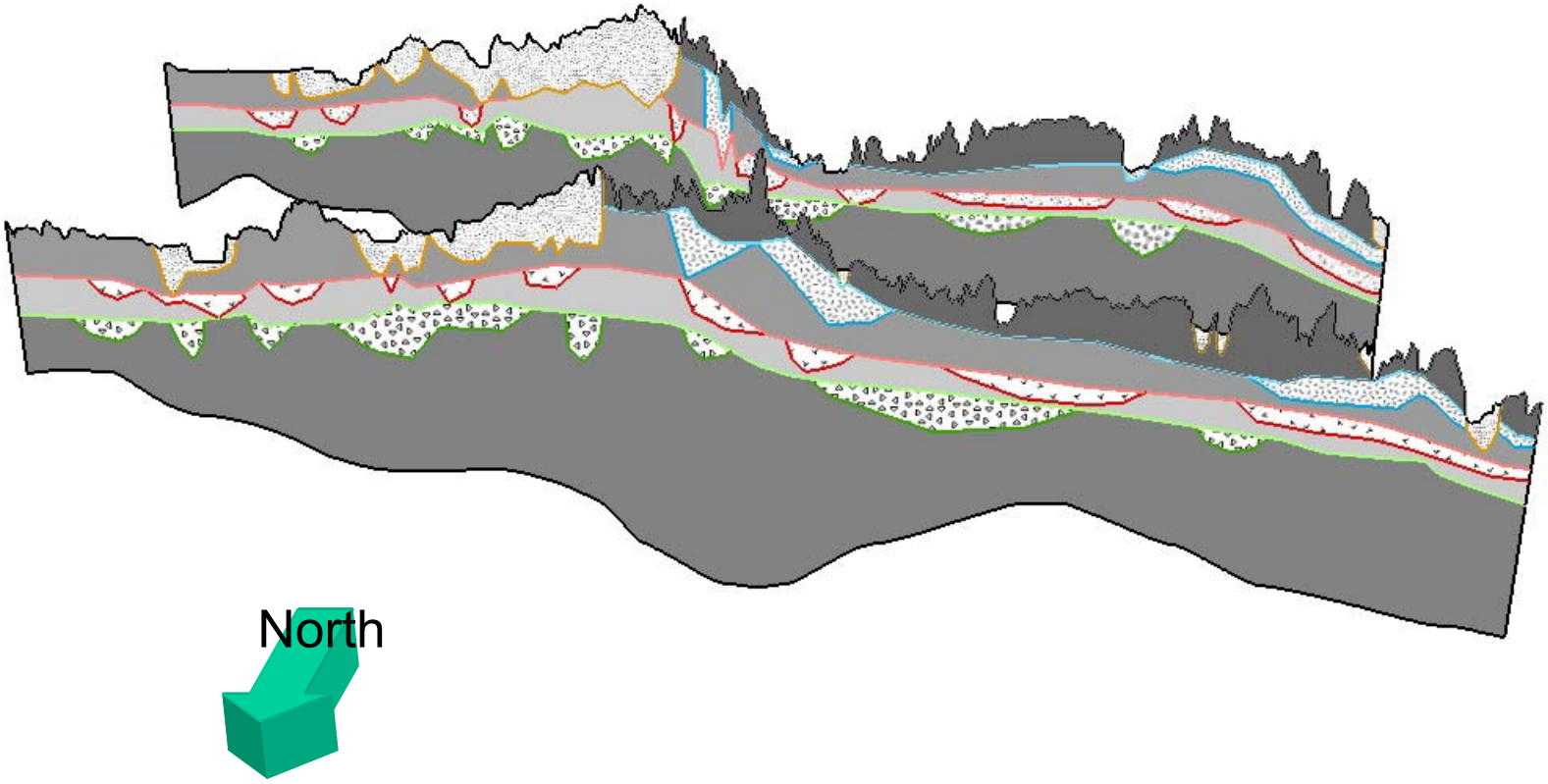


Buried aquifers on the Otter Tail River group
Fargo-Moorhead and Traverse-Grant Regions
Foster
Griggs
Steele
Traill
Polk
Norman
Mahnomen
Clearwater
Hubbard
Stutsman
Barnes
Cass
Clay
Becker
Cass
Wadena
LaMoure
Ransom
Richland
Wilkin
Otter Tail
East margin Lower Goose River group till
Dickey
Sargent
Crow Wing
Todd
Grant
Douglas
Approx. west margin Lower Goose River group till
Marshall
Traverse
Brown
Roberts
Stevens
Pope
Big Stone
Grant
Swift
Kandiyohi
1:1,250,000
0 4 8 16 24 32
Miles
Legend
fmsicemarginsln
UNIT
OT1
OT2
OT3
OT4
DATASET
STRAT
FMS_OT
RESOLUTION
5 km
detail

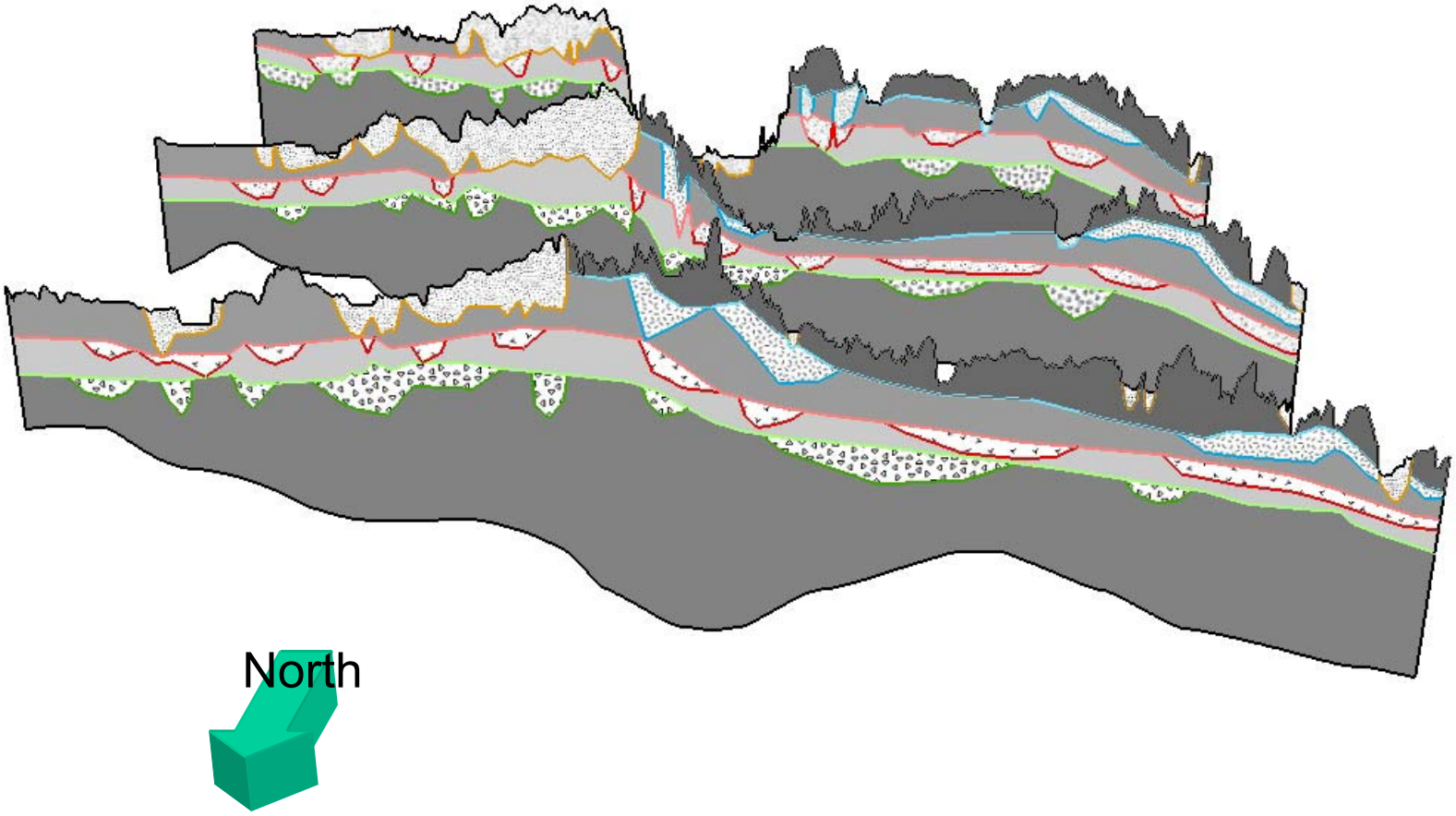
Understanding aquifer distributions in 2D



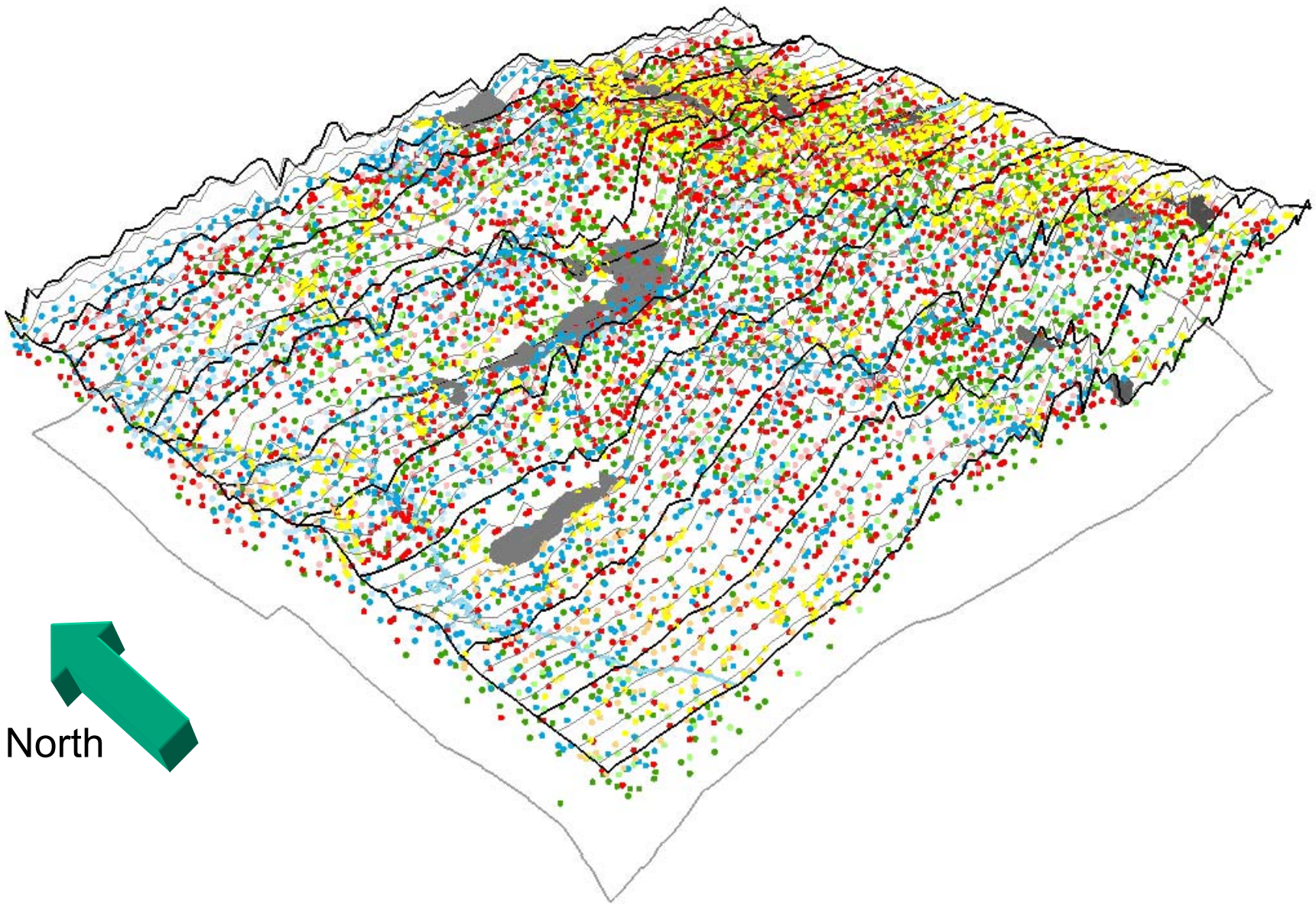
Beginning to see connections in 3D



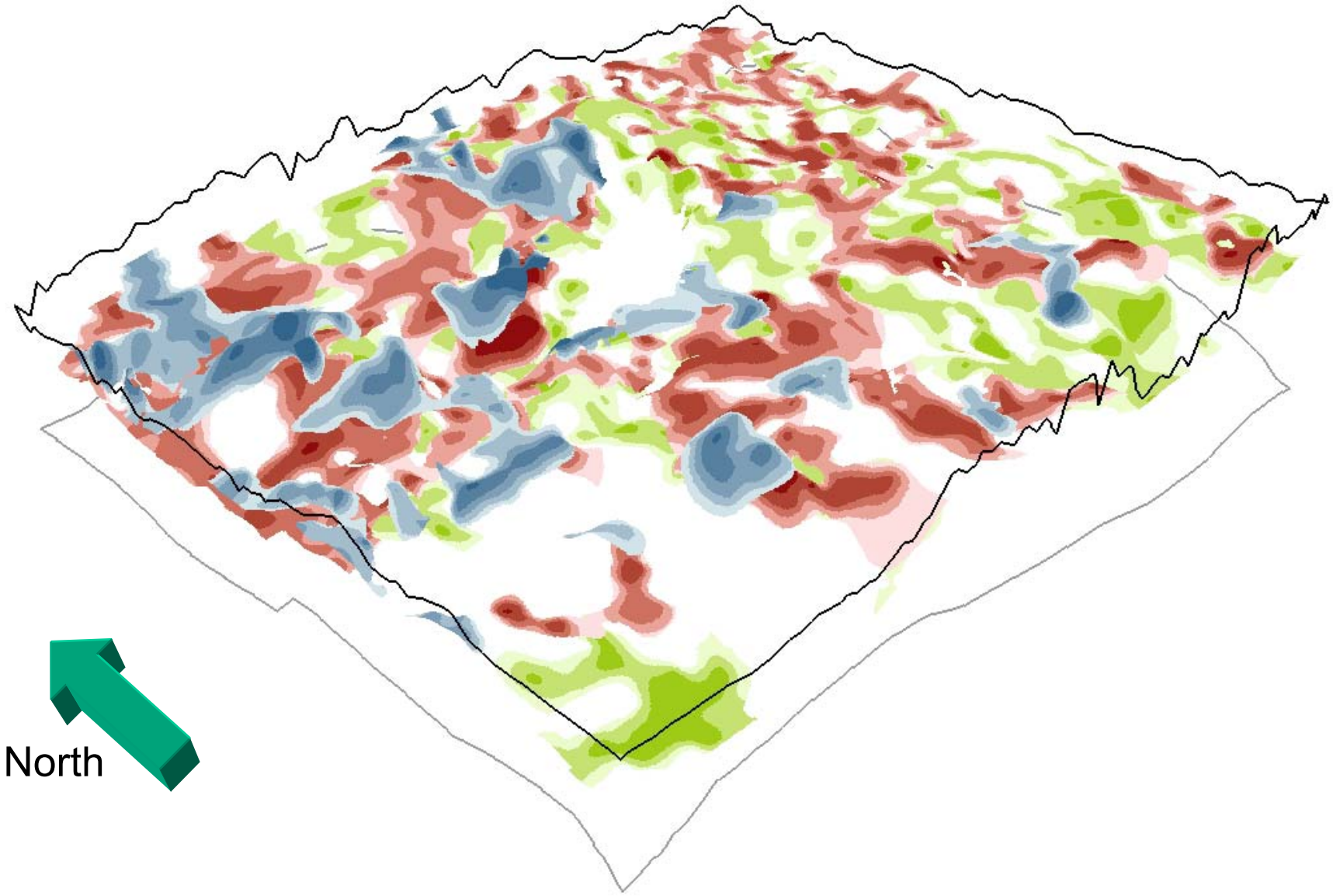
Beginning to map in 3D



Points from cross sections with X,Y, and Z coordinates

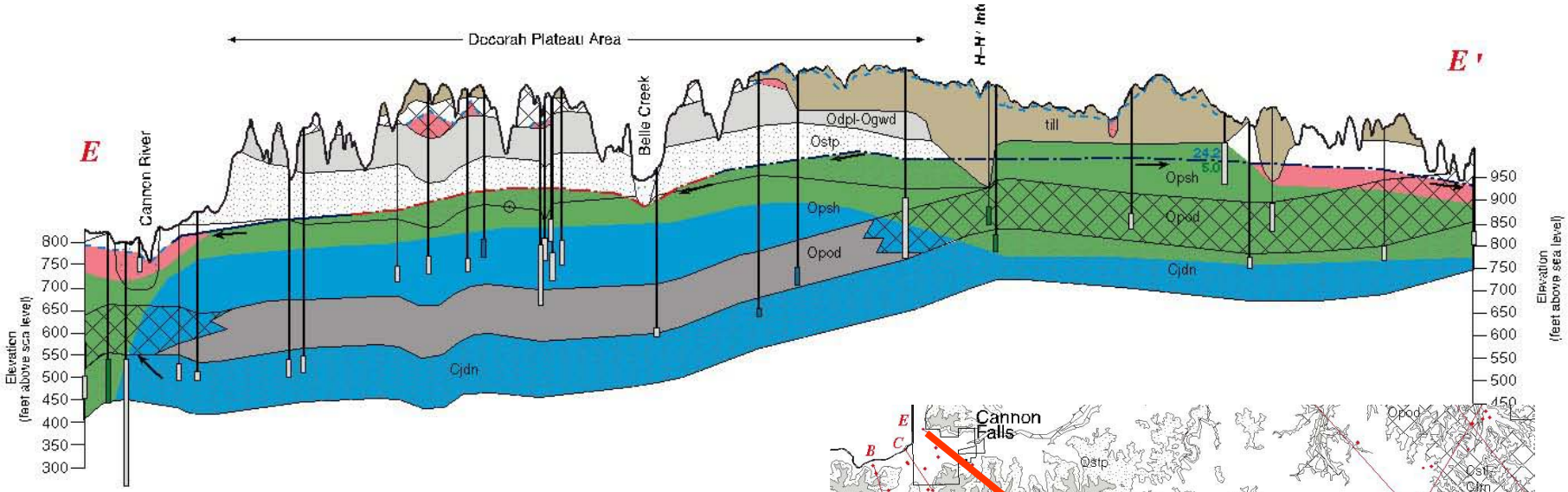


All mapped buried aquifers – contoured thickness



Limitations – Quaternary lithology, stratigraphy, and history

- Many of the drillers logs do not have good color differentiation
- Well log locations need to be verified
- Too few rotosonic holes compared to the size of the atlas series project areas
- Subtle differences in till texture and composition makes differentiation difficult and sometimes subjective



Tritium Age—Tritium age not shown for till or bedrock confining units. Uncolored means unsaturated. Vertical rectangle indicates well screen or open hole

- Recent—Water entered the ground since 1953 (10 or more tritium units).
- Mixed—Water is a mixture of recent and vintage waters (0.8 to less than 10 tritium units).
- Vintage Water entered the ground before 1953 (less than 0.8 tritium units).
- Well not sampled for tritium.

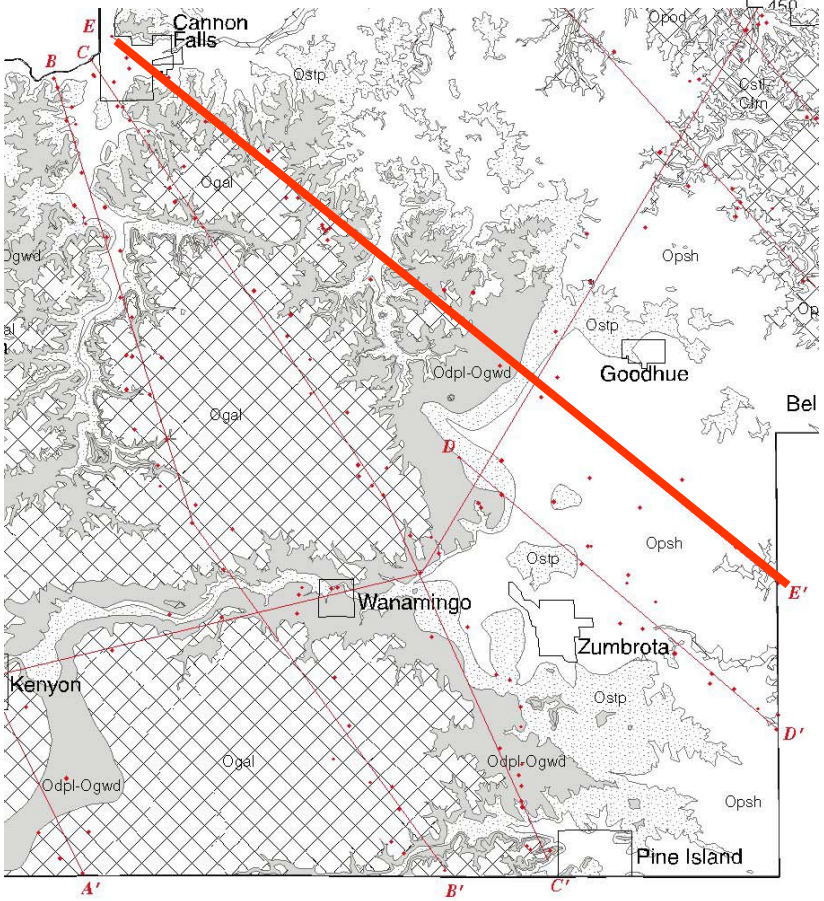
Aquifer Characteristics of Lithologic Units

Moderate to high conductivity under shallow and deep conditions.

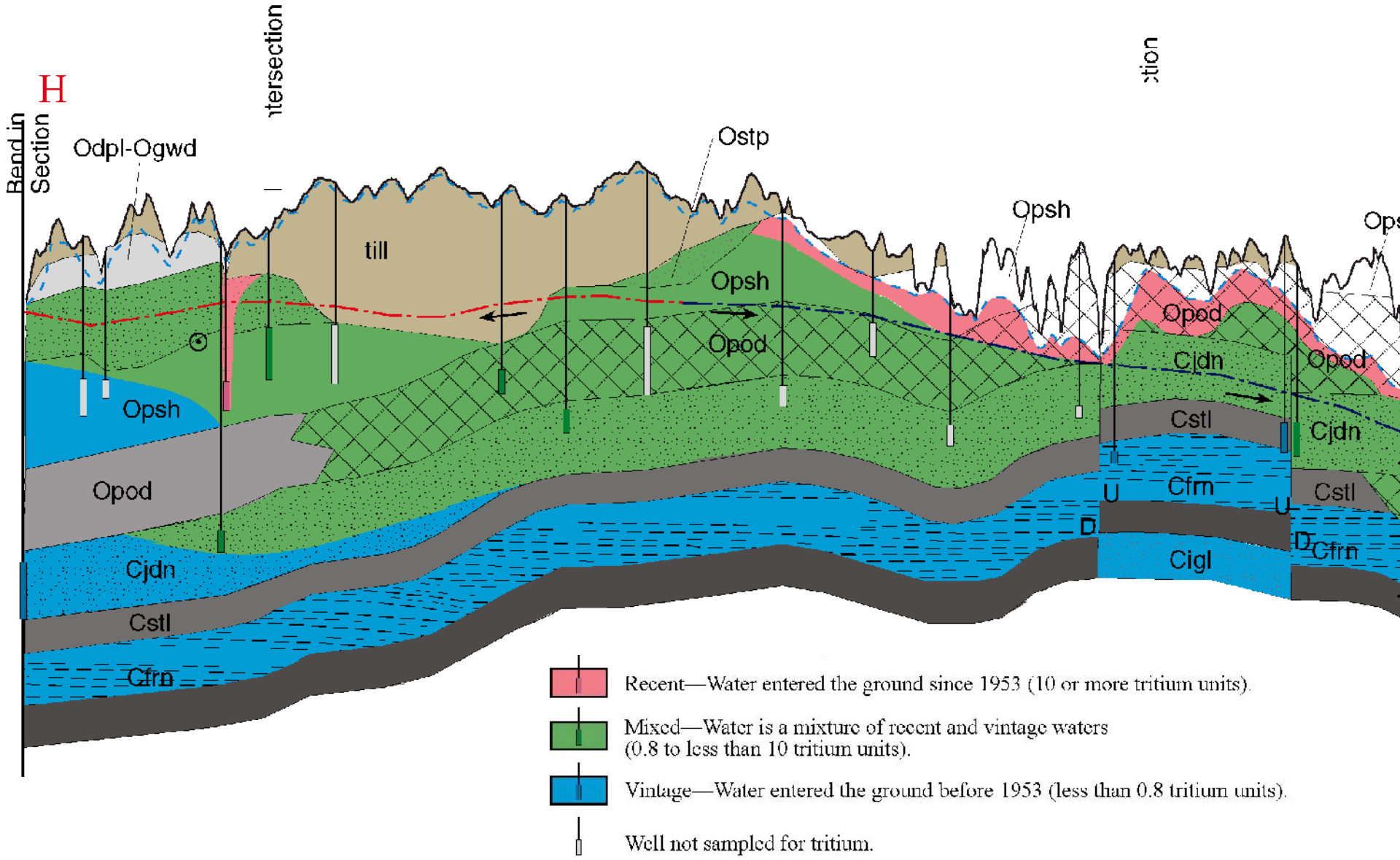
- Sand and gravel deposits
- St. Peter Sandstone (Ostp)
- Shakopee Formation (Opsh)
- Jordan Sandstone (Cjdn)
- Mt. Simon Sandstone (Cmts)

Moderate to high conductivity under shallow conditions. Low conductivity or confining (Oneota Dolomite and St. Lawrence Formation) under deep conditions. Crosshatch pattern indicates fractured, karst, or both conditions indicating enhanced hydraulic conductivity.

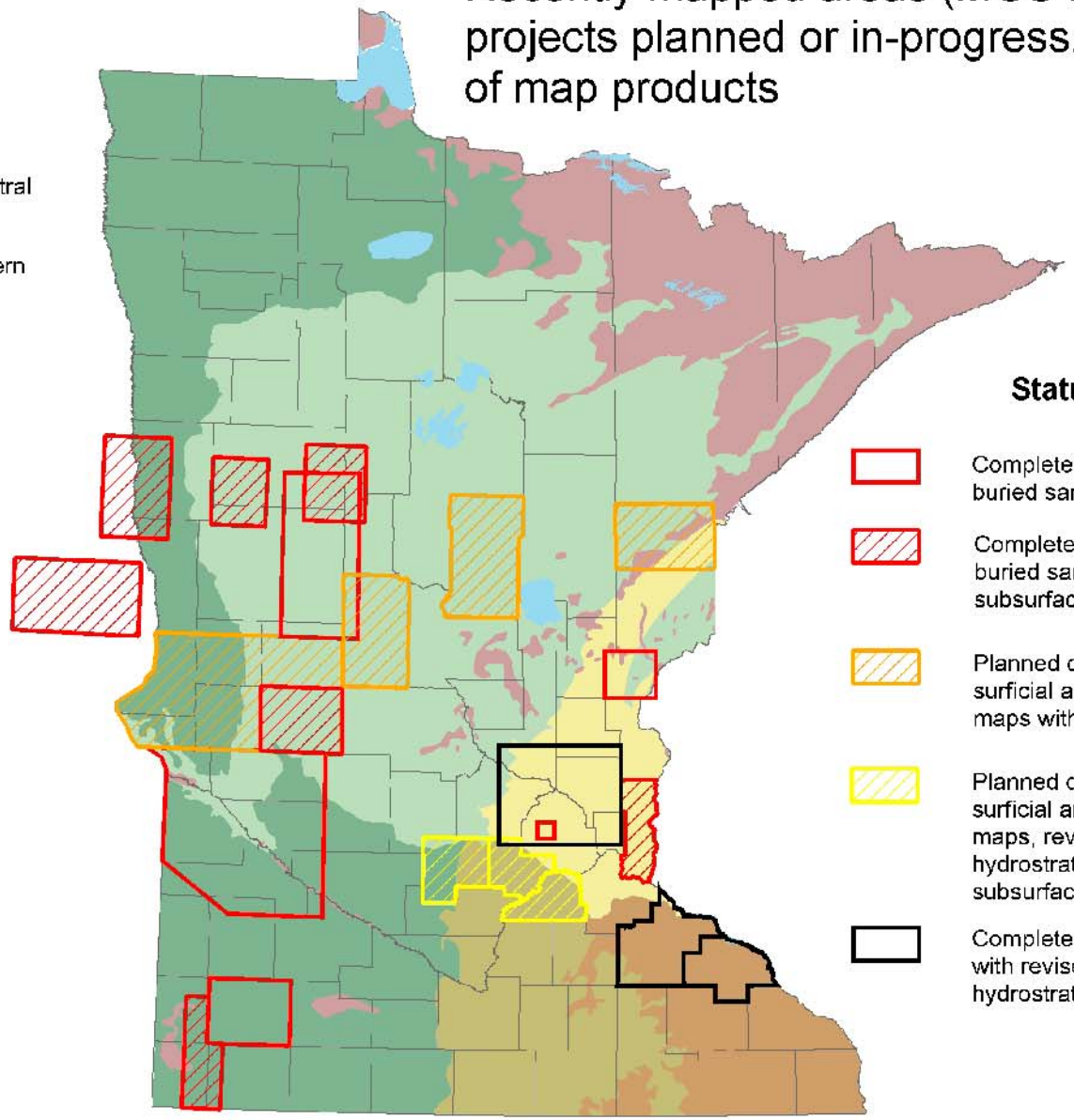
- Galena Group (Ogal)
- Oneota Dolomite (Opod)
- St. Lawrence Formation (Cstl)
- Franconia Formation (Cfrn)
- Ironton-Galesville Sandstone (Cigl)
- Eau Claire Formation (Cecr)



Zumbrota –Goodhue Area



Recently mapped areas (MGS and/or DNR), projects planned or in-progress, and status of map products



JB 11/2/06