



# The County Geologic Atlas Program

*A cooperative effort of*

The Minnesota Geological Survey  
and

The Division of Waters,  
Minnesota Department of  
Natural Resources

# What is a County Geologic Atlas?

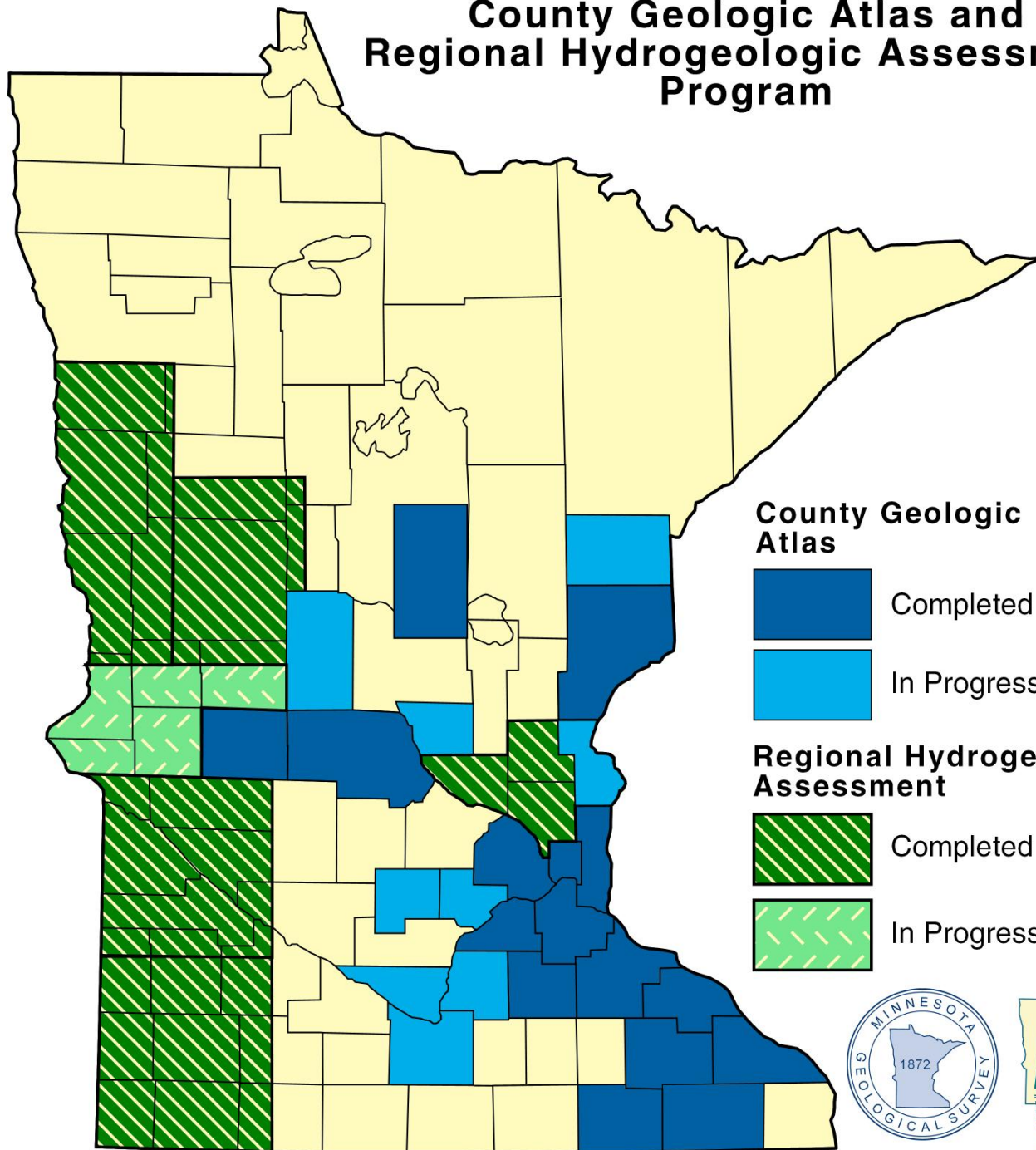
- A study of the geology and ground water resources of a county
  - MGS investigates the geology
  - DNR Waters investigates chemistry, quantity, and pollution sensitivity of the ground water
- Used for planning, environmental protection, and education
- Better decision-making, focus resources



# History of the Program

- Initiated in 1982
- Geologic work completed for 16 county atlases
- Hydrologic work completed for 14 county atlases
- Targeted to counties with development pressure, those with sensitive aquifer systems, and those with interest.

# County Geologic Atlas and Regional Hydrogeologic Assessment Program



## County Geologic Atlas



Completed



In Progress

## Regional Hydrogeologic Assessment



Completed



In Progress



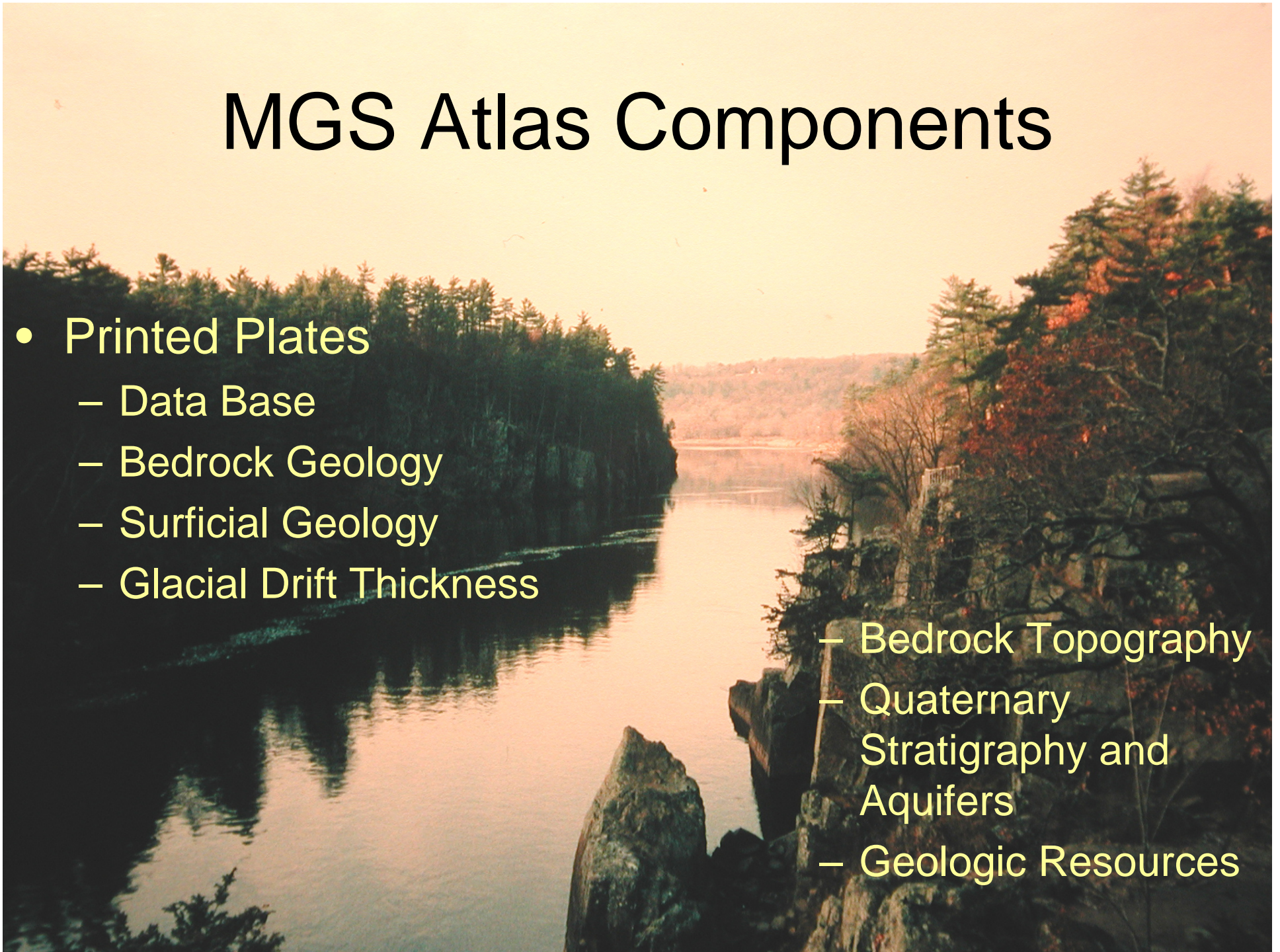


# MGS Atlas Components

- Printed Plates

- Data Base
- Bedrock Geology
- Surficial Geology
- Glacial Drift Thickness

- Bedrock Topography
- Quaternary Stratigraphy and Aquifers
- Geologic Resources





# DNR Atlas Products

- Hydrogeology of the water table system
- Hydrogeology of the confined aquifer and bedrock aquifer systems
- Sensitivity mapping
- Ground water chemistry data
- Dating of ground water





# Additional Components

- Geographic Information System products
  - portable document files (pdfs)
  - Arc project and files of geologic and hydrologic themes and databases
  - County Well Index files
- User workshops and field trips

*Table 2.--Principal types of data and data compilations required for analysis of ground-water systems*

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**Physical Framework**

- Topographic maps showing the stream drainage network, surface-water bodies, landforms, cultural features, and locations of structures and activities related to water
- Geologic maps of surficial deposits and bedrock**
- Hydrogeologic maps showing extent and boundaries of aquifers and confining units**
- Maps of tops and bottoms of aquifers and confining units**
- Saturated-thickness maps of unconfined (water-table) and confined aquifers
- Average hydraulic conductivity maps for aquifers and confining units and transmissivity maps for aquifers
- Maps showing variations in storage coefficient for aquifers
- Estimates of age of ground water at selected locations in aquifers



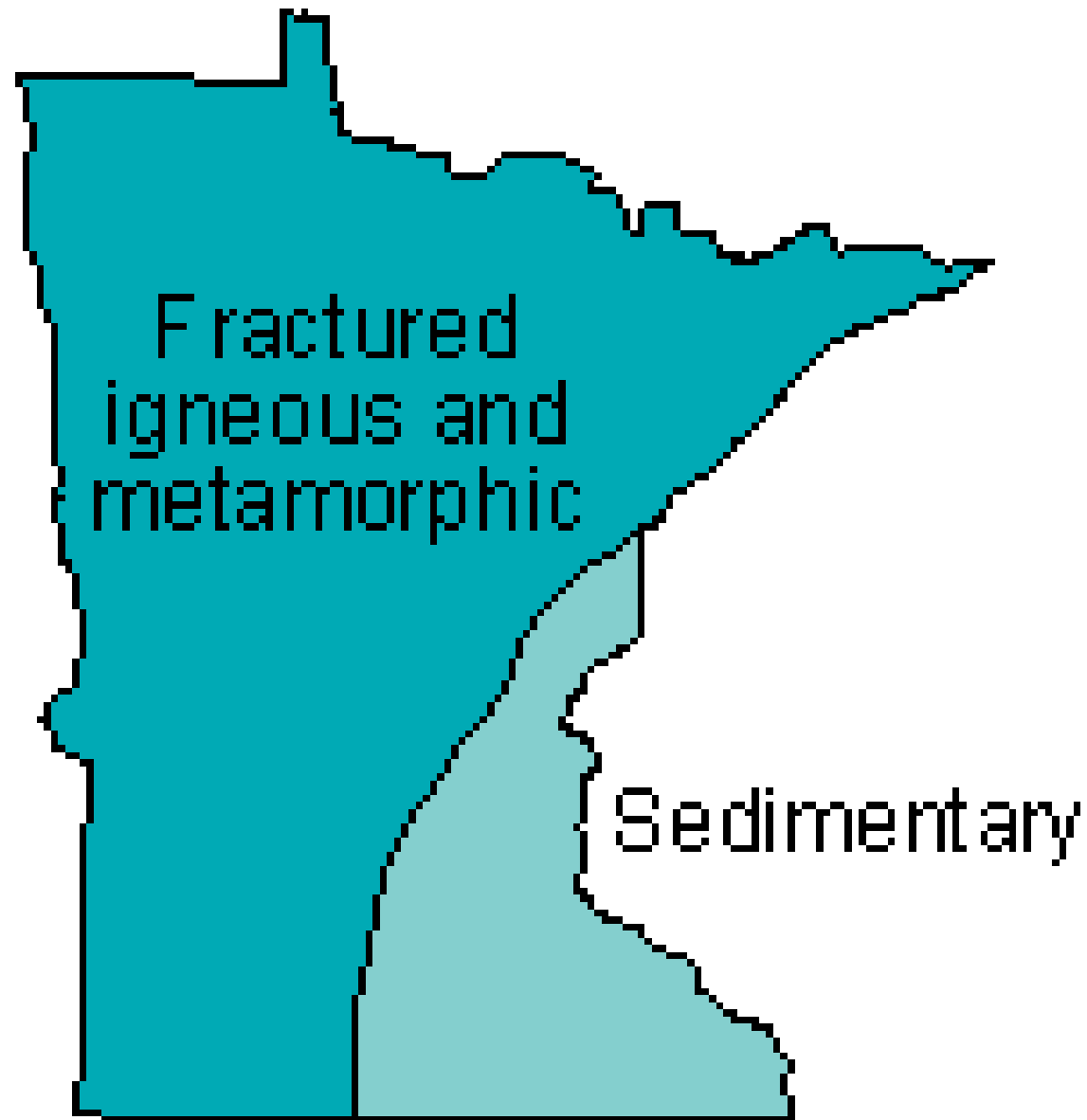
## ***The bottom line.....***

- **If you want to protect and wisely allocate your ground water resources you need to know:**
  - **Where your aquifers are (boundaries, size, thickness, hydrologic properties) and,**
  - **How they are connected to the land surface and to surface water bodies (confined, unconfined, related sensitivity)**

# Data Sources:

- Water well records (County Well Index)
- Limited scientific drilling (3-5 holes per county)
- Exploration drilling records
- Geophysical investigations
  - Aeromagnetic and gravity surveys (mostly Precambrian crystalline rocks)
  - Seismic surveys (mostly depth to bedrock)
  - Downhole geophysical logging (sedimentary rock sequences)



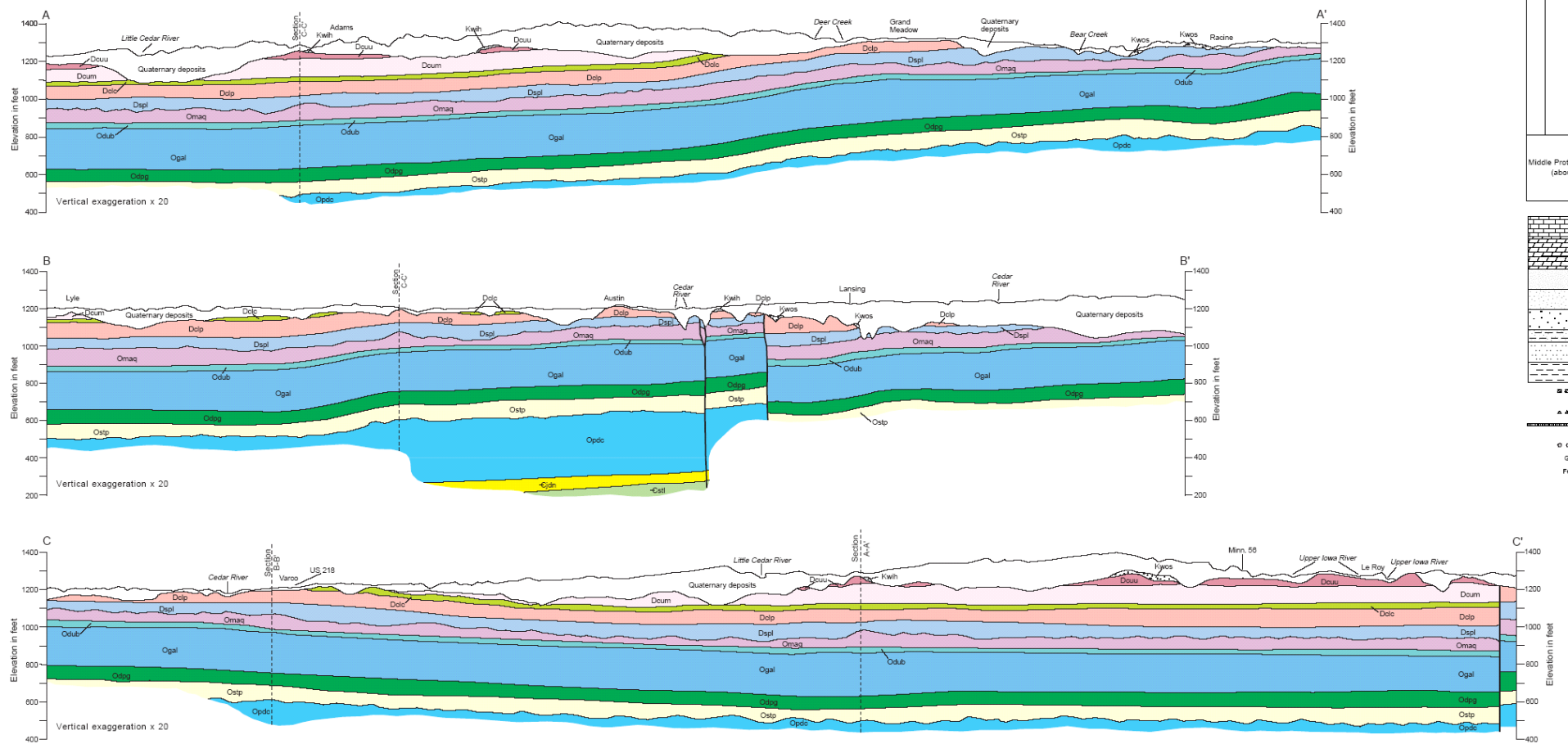


Courtesy of Jim Berg, Minnesota DNR Waters

# Bedrock Aquifer Mapping

- Sedimentary sequence of rocks with lateral continuity and a consistent vertical order
- The effects of erosion are the dominant factor in the distribution of these rocks
- Faulting is a lesser factor



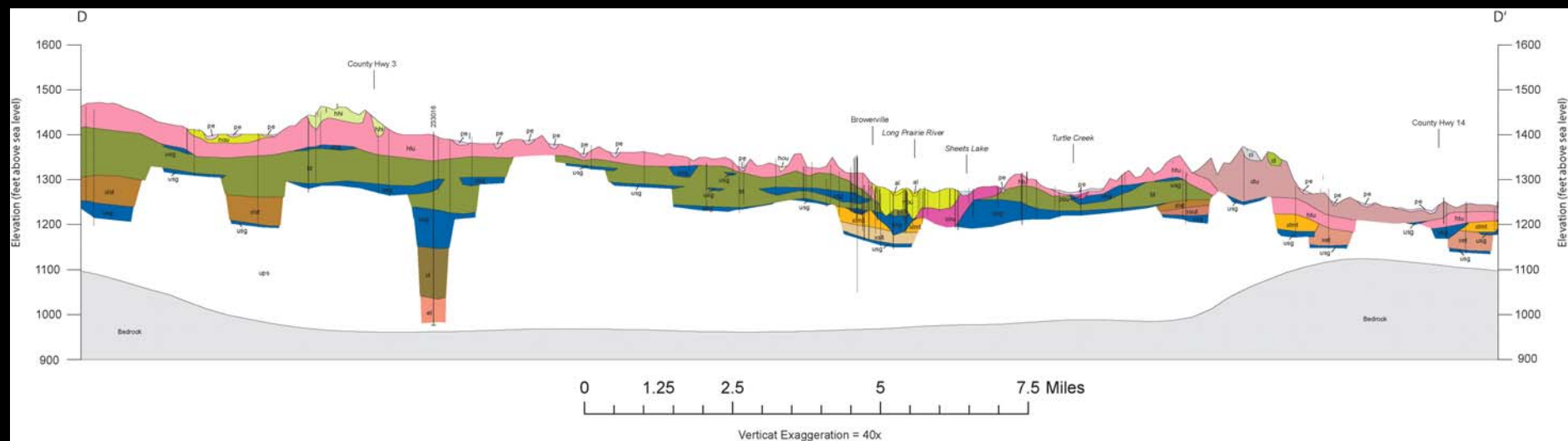


# Glacial Aquifer Mapping

- Aquifers deposited by water, surrounded by confining materials deposited by ice
- Original depositional pattern is very complex (sheets, channels, ice-contact deposits) and erosion superimposes additional complexity
- Size of deposits is variable, but generally much smaller than marine sedimentary aquifers



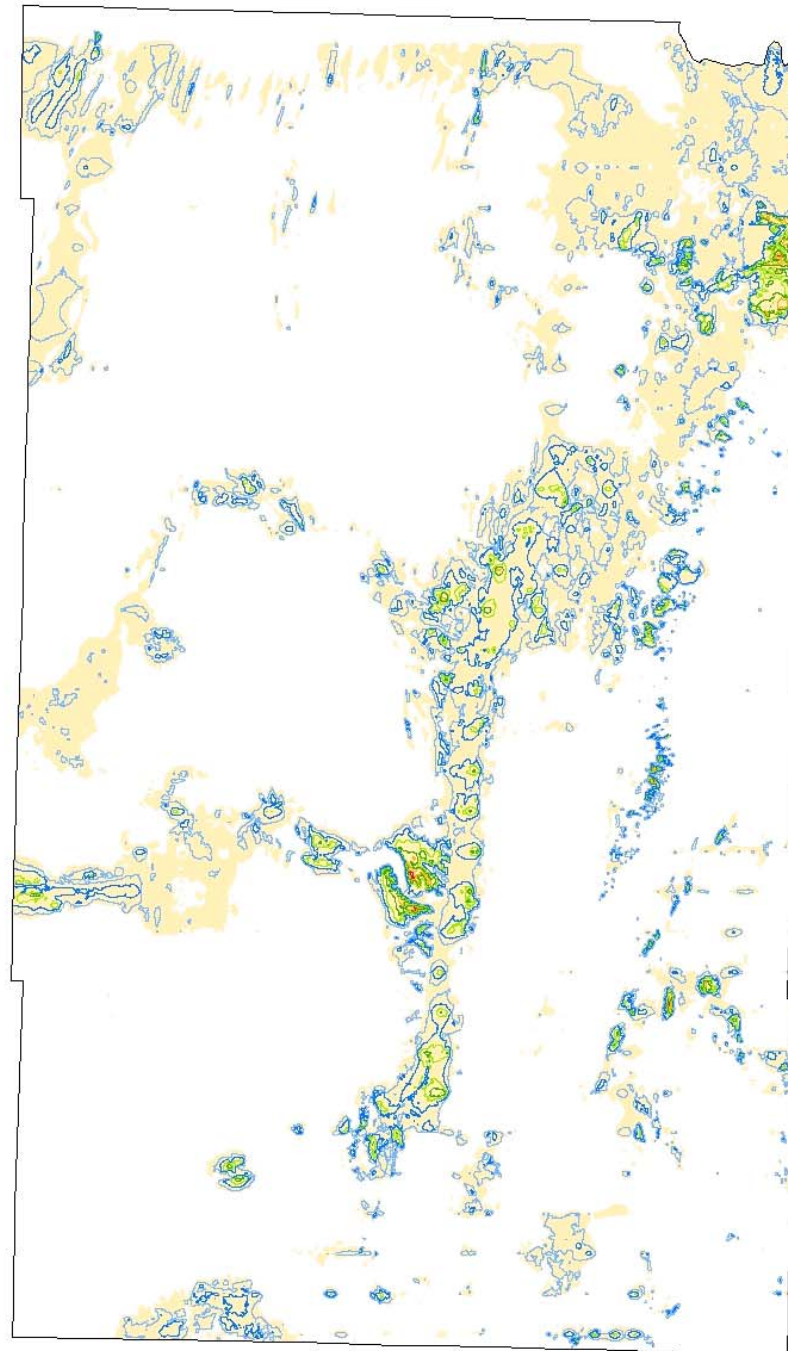




# Subsurface data limitations:

- Depth: Wells tend to end in the uppermost aquifer that provides the quantity and quality of water desired
- Density:
  - Well distribution laterally is determined by population density. Data availability in two counties of similar size can vary by an order of magnitude
  - Distribution of data determines the size of aquifers that can be mapped, and the resolution of aquifer boundaries





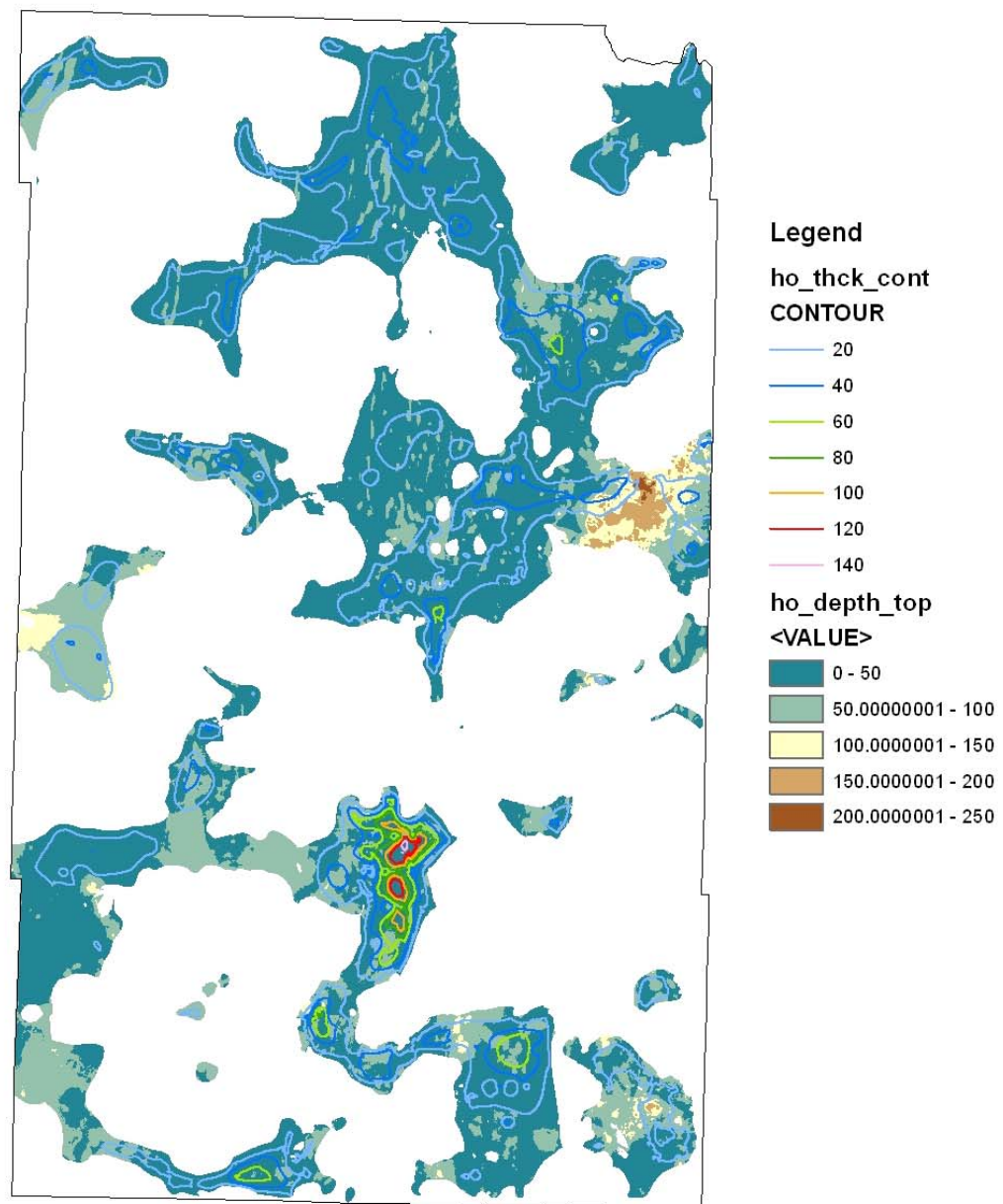
**Legend**

**Surf\_sand thickness (ft)**

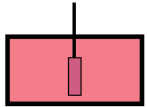
**CONTOUR**

- 20
- 40
- 60
- 80
- 100
- 120

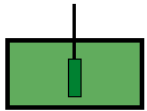
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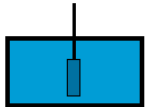
# Tritium



Recent—Water entered the ground since 1953 (10 or more tritium units).



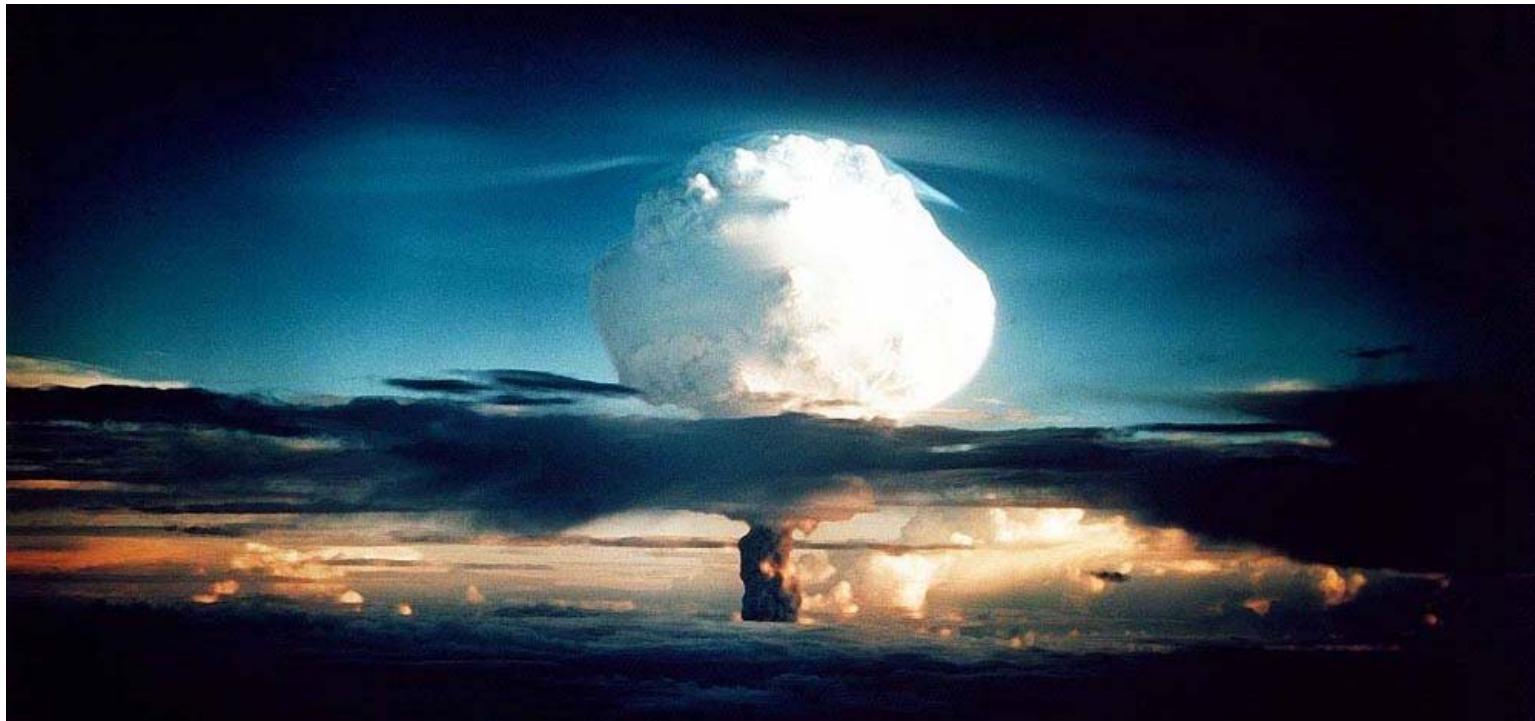
Mixed—Water is a mixture of recent and vintage waters (0.8 to less than 10 tritium units).



Vintage—Water entered the ground before 1953 (less than 0.8 tritium units).



Well not sampled for tritium.



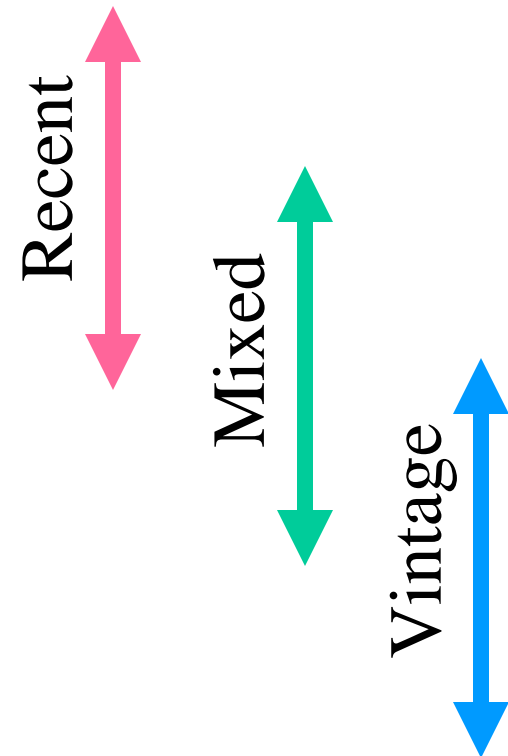


## Sensitivity Ratings

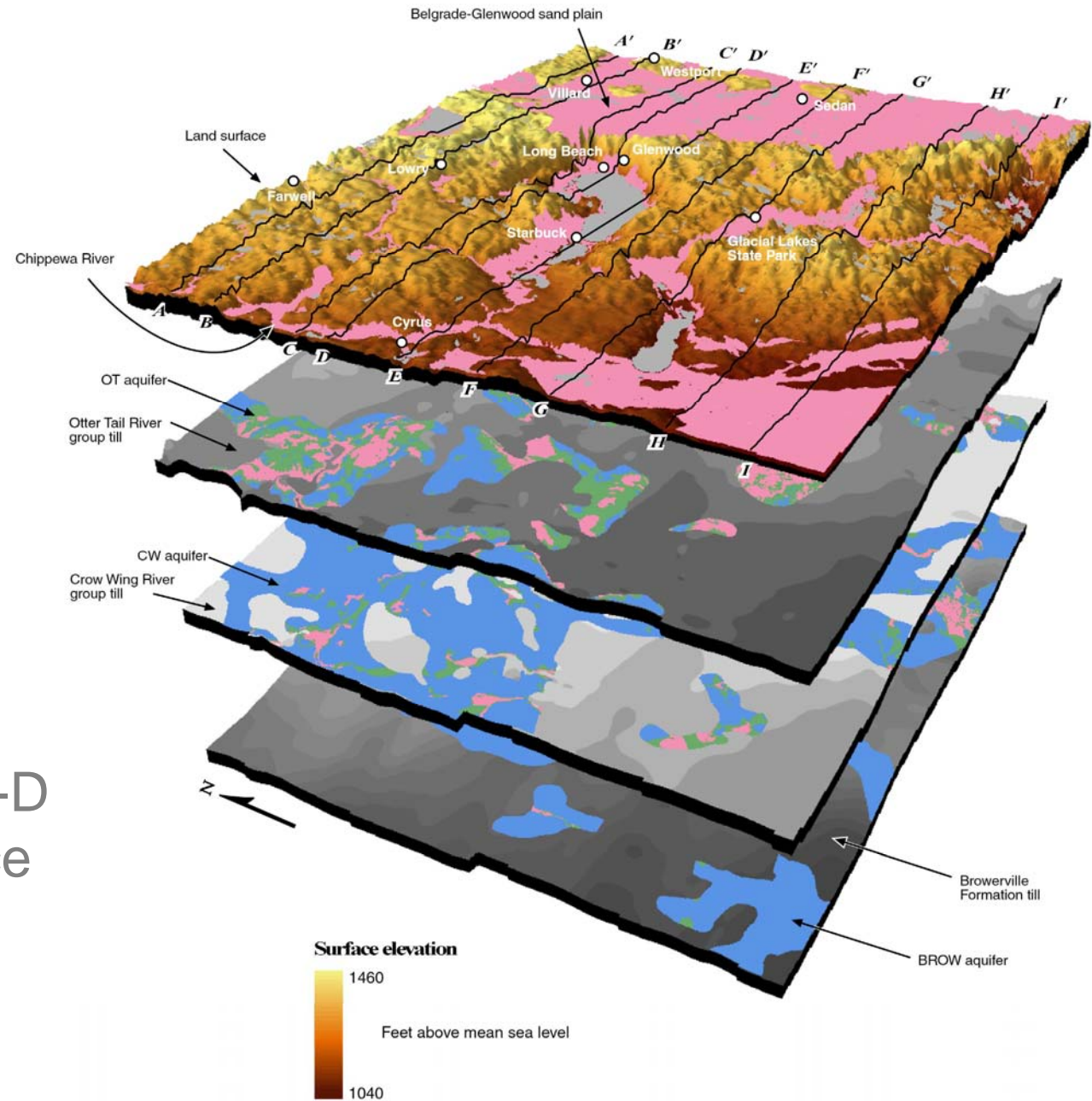
*Estimated vertical travel time for water-borne surface contaminants to enter the uppermost bedrock aquifers (target zone)*

## Tritium Relationships

<b>VH</b>	<b>Very High</b> —Hours to months
<b>H</b>	<b>High</b> —Weeks to years
<b>M</b>	<b>Moderate</b> —Years to decades
<b>L</b>	<b>Low</b> —Decades to a century
<b>VL</b>	<b>Very Low</b> —A century or more



# Pope County

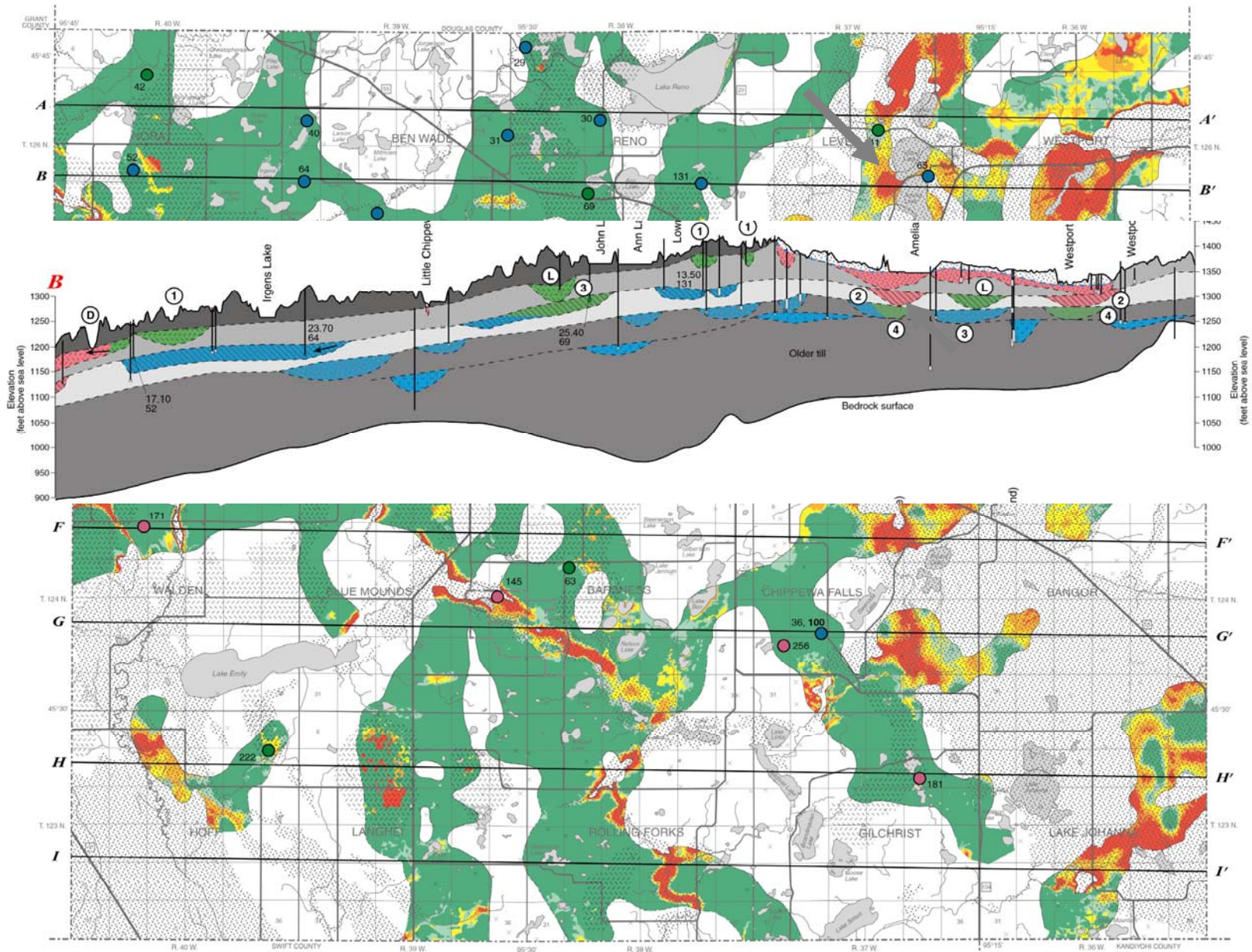


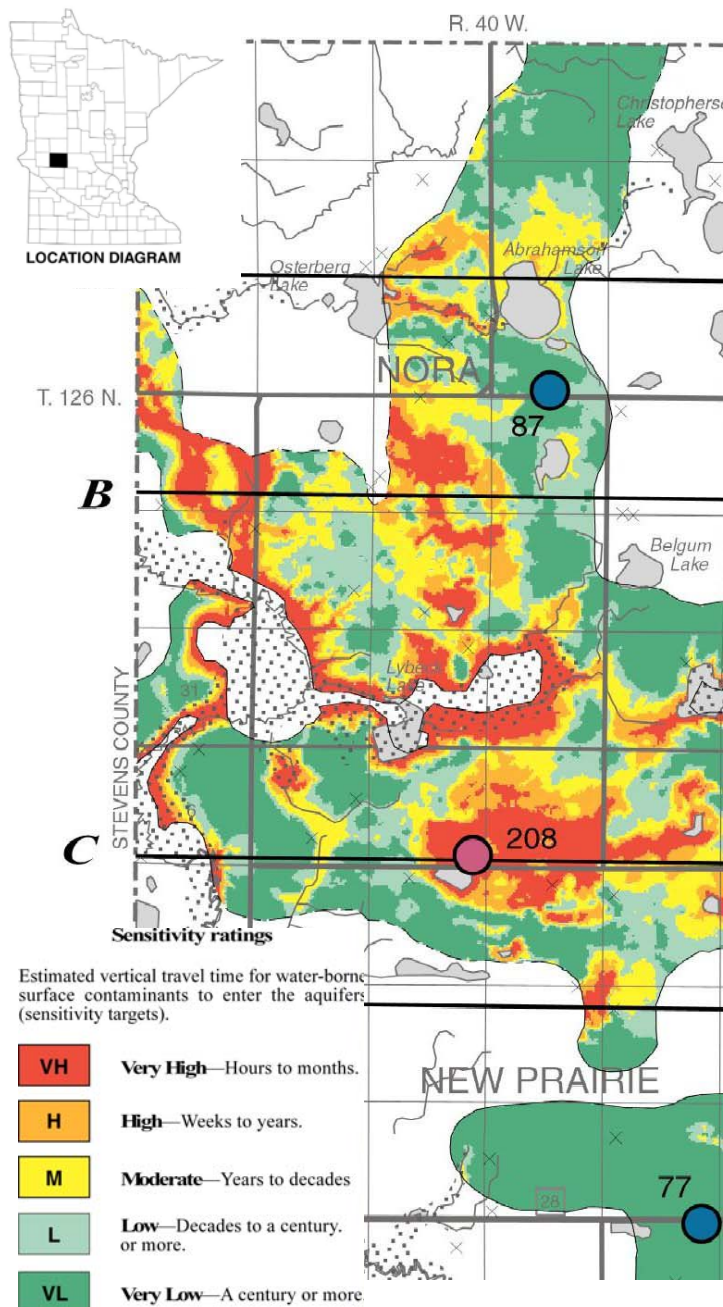
Aquifers in 3-D  
and residence  
Time (age)  
relationships



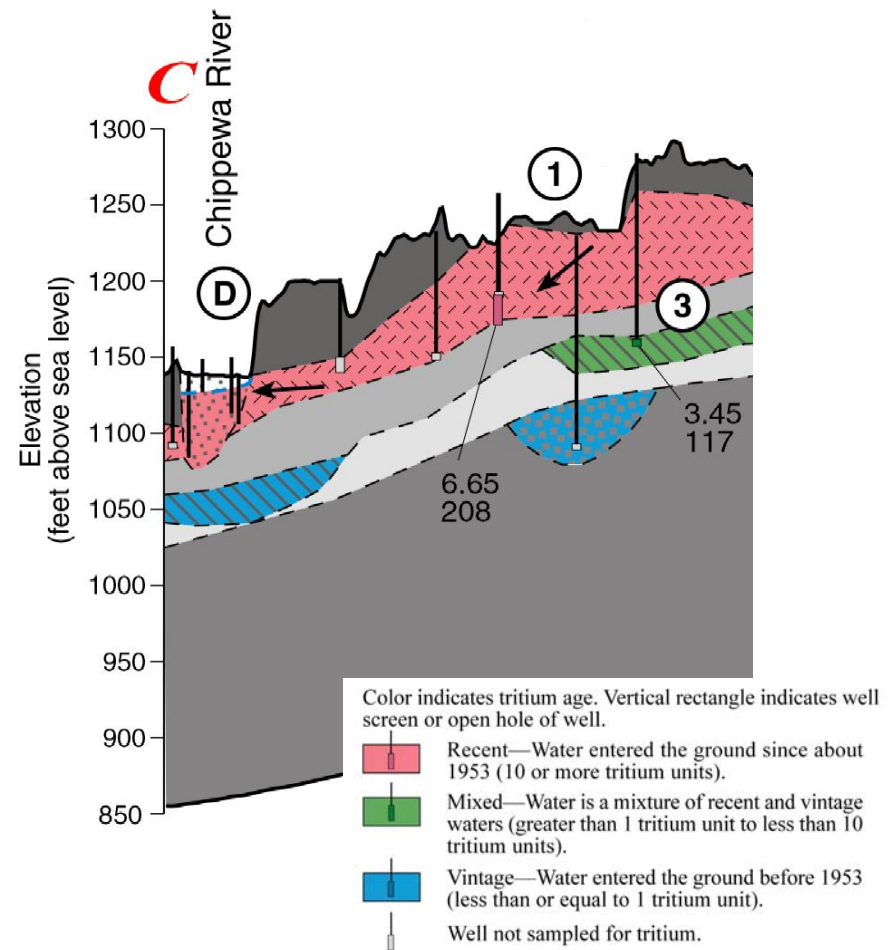




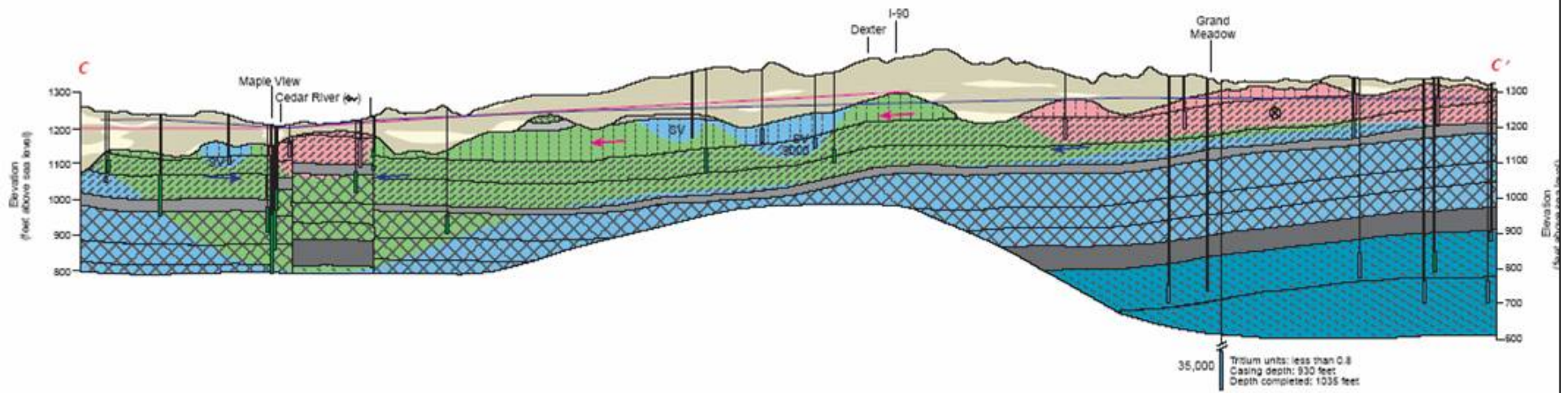




## Local recharge and discharge OT aquifer northwestern Pope County







In this geologic cross-section, the colors represent the age of the ground water. The pink water has entered the ground in the last 50 years, the green water is of intermediate age, and the blue water is as old as 35,000 years. Figure from the Mower County Geologic Atlas, Part B, Minnesota DNR, Division of Waters, 2002.



# CGA Program

- Funding is a major limitation
  - Pass through, indirect
  - Need for local resources
  - Variable (\$200,000/year to >\$600,000/year)
    - LCCMR participation
    - Matching staffing to funding
- Should this be a program?
  - Advantages to a less formal arrangement