Examples of Hypogenic Karst Collapse Structures, Twin Cities Metropolitan Area, Minnesota

Kelton D. L. Barr, *Braun Intertec Corp.*
E. Calvin Alexander, Jr., *University of Minnesota*

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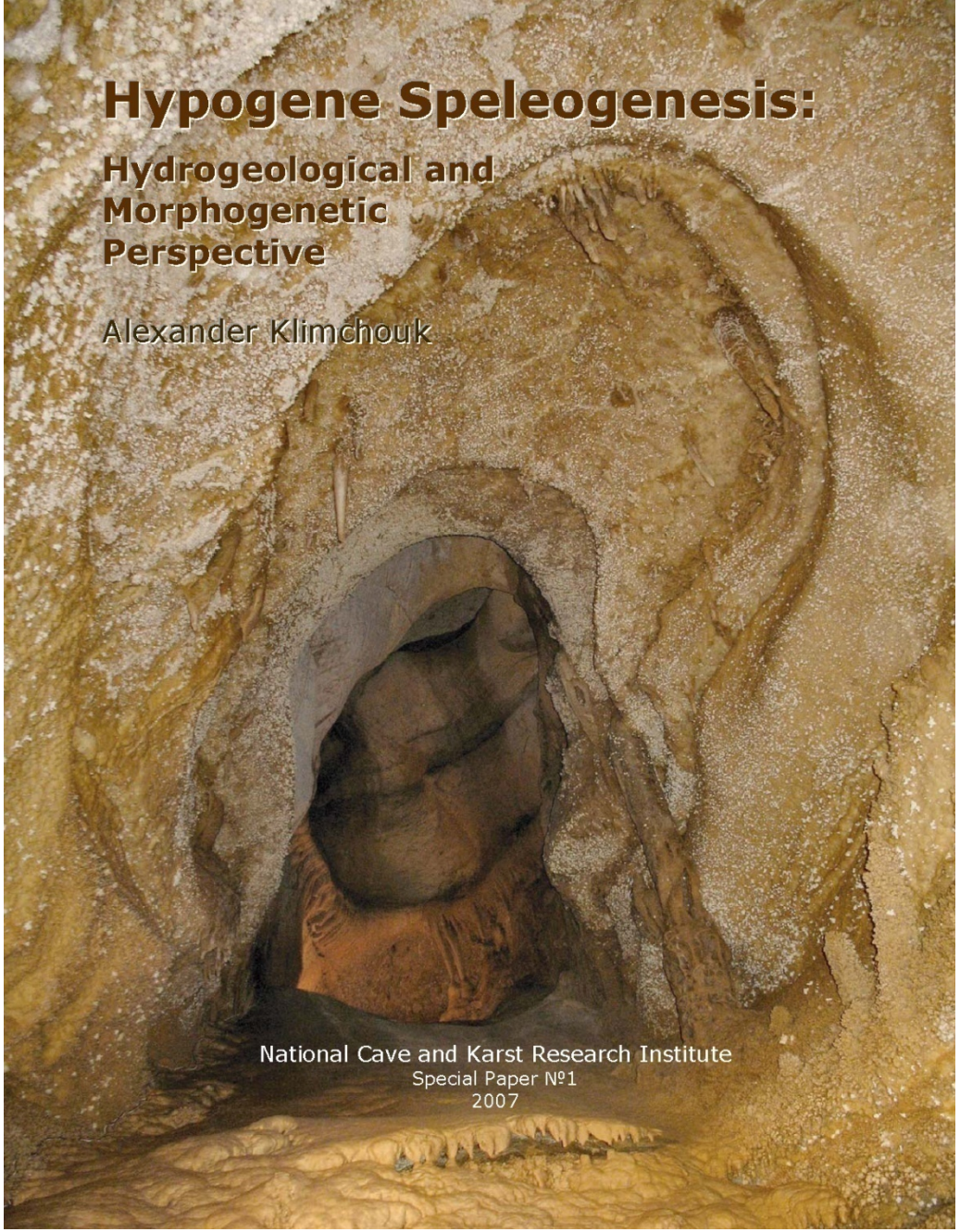

Primary Resource:

Hypogene Speleogenesis: Hydrological and Morphogenetic Perspective

by Alexander Klimchouk

National Cave and Karst Research Institute

Special Paper No. 1

2007

NCKRI

1400 Commerce Drive,
Carlsbad, NM 88220

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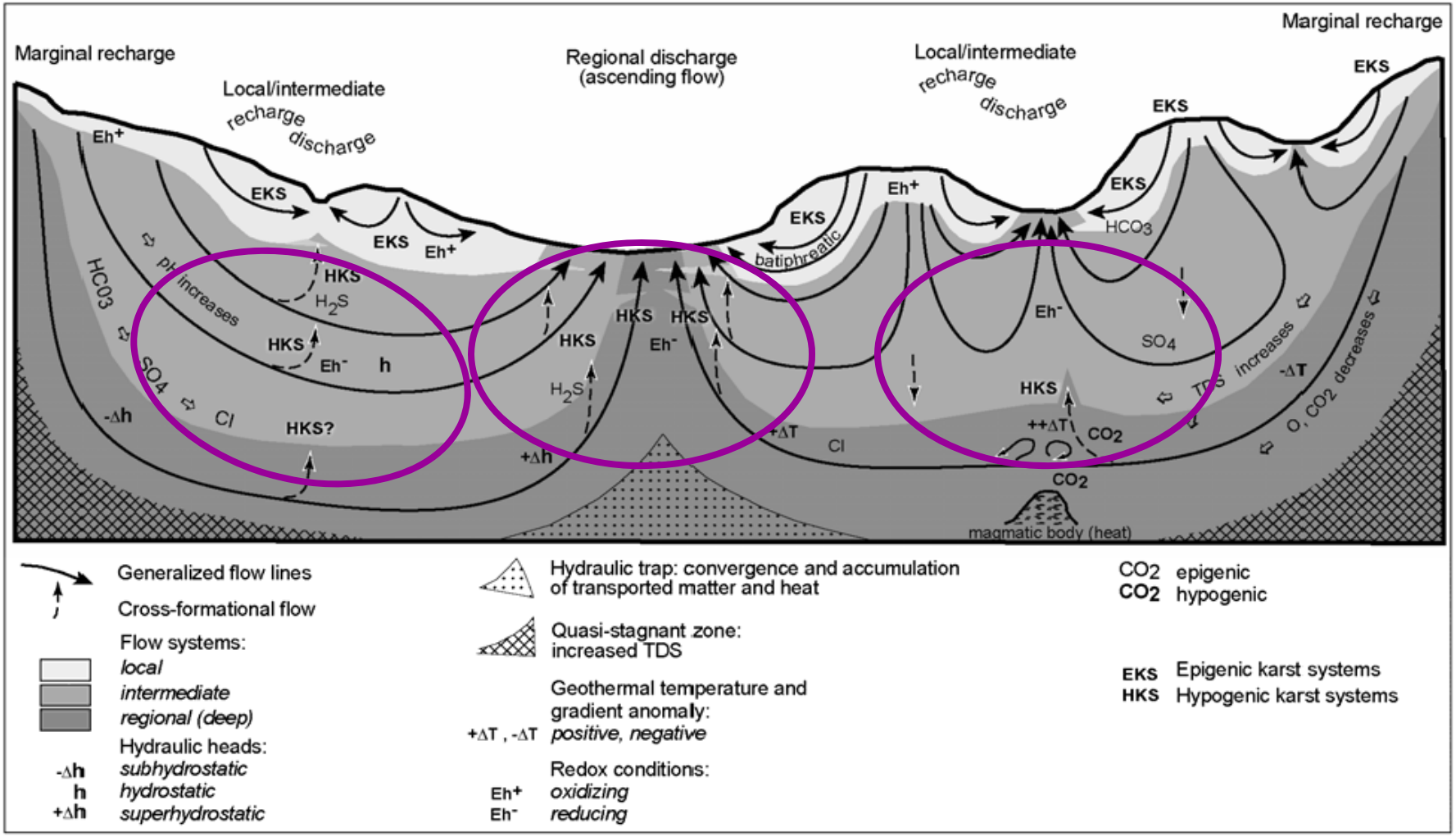
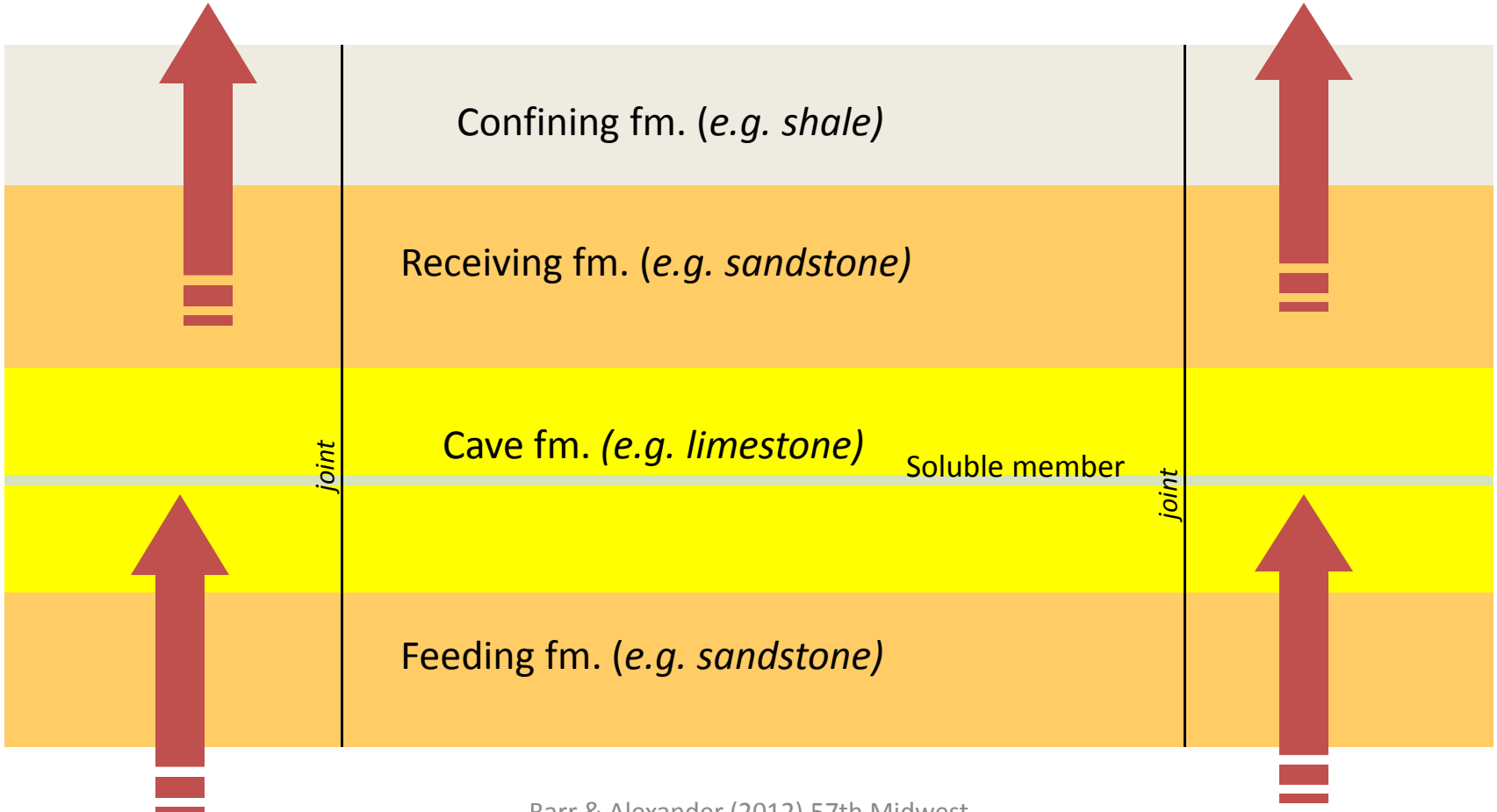


Figure 1. Epigenic and hypogenic karst in the context of basinal groundwater flow. Adopted and modified from Tóth (1999). The figure shows mainly gravity-driven flow in an idealized homogenous basin. In reality, most sedimentary sequences are highly heterogeneous, and gravity-driven flow interacts with other flow mechanisms.

from Klimchouk (2007)

Basic steps in hypogenic karst development

1. Initial conditions



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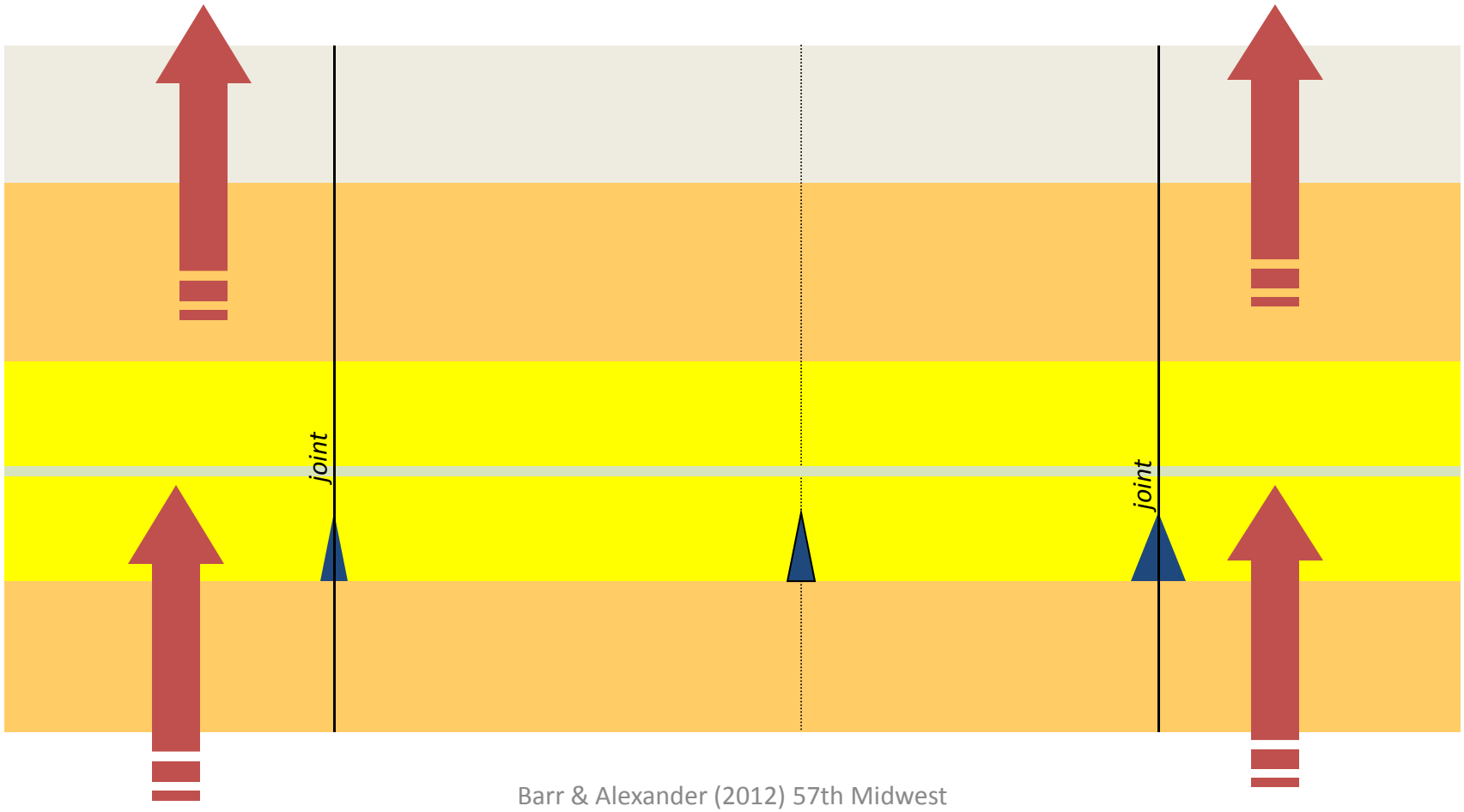
Basic steps in hypogenic karst development
2. Solution enlargement along fractures



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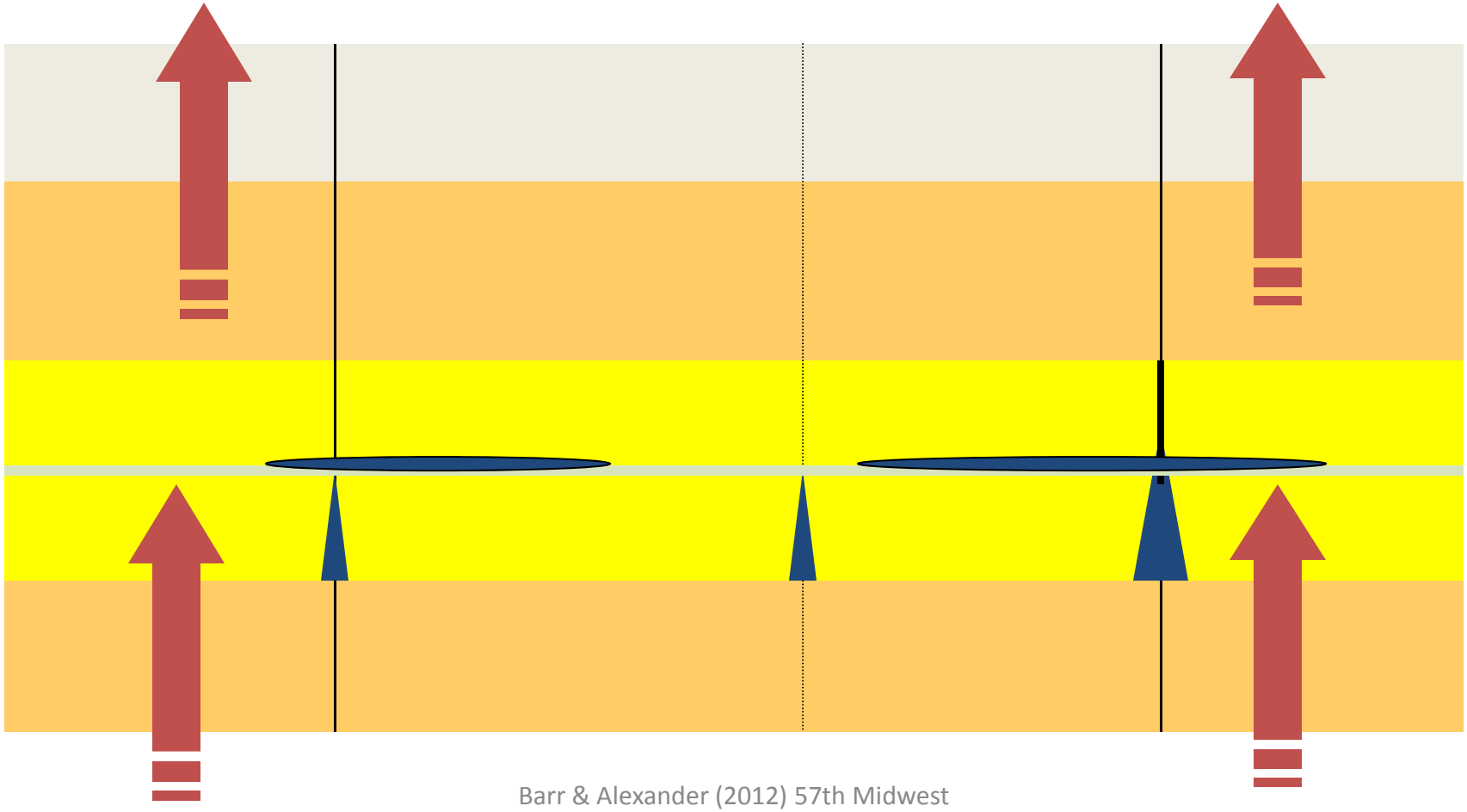
Basic steps in hypogenic karst development

3. Solution enlargement along fractures and beds



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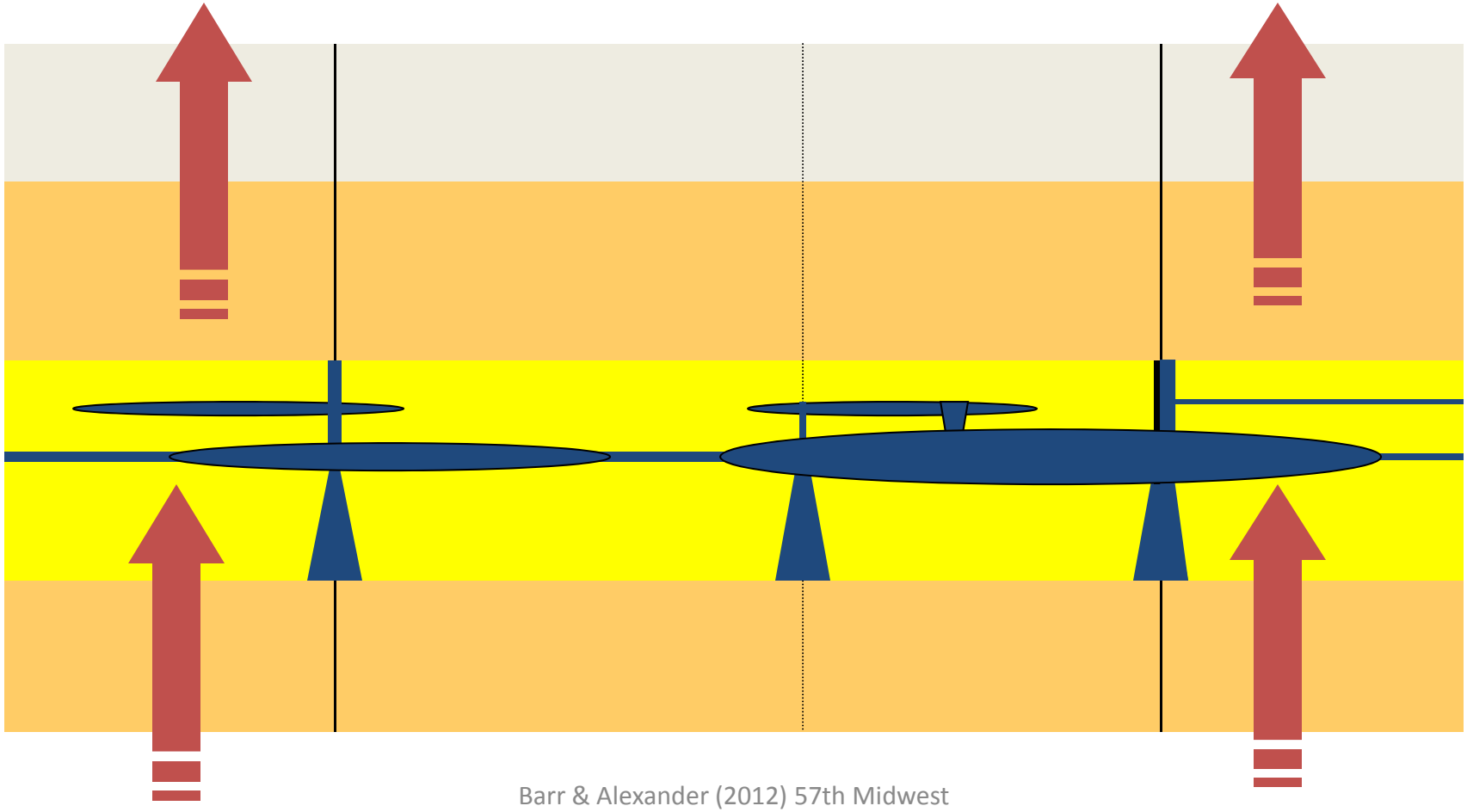
Basic steps in hypogenic karst development
4. Integration of solution enlargements



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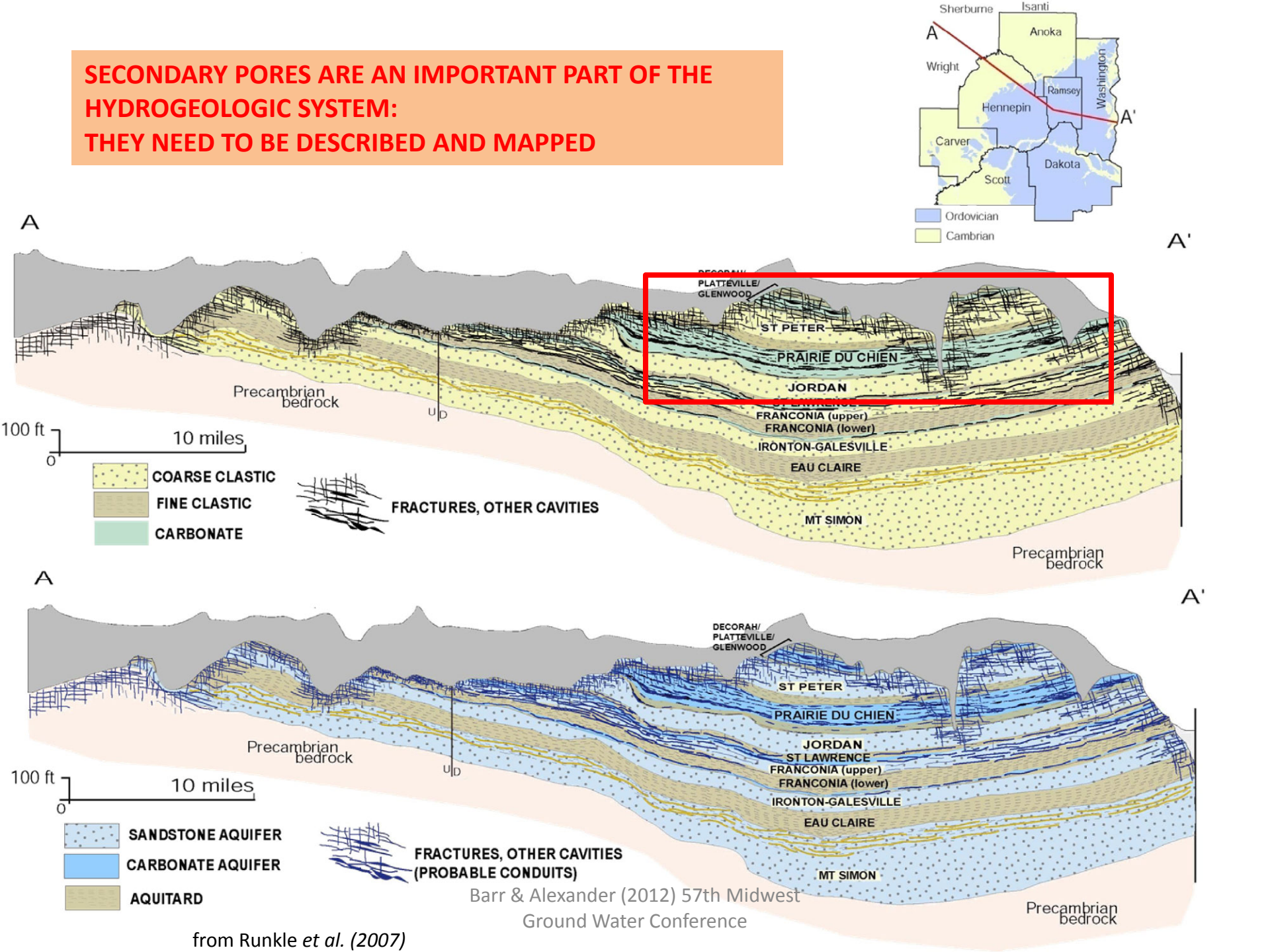
SECONDARY PORES ARE AN IMPORTANT PART OF THE HYDROGEOLOGIC SYSTEM:
THEY NEED TO BE DESCRIBED AND MAPPED



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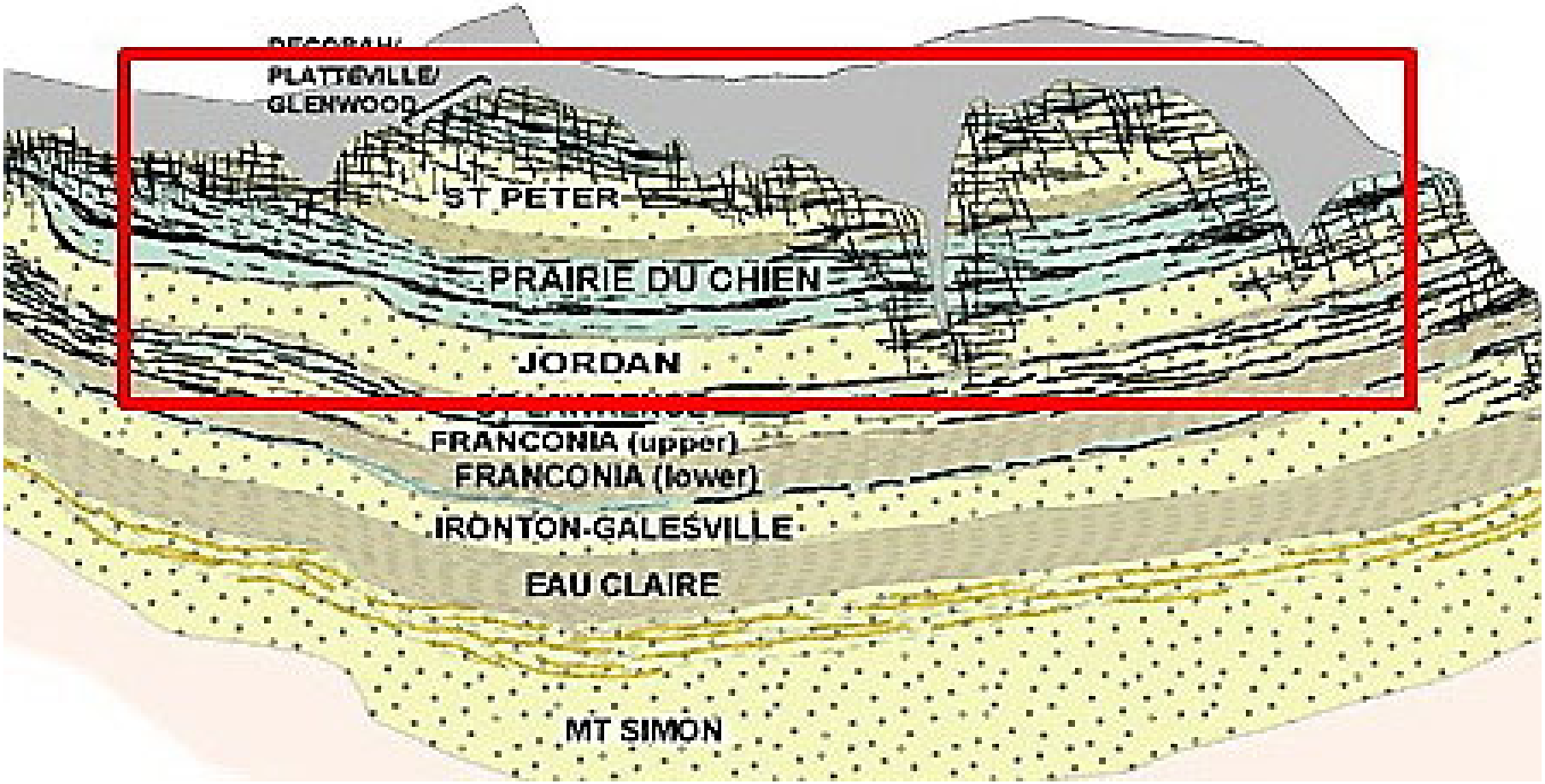
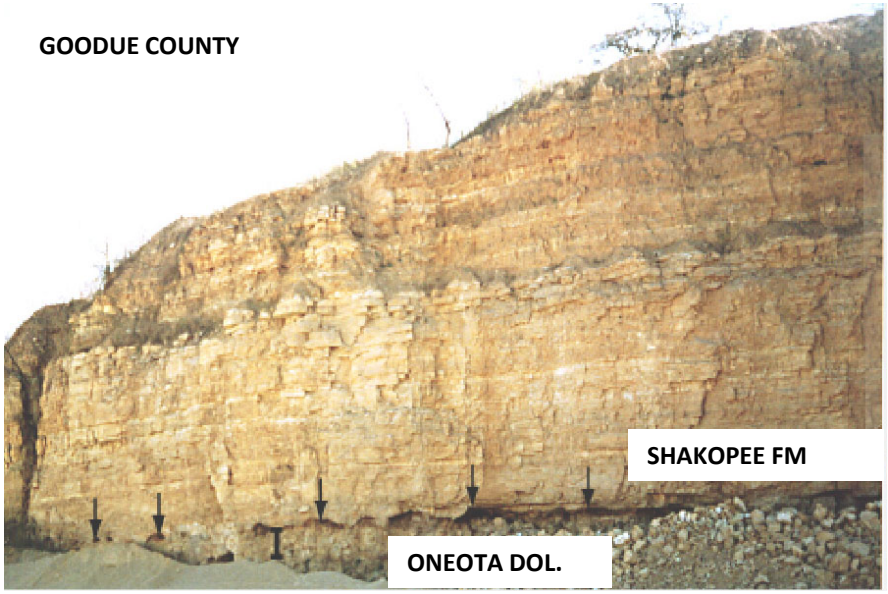
from Runkle *et al. (2007)*

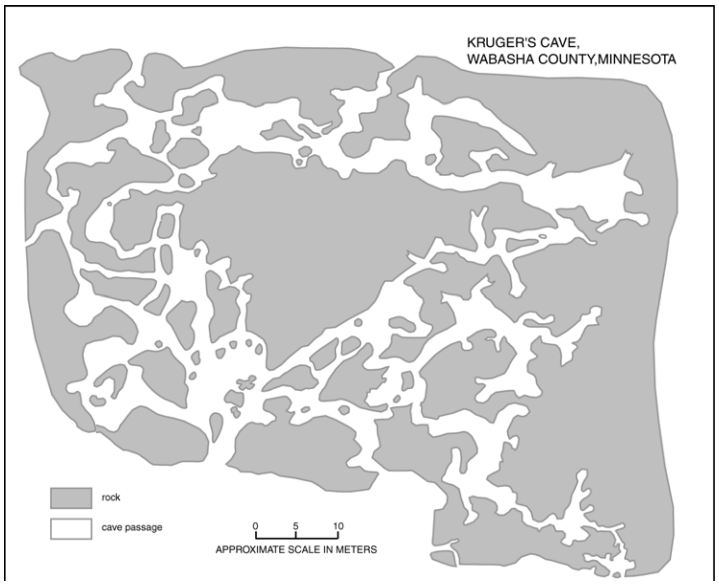


Setting of Prairie du Chien Group:

- Overlying Jordan Sandstone (permeable, insoluble aquifer)
- Underlying St. Peter Sandstone (permeable, insoluble aquifer
- Largely buried

BEDDING PLANE FRACTURES/VUGS (BPFS): EXAMPLE IN PRAIRIE DU CHIEN CARBONATE ROCK

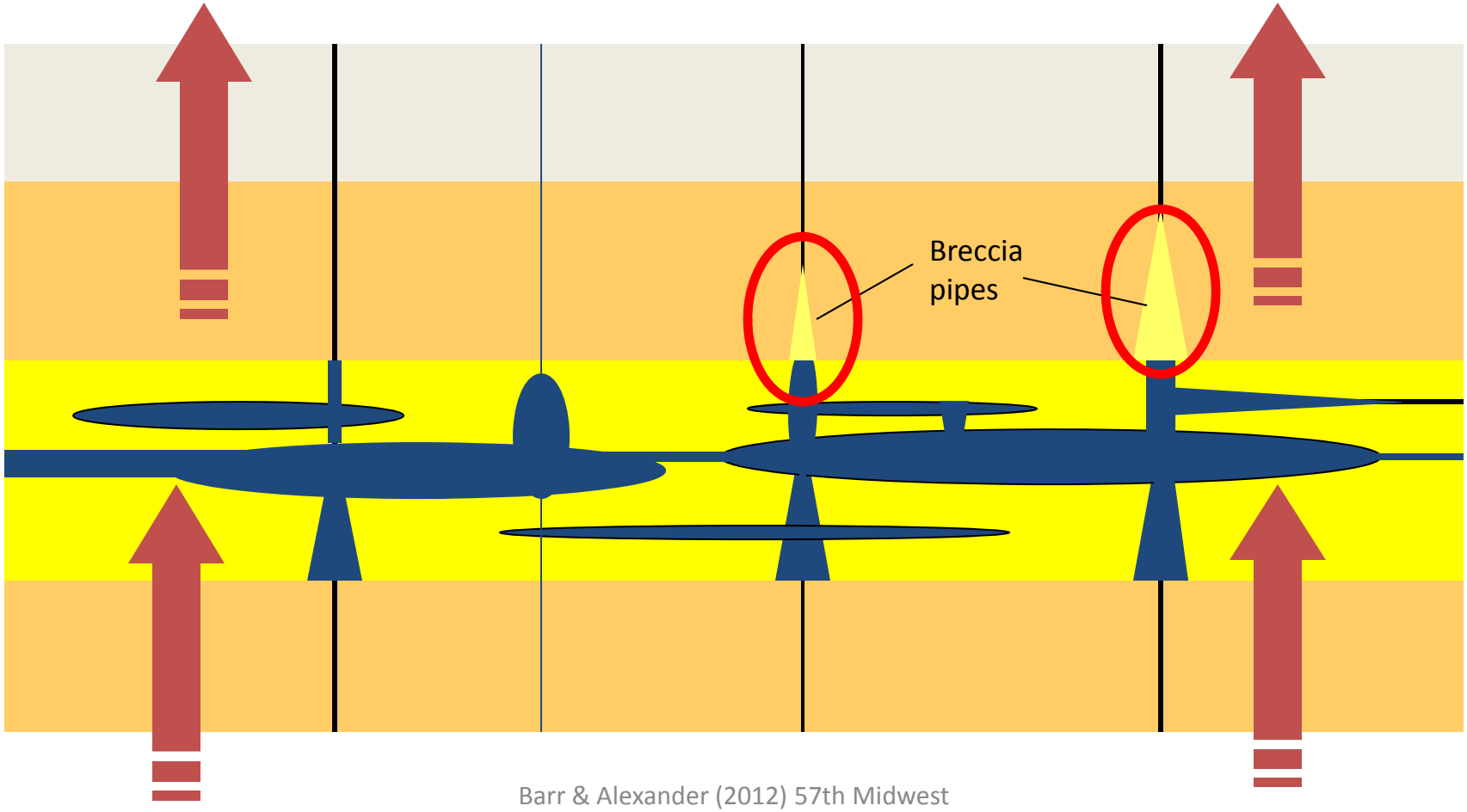




Plan view of this BPF/solution interval

from Runkle (2007), Tipping (2007)

Basic steps in hypogenic karst development
5. Ongoing evolution of karst system



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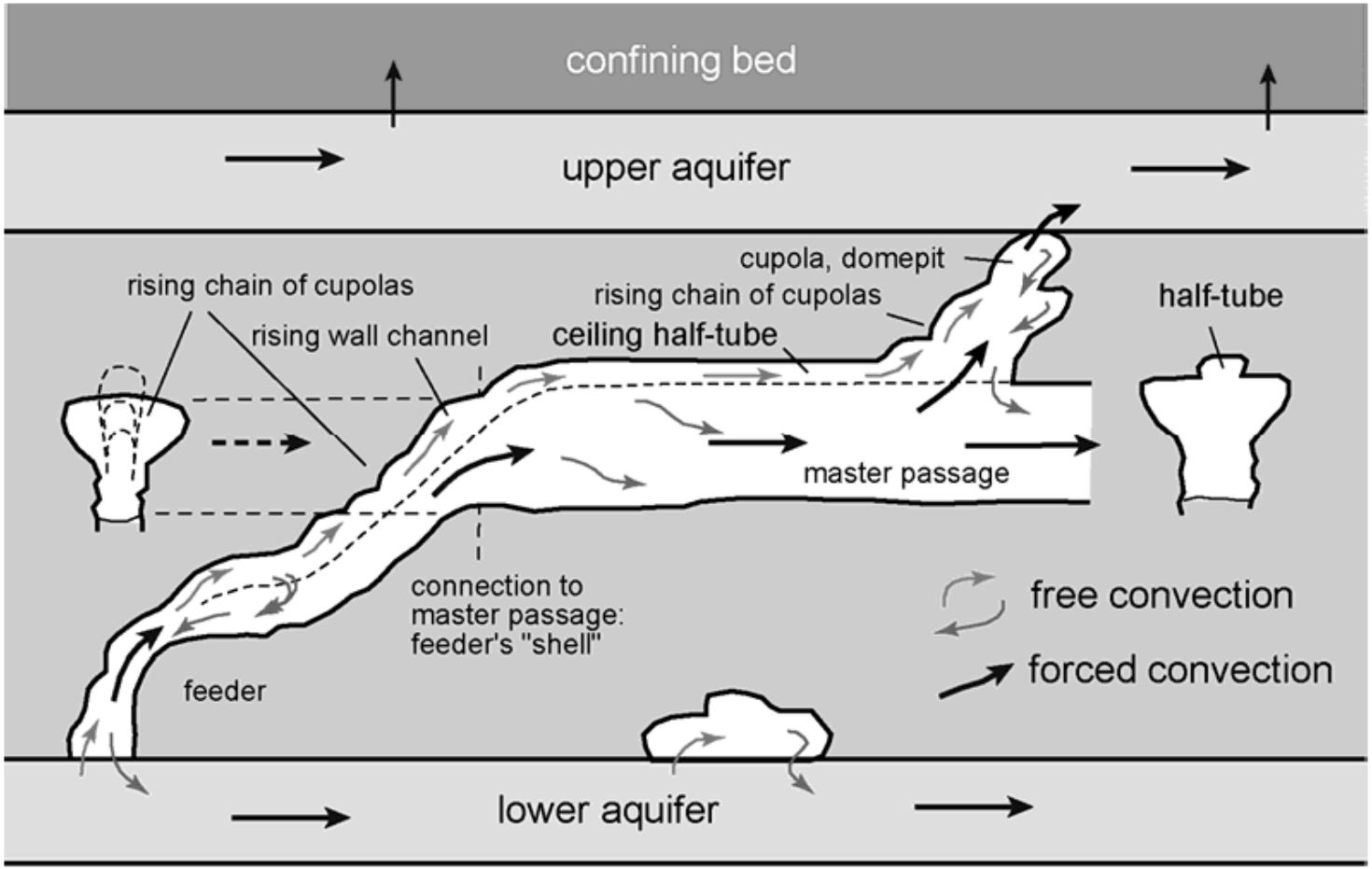

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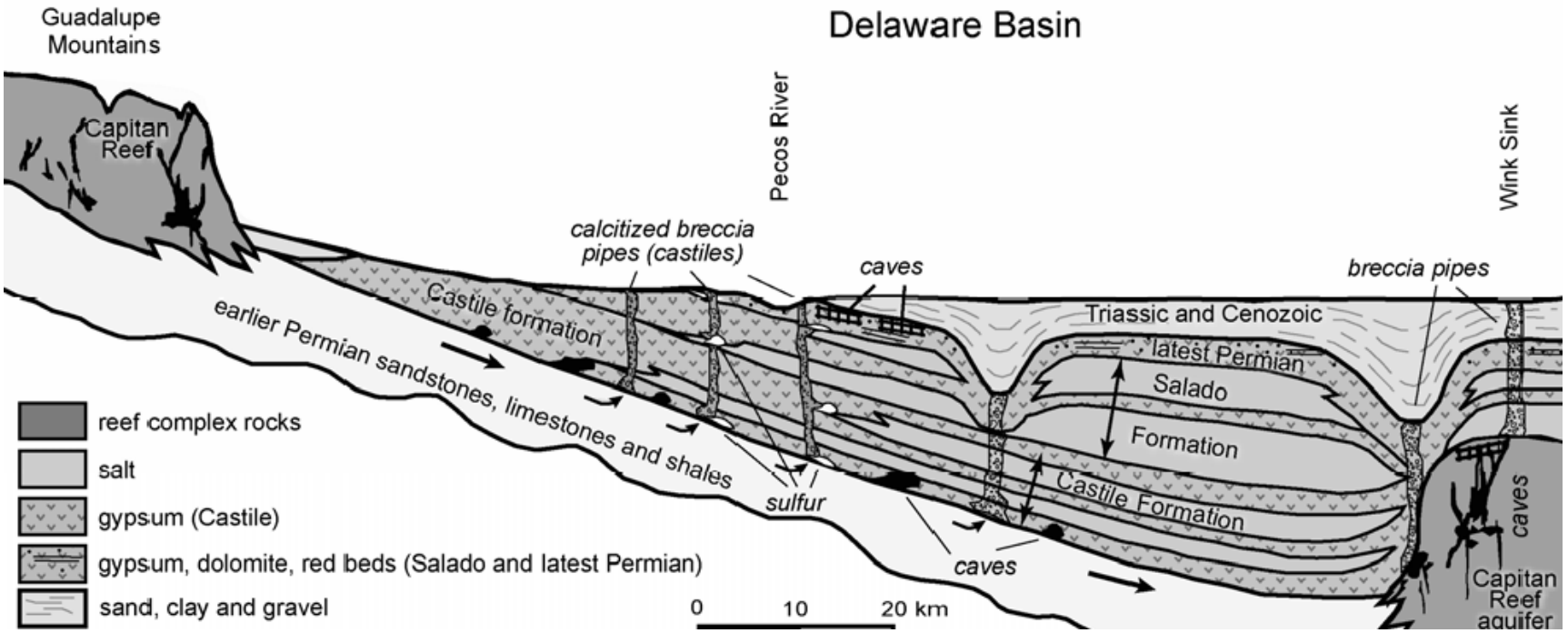
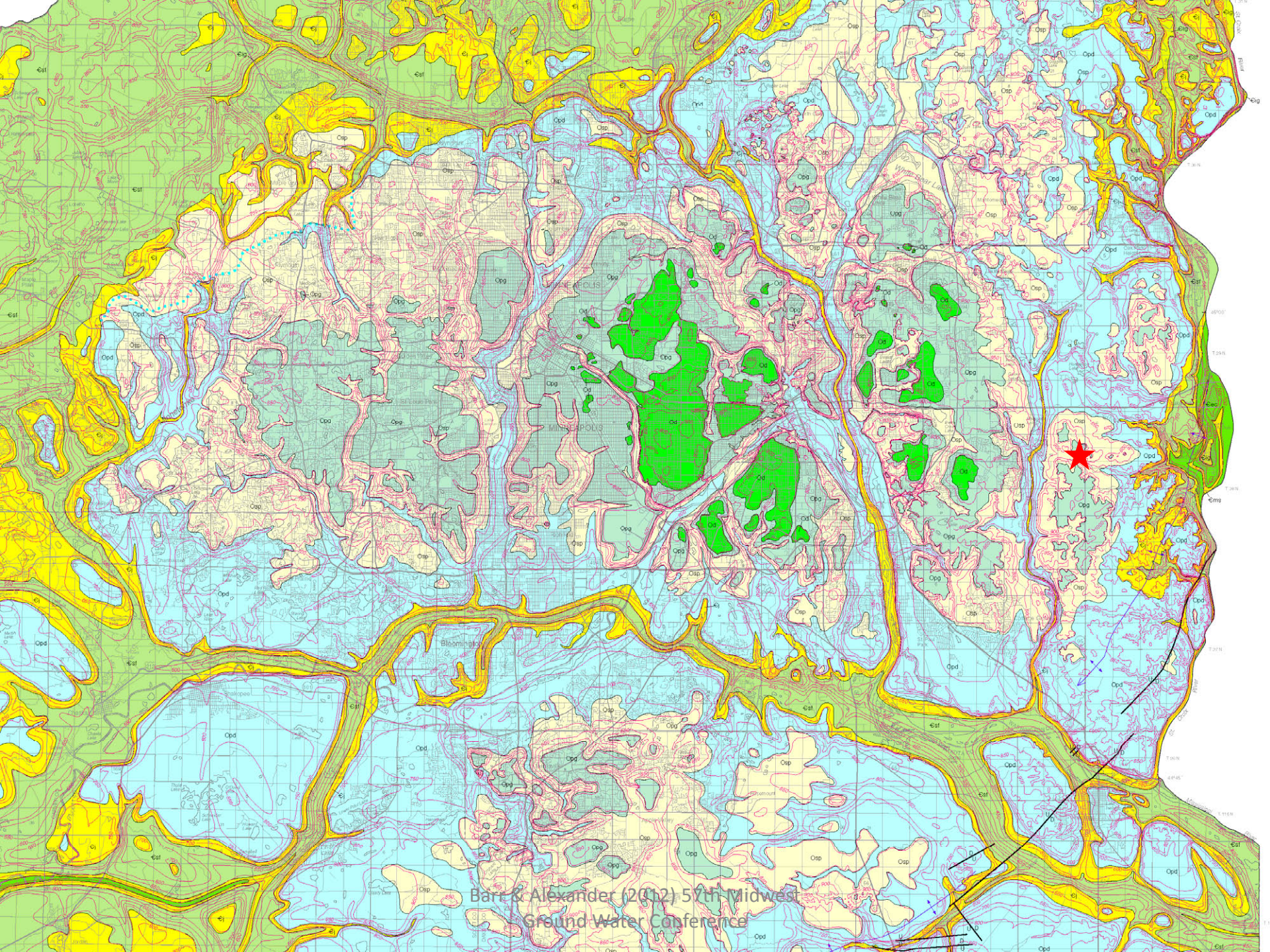
Breccia pipes, NM & TX



from Klimchouk (2007)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Bloomington

“Houston, we have a problem.”

D38 and D44


D44
D38
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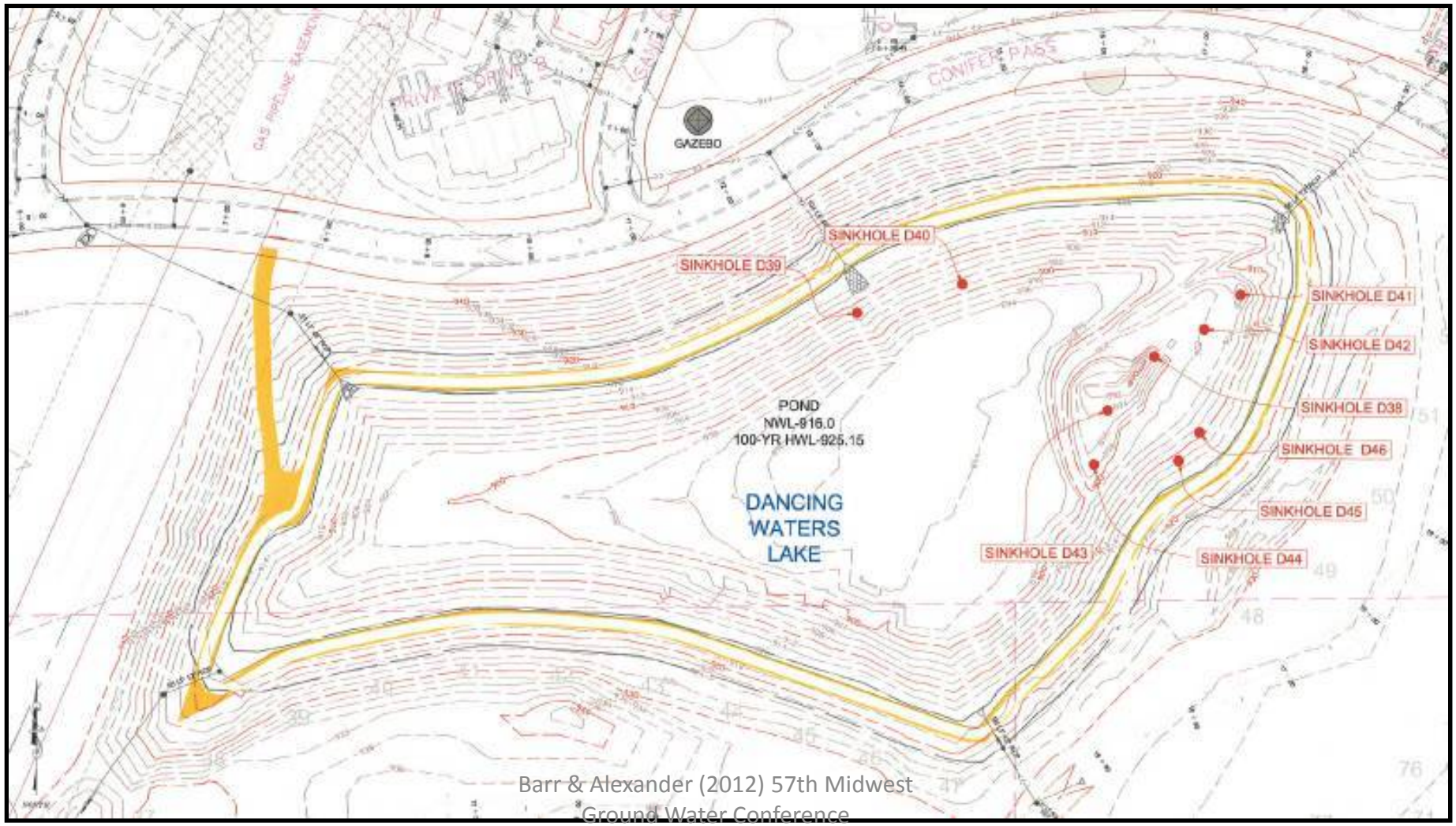
Sinkhole Locations, Dancing Waters, Woodbury, MN



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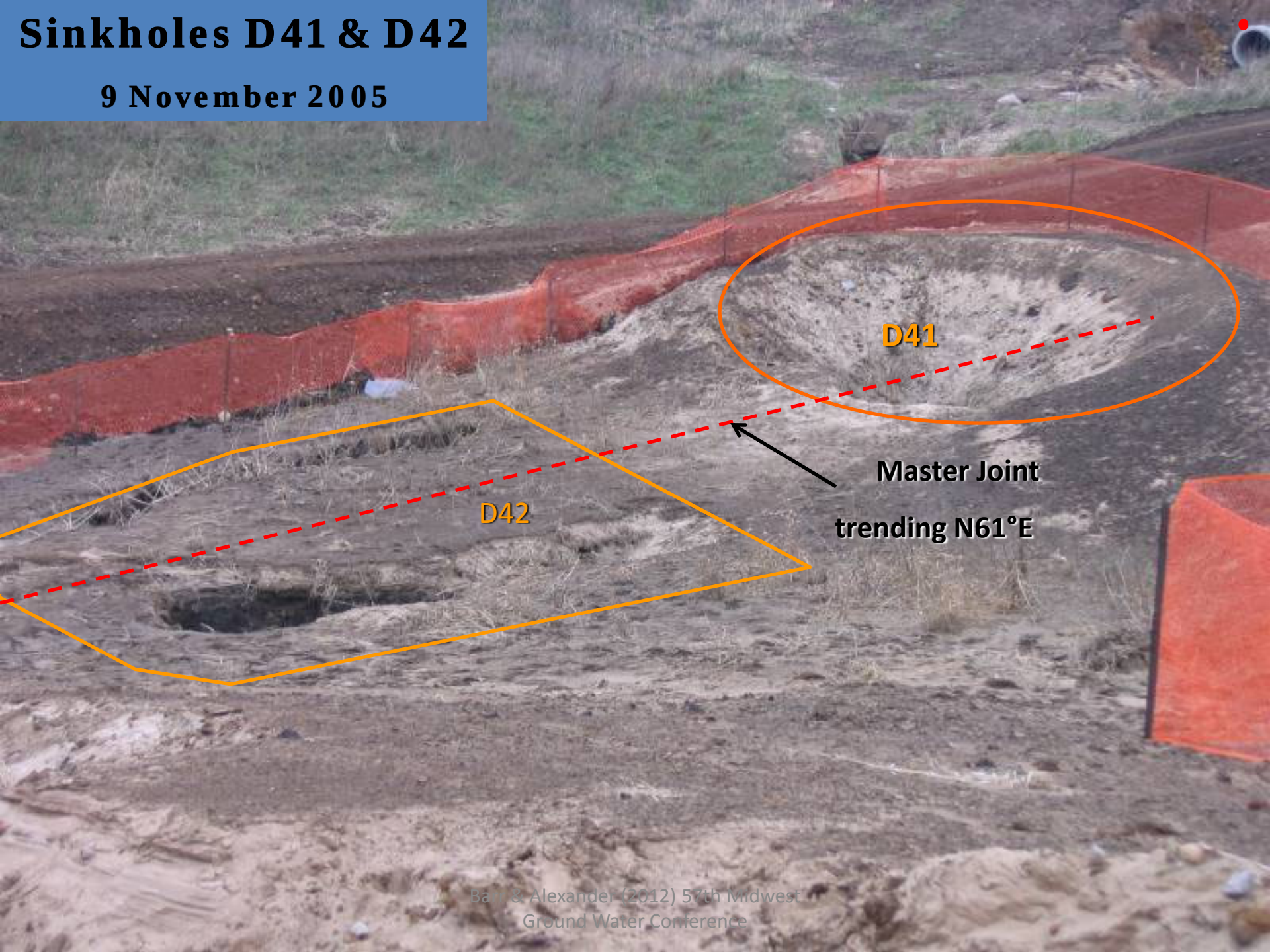
Sinkholes D41 & D42

9 November 2005



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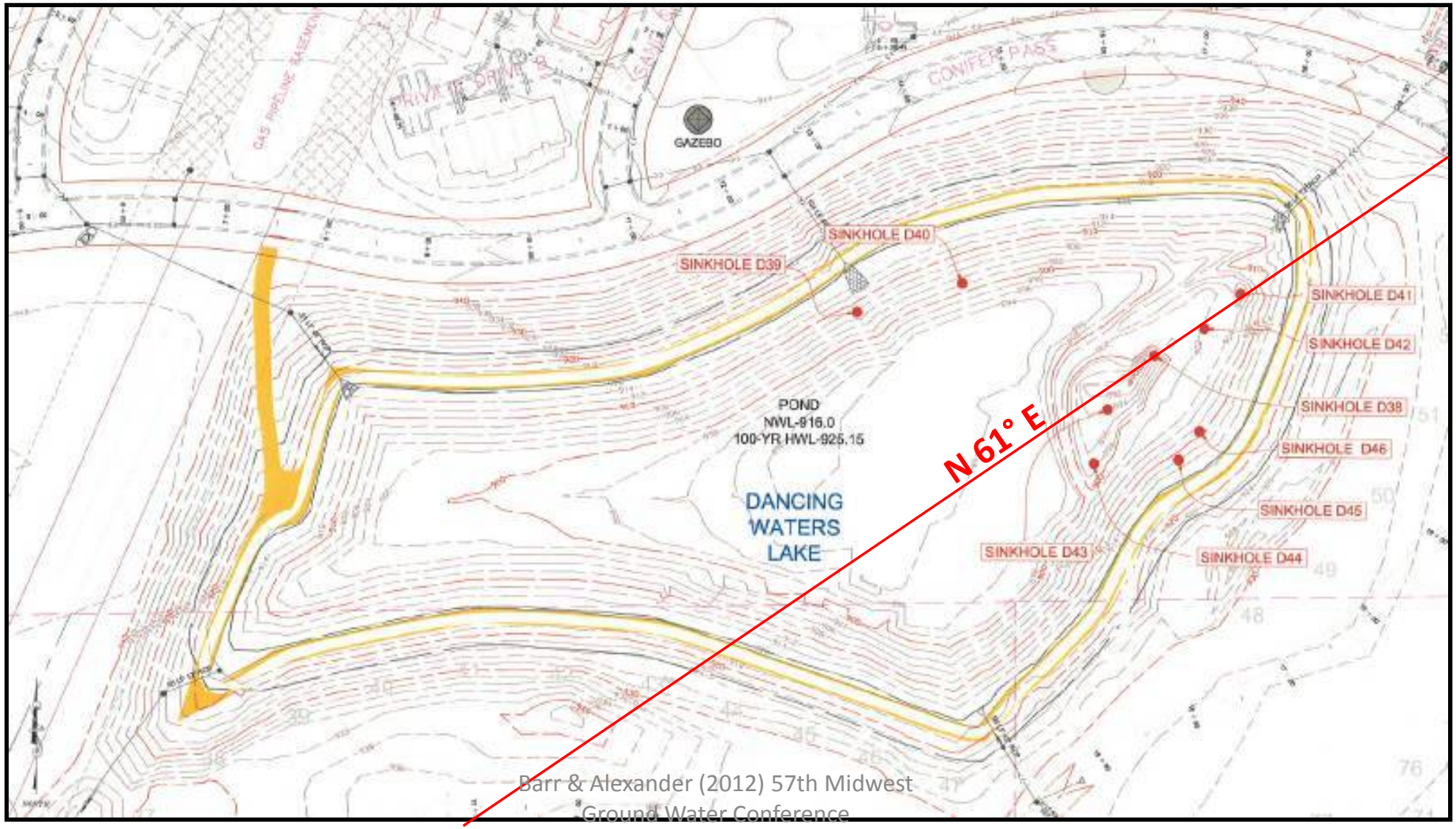
Sinkhole Locations, Dancing Waters, Woodbury, MN



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Gophers?


CM
IN

Photograph by Barr

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A second breccia pipe, Woodbury, MN

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Rock Cores Reveal Soil Filled Fractures

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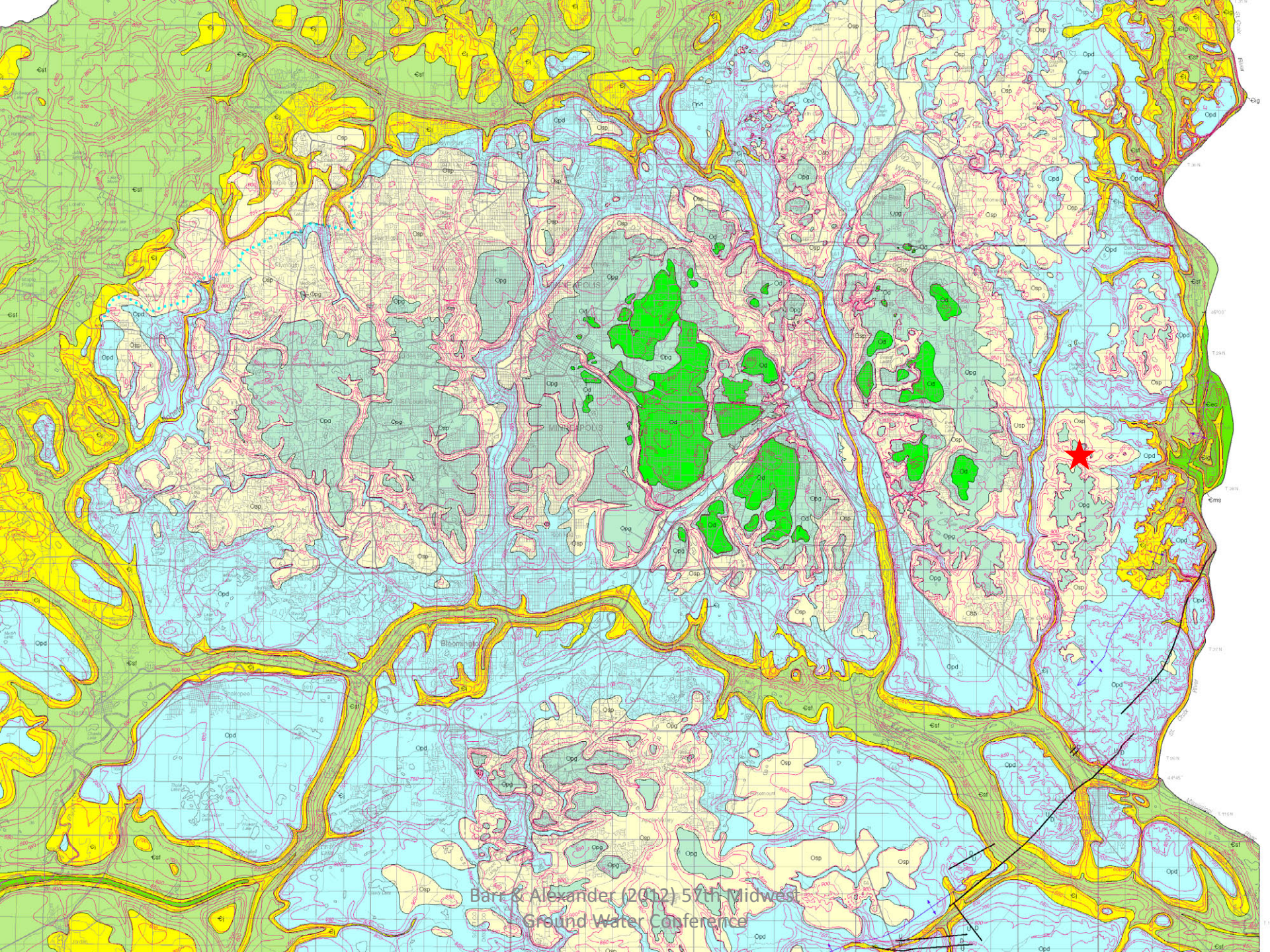
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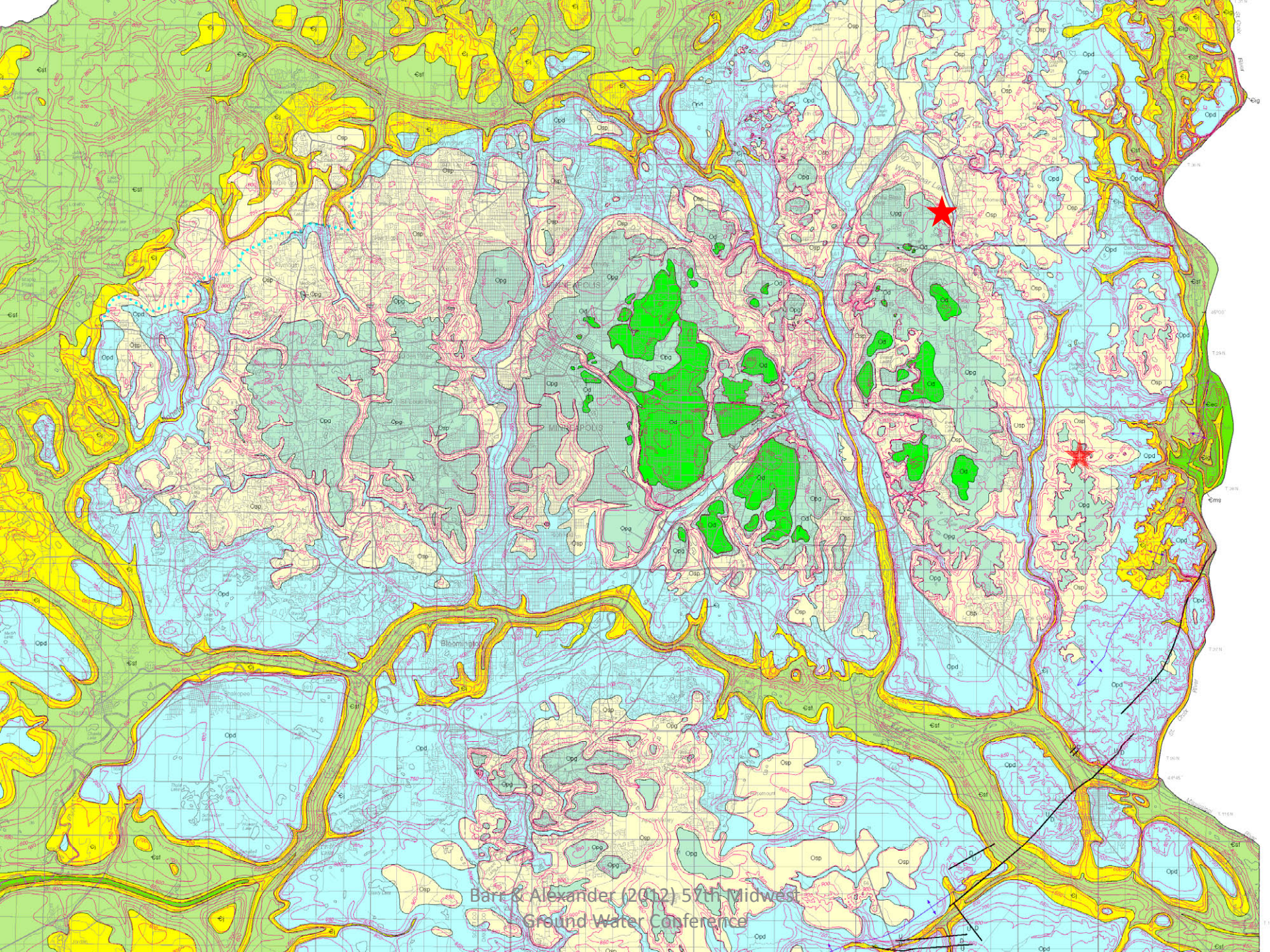

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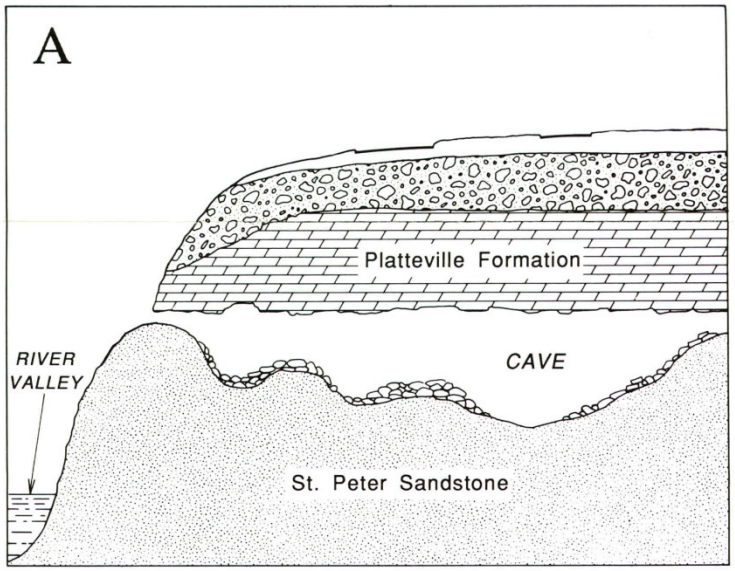
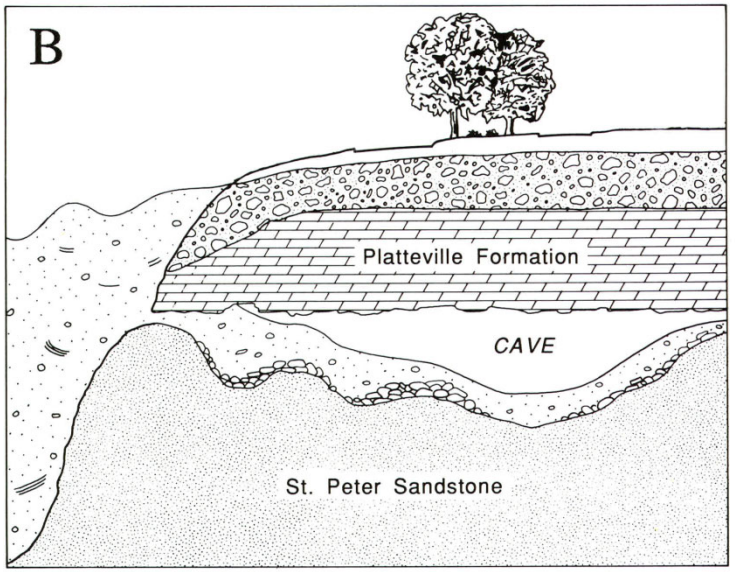




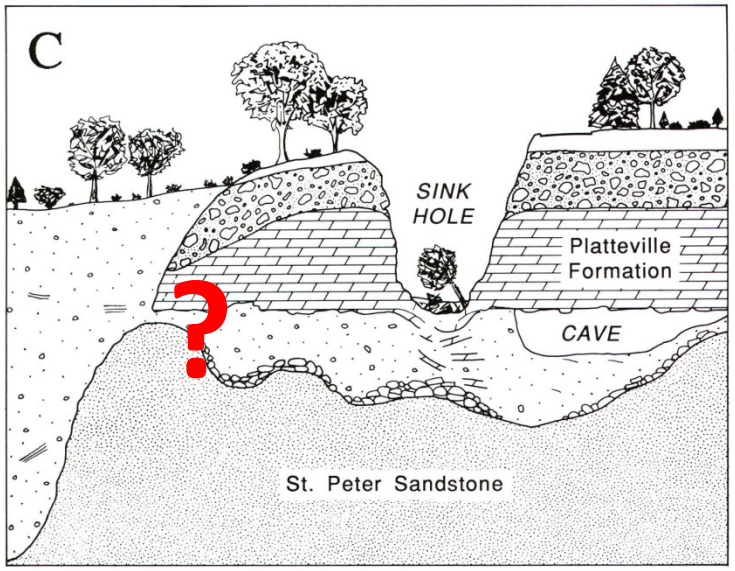
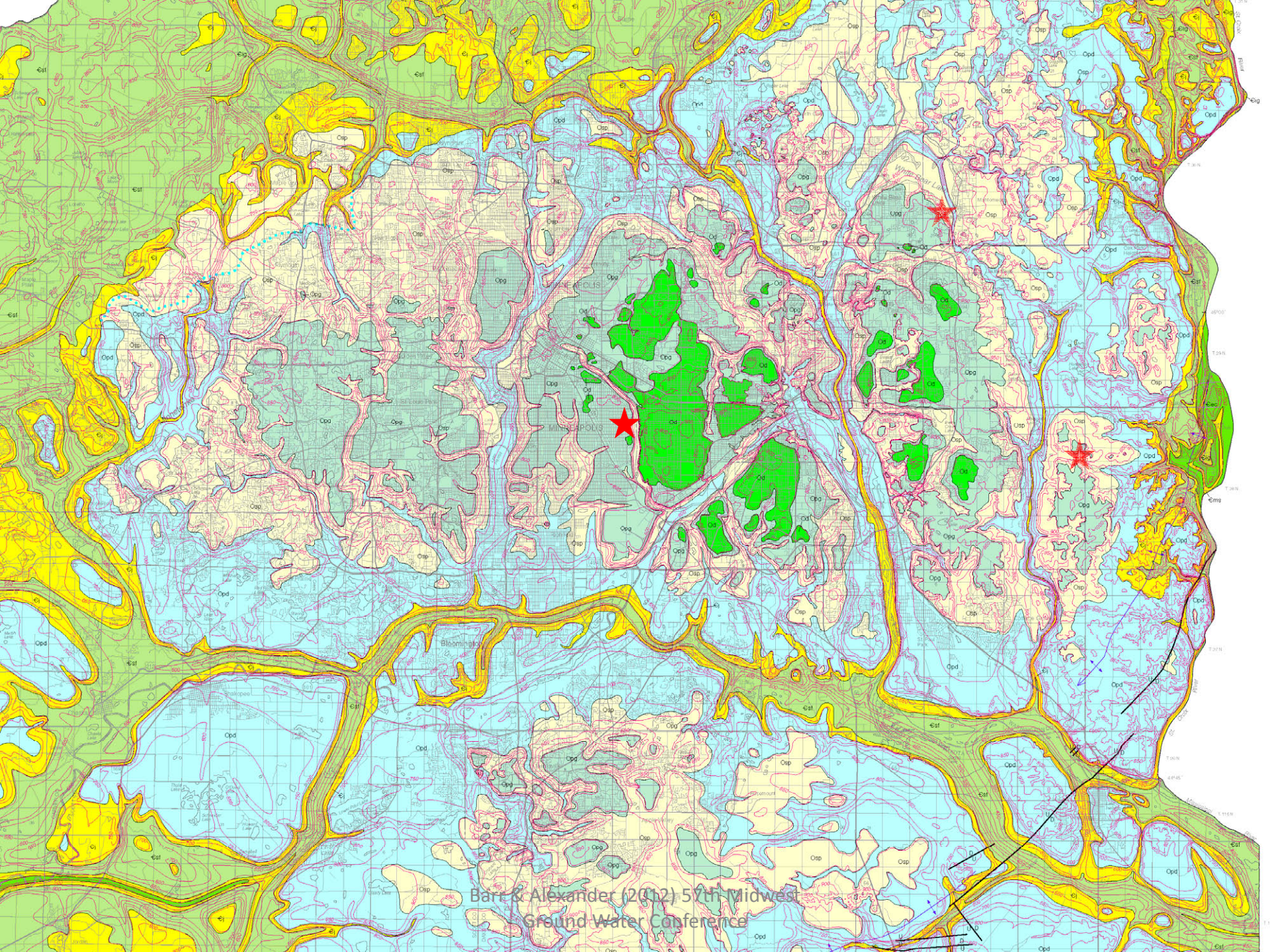


Figure 1. Sinkhole formation near buried bedrock valley, Twin Cities Metropolitan Area. Adapted from Hogberg and Bayer (1967).

A. Section through typical sandstone cave adjacent to river valley.

B. The bedrock valley fills with glacial sediment, partially filling the cave.

C. A sinkhole develops when the cave roof collapses. The collapse may be caused by solution weathering in the Platteville limestone, a sudden shock, or lowering of the water table.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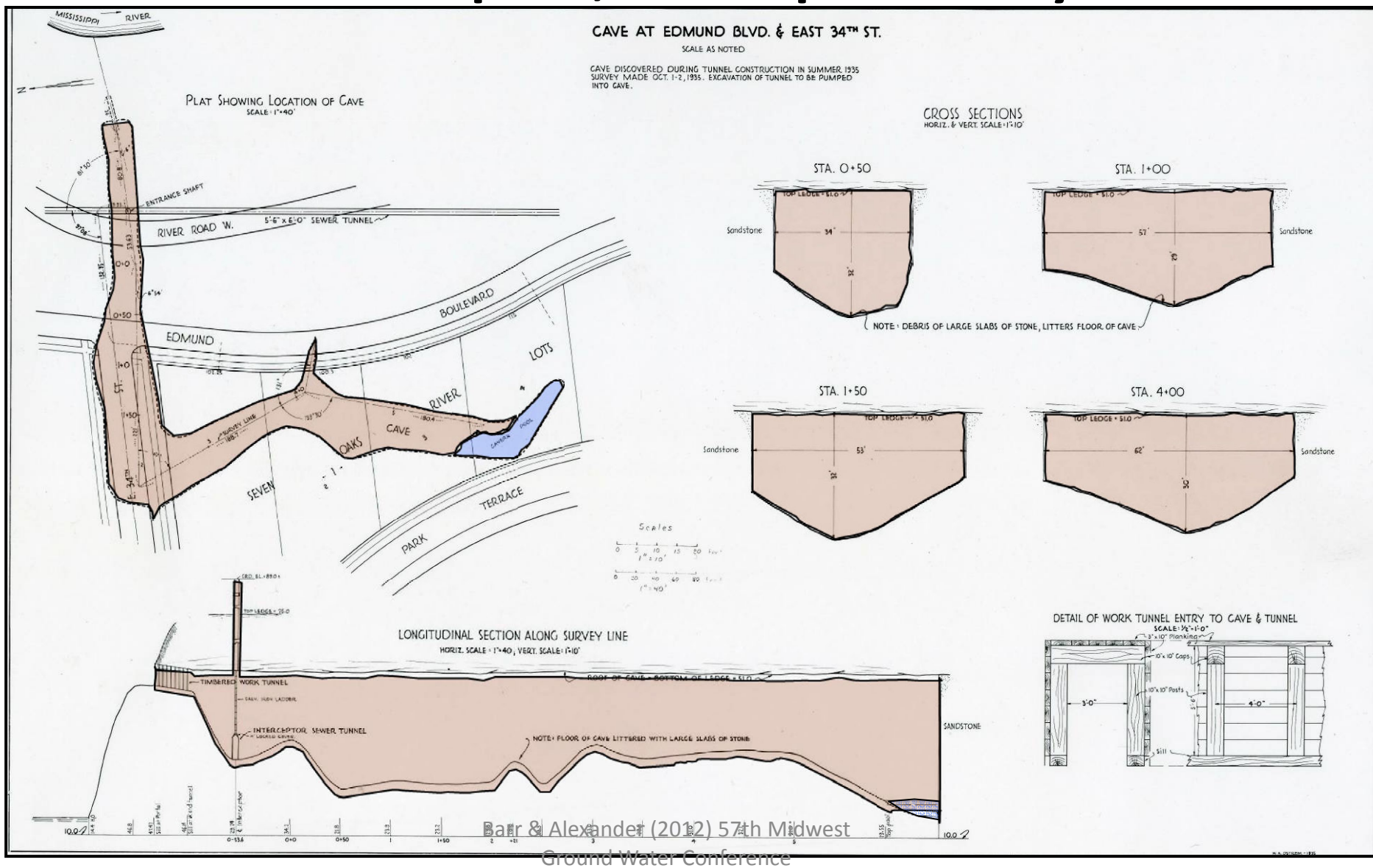
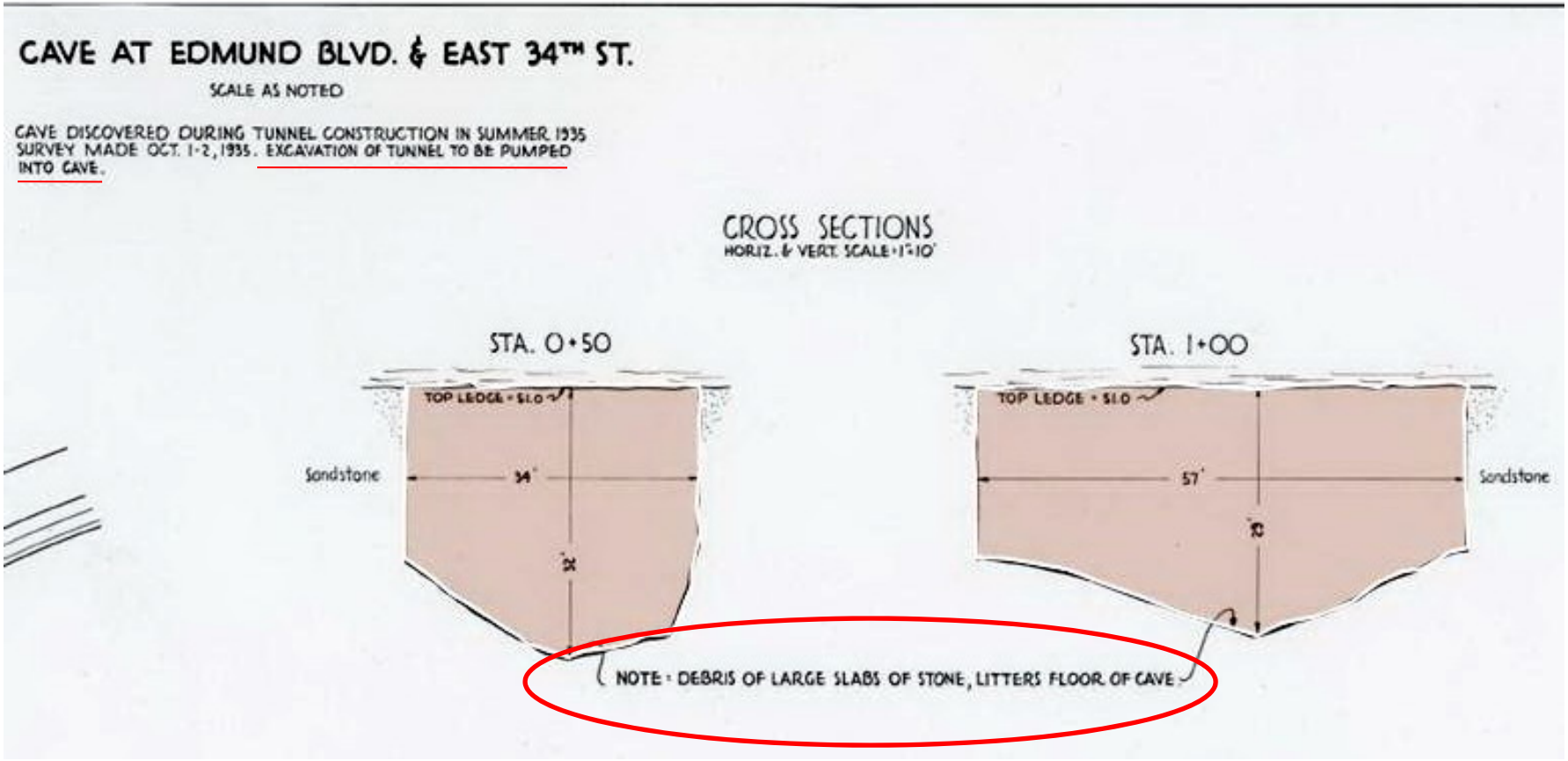
34th St. Sinkhole, Minneapolis

Channel Rock Cavern

Minneapolis, Hennepin County





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Feeders (Channel Rock Cavern)

Photograph by Alexander

Photograph by Barr

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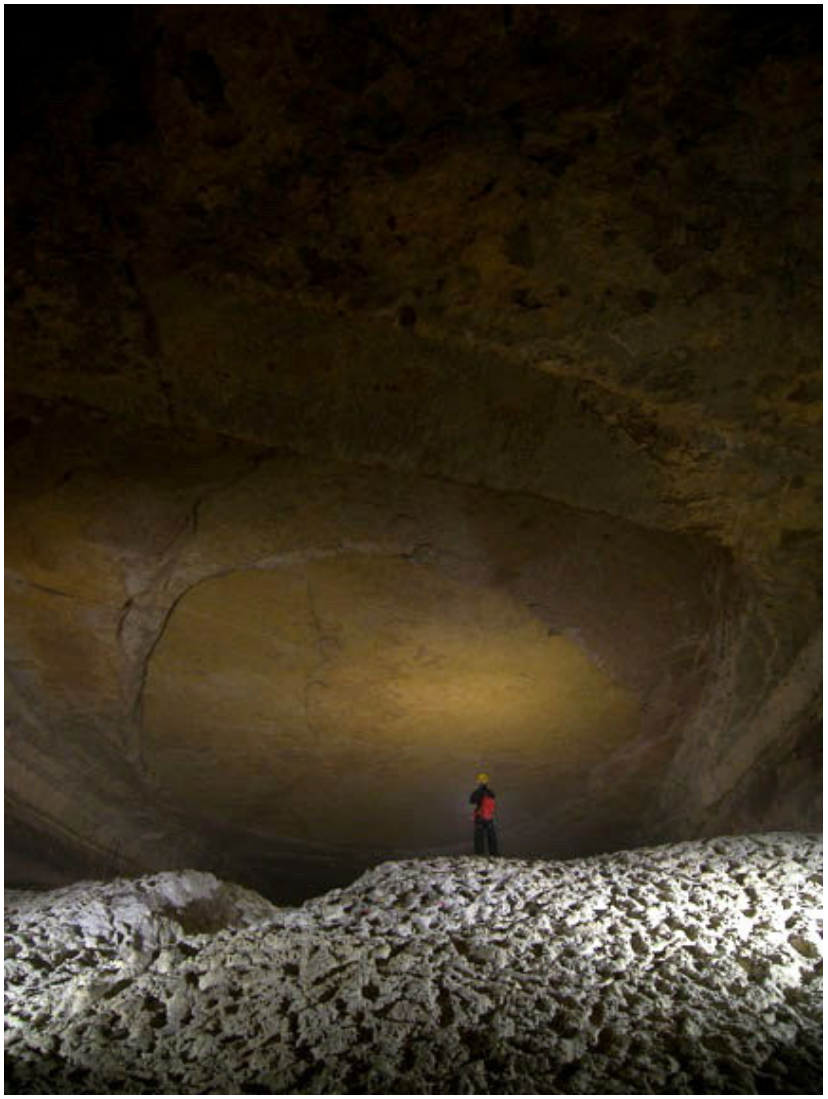
Channel Rock Cavern, Minneapolis, MN



Phtotographs by John Lovaas

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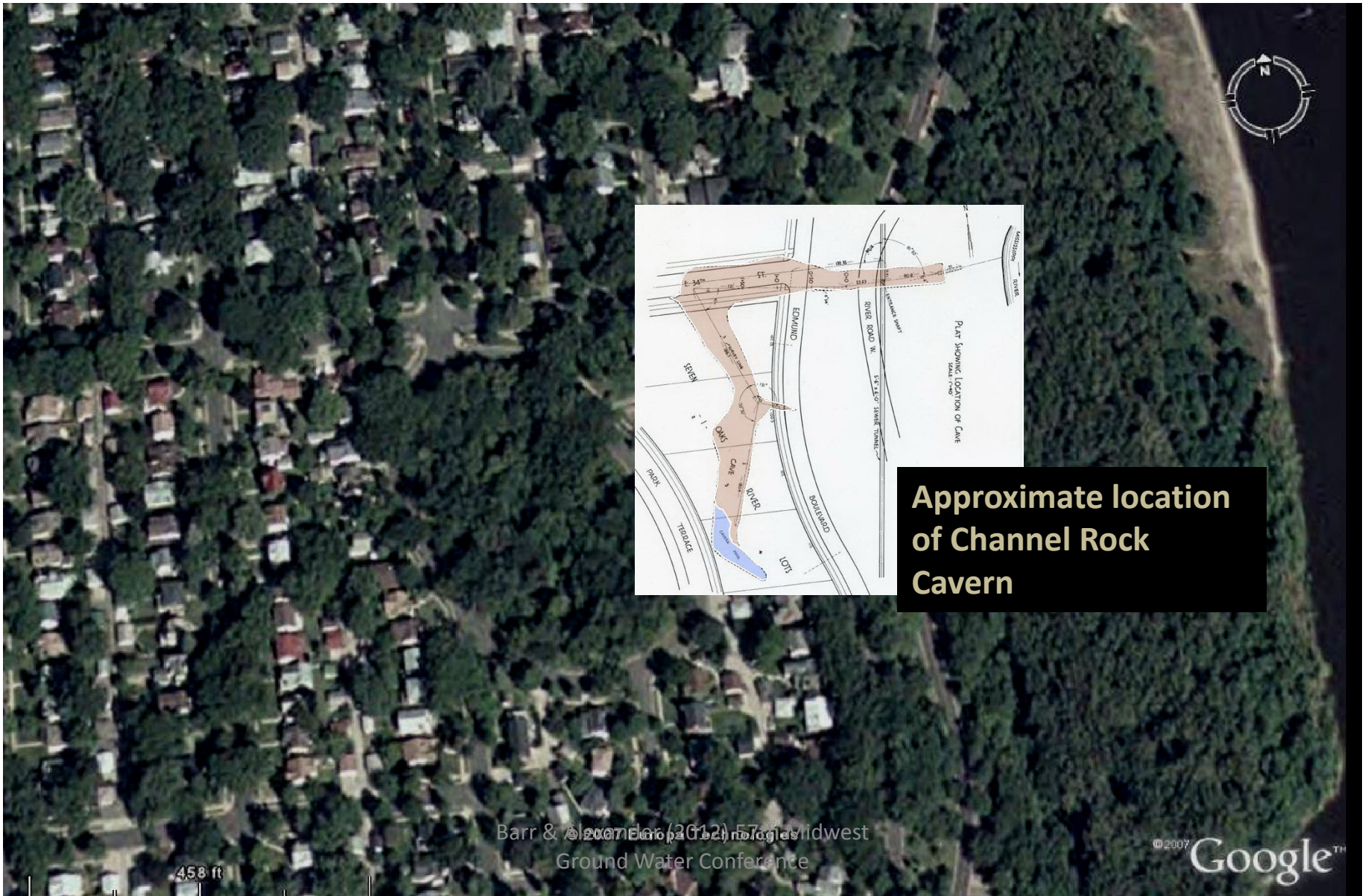
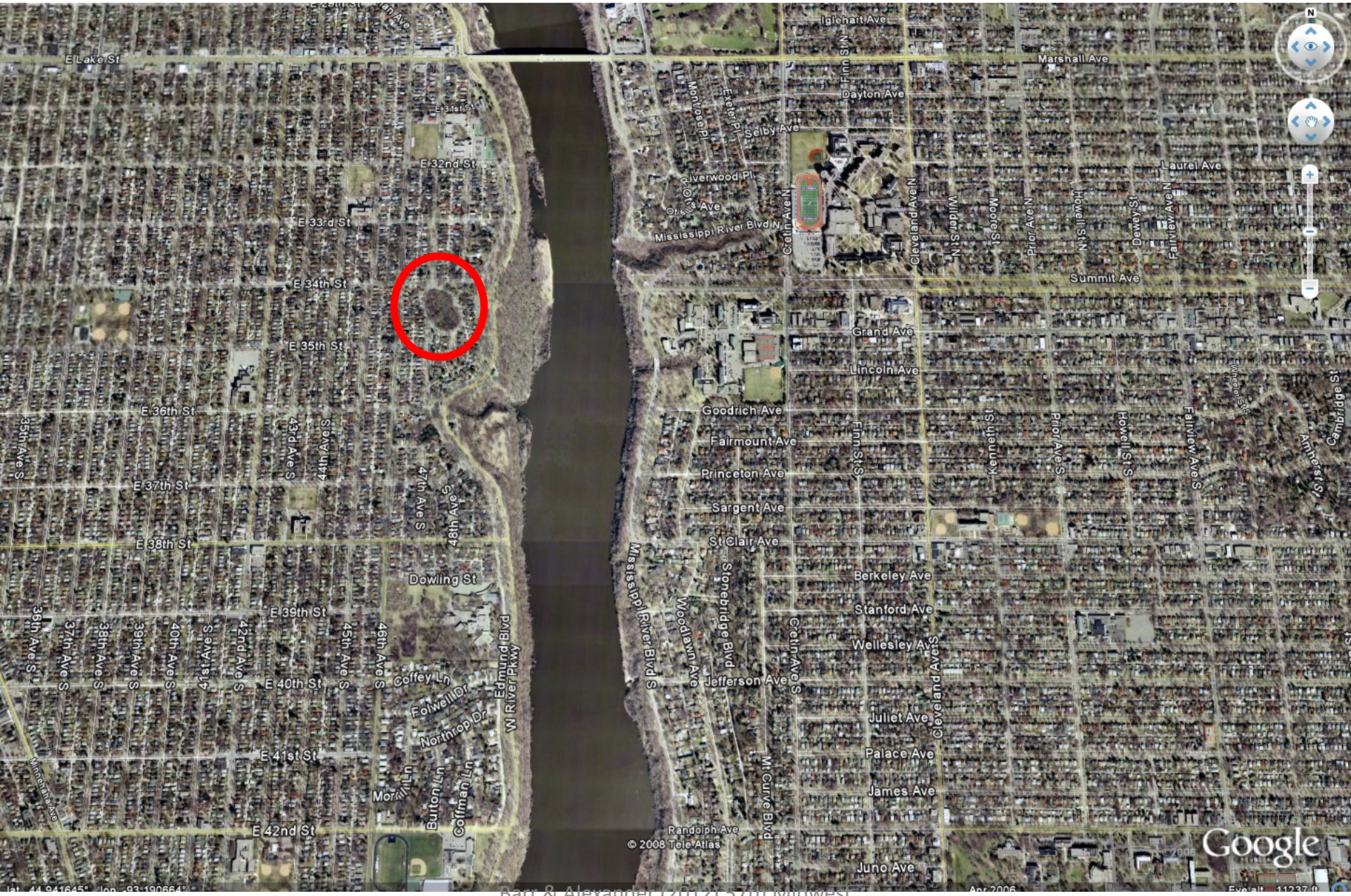
34th St. Sinkhole, Minneapolis





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Laurel Ave
Summit Ave
Grand Ave
Lincoln Ave
Goodrich Ave
Fairmount Ave
Princeton Ave
Sargent Ave
St Clair Ave
Berkeley Ave
Stanford Ave
Wellesley Ave
Juliet Ave
Palace Ave
James Ave
Juno Ave
Randolph Ave
Jefferson Ave
Dowling St
Coffey Ln
Folwell Dr
Northrop Dr
Morrill Ln
Burton Ln
Coffman Ln
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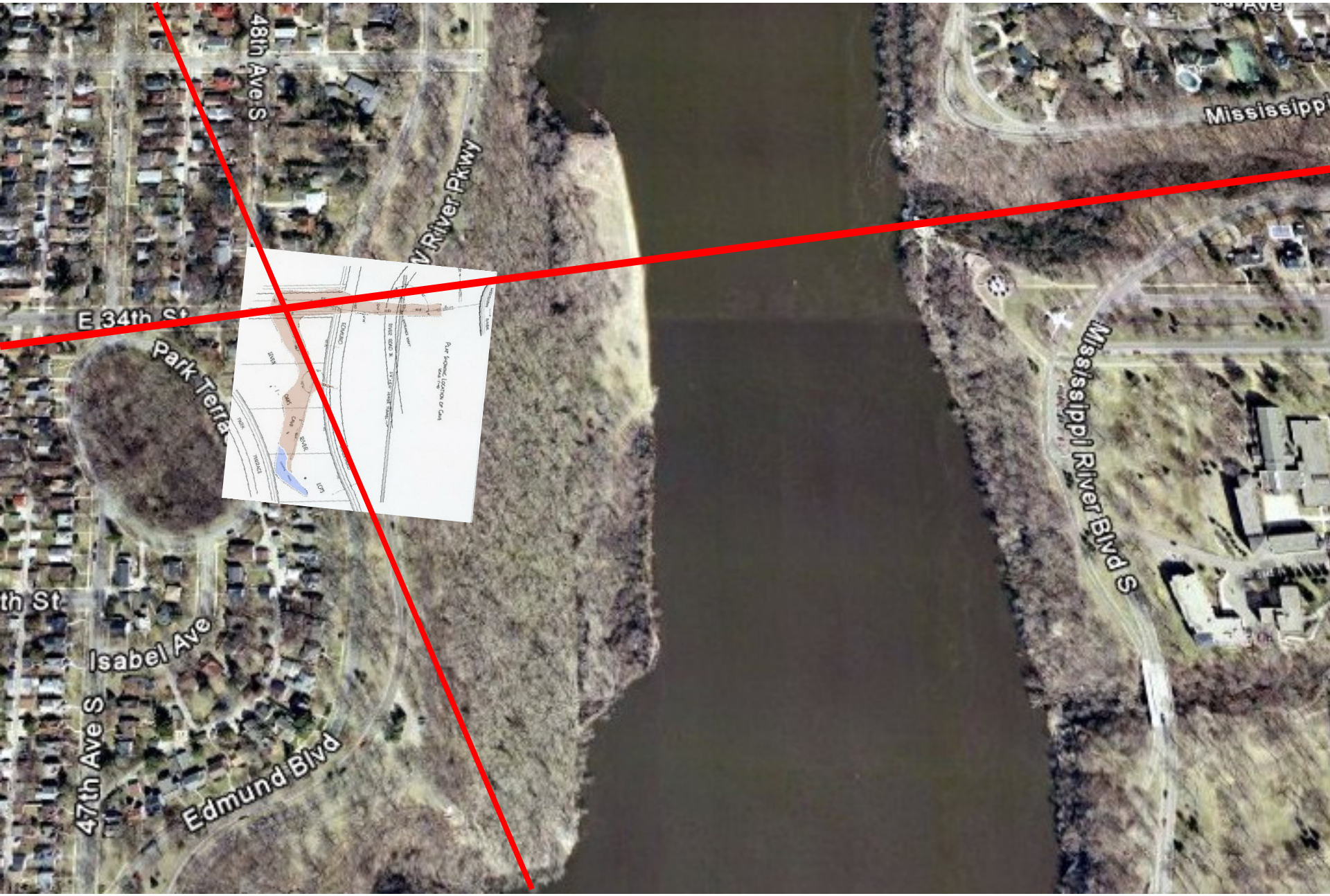

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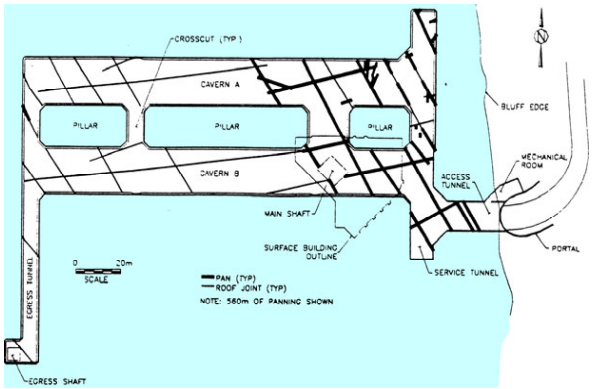
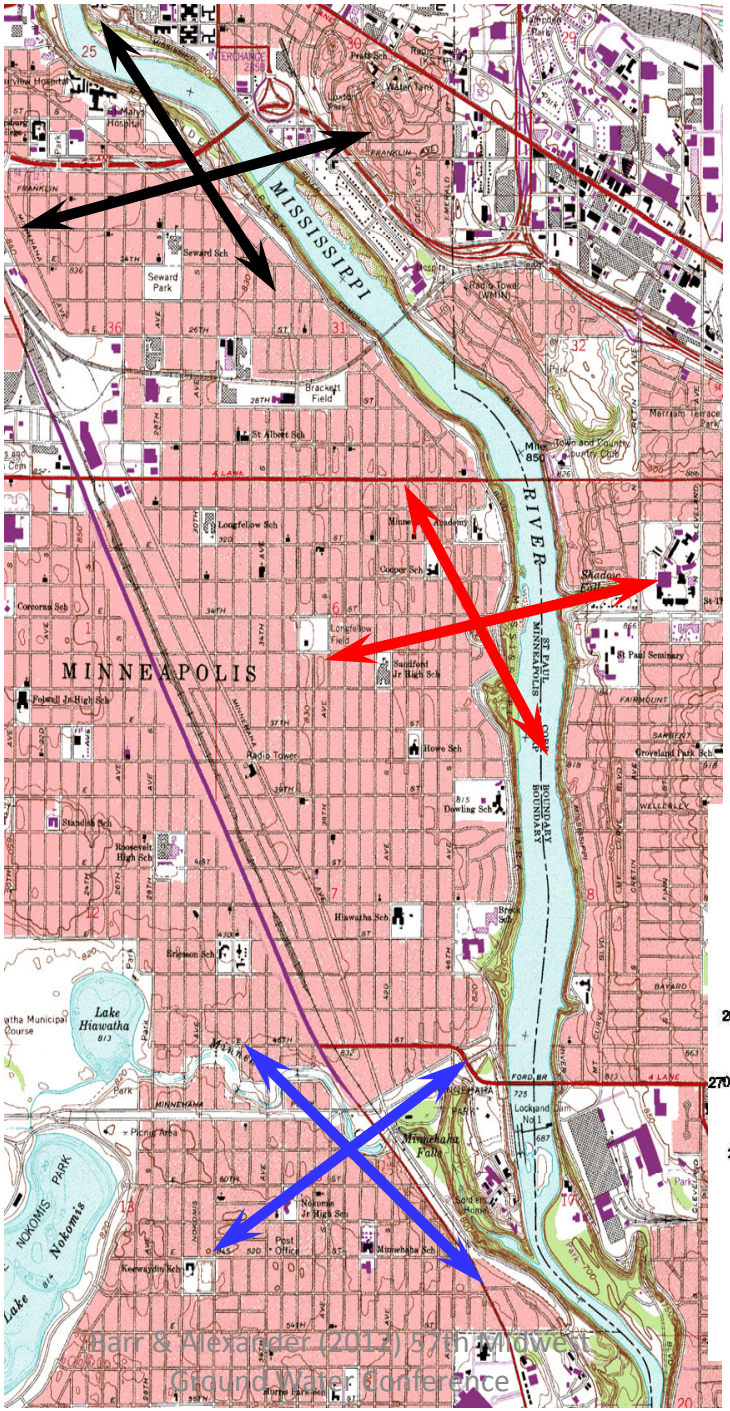
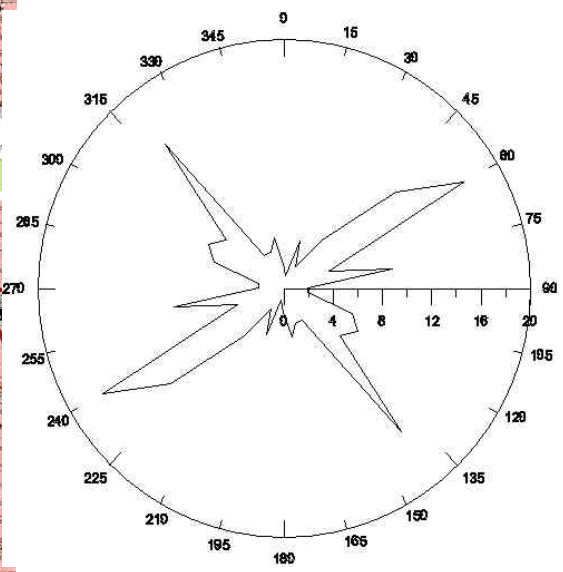

CROSSCUT (TYP.)
CAVERN A
PILLAR
PILLAR
PILLAR
CAVERN B
BLUFF EDGE
MECHANICAL ROOM
ACCESS TUNNEL
MAIN SHAFT
SURFACE BUILDING OUTLINE
PORTAL
SERVICE TUNNEL
EGRESS TUNNEL
EGRESS SHAFT
0 20m
SCALE
PAN (TYP)
ROOF JOINT (TYP)
NOTE: 560m OF PANNING SHOWN


MISSISSIPPI
RIVER
MINNEAPOLIS
ST PAUL
MINNEAPOLIS
BOUNDARY
Lake Hiawatha
Minnehaha Falls
NOKOMIS PARK
Nokomis
Lake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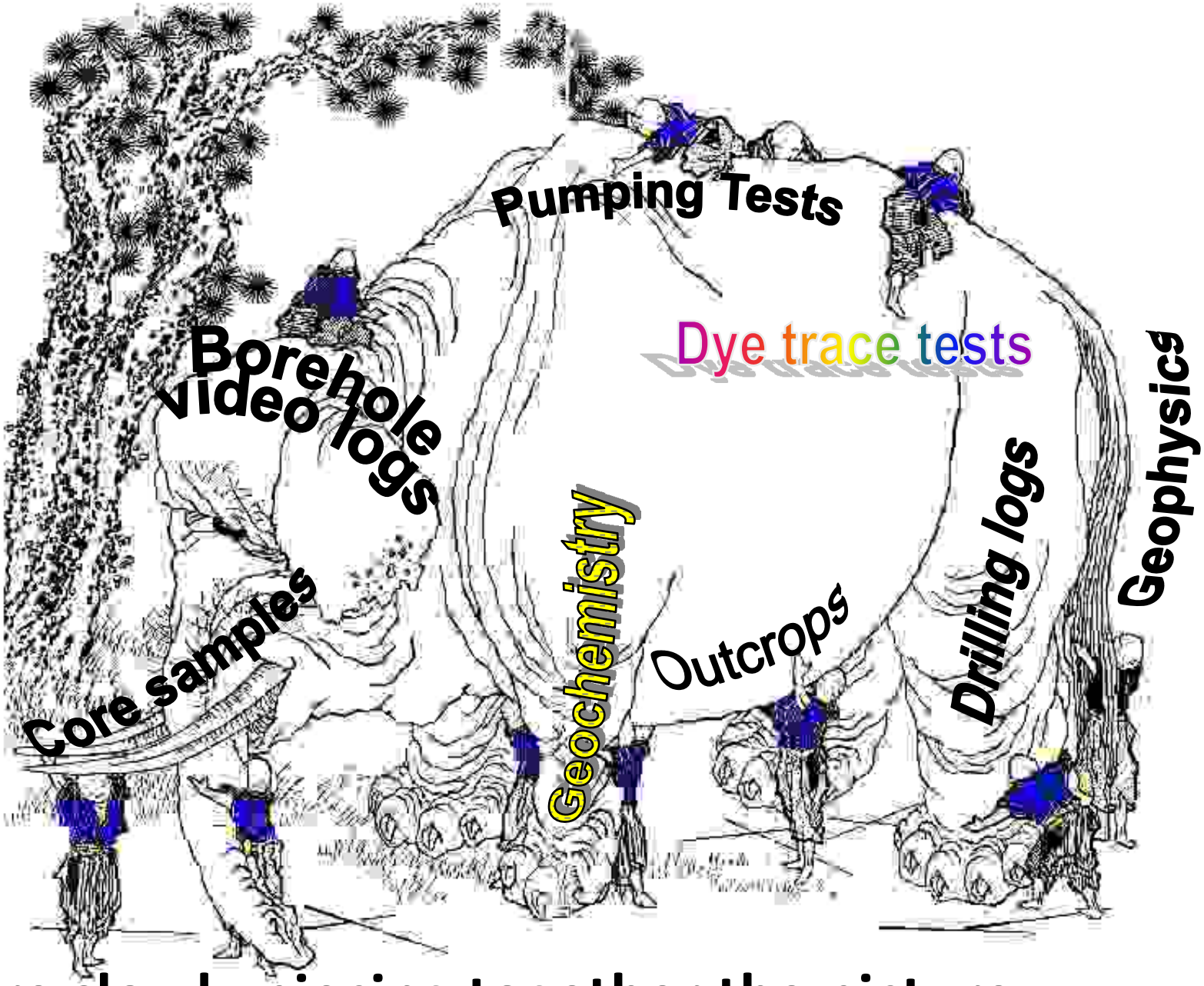
Some Potential Questions

- Is collapse related to nearby bedrock valley? (which valley?)
- If so, are they due to structurally related features?
- OR did the formation of the bedrock valley accelerate the formation of breccia pipes?



We're slowly piecing together the picture…

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