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

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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

- **Confining fm. (e.g. shale)**
- **Receiving fm. (e.g. sandstone)**
- **Cave fm. (e.g. limestone)**
- **Feeding fm. (e.g. sandstone)**

Soluble member

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Basic steps in hypogenic karst development
2. Solution enlargement along fractures
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
SECONDARY PORES ARE AN IMPORTANT PART OF THE HYDROGEOLOGIC SYSTEM: THEY NEED TO BE DESCRIBED AND MAPPED

from Runkle et al. (2007)

Barr & Alexander (2012) 57th Midwest Ground Water Conference
Setting of Prairie du Chien Group:

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

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

Plan view of this BPF/solution interval

from Runkle (2007), Tipping (2007)

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Basic steps in hypogenic karst development
5. Ongoing evolution of karst system
Breccia pipes, NM & TX

from Klimchouk (2007)
“Houston, we have a problem.”

Dancing Waters Collapse Event,
October, 2005
D38 and D44
Sinkhole Locations, Dancing Waters, Woodbury, MN
Sinkholes D41 & D42

9 November 2005

Barr & Alexander (2012) 57th Midwest Ground Water Conference
Sinkhole Locations, Dancing Waters, Woodbury, MN
Gophers?

Open Fractures
Breccia pipe, Woodbury, MN

Photograph by Barr

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A second breccia pipe, Woodbury, MN

Earl & Alexander (2012) 56th Midwest Ground Water Conference
Rock Cores Reveal Soil Filled Fractures

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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.
34th St. Sinkhole, Minneapolis
Channel Rock Cavern
Minneapolis, Hennepin County
CAVE AT EDMUND BLVD. & EAST 34TH ST.
SCALE AS NOTED
CAVE DISCOVERED DURING TUNNEL CONSTRUCTION IN SUMMER 1935
SURVEY MADE OCT. 1-2, 1935. EXCAVATION OF TUNNEL TO BE PUMPED INTO CAVE.

CROSS SECTIONS
HORIZ. & VERT. SCALE = 1' = 10'

STA. O + 50

TOP LEDGE = 51.0

34
30

Sandstone

STA. 1 + 00

TOP LEDGE = 51.0

57
30

Sandstone

NOTE: DEBRIS OF LARGE SLABS OF STONE, LITTERS FLOOR OF CAVE.
Feeders (Channel Rock Cavern)

Photograph by Alexander

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Photograph by Barr
Channel Rock Cavern, Minneapolis, MN

Phtotographs by John Lovaas

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34th St. Sinkhole, Minneapolis

Approximate location of Channel Rock Cavern
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...