Seasonal Water Table Variations In The Onondaga Formation, Western NY

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Background

- Karst landscapes are found in areas with carbonate bedrock
  - Limestone, dolomite
- Unusual hydrology
  - Erratic flooding, diminished surface flow
Regional issue

“Disappearing Lake,” Marcellus, NY
- Basin periodically floods, creating a lake 80 feet deep
Staubitz and Miller (1987) and Kappel and Miller (1996) studied the Onondaga FM in Erie County and observed extreme water table variations over short periods.

Dunn (1992) used ground penetrating radar and observed rubble filled voids in the subsurface. Their well data also shows extreme water level variations.

Plume maps of a TCE spill between Leroy and Caledonia (Fronk, 1994) indicate that groundwater flows east to the springs at Caledonia.

Quaternary mapping indicate soils are very thin in the area.

A recent groundwater modeling study of the Onondaga FM near Onondaga Lake by Yager and others (2007) suggests the regional peizometric surface is above the ground elevation.
Problem statement

- Dynamic seasonal water table levels in the Onondaga Formation are capable of rising rapidly, inundating the epikarst zone. The timing of floods in sinkholes suggests that groundwater moves quickly through bedrock fractures in the Onondaga. This study seeks to understand the dynamics of this system and the impact of pollution in this karst aquifer.
The study area is southwest of Rochester between LeRoy and Caledonia in Western New York.
Study Area

[Map showing the Onondaga Escarpment and the location of LeRoy]
The Onondaga Formation consists of limestone of very low permeability with extensive fractures trending northeast.

In Western New York, it forms a barrier between the Allegheny Plateau and Lake Ontario.

Bedrock beneath thin soils, exposed in stream beds.
Sinkholes
- Water table at Quinlan Rd. sinkhole capable of rising 6 meters in 12 hours
Methodology

- Measure discharge of Oatka Creek using a Marsh-McBirney flow meter at locations upstream, downstream, and on the Onondaga Formation
- Measure water table levels in DEC monitoring wells and home use resident wells using a water level meter. All wells are located in Onondaga Formation
- Barometrically corrected pressure transducers were installed in some wells
Maximum Well Levels

Water Table probably rises within the epikarst zone

- 0.1 - 6.5
- 6.5 - 10
- 10 - 20
- 20 - 36
- 36 - 60
Minimum Well Levels

Low Water Level

- 0.1 - 6.5
- 6.5 - 18
- 18 - 37
- 37 - 60.5
- 60.5 - 88.1

Photo 4. Fracture zones in Caledonia
Minimum Well Levels

Low Water Level

- 0.1 - 6.5
- 6.5 - 18
- 18 - 37
- 37 - 60.5
- 60.5 - 88.1
Total Water Table Range

Water Level Range

- # 0.1 - 2.1
- Y 2.1 - 6.5
- Y 6.5 - 12
- Y 12 - 36
- YY 36 - 56.3
Representative Well Data

Mar 9

DC-12

May 1

Water Level Ft

5.9 ft/day

5.8 ft/day

0 5 10 15 20 25 30 35 40 45 50 55 60

[Graph showing water level changes over time]
Interpretations

• Surficial aquifers south of the area are higher providing a source of groundwater and high energy gradients.

• Piezometric surface is close to the surface during springtime especially in the west.

• Thin residual soils provide little capacity for water storage. Rainfall and snow melt enters the fracture system directly.

• Variations in fracturing and transmissivity within the Onondaga FM may cause groundwater mounding (water table rises)

• In the spring, drainage can’t keep up with the influx of groundwater during snow melt and recharge.

• Sinkholes flood when the aquifer’s capacity to take water is exceeded.
Implications

- This is a *regional* phenomenon
- Provides a mechanism for rapid groundwater movement
- Large water table fluctuations purge aquifer of pollutants
A trichloroethylene (TCE) plume could be impacted by providing a mechanism for propelling vapor intrusion.
Significance

- Piston action drives toxic fumes
- Understanding groundwater behavior and interactions with the surface
- Protecting lives and property
Questions?

Buttermilk Falls, LeRoy, NY 2008