

Groundwater studies

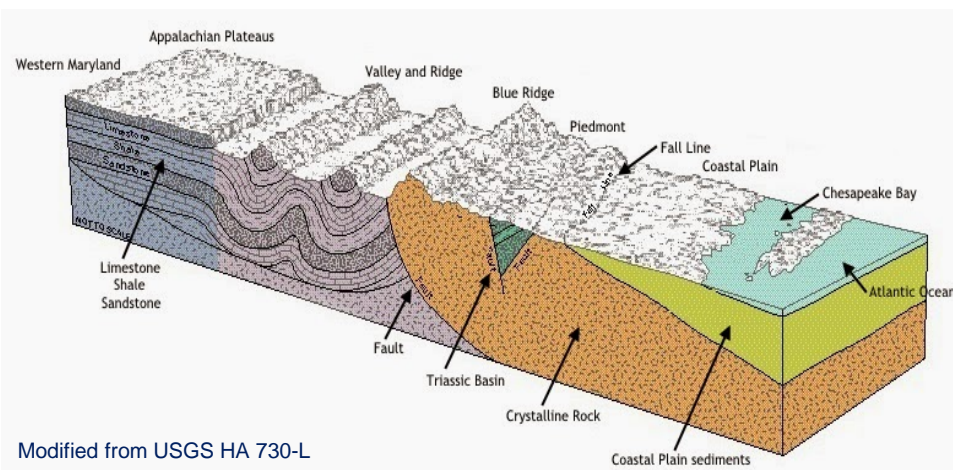
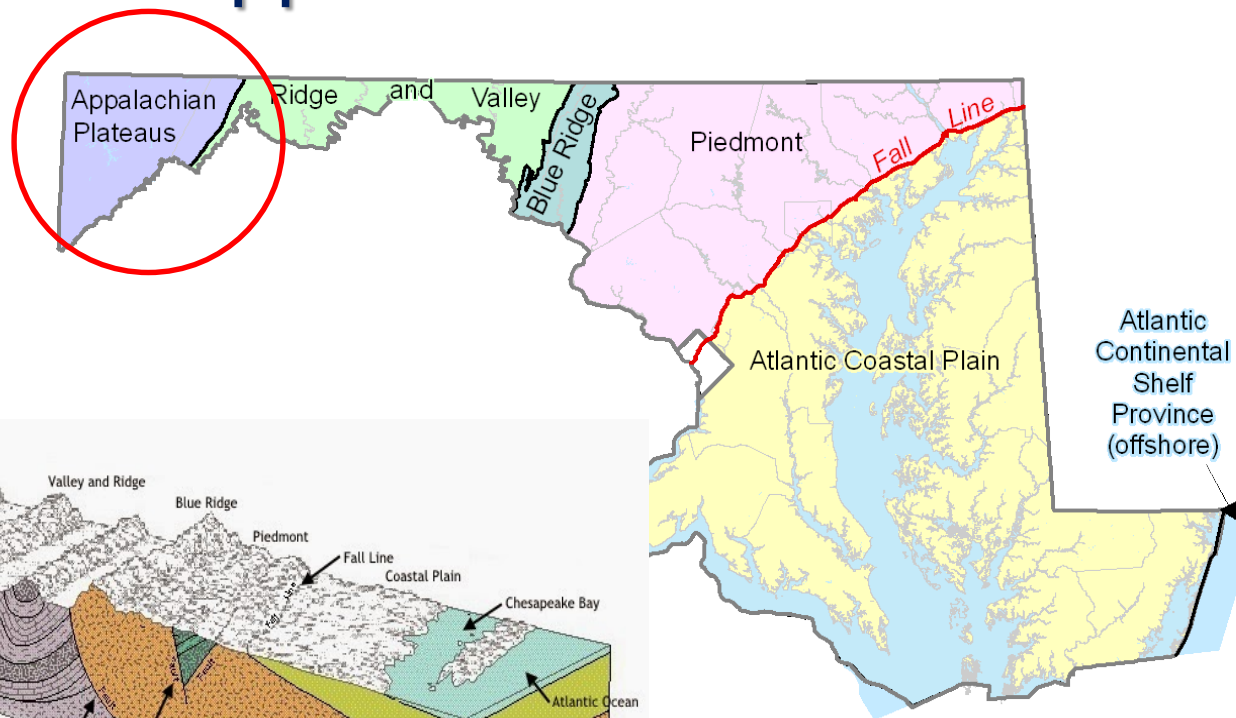


- Methane in wellwater in the MD Appalachian Plateau
- Hydrogeologic studies at three test sites in Garrett County
- Wellwater quality in the MD Appalachian Plateau

UMCES—Appalachian Laboratory
Frostburg, MD
November 29, 2016

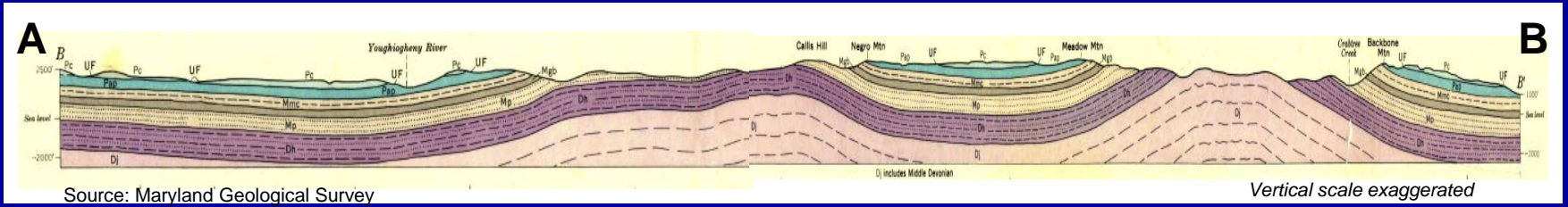
Groundwater studies

Appalachian Plateau

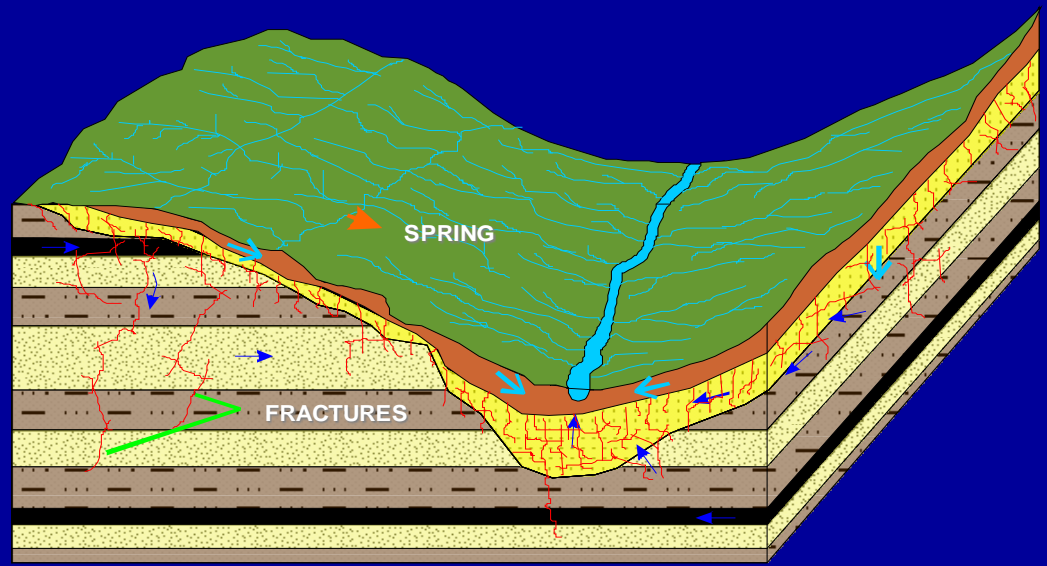
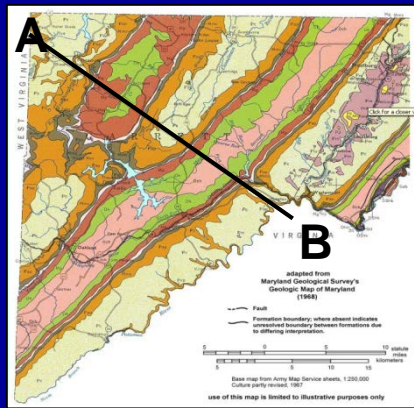


Modified from USGS HA 730-L

Geologic setting



Generalized hydrogeologic setting



Modified from Harlow and LeCain (1991)

Geologic cross section of Garrett County

Methane in wellwater

Study Objectives

- 1) Evaluate baseline methane concentrations in well water
- 2) Determine the occurrence and distribution of methane
- 3) Evaluate source(s) of methane in well water
- 4) Determine methane variability in individual wells



Methane in wellwater



Well selection

Geology

Coal basins (37 wells)

Non-coal regions (50 wells)

Topography

Valleys (41 wells)

Uplands (hilltops/hillsides) (46 wells)

Other criteria

1. Well permit number
2. Submersible pump; well in use
3. Access to untreated well water
4. Reasonable spatial distribution
5. No obvious potential sources of contamination

Number of wells		
	Coal	Non-coal
Valley	17	24
Uplands	20	26

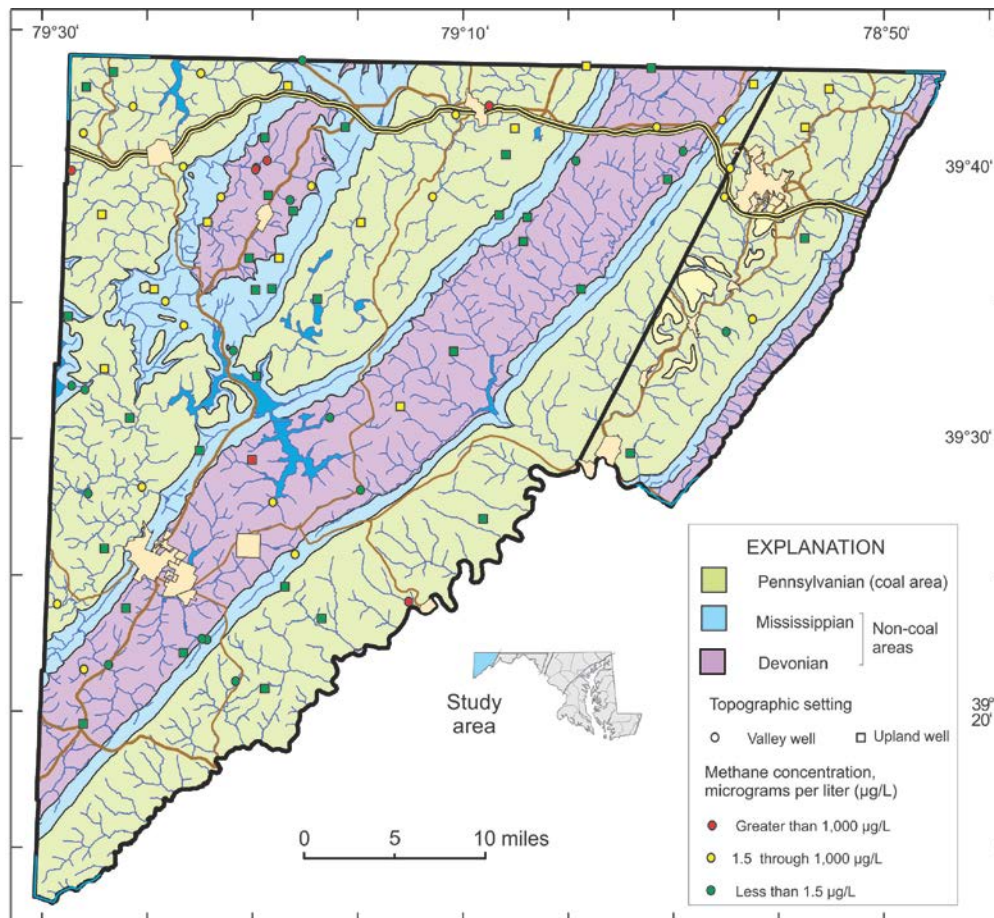
Methane in wellwater

Results

- Range of methane concentrations: <1.5 to 8,550 micrograms per liter ($\mu\text{g/L}$).
- 46 percent of wells (40 of 87) had methane detections ($>1.5 \mu\text{g/L}$).
- 7 wells exceeded 1,000 $\mu\text{g/L}$ of dissolved methane.
- No wells exceeded the 10,000 $\mu\text{g/L}$ (10 mg/L) recommended action level for dissolved methane.

Methane in wellwater

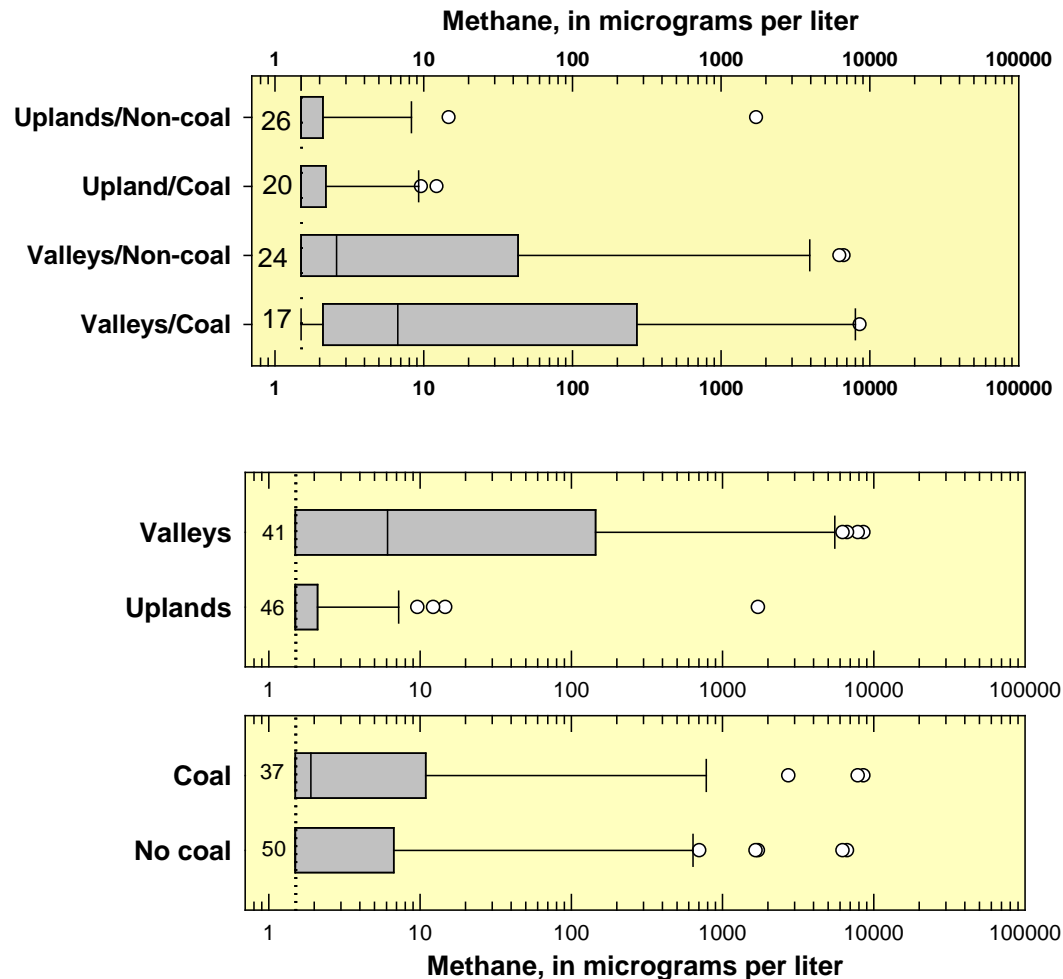
Methane distribution



Methane in wellwater

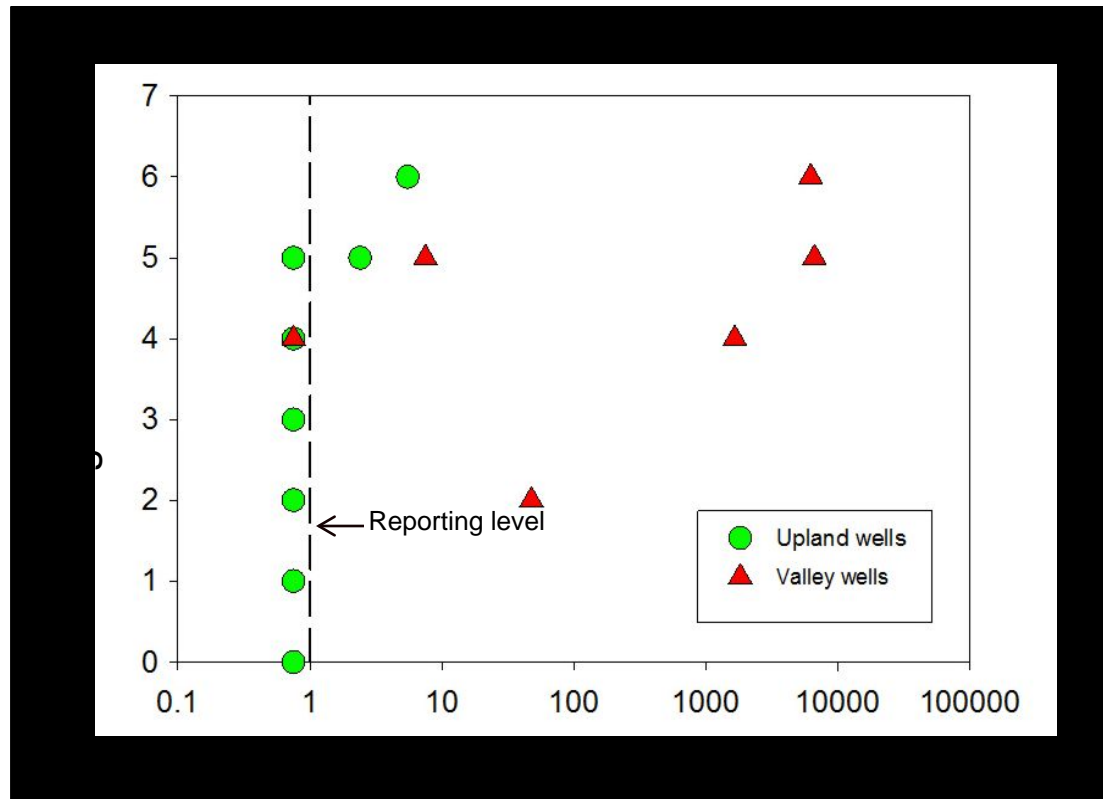


Relation to topographic position and geologic setting



Methane in wellwater

Wellwater methane concentrations near the Accident gas storage facility



Methane in wellwater



Summary

- Methane is commonly present at low (<1 mg/L) concentrations in wellwater in the MD Appalachian Plateau.
- No wells exceeded the 10 mg/L recommended action level for methane.
- Methane tended to be higher in wellwater from valleys compared to upland areas.
- Methane tended to be higher in wellwater in coal basins compared to non-coal basins.
- Monthly methane concentrations were quite variable; well water may not be characterized by a single sample.

Test-well sites

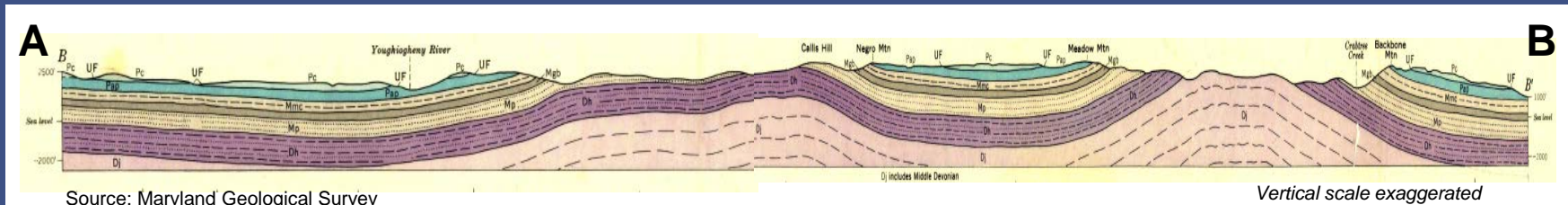


Hydrogeologic studies at three test-well sites in Garrett County

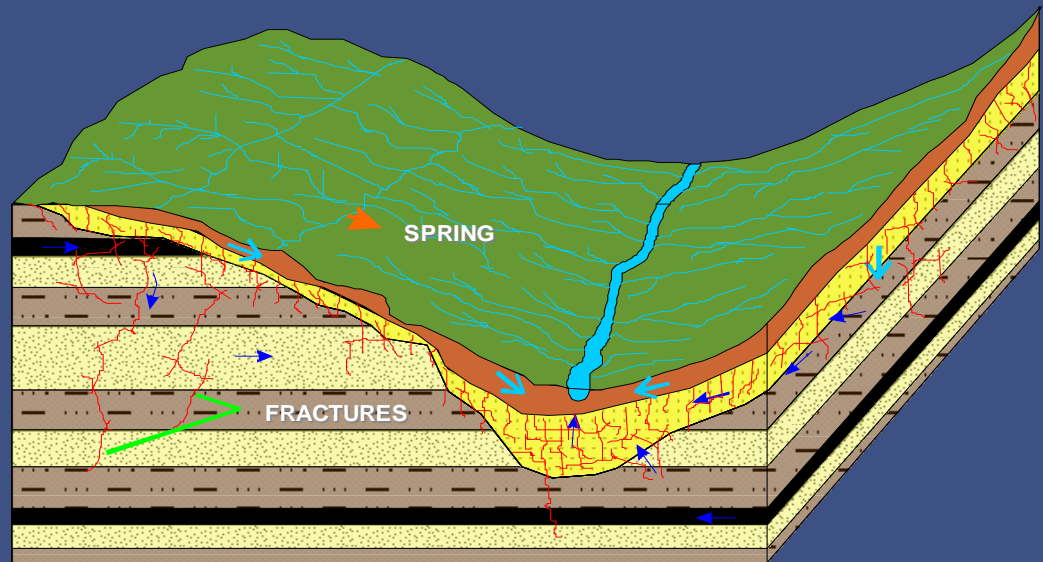
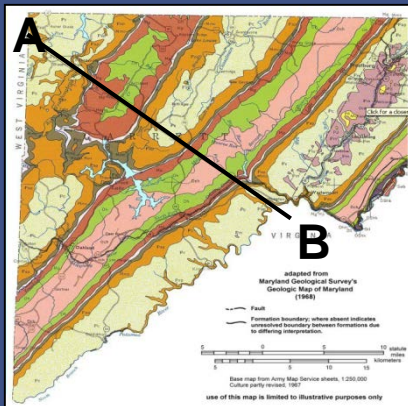
Questions:

- What's the connection between shallow (<200 ft) and deeper (500-1,000 ft) aquifers? How consistent is it?
- How do aquifers respond to precipitation?
- What's the relation between groundwater and nearby streams?

Test-well sites



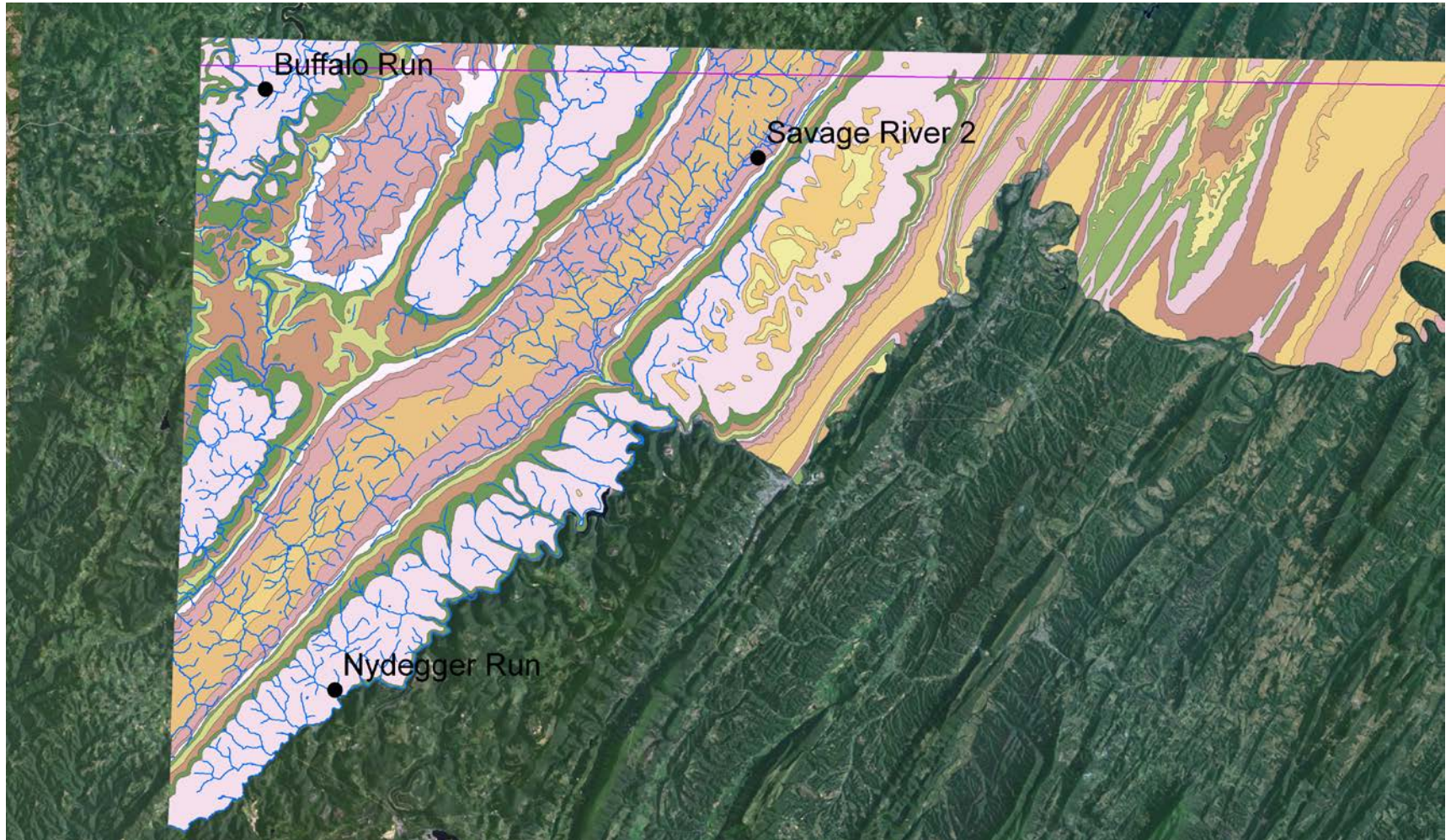
Generalized hydrogeologic setting



Modified from Harlow and LeCain (1991)

Geologic cross section of Garrett County

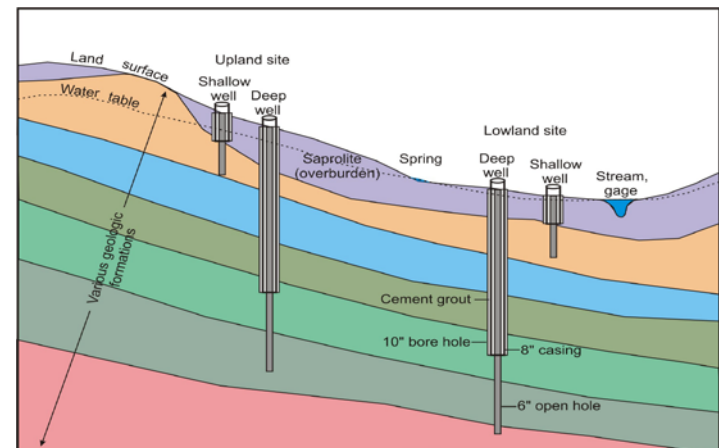
Test-well sites



Test-well sites

Approach:

- Shallow/deep wells at each site
- Aquifer (pumping) tests in each well
- Geophysical logging to identify water-bearing zones
- Water-quality testing



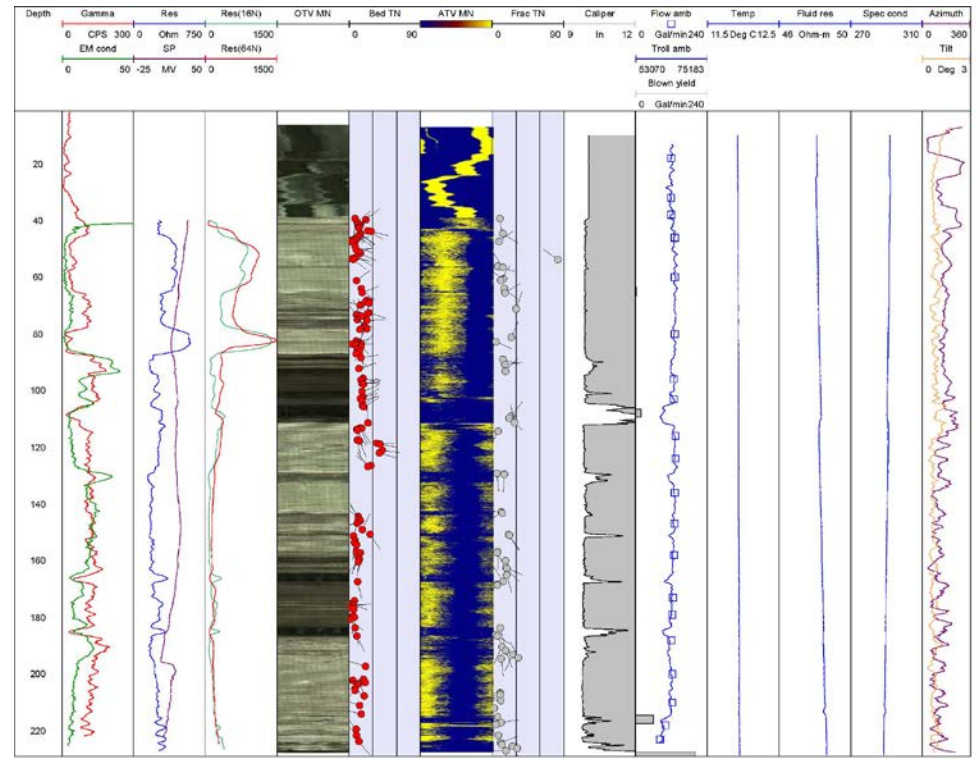
Schematic cross section showing configuration of test wells in Garrett County.

Test-well sites



Geophysical logging:

- Gamma ray, resistivity, caliper
- Acoustic televiewer
- Optical televiewer
- Fracture identification
- Flowmeter



Test-well sites



Hydraulic tests:

- Aquifer tests (measuring water levels in response to pumping/recovery)
- Response of water-well levels to precipitation

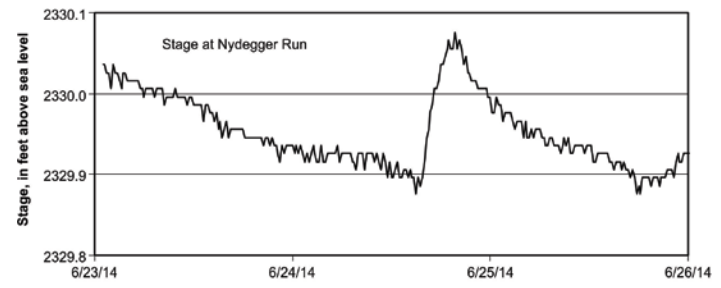
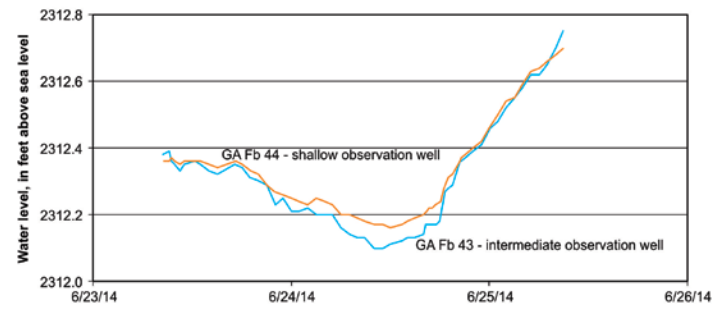
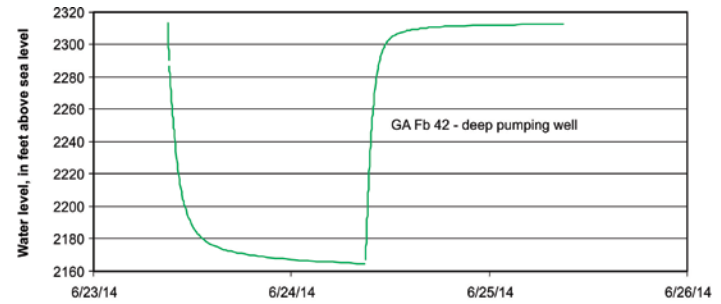
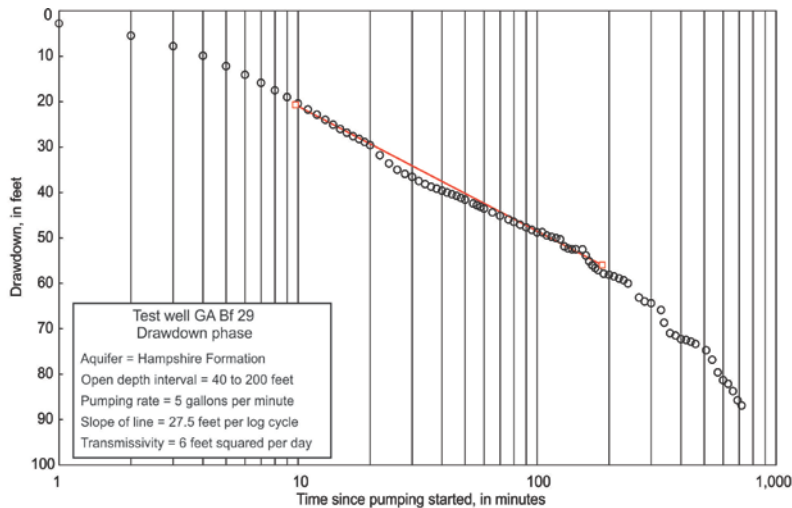
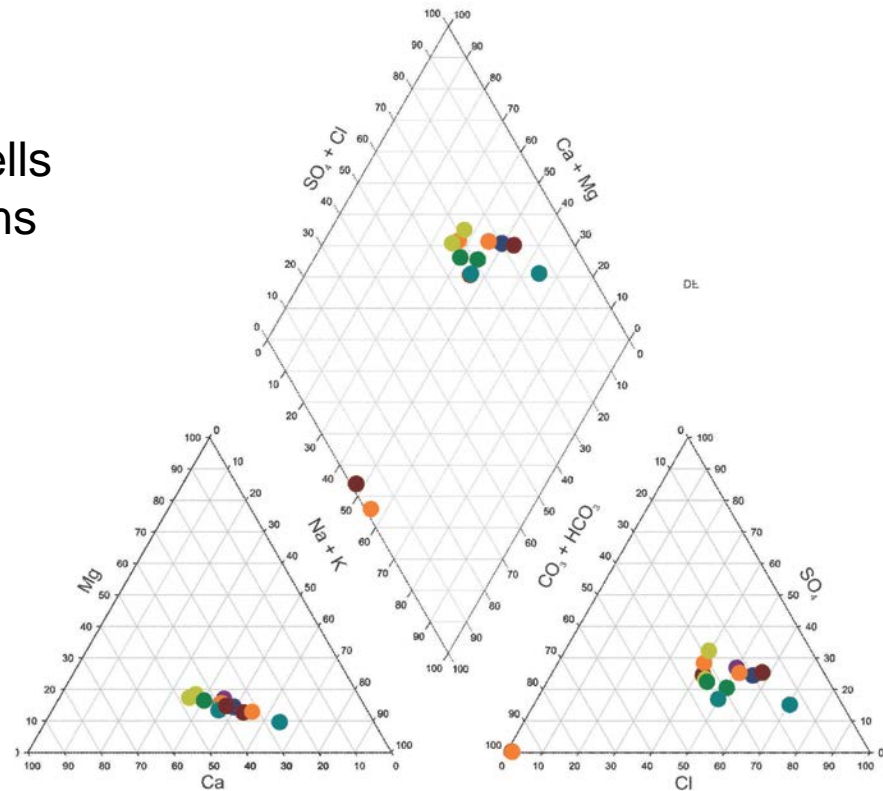
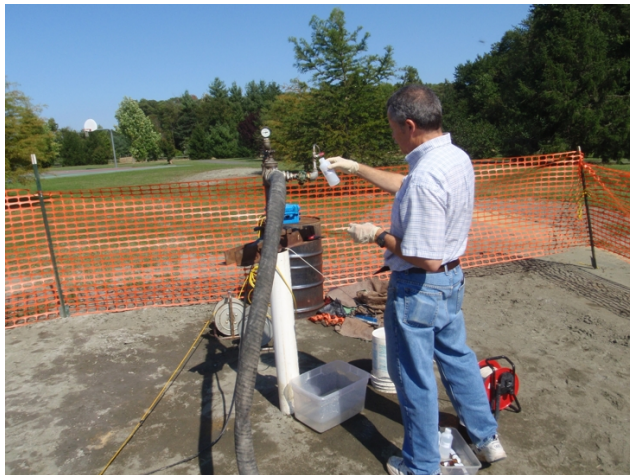


Figure XX. Hydrographs showing water levels in the pumping and observation wells and stage in Nydegger Run during the aquifer test of well GA Fb 42 .

Test-well sites

Water quality

- Relation between shallow/deep wells
- Relation between wells and streams



Test-well sites



Summary of site/well characteristics

SITE	Well	Geologic formation (open section)	Depth of open interval (ft below land surface)	Transmissivity (ft ² /day)	Hydraulic connection between wells	Response to precipitation/stream	Confined or unconfined
Buffalo Run	GA Aa 15	Conemaugh and Allegheny	125-230	828	very little	No	confined
	GA Aa 16	Allegheny	40-120	--		Yes	confined
Savage River	GA Bf 28	Hampshire	500-985	--	none	no	confined
	GA Bf 29	Hampshire	40-200	5		yes	unconfined
Nydeggar Run	GA Fb 42	Pottsville and Mauch Chunk	500-985	2	moderate to strong	yes	confined
	GA Fb 43	Conemaugh	40-200	2,350		yes	unconfined
	GA Fb 44	Conemaugh	20-32	--		yes	unconfined

Test-well sites



Summary of site/well characteristics (cont'd)

SITE	Well	Depth of open interval (ft below land surface)	Water Quality	Comments
Buffalo Run	GA Aa 15	125-230	Sodium-calcium bicarbonate	Flowing artesian wells; 80+ feet of head difference between wells. Stream water quality distinct from wellwater quality
	GA Aa 16	40-120	Sodium-calcium bicarbonate	
Savage River	GA Bf 28	500-985	--	Virtually no transmissive fractures below 500 ft. Stream water quality distinct from wellwater quality. Deep well shows indication of brackish water
	GA Bf 29	40-200	Calcium-magnesium bicarbonate	
Nydeggar Run	GA Fb 42	500-985	Sodium bicarbonate	"Losing" stream (stream elevation higher than water levels in all wells) Shallow wells chemically distinct (higher chloride, iron, sulfate) from deep well
	GA Fb 43	40-200	Calcium chloride	
	GA Fb 44	20-32	Calcium Chloride-bicarbonate-sulfate	

Test-well sites



Summary

- Very different hydrogeologic conditions at each site
- Number of fractures varies between sites
- Fractures contribute different percentages to total flow at individual wells
- Deep groundwater not always connected to stream
- Shallow/deep groundwater connection cannot be generalized
- Several unexplained phenomena observed

Wellwater quality in the MD Appalachian Plateau



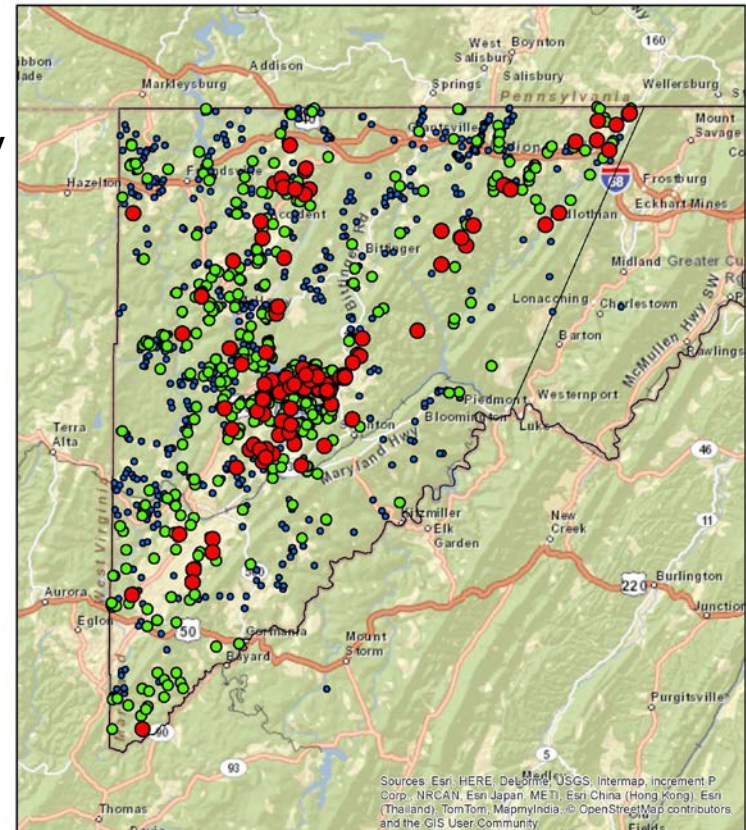
Approach:

- Compile wellwater-quality data from existing databases (MGS, Garrett and Allegany County Health Departments, USGS, MDE)
- 2,300+ drinking-water wells
- Nitrate, iron, manganese, arsenic, chloride
- Major ions, trace elements, radioactivity

Example: arsenic

- Distribution not previously understood
- Hampshire formation: 20% of wells exceed 10 $\mu\text{g}/\text{L}$
- Wells in other geologic units: ~3%

Arsenic in Western MD



Legend

- As \geq 0.010
- 0 < As < 0.010
- Arsenic below detection