An Overview of Geology and Ground Water in Maryland

(With a special focus on Anne Arundel County)
General Overview of
Geology and Physiography of Maryland
Hydrologic Cycle
Watersheds
Ground Water, Aquifers and Wells
Ground Water Availability Issues
Ground Water Quality Issues
General Overview of Geology and Physiography
Rocks and Sediments

Sediments – mainly loose particles
“unlithified” or “unconsolidated”
(sand, silt, clay, gravel, cobbles, boulders; can contain other materials such as shell, bone, teeth)

3 Basic Rock Types:
- Igneous
- Metamorphic
- Sedimentary
Igneous Rocks

crystallized from molten rock (magma)
(extrusive, e.g., basalt; intrusive, e.g., granite)
Metamorphic Rocks
recrystallized by intense heat and/or pressure
(e.g., slate, quartzite, marble, schist, gneiss)
Sedimentary Rocks

Compacted and/or cemented particles

clastic: e.g., sandstone, shale, conglomerate
chemical: e.g., salt, gypsum
organic/biochemical: e.g., coal, chalk, limestone
Geologic Time Scales

http://www.geosociety.org/science/timescale/
Physiography

the study of landscapes and landforms

Physiographic Province:
a region in which all elements of the landscape are similar in geologic structure and gross lithologies and which has had a unified geomorphic history
Appalachian Plateaus

Geology - gently folded shale, siltstone, and sandstone of Devonian to Permian age

Landscape - some steep-sided plateaus, often rugged surface dissected by streams

Geology - gently folded shale, siltstone, and sandstone of Devonian to Permian age
Physiographic Provinces of Maryland

Ridge and Valley

Landscape - generally long ridges and valleys

Geology - strongly folded & faulted sedimentary rocks of Cambrian to Mississippian age. Resistant units form ridges; less resistant underlie valleys.
Ridge & Valley Province
Physiographic Provinces of Maryland

**Blue Ridge**

Landscape – mountains with generally rounded summits

Geology – large fold partially eroded; resistant quartzite forms mountains; valley filling older metamorphic rocks

View looking south
Blue Ridge Province

Harper's Ferry
Physiographic Provinces of Maryland

**Piedmont**
- **Landscape**: low, gentle to rough, hilly terrain; eastern boundary is Fall Zone/Line
- **Geology**: diverse; crystalline igneous & metamorphic rocks; more metamorphosed to the east.
  - Western portions include limestone/dolomite
  - Triassic sedimentary rocks (remnant of basin)
Piedmont Province

Serpentine Barrens

Great Falls
Physiographic Provinces of Maryland

Coastal Plain

Landscape – low, hilly to nearly flat terraced plains
Geology – sediments of mainly Cretaceous to Recent age; gently dip and thicken to southeast
In general, successively older sediments crop out in the area from southeast to the northwest (see cross-section).
Geology of South River-Annapolis Vicinity

Aquia Formation –
  glauconitic sand; olive-green (unweathered), reddish brown (weathered);
  variably clayey and shelly, locally cemented; carbonate and/or calcite cement.
Geology – hands-on

Rocks, minerals and maps
General Overview of Hydrologic Cycle or Water Cycle
Proportion of Global Freshwater

Freshwater lakes and rivers
The Hydrologic Cycle and MD Water Budget

Water budget shown based on estimates from Beaverdam Creek (Rasmussen & Andreasen 1959, USGS Water Supply Paper 1472)

Long-Term Average Water Budget (inches)
General Overview of Watersheds
Watershed

Definition has changed over time

Originally: the ridge of high ground separating two drainage basins

Now commonly used to refer to:
- the drainage basin;
- the region drained by, or contributing to,
  a stream, lake or other water body.
Watershed Delineation
Watershed – Maryland sub-basins

Maryland sub-basins are also referred to as tributary basins.
Maryland's Surf Your Watershed site South River Watershed is an 8-digit code.

http://mddnr.chesapeakebay.net/wsprofiles/surf/prof/prof.html
Surf Your Watershed site

Severn Watershed, an 8-digit hydrologic unit

roughly comparable to Lower Western Shore sub-basin or tributary basin of MD hydrologic subdivision
Watershed Comparison

[Image of a map showing the Severn Watershed andtributary basins]
General Overview of Ground Water, Aquifers and Wells
Aquifer

A geologic unit that stores and transmits ground water in sufficient quantity to supply wells
Porosity

Porosity is a ratio of pore space to the total volume of the rock.
Porosity varies with:
- % Cement
- Sorting
- Fracturing
Permeability

A measure of how fast water will flow through connected openings.
Highly permeable materials will allow for rapid infiltration of precipitation in addition to high yield to wells.

Highly permeable materials are more vulnerable to contamination.
Salisbury Paleochannel = 350 ft/day
Manokin aquifer (fine sand) = 50 ft/day

Groundwater Movement

- Coarse sand
- Medium sand
- Silt
- Clays
- Limestone
- Saprolite
- Granite and gneiss
- Slate

Salisbury Paleochannel = 350 ft/day
Manokin aquifer (fine sand) = 50 ft/day

Age of Ground Water
Ground Water Characteristics in Fractured Rock Areas

- Fracture flow
- Unconfined aquifers
- Other low yield
Ground Water in Limestone

- Sinkholes, rapid outflow
- Little filtration of water
- More susceptible to bacterial, nitrate, and other contaminants
• Unconsolidated sediments
• Confined aquifers
• Usually high well yields

Aquifer (fresh water)
Aquifer (saline water)
Confining beds
Crystalline rocks

Coastal Plain Ground Water Characteristics
Maryland’s Major Coastal Plain Aquifers

Consolidated Rock

Cretaceous

Surficial Aquifer

Confining Unit

Chesapeake Group

Patapsco

Magothy

Aquia

Piney Point

Patuxent
Water Table (Unconfined) Aquifer vs. Confined Aquifer
Water Table Wells and Artesian Wells

Diagram from purdue.edu
Artesian Conditions – flowing wells
Cone of Depression & Drawdown

Unconfined Aquifer vs. Confined Aquifer

Aquifer – classroom exercise

Aquifer model
Unconfined Aquifers of the Piedmont:
Drought

Ground-Water Availability:
What are the issues?

Confined Aquifers of the Coastal Plain:
Long-term water level declines
Population Growth in Southern Maryland

Projected population

Calvert County
Charles County
St. Mary's County

SM Df 71
Aquia Formation

Maryland Coastal Plain: Long-term ground-water-level declines

Water level in Lexington Park, St. Mary's County

Long-term ground-water-level declines
Types of Data:
Lithologic descriptions from cores
Types of Data:
Lithologic descriptions from cuttings
Types of Data:
Water level measurements
~145 wells
State plus County and Regional networks - wells in the Coastal Plan (2011) ~438 wells
Groundwater Withdrawals
10,000 gallons per day
Anne Arundel County

Many permits in Magothy, Patapsco, and Patuxent aquifers
Contour lines showing elevation of the top of the aquifer (in feet mean sea level).

Aquifer formation outcrops and subcrops locally.
Water Levels in Aquia Aquifer
Regional Ground-Water Quality Issues

- Arsenic
- Radium
- Radon
- Salt-water intrusion
Salt-Water & Brackish-Water Intrusion
Ground-Water Flow Cross Section:
Central Anne Arundel Co. toward Bay
Arsenic Concentrations in the Aquia Aquifer
Some Things to Keep in Mind

Outcrop areas for the aquifers we use for drinking water in Anne Arundel County are in this county.

What is applied to the ground surface could have the potential to infiltrate.

Public water supply wells in most Coastal Plain areas come from confined aquifers and it is possible to withdraw ground water at a greater rate than it can be recharged.

There are some naturally occurring and some man-induced ground water quality issues but there are solutions.

Underlying geologic materials are a parent material for most soils.

Increased impervious surface area reduces infiltration and increases runoff.
Some Things to Consider

There are actions we can take that can help maintain or conserve our groundwater resources as well as our surface water resources.

For example:

Consider alternatives to impervious surface materials.

In landscaping consider:
- use of plants adapted to a region and specific location, which may need little or no irrigation, fertilizers, pesticides and herbicides.
- use of rain gardens and landscaping to reduce runoff
- use of rain barrels to capture roof runoff for later use for watering

Store, use and dispose of any household and yard chemicals and fertilizers appropriately.
Maryland Geological Survey
www.mgs.md.gov