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Interdisciplinary Cooperative Geologic Mapping and Ground-Water Resource Analysis of Frederick County, Virginia by the U.S. Geological Survey

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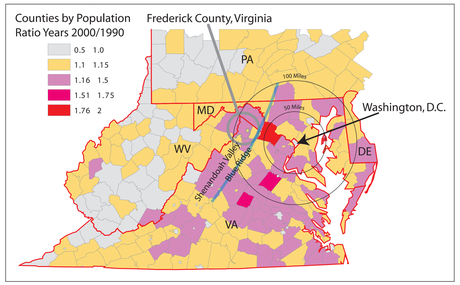
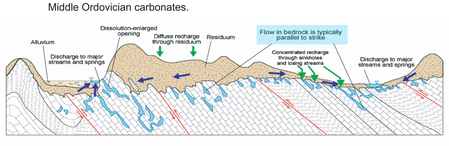
Abstract

As a rapidly expanding "bedroom community" for the Washington, D.C. metropolitan area, the northern Shenandoah Valley of Virginia is facing increased human impacts on ground-water resources. Expansion of industrial and housing development combined with low water tables experienced during recent drought years have prompted local governments to support scientific studies of the karst aquifers of the northern Shenandoah Valley. The aquifer comprises Lower Paleozoic carbonate rocks that have been extensively folded, faulted, and fractured. In many places the fractures have been enlarged by solution into caves and conduits for ground water. In cooperation with the Frederick Co. Sanitation Authority, U.S. Geological Survey (USGS) geologists and hydrologists are studying the geology and ground-water resource in the area around Winchester, VA. The effort, supported by the National Cooperative Geologic Mapping Program (NCGMP), includes new 1:24,000 scale geologic mapping in quadrangles containing the karst aquifer. Special emphasis is put on identifying faults and other structures that may affect the partitioning and movement of ground water on a regional scale. Fracture measurement and analysis are being performed in an attempt to characterize the anisotropy of the bedrock with respect to ground-water flow at local and regional scales. Preliminary results indicate that ground water moves preferentially along strike in the folded and faulted rocks of this area, and many conduits develop along the intersections of joints and bedding planes. The effort also includes installation and monitoring of stream gauges for base-flow data as well as an extensive well monitoring and aquifer tests. Data collected will be incorporated into a numeric ground water flow model being developed for the entire Shenandoah Valley watershed.

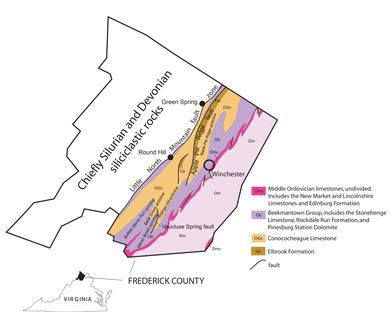


Location of the Frederick County study location in relation to population change in counties in the Washington, D.C. metropolitan area from 1990 to 2000. These trends have accelerated since 2000. Population data from ESRI ArcMap 8.3 dataset.

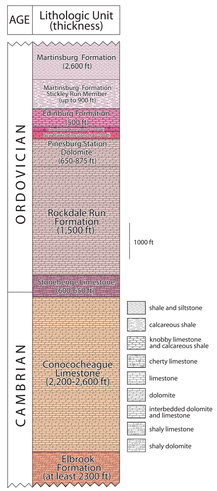
Semple Spring near Winchester, VA flanked by outcrops of Lower and Middle Ordovician carbonates.



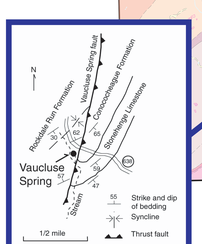
Generalized conceptual hydrogeologic section through the Valley and Ridge (modified from Wolfe and others, 1997)



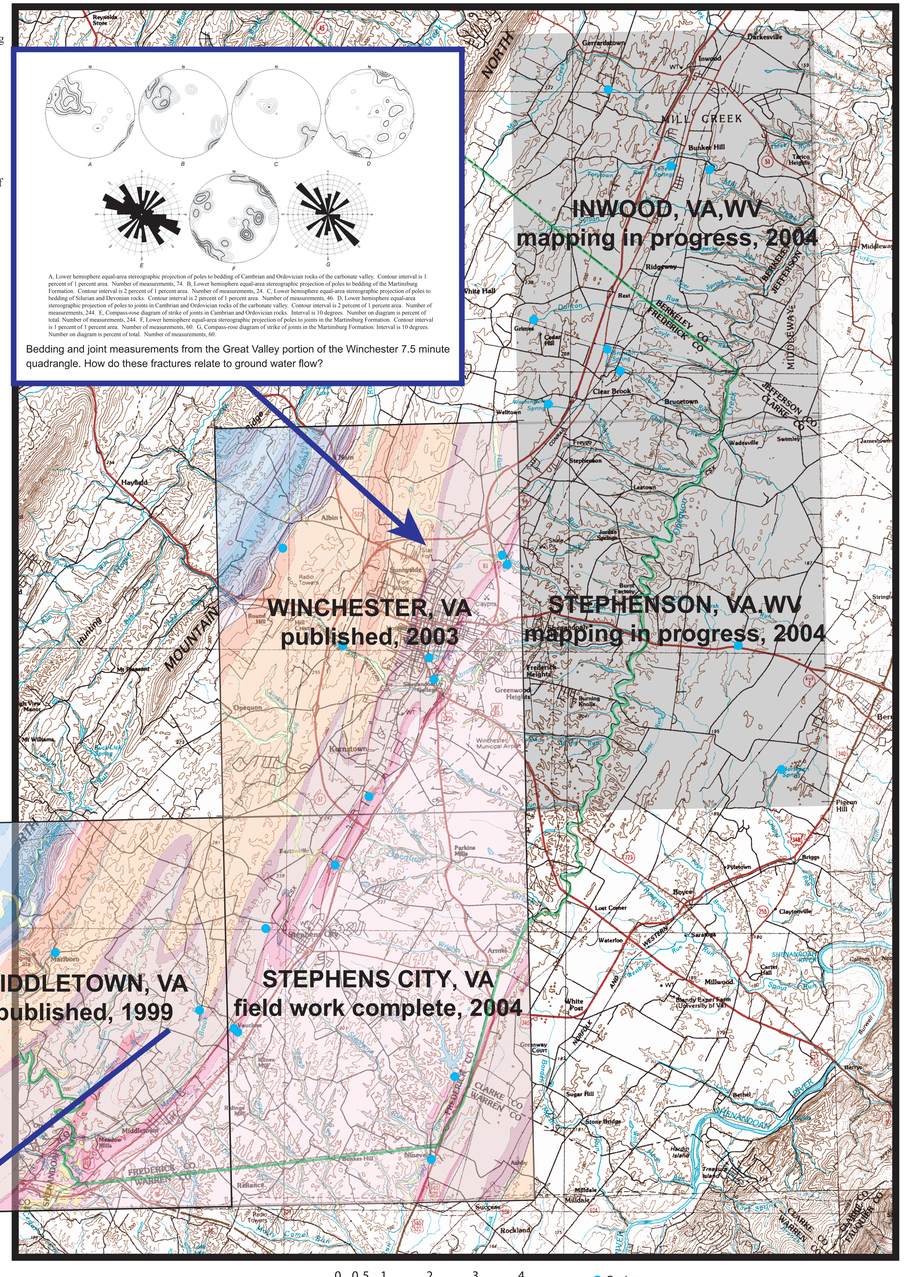
Generalized geology of the Great Valley part of Frederick County, VA



Stratigraphic section of geologic units in the carbonate study area of Frederick , County, VA



What is the realationship between faults, springs and ground water flow?



Status of new 1:24,000 scale geologic mapping in Frederick County, VA by the U.S. Geological Survey. Maps plottted at 1:50,000.

U.S. Geological Survey Water Resources Discipline (WRD) activities include:

Delineation and monitoring of the ground-water flow system by:

- -Operation of water-level monitoring network, conducting water-level measurements during high and low water conditions to provide information for a generalized water-table map.
- -Investigation of the occurrence and nature of subsurface water-bearing fractures by the application of advanced geophysical logging methods.
- -Characterization of the ground-water-flow system by the use of environmental tracer and ground-water age-dating techniques.

Determination of the water balance for the study area by:

- -Estimating/calculating components of the water balance using data collected to date.
- -Performing spring discharge and miscellaneous stream measurements.

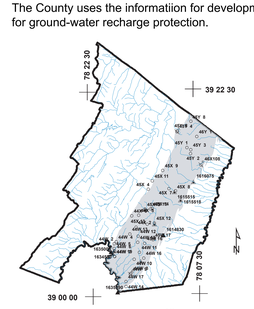
Stream Gaging:

- -Continue operation of stream gages on Cedar Creek and Opequon Creek. Discharge data will be archived and published in the USGS annual data report.

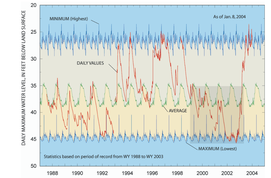
More information available at: http://va.water.usgs.gov/va134/index.htm

Data and information developed by the project are made available to the Frederick County Sanitary Commission and to the general public.

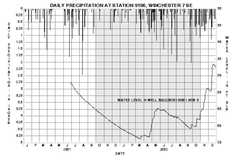
The County uses the informatiion for development planning and ground-waterwater resource managment including prospecting for new supply wells and delineating areas for ground-water recharge protection.

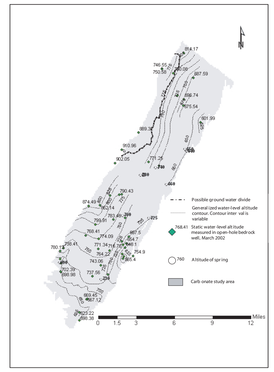


Locaton of observation wells and discharge-measurement stations in the carbonate study area of Frederick County, VA.

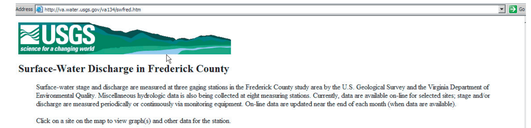


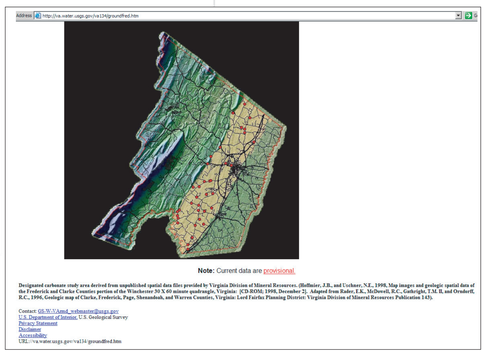
Hydrographs and precipitation records from wells near Winchester, VA, showing the drought of 2000-2002



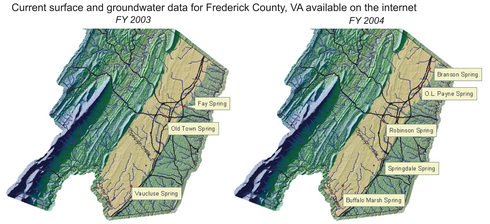


Generalized altitude and configuration of the water table determined from water levels measured in open-hole bedrock wells and perennial spring altitudes, March 2002, Frederick County, Virginia.





Current surface and groundwater data for Frederick County, VA available on the internet



Springs in Frederick County, VA sampled for age dating by U.S. Geological Survey Water Resources Discipline (WRD) scientists in fiscal years 2003 and 2004. Environmental tracers, including chlorofluorocarbons (CFCs), sulfur hexafluoride (SF6), tritium (3H), and tritium/helium-3 (3H/3He) are being used used to determine the age of water discharging from the springs.

REFERENCES:

Harlow, G.E.,Jr., Orndorff, R.C., Nelms, D. L., Weary, D.J., and Moberg, R.M., 2004, Hydrogeology and ground-water availability in the carbonate aquifer system of Frederick County, Virginia: U.S. Geological Survey Scientific Investigations Report [in technical review].

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Wolfe, W.J., Haugh, C.J., Webbers, Ank, and Diehl, T.H., 1997, Preliminary conceptual models of the occurrence, fate, and transport of chlorinated solvents in karst regions of Tennessee: U.S. Geological Survey Water-Resources Investigations Report 97-4097, 80 p.