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### Geology and Hydrology of the Cockeysville Formation

The recently published Delaware Geological Survey (DGS) Bulletin No. 19, "Geology and Hydrology of the Cockeysville Formation in Northern New Castle County, Delaware," edited by John H. Talley, concludes that additional development in the Hockessin area could reduce watersupply capability there. The Bulletin has two parts, "Geology of the Cockeysville Formation" by Kenneth D. Woodruff and Margaret O. Plank of the DGS and "Geohydrology of the Hockessin Area with Emphasis on the Cockeysville Aquifer" by William W. Werkheiser of the U.S. Geological Survey. The project was supported by the Water Resources Agency for New Castle County and Delaware Department of Natural Resources and Environmental Control.

Based on studies of outcrop and borehole data, the Woodruff and Plank report describes the rock units and geologic framework of the study area and identifies folds, faults, and stratigraphic elements of the Piedmont rocks that directly influence ground-water occurrence and flow in environmentally sensitive areas underlain by the Cockeysville Formation. The formation consists mainly of marble with lesser amounts of micaceous schist. Because it is more readily weathered and eroded than surrounding rocks it forms valleys, namely the Hockessin-Yorklyn and Pleasant Hill valleys. Structurally, the rocks of the area comprise northeast-trending asymmetric anticlines overturned to the northwest. They are probably nappes with northern limbs cut off by thrust faults (see cross section B-B').

The Cockeysville Formation is a major source of water in the Hockessin area, where about 1.5 million gallons per day (mgpd) are withdrawn for public water supply. The major contributors of recharge to the Cockeysville Formation are precipitation and leakage into the subsurface from streams that flow over the Cockeysville. In 1991, the year that was studied by Werkheiser, recharge of approximately 0.65 mgpd were from precipitation and 0.55 mgpd were through leakage from streams. Werkheiser concludes that because of the relatively small area of the Cockeysville exposed in the Hockessin area, the reduction of recharge areas through additional development could reduce the water-supply capability of the aquifer.

The geohydrology report documents ground-water quality during 1990-1991 from 29 wells and concludes that all of the water samples were within the criteria set by the U. S. Environmental Protection Agency for safe drinking water. However, nitrate-nitrogen concentrations in 26 wells were above 0.4 mg/L, indicating that water quality is being affected by human activity.

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Bulletin No. 19 is available from the Delaware Geological Survey at the University of Delaware and can be obtained by calling (302) 831-2834 or by e-mail to <dgs@mvs.udel.edu>.

### Ground-Water Quality in Southern New Castle County

The Delaware Geological Survey has issued Report of Investigations No. 52, "Quality and Geochemistry of Ground Water in Southern New Castle County, Delaware" by L. Joseph Bachman and Matthew J. Ferrari, hydrologists with the U. S. Geological Survey (USGS). It documents ground-water quality during 1991-1992 from 63 wells in three major aquifer systems, the Magothy and Potomac, the Englishtown-Mt. Laurel, and the Rancocas.

The report provides evidence for the major geochemical processes that control water quality and concludes that most of the water samples are currently within the criteria set by the U. S. EPA for safe drinking water. Ground water, however, does contain natural iron and radon. Dissolved iron, which is most prevalent in confined aquifers, generally exceeds the U. S. EPA Secondary Maximum Contaminant



Cross section B-B' across the Hockessin Valley showing anticlinal nappe structure and cut-off of the northern limb by a thrust fault. Rock unit abbreviations are bg-Baltimore Gneiss, cm-Cockeysville Formation, and wu-Wissahickon Formation. Boreholes Bb44-9 and -22 confirm the overturned anticlinal structure on the south limb. Mean sea level designated by msl.

Level (SMCL) of 300 micrograms per liter. Relatively high levels of radon were detected in some samples from the Englishtown-Mt. Laurel and Rancocas aquifer systems.

The report also documents that 20 of the 63 samples had nitrate-nitrogen concentrations above 0.4 milligrams per liter, indicating that water composition is being affected by human activity. Three samples exceeded the U. S. EPA Maximum Contaminate Level of 10 milligrams per liter for nitrate-nitrogen. Elevated concentrations of nitrate-nitrogen are most commonly found in shallow unconfined aquifers used primarily for individual water supplies.

The report, a product of the Joint-Funded Program of the USGS with the DGS, is available from the Delaware Geological Survey at the University of Delaware by calling (302) 831-2834 or by e-mail to <dgs@mvs.udel.edu>.

# Geologic Map of the Seaford Area

Recently published Delaware Geological Survey Geologic Map No. 9, "Geology of the Seaford area, Delaware" by A. Scott Andres and Kelvin W. Ramsey, portrays the surficial and shallow subsurface geology of the area between Bridgeville and Seaford.

The map shows the geologic formations at the land surface as well as the distribution of Holocene marsh, swamp, alluvial, and bog deposits. The Beaverdam Formation (Pliocene) and Nanticoke deposits (Pleistocene) are the primary units underlying upland surfaces. They were deposited when sea level was 20 to 50 feet higher than present. Modern marsh, swamp, and alluvial deposits cover floodplain surfaces.

Cross sections show the subsurface configuration of the outcropping geologic units and the underlying Choptank, St. Marys, and Manokin formations (Miocene). The history of geologic investigations of the area, descriptions of the mapped units and the data used to construct the map, and the geomorphology and geologic history of the area are covered in the text section on the map.

The DGS Geologic Map Series publications are important in locating potential economic deposits, such as sand and gravel, and for understanding water resources. The maps are commonly used to design water supply and wastewater disposal facilities and ground-water monitoring systems.

Partial support for the Seaford area map was provided under the StateMap program administered by the Geologic Division of the U. S. Geological Survey under authority of the National Geologic Mapping Act.

# Tom Pickett Retires

By Robert R. Jordan

Thomas E. Pickett, Associate Director of the Delaware Geological Survey, will retire on June 30, 1996. Dr. Pickett has served the DGS, the University of Delaware, and the State of Delaware for more than 30 years. He has contributed importantly as scholar, administrator, and teacher throughout these three decades.

Dr. Pickett was born in Georgia, graduated from the Mt. Hermon School in Massachusetts, and completed his undergraduate training in geology at Duke University. He continued with graduate studies at the University of North Carolina, Chapel Hill, earning the Ph. D. in geology in 1965. Following an engagement with the Smithsonian Institution, he joined the Delaware Geological Survey in 1966. He served as Geologist and Senior Geologist, becoming Associate Director in 1978. His research spanned the stratigraphy and sedimentation of the Coastal Plain, trace fossils, paleoecology, earthquakes, mineral resources, and the history of geology. More than 60 publications covering this wide range of interests testify to his versatility and productivity.

Tom Pickett has conscientiously contributed to the sciences and profession of geology. He is a Fellow of both the Geological Society of America and the Geological Society of London. He has held office in Sigma Xi, the History of Earth Science Society, Delaware Academy of Science, and the Atlantic Coastal Plain Geological Association. In the course of his official duties he has served on many advisory committees and has guided many projects.

All of Tom's associates have appreciated Tom's thoughtful, gentlemanly demeanor. Throughout a long career he has set an example of willingness and loyalty valued by his colleagues and institutions. We will miss his vast experience, and wish him well as he joins wife Sue in Indiana for a new chapter of his career.

### Earthquake Update

By Suzanne Sayer

The three-station DGS seismic network recorded a small earthquake on December 20, 1995, at 11:32 A.M. local time. Because of the noise of midday traffic in Wilmington, the earthquake signal could have gone unnoticed except for a resident who reported that she and her neighbors heard a noise similar to that of the night of the earthquake of October 16, 1995 (see *First State Geology*, Winter 1996). The December 20 event was about a magnitude 1.5 on the Richter scale. The DGS also recorded a small earthquake in the Lancaster, Pennsylvania, area on April 16 at about 10:17 A.M. The DGS commonly receives reports from persons who feel or hear a suspected earthquake that is later verified upon examination of our seismograms.

## Historical Seismicity

By Suzanne Sayer

The DGS is preparing an historical account of seismicity in Delaware. We have searched the microfilm records of the Wilmington Morning News, Wilmington Journal-Every Evening, and the Philadelphia Inquirer newspapers for reported accounts of earthquakes. One result of this research is that of longrumored reports of earthquakes in the 1930s and 1940s, two have been confirmed. The DGS requests that long-term Wilmington residents or their descendants who might have kept a journal or diary or have newspaper clippings about unusual noises, strange shakings, or earthquakes from this period or even before share that information with us so that a more complete historic record of earthquakes can be made.

# Upgraded DGS Seismic Network

By Suzanne Sayer

The DGS has acquired a Sun SPARC5 work station that in conjunction with a 24bit analog to digital converter will enable us to locate precisely any earthquake that occurs in northern Delaware and nearby areas as detected by our three-station seismic recording network in northern New Castle County. Also, the DGS has acquired a Global Positioning System clock, which provides a time signal that is good to a millisecond (1/1000 of a second). A clock this precise is fundamental for accurately locating the epicenter and depth of an earthquake.

The upgraded system is expected to be operational sometime in the summer of 1996. As a member of the Lamont Cooperative Seismic Network (LCSN), the DGS will be acquiring computer programs from the other members to process future earthquake data. At that time the DGS will be able to share the information in near real time with other state and federal agencies, members of the LCSN, and anyone with the necessary software to access the Internet.

Currently the DGS is working on an agreement with the Aberdeen Proving Grounds in Maryland to use their test shots to determine the velocity of the earth's crust between there and our seismic recording stations. This will enable the DGS to calibrate the seismic-recording equipment in a working environment, rather than doing it solely in a laboratory that cannot fully represent real field conditions.

### Short-Term Registration in Delaware

The Delaware State Board of Registration of Geologists has announced implementation of regulations permitting out-of-state geologists to practice in Delaware provided they are properly registered elsewhere. Practice in Delaware for up to 30 days per year is permitted under this process. Longer periods require compliance with Delaware's normal registration provisions. Professional geologists wishing to use the short-term recognition procedures must apply for permission and serve notice when their work is completed. The Delaware Registration Board expressed hopes that this will provide easy access for qualified professionals to do geologic work within the state and that the process will be considered for mutual recognition by other states. For details and applications, contact The Board of Registration of Geologists, Division of Professional Regulation, Cannon Building, Suite 203, P. O. Box 1401, Dover, Delaware 19903; telephone (302) 739-4522.

# Geology in Congress

The National Geologic Mapping Act of 1992 is landmark legislation establishing the importance of geologic mapping in federal statute. It provides a system of cooperation and support between the U. S. Geological Survey, the state geological surveys, and educational institutions to assure progress in mapping at modern scale and detail. The National Geologic Mapping Act would be reauthorized by H. R. 3198, which was considered in a hearing before the House Subcommittee on Energy and Mineral Resources in April.

Dr. Earl H. Bennett, a Delaware geology alumnus now State Geologist of Idaho and President-Elect of the Association of American State Geologists, spoke in favor of the bill on behalf of the Association of American State Geologists. Dr. P. Patrick Leahy, Chief Geologist of the U. S. Geological Survey, testified "...the National Geologic Mapping Act of 1992 has been instrumental in helping focus more attention on the Nation's need for a systematic, high-quality geologic map database to serve as the primary underpinnings for virtually all applied and basic earth science investigations. The Administration supports reauthorization and urges bipartisan support for this legislation." Dr. Robert D. Hatcher, Jr., President of the American Geological Institute, endorsed reauthorization and passage of H. R. 3198 on behalf of the 29 scientific and professional geologic organizations that comprise the Institute.

The establishment of an "organic act" for the U.S. Minerals Management Service (MMS) is another congressional action in which Delaware has interest. MMS is the bureau in the Department of the Interior with jurisdiction over the Outer Continental Shelf (OCS), including such resources as sand and gravel, oil, and gas. Its actions had major implications for Delaware during the Atlantic oil and gas exploration period of the 1970s and early 1980s and now are important for potential sources of beach nourishment sand and future gas exploration. H. R. 1813 would establish MMS in statute, the "organic act," rather than just the Secretarial Order under which it has functioned for about 15 years. State Geologist Robert R. Jordan testified before the House Subcommittee on Energy and Mineral Resources in March, endorsing H.R. 1813 on behalf of the DGS, the Association of American State Geologists, and the American Geological Institute. Jordan noted that important responsibilities assigned to MMS deserve the attention of a stable agency with standing in statute, one that is not vulnerable in its relationships with states and industry to threats of dissolution. Delaware's dealings with the Department of the Interior benefit from having reliable, knowledgeable federal counterparts.

### Nitrogen and Phosphorus in Agricultural Drainage Waters

By A. Scott Andres

New multidisciplinary research is determining what factors control the loss of plant nutrients from farm fields to agricultural drainage waters and how agricultural practices might best be modified to remove them from the waters. Dr. Thomas Sims and William Gangloff, University of Delaware Department of Plant and Soil Science, Judith Denver, U.S. Geological Survey, and Scott Andres, DGS, are cooperatively studying how nitrogen and phosphorus move through soil, ground water, and surface water at two ditched farms in eastern Sussex County. It has been known for two decades that high concentrations of dissolved nitrogen and phosphorus are present in surface water and shallow ground water in many areas of the Atlantic Coastal Plain, Nitrogen and phosphorus compounds are primary causes of eutrophication in the Inland Bays, and high concentrations of nitrate-nitrogen can be a public health concern.

The goal of the research in Delaware is to have the information and knowledge needed to provide sound technical advice to farmers and environmental officials on the practices that work and those that make conditions worse. Innovative drainage and plant-nutrient management practices developed in other areas to control nutrient

loss are being evaluated to determine which, if any, can be adapted for use in Delaware. Control of drainage water through the use of water control structures (WCS) is one of the practices being evaluated. Initial results indicate that WCS in ditch systems are effective in raising water table levels under fields; however, it appears that they do not promote significant removal of nitrate from drainage waters and may promote loss of phosphorus from soils to the ground water. The use of WCS to control the loss of plant nutrients was pioneered in North Carolina, and many of these structures have been installed in Delaware over the past seven years with the expectation of duplicating the successes seen there. Work continues on water sampling and evaluation of WCS.

# **Careers in Geology**

As geology increasingly adds environmental applications to its traditional roles in earth resources, the DGS receives questions about the changing nature of careers in geology. Advice on careers dealing with geology and the environment is now available from the American Association of Petroleum Geologists in a publication titled "Careers in Environmental Geoscience." The publication is a report of a committee written by Robert R. Jordan of the DGS, Rima Petrossian of Radian Corporation, and William J. Murphy of AMOCO. Copies are available through the AAPG Bookstore in Tulsa, (918) 584-2555.

# Cartographic Corner

By W. S. Schenck

- Plans are being made for the fourth time to update the DGSCIC CARTOGRAPHIC database which contains information on maps and aerial photography held at state, county, and local agencies, and some private institutions within Delaware. The database is searchable over the World Wide Web through the DGS home page (http://www.udel.edu/ dgs/dgs.html). The updated version will run from June through fall 1996. There are currently more than 2,300 records in the database providing excellent coverage of aerial photos and maps from 1614 to the present.
- Efforts are being made to provide real time updates to the DGSCIC BENCHMARK and BOUNDARY database. Users will be able to fill out on-line recovery cards for any marks used. Information requested will be name, date, affiliation, and current condition of the monument. This will provide a better on-line history of the vertical control marks and state boundary monuments in Delaware. Look for on-line recovery cards to appear on the BENCHMARK and BOUNDARY web pages early this summer.

# **Publications**

### **Recent DGS Publications**

#### Bulletins

No. 19, Geology and Hydrology of the Cockeysville Formation, Northern New Castle County, Delaware: J. H. Talley, editor; Geology of the Cockeysville Formation: K. D. Woodruff and M. O. Plank; Geohydrology of the Hockessin Area with Emphasis on the Cockeysville Aquifer: W. H. Werkheiser; 59 p., 1 pl.

#### **Report of Investigations**

No. 52, Quality and Geochemistry of Ground Water in Southern New Castle County, Delaware: L. J. Bachman and M. J. Ferrari, 31 p.

#### **Geologic Map Series**

No. 9, Geologic Map of the Seaford Area, Delaware: A. S. Andres and K. W. Ramsey, scale 1:24,000.

#### Other Publications by DGS Staff

- R. R. Jordan, 1995, Report on North American Commission on Stratigraphic Nomenclature: American Association of Petroleum Geologists Bulletin, v. 79, p. 1855.
- R. R. Jordan, R. Petrossian, and W. J. Murphy, 1996, Careers in Environmental Geoscience: Tulsa, American Association of Petroleum Geologists Division of Environmental Geosciences, 54 p.

# **Staff Notes**

### Presentations

Richard N. Benson, "Petroleum Systems of the United States Middle Atlantic

Delaware Geological Survey University of Delaware Newark, DE 19716-7501 Continental Margin," at Temple University Department of Geology, Philadelphia, April 5.

Roland E. Bounds chaired the "Phosphate Mineralogy" symposium as president of Friends of Mineralogy, Pennsylvania Chapter, Newark, DE, November 5, 1995.

Robert R. Jordan, "Delaware's Water Resources: Too Little and Too Much" at Delaware Association of Conservation Districts Convention, January 25.

Kelvin W. Ramsey, "Flooding and Earthquakes in Delaware" to the Delta Chapter of Delta Kappa Gamma, an honor society of teachers, at Delcastle Technical High School, January 25.

#### Service and Awards

- Roland E. Bounds was elected to a threeyear term as national treasurer and concurrently to the national board of the Friends of Mineralogy; he attended the board meeting at the annual convention of the Friends of Mineralogy in Tucson, AZ, February 10, 1996. Bounds completed requirements for the 1910.120 OSHA 40-Hour Safety Training Certificate in April.
- Robert R. Jordan, has been reappointed by Governor Carper to a two-year term as a member of the Delaware State Board of Registration of Geologists. Jordan has been selected as a 1996 recipient of Honorary Membership in the American Institute of Professional Geologists.
- William S. Schenck received a University of Delaware service award for completion of 15 years with the DGS and has been promoted to Associate Scientist. Congratulations, Sandy.

- Suzanne Sayer completed the requirements for the Ph.D. at Virginia Polytechnic Institute and State University and received her degree there on May 10. Her dissertation was an applied shallow geophysical study of complex terranes. Congratulations Suzanne.
- **Charles T. Smith** completed requirements for the 1910.120 OSHA 40-Hour Safety Training Certificate in April; he also completed the requirements for the Environmental Studies Certificate given by the University of Delaware.

#### **Externally Supported Projects**

A. Scott Andres from the Delaware Department of Natural Resources and Environmental Control and the U. S. Environmental Protection Agency in cooperation with the University of Delaware Department of Plant and Soil Science and the U. S. Geological Survey Water Resources Division for the second year of "Assessing the impact of agricultural drainage on ground and surface water quality in Delaware."

First State Geology is published by the Delaware Geological Survey, a State agency established by an Act of the Delaware General Assembly in 1951 and organized as a unit of the University of Delaware. Robert R. Jordan State Geologist and Director Richard N. Benson, Editor, First State Geology

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