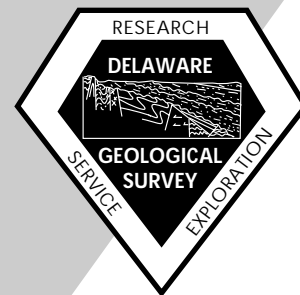


First State Geology

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Aerial view of the Pollack Farm Site viewed toward the east in 1992. The Leipsic River is in the upper left. Right-of-way for Delaware State Route 1 runs from left to right in foreground. Photograph by Tim O'Brian.

The Pollack Farm Fossil Site

By Richard N. Benson

Eighteen million years ago during the early Miocene epoch, central Delaware was the site of a tide-dominated delta with shallow marine waters nearby. Both the land climate and marine environment were subtropical. Densely forested uplands, interspersed with open areas of grasslands, grew right up to the coast. Lowland environments consisted of fresh-water rivers and streams with swamps, marshes, and large lakes on the flood plain.

This story is revealed by fossils recovered from tidal channel deposits of shelly sand beds at the Pollack Farm Site near Cheswold, Delaware, a temporary borrow pit that was excavated during 1991 and 1992 for road material used in the construction of Delaware State Route 1. The sand beds are part of the Cheswold sands of the Calvert Formation that comprise the Cheswold aquifer, an important source of ground water in central Delaware.

The collection of land mammal fossils is considered the most diverse one of the

Tertiary Period (last 65 million years) known in eastern North America north of Florida. Likewise, new and important discoveries are reported for the fossil reptiles and mollusks from the site.

Invertebrate shell fossils include more than 100 species of mollusks. The vertebrate fossils comprise bone fragments and teeth of fish, reptiles, and mammals that inhabited land, fresh-water, and marine environments. A few bird bones were also collected from the site. Many of these fossils are on display in the lobby of the Delaware Geological Survey Building.

A report on this important discovery, funded in part by the Delaware Department of Transportation, is now available from the Delaware Geological Survey (DGS) at the University of Delaware. Thirteen papers on the geology and paleontology of the site, complete with photos of many fossil finds, are published in DGS Special Publication No. 21 (1998), "Geology and Paleontology of the Lower Miocene Pollack Farm Fossil Site, Delaware" edited by Richard N. Benson. The scientific importance of the site attracted contributions by authors from the Delaware Geological Survey, the Smithsonian

Institution, Marshall University, Michigan State University, Smith College, the University of Florida, Vanderbilt University, and the Virginia Museum of Natural History.

Analyses of the ancient environmental setting and age of the deposits in which the fossils occur are based on field studies, the microfossils radiolarians and diatoms, strontium-isotope studies on mollusk shells, and the habitats of living relatives of the fossils from the site.

To obtain a copy of the report or any other DGS publication, call (302) 831-2834. The report is also available under Publications on the DGS web site at <<http://www.udel.edu/dgs/dgs.html>>.

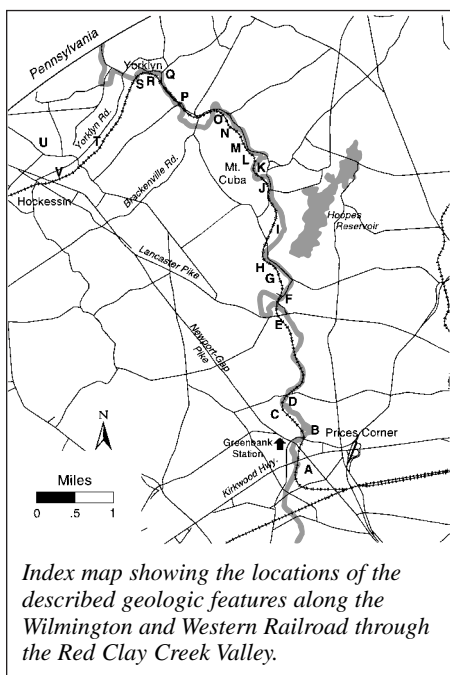
Delaware Piedmont Geology

By W.S. Schenck

Delaware Geological Survey Special Publication No. 20, "Delaware Piedmont Geology Including a Guide to the Rocks of Red Clay Valley," by Margaret O. Plank and William S. Schenck, describes the rocks of the Red Clay Valley and the geologic history of the Delaware Piedmont. It is written for those who would like to know more about rocks in general, for students and teachers of earth science (grades K-12) who would like to know more about Piedmont rocks and what they look like outside the classroom, and for geologists who may be familiar with Appalachian geology but are curious about the Delaware Piedmont.

The first section, "Basic Facts About Rocks," is a brief overview of geology organized to help in understanding the rocks of the Delaware Piedmont. Basic concepts are described, and some of the terminology used by geologists is defined. The second section, "Reading the Rocks: History of the Delaware Piedmont," is a summary of the geology of the Delaware Piedmont. The third section, "A Guide to the Rocks Along the Track," is a railroad log along the tracks of the Wilmington and Western Railroad. It describes the rocks as seen from the train as it travels the Red Clay Valley from Greenbank Station to Hockessin.

To obtain a copy of the publication or any other DGS publication, call (302) 831-2834 or visit our web site at <http://www.udel.edu/dgs/dgs.html> and



click on "Publications" or on "Education" and view this report under Geologic Adventures in the Delaware Piedmont.

Geophysical Investigation of Faults in Northern New Castle County

By *Stefanie J. Baxter*

More than 550 earthquakes have been documented within 150 miles of Delaware since 1677. The largest one in Delaware occurred in the Wilmington area in 1871 and the second largest (magnitude 3.8) in 1973 near the Delaware River in northern Delaware. The faults responsible for the earthquakes have no known traces on the earth's surface; therefore, geophysical methods of their detection in the subsurface are required.

In order to further evaluate seismicity in northern Delaware by means of these methods, the DGS developed a joint cooperative agreement with the U.S. Geological Survey (USGS). Geophysicists with the USGS Geologic Division in Menlo Park, Calif., have developed a geophysical data processing technique suited for the investigation of faults that may be present in the subsurface of northern Delaware. DGS personnel and USGS scientists and support staff from Menlo Park conducted a high-resolution seismic reflection and refraction investigation along a former railroad right-of-way near New Castle, Delaware. The project

was jointly funded by the Federal Emergency Management Agency (FEMA) and the USGS Earthquake Hazards Program.

Seismic surveys are relatively non-invasive methods of imaging the subsurface that use equally-spaced receivers (geophones) to detect vibrations produced by an energy source. The vibrations reflect off geologic features in the subsurface. The recorded arrivals of the vibrations at the geophones produce seismograms that enable us to get a "picture" of the subsurface. The high-resolution seismic reflection and refraction survey was conducted to identify possible faults that may be associated with earthquakes near Wilmington.

Seismic waves were produced by firing eight-gauge shotgun shells into the ground at a depth of approximately 12-18 inches below the surface and by detonating one-pound explosive charges at a depth of approximately 10-15 feet below the surface. Both seismic sources were recorded by an array of 5 seismographs with 300 active channels.

Although we are still working on a final report in cooperation with the USGS, preliminary analysis of the information gathered from this project indicates the basement rocks and overlying sedimentary section (Potomac Formation) are highly faulted. Further work is needed to lend "ground truth" to the seismic images.

Nenad Spoljaric Retires

By *Robert R. Jordan*

After a career with the Delaware Geological Survey spanning more than 33 years, Nenad Spoljaric retired on December 31, 1998. Dr. Spoljaric has been a valued colleague and friend to many of us throughout his service to the Survey, University of Delaware, State of Delaware, and the geologic community.

Dr. Spoljaric is originally from Zagreb, Yugoslavia, receiving a Geological Engineer Degree and holding positions in exploration and research before coming to the U.S. Here he earned an M.A. from Harvard and his Ph.D. from Bryn Mawr. He joined the DGS in 1965 and rose to the rank of Senior Scientist (Geologist), which he has held for many years. His specialties have been particularly pertinent to the understanding of Delaware geology: ancient fluvial sediments, rift basins, glauconitic sediments, and clay mineral analysis, among other subjects.

Dr. Spoljaric's many publications testify to many important scholarly achievements. The scope of his work ranges from fundamental geological science to lucid explanations of its applications for the public. His educational efforts range from service on Ph.D. committees to talks for grade school classes.

Nenad Spoljaric is certified as a Petroleum Geologist by the American Association of Petroleum Geologists. He has traveled widely in North America, Europe, and Asia presenting papers, participating in conferences, and studying classic geologic sites. In short, Dr. Spoljaric is a long-term contributor to the world of geological science as well as to his local community.

Dr. Spoljaric's colleagues at the Survey and his many other associates are grateful for our relationships and will miss his great reservoir of experience and knowledge. We wish Nenad and his wife Barbara good health and great happiness in his retirement earned through a distinguished career.

GSA Donath Medal to Terry Plank

Terry Plank, assistant professor in the department of geology at the University of Kansas and daughter of our DGS volunteer geologist Margaret O. (Peg) Plank, is the recipient of the 1998 Young Scientist Award, the Donath Medal, presented by the Geological Society of America (GSA) on October 26 during the GSA annual meeting in Toronto. The medal along with a cash prize is awarded to a young scientist for outstanding achievement in contributing to geologic knowledge through original research that marks a major advance in the earth sciences.

In the words of her citationist Charles H. Langmuir, "Terry Plank has made major advances to our understanding of the plate tectonic geochemical cycle . . . Her ability to identify crucial problems, amass encyclopedic knowledge, obtain crucial data, develop innovative models, write seminal papers, and lead the community identifies Terry Plank as a truly outstanding young scientist."

We congratulate Terry and wish her continued success in her career.

Hydrogeology and Geologic History of the Great Cypress and Burnt Swamps

By *A. Scott Andres*

DGS staff members A. Scott Andres and C. Scott Howard are conducting research to characterize the hydrogeology and geologic history of the Great Cypress and Burnt swamps. This work is coordinated with three other ongoing efforts: a Delaware Natural Heritage Program project "Management, Conservation, and Restoration Recommendations for the Great Cypress Swamp," a Delaware Department of Transportation project "Great Cypress Swamp Wetlands Mitigation Bank," and a

U.S. Fish and Wildlife Service wetlands restoration demonstration project. The coordination of resources has greatly enhanced all of the individual projects and is a good example of how cooperative multi-disciplinary research can work.

The hydrogeologic work focuses on characterization of the hydrogeologic framework of the swamp (e.g., aquifers and confining beds), the expected range of ground-water depths, and the interactions of ground water and the extensive ditch network in the swamps. This effort includes installation of piezometers, measurement of ground-water levels and hydraulic properties of subsurface materials, and development of digital ground-water flow models.

The geologic history work is focusing on the evolution of the area during Pleistocene and Holocene times. This effort includes analyses of fossil palynomorphs and other organic matter by DGS volunteers Johan J. Groot and Ralph Orlansky, determination of sediment ages from carbon-14 analyses, a ground penetrating radar survey done with Susan McGeary and Lisa Donahoe of the University of Delaware Department of Geology, and analyses and interpretation of sediment composition from numerous borehole samples.

Inland Bays Research

By A. Scott Andres

Because of a 1997 federal court-mediated agreement involving Section 303(d) of the Clean Water Act as amended by the Water Quality Act of 1987, the Delaware Inland Bays watershed is the focus of numerous research and monitoring projects aimed at quantifying inputs of pollution and the assimilative capacity of water bodies. Toward this goal, DGS staff members A. Scott Andres and Thomas E. McKenna are participating in several multi-disciplinary, multi-agency research projects that are studying the input and effects of nitrogen and phosphorus on Rehoboth and Indian River bays. In addition, the DGS is contributing staff and other resources to streamflow gaging work being done by the U.S. Geological Survey (USGS).

The U.S. EPA/NOAA/NASA program "Research and Monitoring Program on Ecological Effects of Environmental Stressors using Coastal Intensive Sites" (CISNet) funded a 3-year project "CISNet: Nutrient Inputs as a Stressor and Net Nutrient Flux as an Indicator of Stress Response in Delaware's Inland Bays Ecosystem," led by William J. Ullman of the University of Delaware College of Marine Studies (CMS). As part of this effort McKenna and Andres along with John A. Madsen of the University of Delaware Department of Geology and David Krantz of the USGS are investigating the

locations, quantity, and quality of ground water that is flowing upward through the bay bottom. Andres, Ullman, and Joseph R. Scudlark (CMS) are leading an effort to characterize the processes by which water and plant nutrients (nitrogen and phosphorus) move in streams during baseflow and stormflow periods. Ullman and Andres are evaluating the magnitude of temporary nutrient storage in bay sediments. The Delaware Department of Natural Resources and Environmental Control (DNREC) funded a year-long surface-water-quality monitoring effort "Inland Bays Watershed Project" that is being conducted by Ullman, Scudlark, and Andres in conjunction with the DNREC and USGS. This project enhances the CISNet project by increasing the number of sampling sites equipped with automated water sampling, flow gaging, and telemetry instruments. Additional streamflow measurements are being funded by the DGS through the DGS-USGS joint-funded program.

Information about the 1997 agreement can be obtained from the Watershed Assessment Branch of the DNREC.

State-Wide Ground-Water Recharge Mapping Nearing Completion

By C. Scott Howard

The Ground-Water Recharge Mapping program is now nearing completion. This program, begun in the early 1990s, is jointly funded by the U.S. Environmental Protection Agency and the Delaware Department of Natural Resources and Environmental Control. The thrust of this program is to investigate the upper surface of the Atlantic Coastal Plain in Delaware, which consists of the unsaturated zone and the top of the unconfined aquifer. The materials in this interval are studied and evaluated primarily on the basis of the percentages of sand, silt, and/or clay present at a location. A methodology for interpreting these data has been developed by the staff at DGS, and it characterizes the potential for recharge as either excellent, good, fair, or poor.

The products of the research are maps that show the areal distribution of the four categories of recharge potential, thus indicating an area's ability, or potential, to transmit water into the water table aquifer system and ultimately into the major confined aquifer systems. The completed maps are used by several state and local agencies to assist in their water planning.

Recently, the Recharge Mapping program was funded to complete the mapping of Kent

and Sussex counties. To date, with the fall 1998 completion of the Harrington and Greenwood 7.5-minute quadrangles, 22 quadrangles are now mapped. The completion of the Lewes and Cape Henlopen maps is scheduled for early 1999. Thirteen quadrangles remain, several of which are boundary quads with Maryland. This last effort to complete the recharge mapping of the state is expected by early 2000.

Digital Line Graphs (DLGs) Available

By W.S. Schenck

Digital Line Graphs (DLGs) are available for 54 U.S. Geological Survey (USGS) topographic quadrangle maps of Delaware. With support from the Delaware General Assembly, six layers were collected through an innovative partnership with GeoDigital Mapping, Inc. of Sterling, Virginia. The layers were collected from the 1992-93 complete revision topographic maps that were products of a 5-year cooperative mapping program with the USGS. The layers include transportation, hydrography, boundaries, vegetative cover, non-vegetative cover, and manmade structures. These layers plus the hypsography layer collected in 1993-94 make a complete DLG package for the Delaware topographic quads.

Delaware is the only state in the nation to have complete and up-to-date topographic coverage in analog and digital format. All the DLG layers are available on CDs that can be borrowed from the Delaware Geological Survey Earth Science Information Center through the University of Delaware Research Data Management Services (RDMS) web page at <http://www.rdms.udel.edu/rdms/gis/drgdlg/>. Please contact W.S. Schenck at the DGSESIC by calling (302) 831-8262 or via e-mail at rockman@udel.edu for loan copies of the CDs or for further information.

DBPG News

By W. S. Schenck, outgoing president, Delaware Board of Professional Geologists

This is a new column that will be running in support of the Delaware Board of Professional Geologists (DBPG). As outgoing president I can report that the Board has had a very busy year. We successfully made it through the legislative sunset review process and have a new law as of June 17, 1998. I will remain on the Board until January 31, 1999. I would like to take this opportunity to introduce Elizabeth Brown as the new Board president. Liz graduated from Virginia Tech and worked for an oil company for 10 years before moving to Delaware. She currently

works for the consulting firm Davis, Bowen, and Fridel in Milford. As a conscientious member of the Board, she will continue to provide the necessary leadership for the Board's next task of rewriting new regulations.

By Elizabeth Brown, incoming Board president

As part of this inaugural column from the DBPG, I would like to thank Sandy Schenck for his many years of dedication and hard work as president. This past year Sandy has been working to revise existing regulations to conform to the new law, Delaware Code, Title 24, Chapter 36: Geology. Other changes in 1999 will include the election of a vice president and secretary and the expansion of the Board from 5 to 7 members, four of whom will be geologists.

Perhaps the most dramatic change to our regulations is the establishment of the National Association of State Boards of Geology (ASBOG) exam as part of the requirements for licensure. Although this test will not affect persons currently licensed, a reminder that licenses which have lapsed by more than one year will only be re-issued after the practitioner takes and passes the test.

Of importance to licensed geologists is the new requirement that the Board must establish continuing education standards for use in consideration of renewals of licenses. In the next months the regulations to put this and the other requirements included in Chapter 36 into action will be developed and then put forward for public comment.

I encourage Delaware's professional and aspiring geologists to consider these changes which will affect us, and to participate in the public hearing process.

Publications

Recent DGS Publications Reports of Investigations

- No. 57, Evaluation of the Stream-Gaging Network in Delaware: Edward J. Doheny (U.S. Geological Survey), 1998, 54 p.

Special Publications

- No. 20, Delaware Piedmont Geology Including a Guide to Rocks of the Red Clay Valley: Margaret O. Plank and William S. Schenck, 1998, 64 p.
- No. 21, Geology and Paleontology of the Lower Miocene Pollack Farm Fossil Site, Delaware: Richard N. Benson, editor, 1998, 191 p.

Other Publications by DGS Staff

- **Robert R. Jordan**, "Energy and Environment on the East Coast," American Institute of Professional Geologists 35th Annual National Meeting Technical Abstracts with Programs, p. 12.

Staff Notes

Presentations

- **A. Scott Andres**, "Effects of Agricultural Drainage Practices on Water Quality," to Delaware Departments of Natural Resources and Environmental Control and Agriculture, September 29; "Geochemical Heterogeneities Due to Artificial Drainage and Geologic Controls: Implications for Fate and Transport of Nitrogen and Phosphorus," at the 1998 Annual Convention of the National Ground Water Association/Association of Groundwater Scientists and Engineers, Las Vegas, Nevada, December 13-16.
- **Stefanie J. Baxter** and **Thomas E. McKenna**, "Preliminary Results of a High-Resolution Reflection and Refraction

Survey in the Atlantic Coastal Plain of Delaware, Four Kilometers South of the Fall Line," at 70th annual meeting of the Eastern Section of the Seismological Society of America, Millersville, Pennsylvania, October 18-20.

- **C. Scott Howard**, "Ground-Water Recharge Mapping in Southern Delaware: Methodology and Results," at the 1998 Annual Convention of the National Ground Water Association/Association of Groundwater Scientists and Engineers, Las Vegas, Nevada, December 13-16.
- **Robert R. Jordan**, "The East Coast Petroleum Province: Science and Society," at American Association of Petroleum Geologists, Eastern Section Meeting, Columbus, Ohio, October 7.
- **William S. Schenck**, "The Delaware Board of Professional Geologists," to Philadelphia Geological Society, West Chester University, West Chester, Pennsylvania, November 19.

Service and Awards

- Congratulations to **A. Scott Andres**, who was promoted to Senior Scientist, and **William S. Schenck**, who was promoted to Scientist.

Externally Supported Projects

- From the Delaware Department of Natural Resources and Environmental Control, Division of Fish and Wildlife, to **A. Scott Andres** for "Geologic History and Ground Water Geology of the Great Cypress Swamp."
- From the U.S. Department of the Interior, U.S. Geological Survey, Statemap Program, to **Kelvin W. Ramsey** for "Geologic Map of the Milton and Ellendale Quadrangles, 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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