First State Geology

Current information about Delaware's geology, hydrology and mineral resources

Published twice yearly by the Delaware Geological Survey, University of Delaware, Newark, DE 19716

Vol. 10, No. 1 Winter 1992

Miocene Fossils Uncovered

By Kelvin W. Ramsey

An excavation along the Smyrna bypass segment of the new Route 1 construction has yielded a significant fossil find. Beds of material composed of sand, shell, and scattered vertebrate bones and teeth were uncovered. On the bases of a preliminary examination of the shell species and the stratigraphic position of the beds within the Calvert Formation, the fossils have been dated as early Miocene, or about 17 million years old. This fossil find is the first of its kind in Delaware and is similar in age and type to the famous Calvert Cliffs fossil beds in Maryland on the western shore of Chesapeake Bay.

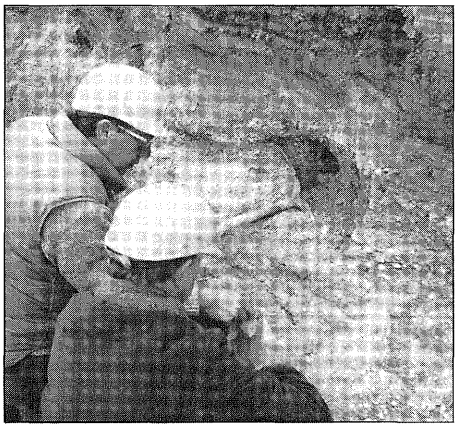
Once examination of the shells is completed, it is estimated that over 100 species of molluscs will be identified, including several new species never before described. Among the shells are abundant large (up to 12 inches long) specimens of *Crassostrea virginica*, the oyster that currently lives in Delaware and Chesapeake bays. These are among the oldest specimens of this species ever reported. Also found were various species of gastropods (relatives of the snail) including at least two species of *Busycon*, the common whelk found in Delaware Bay today.

Bones and teeth from the shell beds include scattered hammerhead and sand shark teeth and vertebrae and ribs of manatees and porpoises. More rare are pieces of land turtle shells and a vertebra identified as a part of crocodile. Also found was a tooth belonging to a primitive horse and a bone identified as a part of a tapir.

On the bases of the collective information of the stratigraphy of the site, the types of shell and bone found, and additional data from nearby wells and bore holes, the fossils accumulated in a nearshore depositional environment in a large marine embayment with some fresh water input. The climate was subtropical to tropical.

This site is the most significant fossil find in Delaware since the uncovering of Cretaceous fossils by the construction of the Chesapeake and Delaware Canal during the 1820s. Studies of the fossil assemblage will add much to our knowledge of a portion of the geologic history of the state previously known only from samples from a few drill holes. In addition, information from the new site will be of practical use in hydrogeologic applications.

Vertebrate bones and teeth recovered from shell bed.



Exposed Miocene shell bed (at level of pick).

Cockeysville Project

By Kenneth D. Woodruff

Results of a two-year hydrogeologic study of the Hockessin-Yorklyn and Pleasant Hill valleys of northern Delaware, which are underlain by the marble of the Cockeysville Formation, indicate that ground-water recharge and pumpage have been about balanced over a period of several years. However, temporary overdrafts of ground water may occur, even in years of normal to slightly above normal precipitation, depending on weather conditions and when precipitation occurs. The study, completed in October 1991, was prompted by concern of state and New Castle County officials over the intense development that has occurred in the valleys and the possible loss of ground-water recharge. The Cockeysville Formation locally may yield several hundred gallons per minute of high-quality ground water to individual wells. Most of the pumping is from the Hockessin-Yorklyn Valley where water from the Cockeysville is withdrawn by a major well field. The total outcrop area in Delaware is small, only about two square miles, and the effect of development on the recharge was not clear. On the basis of a 1972 DGS geologic map, the county classified the outcrop area as a Resource Protection Area in which new development is subject to certain land-use restrictions.

The DGS was asked to refine the limits of the Cockeysville outcrop area, determine the long-term ground-water yields, the amount and source of recharge, and the effect of loss of recharge on the ground-water supply. It was apparent that the geologic framework studies alone would entail a major effort, and, therefore, the assistance of the U. S. Geological Survey was requested for the hydrologic investigations. This brought the specialized skills of the federal agency to the task and effectively increased both manpower and funding.

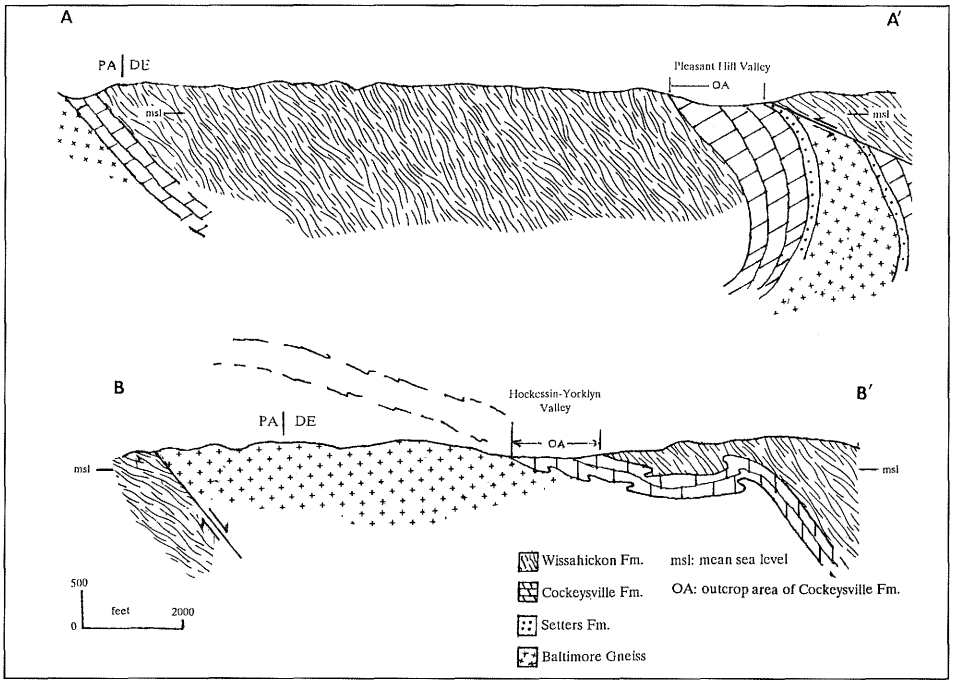
Program activities involved drilling and coring, conventional geologic field mapping, a detailed gravity survey, geophysical logging, installation of a continuous recording stream gage on Mill Creek, stream seepage measurements, and analyses of pumping, ground-water level, and precipitation records. A water budget approach was used to determine the amount of recharge available to the outcrop area.

An unexpected result of the geologic mapping was the verification of the Baltimore Gneiss and the Setters Formation

in Delaware. Although their presence had been suggested by a number of workers, the formations had not been formally mapped before. Their identification in the present study was a key factor in deciphering the geologic structure of the valleys. The structure and the relationship of the Cockeysville to the structure appear to be different for each valley. In the Hockessin-Yorklyn Valley, the Cockeysville lies on the south side of a large regional anticline, cored by Baltimore Gneiss, with the various rock units right-side up. The Baltimore Gneiss is exposed in a ridge along the northwest side of the valley. In the Pleasant Hill Valley, the Cockeysville crops out on the north side of a more tightly folded anticlinal structure, overturned to the northwest. The Setters Formation overlies the Cockeysville along the south side of the valley, although stratigraphically it would be beneath the Cockeysville in a normal sequence. Thrust faulting across the structure from the southeast has placed the Wissahickon Formation on top of the Setters Formation, rather than in its normal position on top of the Cockeysville. No Baltimore Gneiss is exposed in the Pleasant Hill Valley. The two valleys are separated by a strike-slip fault that cuts off the western end of the Hockessin-Yorklyn Valley. Thus there is no physical continuity of the Cockeysville marble between the valleys. Gravity modeling and aeromagnetic data were used to guide the structural interpretations.

The water budget studies indicate that recharge to the marble is from two sources, directly from precipitation on the outcrop area and from streams that flow across the marble. The thick, sandy weathered zone that is developed on top of the Cockeysville in many places acts as a ground-water storage reservoir from which recharge enters solution channels and fractures in the deeper, unweathered rock. In some places, pumping has dewatered the weathered zone.

In the Hockessin-Yorklyn Valley, about 22 percent of the total streamflow of Mill Creek and its tributaries is diverted to ground-water recharge. This accounts for about 40 percent of the water that is actually pumped. During the study period, the amount of water pumped was about 1.5 million gallons per day (MGD) whereas the actual recharge to the outcrop area was about 1.2 MGD. The overdraft was taken from storage in the weathered zone and from shallow fractures in the harder rock. However, there is no clear downward trend in ground-water levels because higher than normal rainfall in other years apparently made up for loss of storage in drier years. Nevertheless, the supply and demand appear to be delicately balanced. Keeping this balance depends on maintaining recharge to the Cockeysville and on the fact that higher than normal precipitation does occur occasionally. In the Hockessin-Yorklyn Valley, a small amount of water is contributed from the Wissahickon Formation which overlies the Cockeysville on the south side of the valley. However, the north side of the valley, which is flanked by the Baltimore Gneiss, is for all practical purposes a barrier to ground-water flow into the Cockeysville.



Geologic cross sections across the Pleasant Hill and Hockessin-Yorklyn valleys.

A summary report of the major findings of this study has been prepared for New Castle County and the Department of Natural Resources and Environmental Control (DNREC), the sponsors of the project. Technical details of the study will be published as DGS Bulletin No. 19, "Geology and Hydrology of the Marble Valleys of Northern Delaware."

Cartographic Corner

By W. S. Schenck

■ The National Geodetic Survey (NGS) has made available new elevation data for points in the National Vertical Network based on the improved North American Vertical Datum of 1988 (NAVD88) which supersedes the National Geodetic Vertical Datum of 1929 (NGVD29). Some older data and data in areas of rapid vertical crustal motion will not be included in current published listings but will be released in future publications during 1992. Most of these points are located in the west and southwest and do not affect Delaware. New elevation information is being ordered by the DGS to update the BENCHMARK data base.

■ DGSCIC has made a proposal through the Earth Science National Network to receive the ATLAS GIS software package to improve the handling and access to DGSCIC information. The two main DGSCIC data bases, DGSCIC CARTOGRAPHIC and BENCHMARK, along with the DGS List of Publications will be tied to a graphic front end. Information regarding Delaware's earth science information will then be accessible by coordinate search. Work should begin early 1992.

■ The DGSCIC is updating the DGSCIC CARTOGRAPHIC data base. The last update was during 1988-89. The 1992 update will inventory all maps and aerial photographs acquired by federal, state, county, and local agencies in Delaware.

Final Field Work Phase is Started for Delaware/USGS Topographic Joint-Funded Agreement

U. S. Geological Survey (USGS) field crews have converged on Kent County. The Dover Project (essentially Kent County) is now in the full field work stage of the map-making cycle for the production of total revision mapping for new 7.5-minute topographic maps for Delaware. The Georgetown (Sussex County) and the Wilmington (New Castle County) projects have passed field review and have been sent to the USGS Mid-Continent Mapping Center where the maps will be produced.

The Georgetown Project is leading the way and is almost through the contouring (compilation) phase and is about ready for the cartographic phases. The Wilmington Project is nearly ready for the compilation phase.

The last project, the Lewes Project consisting of the Lewes, Cape Henlopen, Fairmount, Rehoboth Beach, Frankford, and Bethany Beach quadrangles, is currently in the cartographic finishing phase and will shortly be put in queue for printing. The maps should be published early 1992.

Hydrology News

By A. Scott Andres

Ground-Water and Nitrate Discharge to Rehoboth and Indian River Bays

Preliminary results of this project indicate that the potential for direct discharge of ground-water-borne nitrate-nitrogen to Rehoboth and Indian River bays is in the range of 690 to 1800 kilograms per day (1518 to 3960 pounds per day). This amount of nitrogen is similar in magnitude to the total of surface discharges of nitrogen by all of the wastewater treatment plants in the area. Given the magnitude of the ground-water-borne nitrogen discharge, it is likely that ground water makes a significant contribution to the relatively high concentrations of nitrogen observed in parts of the bays.

This one-year-long project is funded by the Inland Bays Estuary Program. It builds on six years of intensive work done by the DGS as part of its hydrologic mapping program as well as other internal and outside sponsored programs. The project is another example of how the DGS targets research on geographic areas and problems of concern to the state.

Results of Ground-Water Quality Survey in Sussex County Published

DGS Report of Investigations No. 49, "Results of the Coastal Sussex County, Delaware, Ground-Water Quality Survey," and Open File Report No. 33, "Ground-Water Level and Chemistry Data from Coastal Sussex County, Delaware, Ground-Water Quality Survey," both by A. Scott Andres, report the results of a multi-year ground-water study.

Nitrate is a common contaminant in the near-surface Columbia aquifer, the primary source of fresh water in coastal Sussex County. Nitrate concentrations exceeding the maximum contaminant level for drinking water occur in nearly 23 percent of all wells sampled. These high concentrations occur over much of the study area and at all depths in the Columbia aquifer. Nitrate is in the aquifer as a result of agriculture and wastewater disposal practices.

The reports also contain information on the major ion content of ground water, as well as related geologic and hydrologic characteristics of the Columbia aquifer.

Publication on Ground-Water Recharge Mapping Methodology

A report on a methodology for mapping ground-water recharge areas in the Coastal Plain of Delaware has been published as Open File Report No. 34, entitled "Methodology for Mapping Ground-Water Recharge Areas in Delaware's Coastal Plain," by A. Scott Andres.

Mapping of ground-water recharge areas is an important step in understanding Delaware's ground-water resources, and such mapping provides factual information to guide the development of ground-water protection strategies.

New Telephone Numbers

Effective January 18, 1992, the new telephone numbers for the DGS will be (302) 831-2833 (office) and (302) 831-3579 (FAX).

K. D. Woodruff Retires

By Robert R. Jordan

Kenneth D. Woodruff will retire in January 1992 after more than 25 years of distinguished service, the last 14 as Associate director for Hydrology and Geophysics. That long, unusual title suggests Mr. Woodruff's ability to do so many things so well. His research has spanned surface-water, ground-water, and geothermal hydrology; gravity, magnetic, seismic, and borehole geophysics; seismic, radon, and pollution hazards; and hydrologic, geologic, and subsurface mapping. He has been administrator, advisor, inventor, and teacher. The scope and volume of Mr. Woodruff's efforts are truly remarkable. The results of his work are found in more than 30 publications of the DGS alone, and also lie in innumerable committee reports, memoranda, and advisories.

Mr. Woodruff's abilities, willingness, and modesty have earned the respect and gratitude of colleagues and the people of Delaware he has served so well. His modesty forbids conventional attempts to acknowledge his contributions. We can only offer sincere gratitude and best wishes.

Radon Study

By Kenneth D. Woodruff

A reconnaissance study to determine the radon generating potential of glauconitic sediments (greensands) in Delaware was initiated in October. Glauconite is a complex clay mineral with high concentrations of potassium and iron. It has a high ion exchange capacity and tends to scavenge metals, including uranium. Radon-222 is generated in the radioactivity decay chain of uranium-238 and is suspected as a cause of lung cancer. At background levels in outdoor air, radon does not present a health risk, but it may become a problem when levels build up indoors. Presently, the U. S. Environmental Protection Agency (EPA) has suggested a level of 4 picocuries per liter as an upper limit above which more testing should be done or some remedial action should be taken. According to data released by the EPA (Region 3) for Delaware, 15 to 20 percent of the buildings tested for radon that are located over greensand showed concentrations above 4 picocuries per liter. This suggests that concentrations of uranium or its daughter products may be higher than in other types of sediments.

In Delaware, glauconite occurs primarily as disseminated particles within a coarser-grained matrix or as coatings on other particles. Sediments containing glauconite subcrop beneath surficial sands over an area of about 70 square miles extending from the Chesapeake and Delaware Canal south to near Townsend in New Castle County. The subcrop area can be detected on aeroradioactivity maps. Other glauconitic units occur farther south in Kent and Sussex counties but are found at depths of about 300 feet and greater below land surface. In most cases glauconitic sediments give higher than normal responses on natural gamma-ray bore-hole logs. However both potassium and thorium isotopes, neither of which produce radon-222, also contribute to the natural gamma radiation.

The study is sponsored by the Division of Public Health of the Delaware Department of Health and Social Services and is designed to look at order of magnitude values of uranium in the greensands, radon concentrations in overlying soils and surficial sediments, and background radioactivity at the ground surface. These data will be compared to data from other areas not over glauconitic sediments. Complicating factors include the depth of the water table, thickness of the overlying non-glauconitic sediments, and the possible separation of the daughter products of uranium decay from the source. Field work included installation of radon measuring sites and sediment sampling. Mapping of surface radioactivity is now underway, and results of chemical analyses of the sediments are being analyzed. Correlation of variables in radon studies are often not clear and much depends on site specific conditions. The study is expected to be completed early 1992.

Publications

Recent DGS Publications

Reports of Investigations

No. 49 Results of the Coastal Sussex County, Delaware, Ground-Water Quality Survey: A. S. Andres, 28 p.

Open File Reports

No. 33 Ground-Water Level and Chemistry Data from Coastal Sussex County, Delaware, Ground-Water Quality Survey: A. S. Andres, 31 p.

No. 34 Methodology of Mapping Ground-Water Recharge Areas in Delaware's Coastal Plain: A. S. Andres, 18 p.

Atlas Series

Marydel Quadrangle (MAR) Atlas Series: N. Spoljaric, editor, 10 p.

Forthcoming DGS Publications

Bulletin No. 19, Geology and Hydrology of the Marble Valleys of Northern Delaware: K. D. Woodruff, editor; contributions by M. O. Plank, W. H. Werkheiser, and K. D. Woodruff.

Hydrologic Map Series No. 8, Geohydrology of the Middletown-Odessa Area, Delaware, Sheet 1-Basic Geology and Hydrology: K. D. Woodruff.

Miscellaneous Map Series No. 5, Map of Exposed and Buried Early Mesozoic Rift Basins/Synrift Rocks of the U. S. Middle Atlantic Continental Margin: R. N. Benson, scale 1:1,000,000.

Other Publications by DGS Staff

Johan J. Groot, 1991, Palynological Evidence of Late Miocene, Pliocene and Early Pleistocene Climate Changes in the Middle U. S. Atlantic Coastal Plain: Quaternary Science Reviews, Vol. 10, p. 147-162.

Staff Notes

Robert R. Jordan was installed for a two-year term as Treasurer of the American Geological Institute (AGI), the umbrella organization for 19 national scientific and professional geologic societies, at the AGI Council of Member Societies, San Diego, California, October 21. Also, he was appointed to a term on the Committee on Committees of the American Association of Petroleum Geologists.

John H. Talley was reappointed by DNREC Secretary Clark as chair of the Onsite Systems Advisory Board.

Dorothy C. Windish, Senior Secretary, received a 15-year service award at a Service Awards Recognition Luncheon, Nov. 20.

Student assistants who are or have been employed on various DGS projects are **Lynn Andrews, Dawn Denham, John Fulton, Ned Grace, Michael Graybill, Scott Howard, Mary Ann Levan, Narender Pendkar, Alex Richardson, Pat Thomas, Susan Thompson, Monica Tsang, Robert Vogel, Laura Wagner,** and **Joel Zickler.**

Presentations

A. Scott Andres, "Ground-Water and Nitrate," to Nanticoke Watershed Preservation Association, July 18; "Ground-Water and Nitrate Discharge to Rehoboth and Indian River Bays," to Inland Bays Estuary Program Implementation Committee, October 3; "Drinking-Water Quality in Eastern Sussex County," to Rehoboth Kiwanis Club, October 17.

Richard N. Benson, "Buried Mesozoic Rift Basins of the U. S. Middle Atlantic Continental Margin," at 1991 meeting of the Eastern Section of the American Association of Petroleum Geologists, September 9, Pittsburgh.

Roland E. Bounds, "The West Branch Pegmatite, Newark, Delaware," at the symposium on specimen mineralogy of the Mid-Atlantic region sponsored by Friends of Mineralogy, Pennsylvania Chapter, November 9, West Chester, PA.

Johan J. Groot, "Palyno- and Climato-Stratigraphy of a 300-Meter Thick Quaternary Sequence, Upper Continental Slope off New Jersey," at 24th Annual Meeting, American Association of Stratigraphic Palynologists, October 22, San Diego.

Robert R. Jordan, Citation for William L. Fisher, 1991 Awardee, American Geological Institute Medal in Memory of Ian Campbell, October 22, San Diego.

Thomas E. Pickett, "Geology of the White Clay Creek Area," at the White Clay Creek Preserve headquarters, August 1, Newark.

William S. Schenck, "Delaware's Boundaries," to Soil Conservation Service, September 5, Dover; "How Are Maps Made?" and "What Are Topographic Maps?" to 6th grade class at Redding Middle School, September 6, Middletown, and to 4th grade classes at Warner Elementary School, November 6-8, Wilmington.

John H. Talley, "Geologic and Hydrologic Resources at the Delaware Geological Survey Available to the Well Drilling Industry in Delaware," Delaware Water Well Association, October 7, Dover; "Delaware's Ground-Water Resources - Origin, Occurrence, Availability, Quality, Quantity, and Use," Environmental Protection Agency-sponsored management workshop on Wellhead Protection Programs: Tools for Local Governments, October 22, Dover; "Hydrogeology of Delaware" at Delaware Academy of Science symposium on water, November 12, Newark.

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

CHANGE OF ADDRESS?
Send mailing label and your new address, and/or

REQUESTS FOR PUBLICATIONS to:
Dorothy Windish
Delaware Geological Survey
University of Delaware
Newark, DE 19716-7501
302-831-2834

Delaware Geological Survey
University of Delaware
Newark, DE 19716-7501