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. 12, No. 2 Summer 1994

Geologic Map No. 8

By Kelvin W. Ramsey

The recently published geologic map of the Milford and Mispillion River quadrangles, Delaware Geological Survey Geologic Map No. 8, shows the surficial geology of a portion of Delaware between Houston and Delaware Bay,including the city of Milford (see Winter 1994 issue of *First State Geology*). The map shows the distribution of geologic units (formations) that are found at the land surface. On the basis of borehole and other subsurface geologic information, the distribution and character of the units in the subsurface are also described. Two newly recognized geologic units are named the Lynch Heights and Scotts Corners formations.

The accompanying figure is a cross section through the northern part of the map area showing the geologic units to a depth of about 250 feet. The deepest unit shown is the Calvert Formation (Tc) consisting of interlayered beds of sand and clay. A sand unit in the Calvert penetrated by deep wells is called the Frederica aquifer, a major source of water within the area. Above the Calvert lies the Choptank Formation (Tch), composed of two fining-upward units, each starting with a coarse sand that grades upward into a silty clay. These two units are informally designated the lower and upper Choptank. The sand at the base of the Choptank is another aquifer; it is used as a source of domestic water supply. The St. Marys Formation (Tsm), above the Choptank, comprises fine sand, silt, and clay. The Calvert, Choptank, and St. Marys formations are all of Miocene age, in Delaware between about 22 and 7 million years old.

Above the Miocene units are several geologic units younger than about 1 million years that were deposited during and between times of glaciations in northeastern North America. The oldest of these is the Columbia Formation (Qcl), coarse sand and gravel deposited by rivers flowing from the melting glaciers. The younger two units, the Lynch Heights and Scotts Corners formations were deposited in settings marginal to an ancestral Delaware Bay when sea levels were higher than at present. The older of the two (about 250,000 years old on the basis of pollen found within the unit), the Lynch Heights (Qlh), is composed of interbedded medium to fine sands and silty clays. The younger (between 125,000 and 80,000 years old) Scotts Corners Formation (Qsc) is much thinner than the Lynch Heights and consists of coarse to fine sand with some silty clay beds, some of which contain pieces of plants that once grew in the marshes and swamps along a Delaware Bay that was larger than at present. The map also shows the distribution of sediments being deposited in the modern swamps (Qsw) and marshes (Qm) as well as textures of bottom sediments of Delaware Bay.

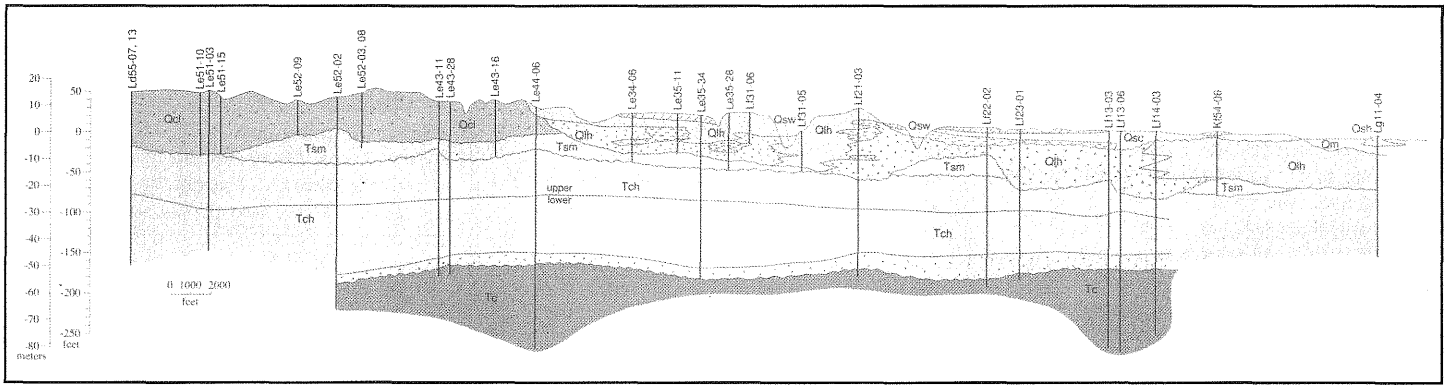
Water Conditions Improve in Early 1994

By John H. Talley

Water conditions improved significantly during the past several months in response to above normal precipitation and associated overland runoff and groundwater recharge. Precipitation for the first half of the water year, October 1, 1993 - March 31, 1994, ranged from 33.61 in (12.99 in above normal) at Greenwood to 25.03 in (5.30 in above normal) at New Castle.

A significant amount of precipitation occurred during January, February,and March with three-month totals ranging from 20.63 in (10.31 in above normal) at Georgetown to 15.9 in (9.38 in above normal) at new Castle. Substantial recharge to shallow aquifers occurred during this period, so water levels in observation wells were above normal. One record high level was established, and two other wells had second highest levels of record.

Streamflows throughout Delaware responded rapidly to the precipitation. Above normal streamflows were exacerbated by saturated soil conditions as well as frozen ground during the early part of 1994. This resulted in higher than normal direct overland runoff. Record high monthly mean streamflows were recorded in March



Cross section showing subsurface geology between Houston (left) and Big Stone Beach (right).

on Brandywine, Red Clay, and White Clay creeks, and the St.Jones and Nanticoke rivers.

Water conditions also improved dramatically in the upper Delaware River basin. In January, water levels in New York City's three reservoirs in the basin were at a low enough point that an automatic "drought warning" would have occurred. Fortunately, officials throughout the Delaware River basin agreed to count the "frozen asset" of the thick snow pack that would be captured by the reservoirs in the Catskill Mountains, and a false warning was avoided. As of April 16, the reservoirs were full and spilling. The combined capacity of these reservoirs is 270.837 billion gallons. It appears that our region is fairly well prepared for increased water demands associated with the coming summer months.

Although the wet weather during the past several months resulted in improved water conditions, it also had an adverse effect on construction and agricultural activities. Heavy precipitation and cold temperatures prevented access to many construction sites, and according to the Delaware Agricultural Statistics Service, excessive moisture in the fields delayed Delaware farmers in completing spring field preparation and planting.

Continuing Seismic Activity

By Charles T. Smith

The 1993 seismic activity in the region including northern Delaware (see last two issues of *First State Geology)* continued into 1994, this time in the Reading, Pennsylvania, area, where, on January 15, 16, and 17, there were 53 earthquakes, 48 of which were detected by DGS seismometers. Five of the events exceeded magnitude 2.8. The two largest occurred on the 15th, a 4.0-followed by a 4.6-magnitude event. According to Pennsylvania state geologist Donald M. Hoskins, the latter was the highest magnitude yet recorded for a Pennsylvania earthquake. Through May 7, the DGS seismometers have recorded five additional earthquakes in the Reading area in the magnitude range of 1.8 to 2.5.

According to the *Philadelphia Inquirer* (January 17 and February 7), damage caused by the Reading events was described by officials as buckled roads, cracked plaster, damaged woodwork, cracked basements and sidewalks, fallen shelving, and cracked roofs. Two sink holes opened up in the area. Also, gas, power, and water lines were damaged. Local officials estimated approximately 205 homes and public structures received an estimated $2.6 million in damages.

Fortunately no injuries were reported from the Reading earthquakes this year, but last year on May 10, a 2.8-magnitude event resulted in one notable injury. The National Earthquake Information Center (NEIC) reported one person in the Reading area lost his balance, fell off his bicycle and was injured. This is believed to have been one of the smallest earthquakes in the United States for which the NEIC had received confirmed casualty reports.

Delaware experienced two small earthquakes so far in 1994. A 1.9-magnitude event was recorded at 10:46 a.m. on February 11 in the Wilmington area. No one reported experiencing the quake. The seismogram shows evidence that it was of shallow origin (<1 km), very similar to the one that occurred on November 8, 1993.

The second Delaware event was recorded on April 23, 1994, at 5:09 a.m. This 2.0-magnitude earthquake awoke several Wilmington residents on either side of the Brandywine River near West Street, and the police did receive a few calls.

During 1993, the DGS seismometers recorded 31 earthquakes in the region, all with magnitudes less than 2.8. Nearly twice that many have been recorded from the region during the first quarter of 1994, in addition to the larger earthquakes that occurred world-wide, including the Northridge earthquake in California on January 17. Although coincidental, there is no physical relationship between the California and Reading seismic activity.

Unusual Noises on Seismographs

By Charles T. Smith

The locations of the seismometers in Delaware in relation to the growing urban population sometimes result in seismograph records of human activity. This is classified as "noise" as opposed to the "signal" of a true seismic event.

Trucks, lawn mowers, and construction activity in the areas of the instruments are something we have come to know about. Even horses jumping at Bellevue State Park have made their marks on our records.

Unusual signatures on the seismiograms can also mean that the instruments may need adjustment or repair. The seismometer at Bellevue State Park recently began sending some strange wave patterns, and it was feared the seismometer needed a serious adjustment.

The seismometer was tested on site and was found to function perfectly. Just as we were about to leave the site, someone appeared with an extension cord and plugged it into the outlet we use to power the seismometer. Attached to the cord was an oscillating pad sander that was being used to sand the rails used for horse-jumping. Also, a radio was playing as a person was painting in preparation for a horse show. Either the radio sitting atop the instrument housing or the oscillating sander made the unfamiliar wave patterns that we saw on our seismograms.

Our experience in reading seismograph records generally allows us to distinguish between true seismic events and noise. The sources of the noises, however, can be quite interesting, as in the example described.

New Earthquake Database

By Charles T. Smith

Historically, Delaware and surrounding areas have experienced earthquakes since the 1700s. Perhaps the largest known event to have occurred in Delaware was in the Wilmington area in 1871.

The Delaware seismic monitoring network had its beginnings with a single seismic station in 1972 following local earthquake events in northern Delaware. Local and regional seismic data have been recorded since that time.

A computer link to the National Earthquake Information Center was established in the early 1990s. Through this, rapid access to earthquake locations and magnitudes enabled the DGS to learn more about what our seismometers could actually detect and record on a world-wide basis.

The increase in regional earthquake activity in 1993 and the growing data files created the need for a database where data will be in one place so they can be computer-sorted and studied. Now the DGS can efficiently prepare data summary lists for exchange with other operating seismic networks. The database as a tool along with the computer link should greatly increase our ability to analyze present data and gain a better understanding of regional seismic activity as well as provide quicker responses to public enquiries.

Cold Weather Booms

By Roland E. Bounds

The Delaware Geological Survey received several inquiries concerning booming sounds heard around the area during the middle and late part of January. Most of the concerns were whether or not the "booms" were earthquakes, particularly because this was a time when people were being sensitized to earthquakes from media reports about Northridge, CA, and Reading, PA. Our seismograph records revealed no indication of any seismic activity of any kind during the times of the booms.

The booms also coincided with the coldest temperatures to hit Delaware in several years. Many reportedly sounded like a tree or a snowball hitting the houses concerned. There was no particular concentration of times or localities in conjunction with the booms to indicate a unified source for them.

The most likely source was suggested by several contractors and other individuals with cold weather experience in more northerly areas. A house is made up of many different materials and has a variety

of stresses put on it during cold weather. These materials tend to expand and contract at different rates depending on inside and outside temperature and humidity. Many of the booms, and in some cases some damage, were caused by the differential shifting of the house materials. Plaster walls in old houses are notoriously susceptible to these stresses, especially if they have little or no original insulation which leads to a great difference between indoor and outdoor temperatures. The noises also came from trees that were contracting owing to the sharp drop in temperature.

The cold weather booms are one of several examples of perceived seismic activity reported to the DGS. Others include sonic booms, weapons testing,blasting for construction projects, and explosions.

New Geohydrologic Map of the Seaford area

A new 1:24,000-scale geohydrologic map of the Seaford East (SEE) and Seaford West (SEW) quadrangles has been completed. Delaware Geological Survey Hydrologic Map No. 9 by A. Scott Andres has information on the subsurface geology, ground-water quality, aquifer characteristics, ground-water recharge potential, and water-data collection sites of the Seaford-Bridgeville area. The information presented on the map is useful to the public and those in government, industry, and consulting who work with water resources issues.

A new feature, in color, on the map shows ground-water recharge potential, the distribution of areas characterized by their ability to transmit water into the near-surface Columbia aquifer. Many other types of basic data and interpretative summaries include locations of wells having associated aquifer test or water quality data; locations of stream gaging and stream sampling sites; locations of landfills, sewage treatment plants, and spray irrigation facilities; aquifer test data; graphs of monthly precipitation values, streamflow, and ground-water levels; a statistical summary of ground-water quality data; a cross section; descriptions of geologic units; and, a discussion of the hydrogeology of the area.

Delaware's Stream Gages

By John H. Talley

As part of its basic charge to conduct geologic and hydrologic research and service, the DGS, through its Joint-Funded Program with the Water Resources Division of the U. S. Geological Survey, is currently operating and maintaining 18 continuous-record surface water stream-gaging stations throughout Delaware. The stations are supported by the Delaware Geological Survey, Department of Natural Resources and Environmental Control, Water Resources Agency for New Castle County, cities of Wilmington and Newark, Artesian Water Company, Wilmington Suburban Water Company, and General Motors, Inc.

The information obtained from the stream gages over many years provides a database that is used by numerous state, federal, county, and municipal agencies, consultants, and private citizens. Data are used for determination of the adequacy of water resources to meet increasing demands for public water supply; evaluation, planning, development, and management of water resources; evaluation of drought-no drought conditions; flood forecasting; flood evaluation; flood control; flood-plain management; emergency response; irrigation management; design of bridges, culverts, flood control, and sediment and erosion control structures; bridge scour; pollution abatement, NPDES (pollution loading); surface-water quality; and wildlife management.

At the present time, three stream gages are equipped to provide data access via telecommunications. Real-time data are required to evaluate flood conditions, develop flood forecasts, and to evaluate water-supply conditions during periods of low flows in water courses used for public and industrial supplies.

Three precipitation stations and six continuous-record tide gages are being operated under the DGS-USGS program in support of DNREC-sponsored projects.

Basic data from this cooperative effort are contained in the annual publication by the USGS of a water data report titled "Water Resources Data for Maryland and Delaware." The report also contains information on surface- and ground-water quality; low-flow partial record and miscellaneous surface-water stations; tidal crest-stage partial-record stations; ground-water levels; and selected DGS and USGS reports on ground-water resources in Delaware. The DGS will provide additional information on request.

New Boundary Agreement Signed with Pennsylvania

On April 21, 1994, the Delaware boundary commissioners signed a joint agreement with the Commonwealth of Pennsylvania regarding the Top of the Wedge Line and the 12-mile Circle, the boundary lines between Delaware and Pennsylvania. This is the first time since 1892, when the lines were monumented, that the boundary has been intact and every marker location agreed upon.

In 1892, a joint commission of Delaware and Pennsylvania hired Col. W. C. Hodgkins, then of the U. S. Coast and Geodetic Survey, to resurvey and monument the boundary between the states. Hodgkins resurveyed the complex compound arc 12-mile Circle and the Top of the Wedge Line, monumenting the boundaries every 1/2 mile with pyramidal granite monuments. The even-mile monuments have the miles noted on the west face, "P" on the north face, "D" on the south face, and "1892" on the east face and extend from Arc Corner (0 monument located in Walter S. Carpenter State Park, near Newark) to Terminal Monument (monument 22) located on Sun Oil property near the Delaware River. The half- mile monuments have a "1/2" on the west face only.

This action completes work begun on the DE-PA boundaries in 1985. The states agreed to replace six missing monuments and to protect several others. Five missing monuments were replaced with aluminum disks set in concrete posts. One missing monument, DE-PA #3, was found during the construction of the development Merestone and reset in March 1991 (see *First State Geology*, v. 9, no. 2). The new agreements contain the boundary monuments' geodetic locations in both U. S. horizontal datums NAD27 and NAD83(91).

Also on April 21 at a joint meeting with the Maryland and New Jersey boundary commissions, agreements were signed with Maryland amending new lists of monument locations in both horizontal datums NAD27 and NAD83(91). The commission agreed to work with New Jersey to replace Reference Monument #2 after which a new agreement will be sought for the 1934 Mean Low Water Line.

Computing News

Recently installed communications hardware and software at the DGS provide direct access to the University's computing facilities and indirectly to Internet. The Internet is a network of computers at universities, research laboratories, government offices, corporations, and nonprofit agencies. Most of the staff at the DGS now have the capability to send and receive electronic mail, and to send and retrieve text or program files from other computers on the network. Internet mail addresses for DGS staff members can be obtained by contacting the DGS. These additions are part of our continuing efforts to improve the delivery of services and internal efficiency.

Cartographic Corner

By W. S. Schenck

- All of the new 7.5-minute topographic maps have now arrived at the DGS from the USGS Distribution Center and are available for purchase. These maps are the culmination of a 5-year cooperative effort by the DGS and the USGS to produce new topographic maps of the

state. The maps are projected in NAD83 horizontal datum and have a correction factor for conversion to the new vertical datum NAVD88. The quadrangles south and east of Middletown have 5-foot contours and the maps to the north have 10-foot contours. The quadrangles are available for $2.50 each from the DGSCIC. For further information, please call 302-831-8262. .

- The DLG digital hypsography for the new Sussex County topographic quadrangles is now available on 9-track tape from the USGS Earth Science Information Center in Reston, Virginia. For information on prices and ordering call the USGS Reston ESIC at (800)USA-MAPS.

Publications

Recent DGS Publications

Geologic Map Series

No. 8 Geologic map of the Milford and Mispillion River Quadrangles: K. W. Ramsey, scale 1:24,000.

Hydrologic Map Series

No. 9 Geohydrology of the Seaford area, Delaware: A. S. Andres, scale 1:24,000.

Other Publications by DGS Staff

N. Spoljaric, 1994, Glauconite, *in* Carr, D. D. ed., Industrial Minerals and Rocks, 6th edition: Society for Mining, Metallurgy, and Exploration, Inc., p. 551-559.

Staff Notes

Presentations

Richard N. Benson, "Geology of the Mid-Atlantic Outer Continental Shelf with a Focus on Hydrocarbon Potential," at 10th annual Earth Science Conference, New Jersey Earth Science Teachers Association, Kean College, Union, NJ, March 12.

Robert R. Jordan, "Role of Geology in Mid-Atlantic OCS Oil and Gas Policy Development" and "Shoreline Processes and Policies in Delaware," at Northeastern Section, Geological Society of America meeting, Binghamton, NY, March 28.

Kelvin W. Ramsey, session co-chair with Susan D. Halsey, New Jersey Department of Environmental Protection, "Sedimentary Geology and Public Policy," at Northeastern Section, Geological Society of America meeting, Binghamton, NY, March 28.

Service and Awards

Robert R. Jordan, reappointed for three-year term to U. S. National Committee on Geology, National Research Council; re-elected chairman of the Delaware State Boundary Commission; certificate of appreciation from the National Research Council for service in evaluating Alaskan environmental information.

Kelvin W. Ramsey, elected president of Eastern Section of SEPM (Society for Sedimentary Geology).

Charles T. Smith, University of Delaware Salaried Staff Merit Award, in recognition of his 1993 contributions to the DGS which include reorganization of the seismic laboratory, development of the earthquake database, and repair and maintenance of seismic detection and recording instruments.

Externally Supported Projects

A. Scott Andres from the University of Delaware Water Resources Center for GIS analysis of nitrates in ground water (with John Mackenzie, Carmine Balascio, and Radolfo Tanjuakio, College of Agricultural Sciences) July 1994 - June 1995; and ground-water modeling for wellhead protection under hydrological and geological uncertainties (with Alex Cheng, College of Engineering) July 1994 - June 1995; from the Delaware Department of Natural Resources and Environmental Control and the U. S. Environmental Protection Agency for year 4 of ground-water recharge mapping, Millsboro, Harbeson, and Milford quadrangles.

John H. Talley, from the Delaware Department of Natural Resources and Environmental Control for ground-water level and quality monitoring of aquifers in coastal Sussex County.

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.
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