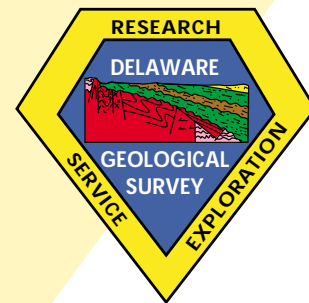


# First State Geology

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

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University of Delaware



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## DGS Celebrates 50<sup>th</sup> at Coast Day

By W. S. Schenck

On October 7, the DGS celebrated its 50th Anniversary and the Sea Grant Program celebrated its 25th at Coast Day, an annual event sponsored by the University of Delaware Sea Grant College Program and Graduate College of Marine Studies held at the Hugh R. Sharp Campus in Lewes, Delaware.

Over 10,000 people were in attendance to help join in the celebration. Governor Ruth Ann Minner, Dr. Charles (Chip) Groat, Director of the U.S. Geological Survey (USGS); Edward Shaw, Special Assistant to the Director of the U.S. Minerals Management Service; and Julia A. Jackson of the American Geological Institute were invited speakers and exchanged anniversary greetings with DGS Director Robert Jordan.

Displays by DGS staff covered a range of topics including water conditions in Delaware, offshore sand resources, water quality of the inland bays, and

fossils common to Delaware. Activities included a fossil dig for the kids, a Rock 'N Fossil Road Show, and the sale of USGS topographic maps.

Keeping with the coastal theme of the day, Kelvin Ramsey and Lillian Wang produced a poster (see figure) displaying the historical coastline changes of Cape Henlopen. Coastlines are not static

features; perhaps the most striking example of shoreline movement in Delaware is at Cape Henlopen which has grown northward approximately one mile in the last 160 years. The migration of the cape is depicted through maps and aerial photographs.

Robert Jordan presented Governor Ruth Ann Minner with a framed copy of the poster. Visitors to the DGS

received a copy of the poster, a DGS bookmark, and a piece of anniversary cake. Full-size copies of the poster, Special Publication No. 26, are available by contacting the DGS. It may be downloaded at [www.udel.edu/dgs/Publications/webpubl.html](http://www.udel.edu/dgs/Publications/webpubl.html)



## Long-Term Below Normal Water Conditions

By J. H. Talley

The DGS in cooperation with other state and federal agencies measured below normal precipitation throughout Delaware from October 1, 2000, through November 30, 2001. Delaware has entered into the time of year when water use and evapotranspiration decline substantially. It is, therefore, relatively unlikely that a water-supply drought will occur at least until the spring or summer of 2002.

Northern Delaware was exceptionally dry during the five-month period July through November when deficit precipitation totaled 9.85" at Wilmington and 7.83" at New Castle. The rapid increase in deficit precipitation for this period in Wilmington is shown in the adjacent graph. State climatologist Dan Leathers says the total rainfall for September through November was the third driest since 1895 and the driest since 1922. The Delaware Agricultural Statistics Service reported in November that topsoil moisture and subsoil moisture were significantly below normal, only 4% and 12% adequate, respectively. The five-year average is 67% and 61%, respectively. The significance of these very low values is that the soil and subsoil moisture deficiencies must be eliminated before ground-water recharge can occur.

Precipitation in the late fall of 2000 and winter of 2001 was adequate for ground-water recharge to

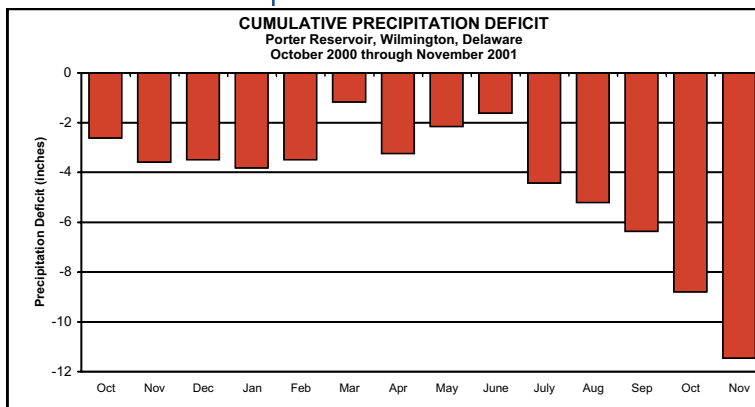
maintain ground-water levels in the normal range through October; however, water levels have continued to fall through November, a time when water levels generally rise in response to ground-water recharge. In the absence of above to well-above normal precipitation and non-frozen ground conditions during the next several months, water levels will decline into the below normal range, and the amount of ground water available for base flow discharge (fair weather flow) will remain below normal when we enter the high water demand period next summer.

Monthly mean streamflows declined significantly during October and November in response to record and near record low precipitation during the fall. Although streamflows have been below or slightly above record lows, they have been adequate to meet seasonally low public water-supply demands in New Castle County.

Despite record lows in October and November for the Water Conditions Index, we have been able to meet public water supply demands because of lower seasonal demands coupled

with positive action taken by the Governor's Water Supply Coordinating Council (WSCC) and water utilities during the past two years to enhance supplies and cooperation. The WSCC continues to advocate water conservation, especially during this dry period.

Similar below normal water conditions exist in nearby areas of Pennsylvania, New Jersey, Maryland, and New York where declarations of drought watches and drought warnings have been issued. The DGS will continue to monitor and analyze all water conditions indicators, especially ground- and surface-water conditions, into the winter and spring of 2002 to determine the adequacy of supplies as we enter the high-use summer season



The largest 14-month cumulative deficit occurred at Wilmington (11.45" below normal)

and to coordinate water-related activities with state and local officials and members of the WSCC. Delaware will continue to work closely with other Delaware River Basin states, the Delaware River Basin Commission, the Delaware River Master, and the Christina River Drought Management Committee to carefully monitor water conditions and coordinate responses to dry conditions.

Current, as well as historic DGS water condition summaries and indexes, other DGS hydrologic information, and pertinent links to other sites such as online USGS streamgaging data are available on the DGS web site at [www.udel.edu/dgs/hydro.html](http://www.udel.edu/dgs/hydro.html).

## Geologic Map of Ellendale and Milton Quads

By *K. W. Ramsey*

A new geologic map of the Ellendale and Milton quadrangles has been published. The map covers the area just south of Milford to just north of Georgetown and to the east of Milton to just west of Lewes, and shows the distribution of geologic units found at the land surface. These units include old coastal and bay bottom sediments deposited when sea level was higher than present (Lynch Heights and Scotts Corners formations) as well as river and estuarine deposits from about 2.5 million years ago (Beaverdam Formation). More recent deposits mapped include Carolina Bays (the wetlands which now contain rare and endangered plant and animal species), upland sand dunes, upland deposits that include much of the swampy areas in and near the Ellendale State Forest, and the modern swamps and marshes of the Primehook National Wildlife Refuge.

Geologic Map No. 11, by Kelvin W. Ramsey, can be downloaded directly at [www.udel.edu/dgs/Publications/webpubl](http://www.udel.edu/dgs/Publications/webpubl), ordered online at [www.udel.edu/dgs/Publications/pubform.html](http://www.udel.edu/dgs/Publications/pubform.html), or by calling (302) 831-2833. Partial support of the mapping research was provided by a grant from the Statemap Program, a cooperative effort of the Association of American State Geologists and the U.S. Geological Survey, funded by Congress as a part of the National Geologic Mapping Act.

## New DGS Report on Piedmont Geochemistry

By *W. S. Schenck*

A report on the geochemistry of Ordovician and Silurian mafic rocks in the Wilmington Complex in Delaware, the James Run Formation in Cecil County, Maryland, and the Wissahickon Formation in Delaware and southeastern Pennsylvania has been published. Samples collected in conjunction with the newly published Piedmont Geologic Map (Geologic Map 10) as well as analyses conducted by the Pennsylvania Geological Survey were used in this study. The analyzed samples of the Wilmington Complex are separated into six geochemical groups based on rare earth element (REE) patterns and mantle-normalized spider diagrams. Although penetrative deformation and metamorphism have obscured contacts and original fabrics, the REE are consistent within the mapped lithodemic units and are compared to modern basaltic magmas from known tectonomagmatic environments. The analy-

ses suggest that the Wilmington Complex and James Run units in Cecil County, Maryland, represent a suprasubduction zone. The rocks record stages of an arc complex from its beginning as boninites to arc mid-ocean ridge basalts (MORBs) with coeval granitic magmas to backarc basin basalts (BABBs) related to late extension within the arc. Wissahickon Formation mafics are mainly within-plate and ocean-floor basalts. Copies of this report are available from the DGS by calling (302) 831-2833, or order the report from the DGS web site at [www.udel.edu/dgs/Publications/pubform.html](http://www.udel.edu/dgs/Publications/pubform.html).

## Delaware: A National Map Pilot Project

By *John Callahan, UD Research Data Management Service*

In the November 2001 issue of *Geospatial Solutions*, Delaware is at the top of the list of states that will be included as pilot projects for the National Map. The National Map, (<http://nationalmap.usgs.gov/>) maintained and distributed by the U. S. Geological Survey (USGS), is the nation's primary map series and is currently undergoing reevaluation. DGS, other Delaware state agencies, and the University of Delaware are working with the USGS to develop integrated procedures to accomplish the goals set forth by the reevaluation process. When completed, Delaware will be the first state serving its entire Spatial Data Framework in support of the National Spatial Data Infrastructure.

The goal of Delaware's pilot project, the Delaware Data and Map Integration Laboratory (DataMIL), is to provide the procedures and mechanisms for maintaining a continuously updated distributed database, while simultaneously allowing users to map and retrieve the most current spatial information. The Delaware DataMIL will establish the foundation on which the Delaware Spatial Data Infrastructure can continue to grow. In conjunction with the Delaware Geographic Data Committee and the State Mapping Advisory Committee, it will dramatically enhance open communication among spatial data providers and users within Delaware. Significant cost savings will be realized due to the decrease of redundant data creation, quicker data accessibility, improved GIS training throughout the Delaware GIS community, and less staff support of spatial data technical issues.

The DataMIL web site will facilitate interactive, on-line discussions concerning how spatial data can be seamlessly shared and utilized. Core features of the web site are the Data Integration Lab and the Map Production Lab. The Data Integration Lab will initially include a data extraction and download service, metadata retrieval access, a feature-commenting mechanism, a discussion forum, an ArcIMS mapservice, and data manipulation tools. A user will have the ability to edit the data points of a particular layer and submit the edited points to the data administrator of that layer for evaluation.

The three primary functions of the Map Production Lab are to display the Delaware Framework layers together on-line on one site, to extract and download these layers, and to produce high quality, printable maps. Users will be able to create these high-quality maps for nearly any defined paper size, centered at virtually any location, at any scale, within the state.

Members of DataMIL also are working on standards and procedures for maintaining a distributed database. This database will consist of the Delaware Framework layers (see Summer 2001 issue of *First State Geology*) as well as Delaware's portion of the National Map. Ideally, the actual data files will be housed and maintained by the data source provider, but accessed, mapped, and evaluated by the Delaware community. Issues being addressed include varying data quality standards among data providers, data formats, update frequency, network bandwidth, and staff technical capabilities.

## Delaware Geographic Names Committee (DGNC)

By *W. S. Schenck*

The first meeting of the Delaware Geographic Names Committee (DGNC) was held in October. The DGNC, created by the State Mapping Advisory Committee to serve as a subcommittee of the Delaware Geographic Data Committee, provides a means through which geographic features can be officially named within Delaware. In the past, William S. Schenck, serving as the Delaware state names authority, has worked with the U. S. Board on Geographic Names (USBGN) to provide information related to Delaware names being considered by the USBGN. The DGNC will now supplement this process.

Members of the DGNC are William S. Schenck, chairman and state names authority, DGS; Michael B. Mahaffie, chairman DGDC, Office of State Planning and Coordination; Dr. Carol E. Hoffecker, UD Department of History; Shelly McCoy, UD Morris Library-Map Library; Chief Kenneth Clark, Nanticoke Tribe; George M. Kent, Delaware Department of Transportation; and Timothy A. Slavin, state archivist, Delaware State Archives.

## DGS Releases First Digital Map Products to GIS Community

By *W. S. Schenck*

The DGS released three georeferenced geologic map images that can be downloaded and used in GIS systems. Geologic Map 8, Geologic Map of the Milford – Mispillion River Quadrangles; Geologic Map 9, Geologic Map of the Seaford Area; and Geologic Map 10, The Bedrock Geology of the Piedmont of Delaware and Adjacent Pennsylvania can be downloaded from the DGS Digital Products web page at [www.udel.edu/dgs/inftech.html](http://www.udel.edu/dgs/inftech.html).

## Ground-Water Discharge to Estuaries

By *T. E. McKenna*

A symposium on "Ground-Water Discharge to Estuaries" was convened on November 5th at the Geological Society of America's (GSA) National Meeting in Boston. The symposium was an outgrowth from the ongoing participation of DGS staff in the EPA-funded CISNet Project that focuses on nutrient loading to Delaware's Inland bays (see Winter and Summer 1999 and Winter 2000 issues of *First State Geology*).



As judged by attendance and the ensuing discussions, the symposium was a success. Attendees benefited from the interdisciplinary nature of 22 presentations by geologists, hydrogeologists, geophysicists, geochemists, oceanographers, and ecologists. Talks ranged across all spatial scales from laboratory-tank studies on the effects of tides on shallow ground-water flow and circulation to quantifying the magnitude of ground-water discharge on the continental shelf. Many of the studies were initiated to address the problem of the eutrophication of water bodies due to excess nutrients, and there was general agreement that ground-water plays an important role in nutrient loading to estuaries. There was also consensus that field-based estimates and measurements of the magnitude of ground-water discharge are two to three orders of magnitude higher than estimates from ground-water flow models, indicating a need to reevaluate our underlying conceptualization of the problem to possibly incorporate more detail on bioturbation, wave-setup, and tidal pumping.

Seven presentations focused on ground-water discharge from the Delmarva Peninsula to the Delaware Bay and the Delaware and Maryland inland/coastal bays, including four talks based directly on CISNet research. Three presentations focused on the results from an international project to understand the magnitude of submarine ground-water discharge and its influence on coastal oceanographic processes (sponsored by the Scientific Committee on Oceanic Research and the International Geosphere-Biosphere Programme and chaired by William Burnet at Florida State University).

The session was co-chaired by Tom McKenna of the DGS and Jonathon Martin of the University of Florida. For more information including the technical abstracts for the talks at the session go to [www.udel.edu/dgs/tmck/sgd](http://www.udel.edu/dgs/tmck/sgd).

## New Stratigraphic Framework for the Potomac Formation

By R. N. Benson and P. P. McLaughlin

Water resource issues have become important in northern Delaware because of increasing development of rural areas and, with it, the increasing demand for water. In an effort to better understand ground-water resources of the Coastal Plain of northern Delaware, we are studying the aquifers of the Potomac Formation. The formation in this area is composed of sands and muds that were deposited in ancient rivers and floodplains during the middle part of the Cretaceous Period, about 110 to 95 million years ago. Many of the sands are important aquifers as they produce significant volumes of water.

We have established a new stratigraphic framework for the correlation of aquifer units. The framework is based on a geophysical well-log correlation datum that approximates the boundary between Upper and Lower Cretaceous sediments. The boundary is defined by studies of fossil pollen and spores in samples of sediment cores from two wells near Delaware City and a well near New Castle. The datum and several approximately synchronous geophysical log correlation lines have been established on intersecting geologic cross sections. Within this correlation framework the degree of lat-

eral connection between potential aquifer sands has been determined. The sands are not correlated parallel to the basement unconformity, but instead overlap it in an updip direction. These findings are critical to the development of a viable ground-water model for the Potomac Formation.

To better manage the ground-water resources of northern Delaware, the Delaware Department of Natural Resources and Environmental Control has contracted with the U.S. Army Corps of Engineers to do a ground-water model study of the Potomac Formation in northern New Castle County. Based on the stratigraphic framework defined in our studies, three model layers have been identified: upper and lower layers of relatively high permeability with a greater degree of connection between sands, and a middle layer that contains more muds than sands and is of lower permeability. Work on the model using these layers is underway.

We anticipate that the new stratigraphic framework will resolve problems with aquifer recharge that were encountered in a 1984 ground-water modeling study that assumed aquifer layers were parallel to the basement unconformity.

## DGS Welcomes Cheryl Duffy

By A. S. Andres

Cheryl Duffy has joined the DGS staff to work on a project to delineate wellhead protection areas for the rapidly developing Lewes - Rehoboth Beach region. Cheryl has recently completed her MS degree in geography from the University of Delaware with an emphasis on climatology. Her MS work required extensive use of computers to manipulate large data sets, a skill that is especially applicable to wellhead protection delineations that uses complex computer models to simulate ground-water flow.

The project is being conducted in cooperation with the Water Supply Section of the Department of Natural Resources and Environmental Control as part of Delaware's Source Water Protection Program. State and local governments will use the results to help manage drinking water resources. A. Scott Andres and John Talley are overseeing this effort.

## Geohydrology of the Smyrna-Clayton Area

By A. S. Andres

Geohydrologic Map No. 10 "Geohydrology of the Smyrna-Clayton Area, Delaware" by A. Scott Andres was recently released. The map and poster publication covers the Millington, Clayton, Smyrna, and Bombay Hook quadrangles and provides a variety of information that will be useful in guiding anticipated growth and development, protecting water resources, and cleaning-up of contaminated water supplies.

The publication is produced in a two-sided format that is much different from previous hydrologic map series publications. One side is a 1:24,000-scale map showing information on aquifer characteristics, water-data collection sites, and aquifer recharge and resource potentials. The other side is a colorful poster-style portrayal of information on surficial and subsurface geologic units, ground-water levels,

stream discharge, precipitation, aquifer characteristics, and general water quality. Full color charts, maps, and illustrations make it possible to include more information in a format that is easier to read and use than previous hydrologic maps. A visually striking effect is the background, which was produced from a satellite-captured digital image of the Delmarva Peninsula.

## Ground-Water Recharge Mapping Project Completed

By T. A. Keyser

Mapping of ground-water recharge potential for the Coastal Plain of New Castle, Kent, and Sussex counties is completed. A preliminary ground-water recharge potential map of Sussex County was on display at Coast Day as part of the celebration of the DGS's 50th Anniversary. The map was constructed on the basis of an understanding of the subsurface geology and the potential to transmit water to the shallow Columbia aquifer.

The recharge maps are used by the Department of Natural Resources and Environmental Control (DNREC), the Delaware Department of Agriculture, and county planning departments to ensure that supplies of ground water will meet future demands, to maintain adequate discharge of ground water to bodies of surface water, and to reduce the potential for degradation of ground-water quality.

This multi-year project has been supported by DNREC, through the Clean Water Act, and by New Castle County. The completed maps are slated for distribution in digital Geographic Information System format in February 2002. The recharge map of Sussex County shown at Coast Day is posted at [www.udel.edu/dgs/asa/graphics/cdgwrn.jpg](http://www.udel.edu/dgs/asa/graphics/cdgwrn.jpg)

## DBPG News

By Elizabeth Brown, Secretary, Delaware Board of Professional Geologists

The Board is now receiving a small but steady number of courses and seminars to evaluate for Continuing Education Units (CEU). We encourage anyone considering a course to forward the information to the Board (attention Eric Trinkle at Board of Professional Geologists, Delaware Div. of Professional Regulation, 861 Silver Lake Blvd., Dover, DE, 19904). Course time directed toward geology or its sub-disciplines is awarded one CEU per hour. Once a course has been reviewed and CEUs assigned, its name will be placed on the list hosted on the Delaware Geological Survey web site at [www.udel.edu/dgs/DBPG/conted.html](http://www.udel.edu/dgs/DBPG/conted.html).

Submission and approval of courses now will not only assure a smooth renewal of your license next September/October, but will also help your professional peers learn about educational opportunities.

The Board held its annual election of officers. The officers for 2002 are: Peder Hansen, Presiding President; Jerome Cooper, Vice-President; and Elizabeth Brown, Secretary.

## Publications

### Recent DGS Publications

#### Report of Investigations

No. 60, Geochemistry of the Mafic Rocks, Delaware Piedmont and Adjacent Pennsylvania and Maryland: Confirmation of the Arc Affinity: Margaret O. Plank, Lee Ann Srogi, **William S. Schenck**, and Terry A. Plank.

#### Geologic Map Series

No. 11, Geologic Map of the Ellendale and Milton Quadrangles, Delaware: Kelvin W. Ramsey, 1:24,000.

#### Hydrologic Map Series

No. 10, Geohydrology of the Smyrna-Clayton area, Delaware: A. Scott Andres, 1:24,000.

#### Special Publication

No. 26, Historical Coastline Changes of Cape Henlopen, Delaware: Kelvin W. Ramsey and Lillian T. Wang.

### Other Publications by DGS Staff

Jonathan D. Karr, William J. Showers, J. Wendell Gilliam, and **A. Scott Andres**, Tracing nitrate transport and environmental impact from intensive swine farming using delta-N-15: *Journal of Environmental Quality*, p. 1163-1175.

## Staff Notes

### Presentations

The following presentations were given by DGS staff at the Geological Society of America Annual Meeting held in Boston, Massachusetts, November 4-9: **Thomas E. McKenna** co-chaired and organized with Jonathon Martin of the University of Florida a session titled "Ground-Water Discharge to Estuaries;" **Thomas E. McKenna**, **A. Scott Andres**, **Lillian T. Wang**, and Tracy L. DeLiberty, "Mapping of Locations of Ground-Water Discharge in Rehoboth and Indian River Bays, Delaware, Using Thermal Imagery;" Lyndon A. Brown, John A. Madsen, David E. Krantz, and **Thomas E. McKenna**, "Mapping of Holocene Paleochannels of

Delaware's Inland Bays Using High-Resolution Seismic Reflection Methods: Implications for Groundwater Discharge to Shallow Estuaries;" **Kerry P. Steck**, **Thomas E. McKenna**, **A. Scott Andres**, and Tracy L. DeLiberty, "Use of a GIS Model to Estimate Ground-Water Discharge to Rehoboth and Indian River Bays, Delaware;" **Richard N. Benson** and **Peter P. McLaughlin, Jr.**, "New Perspectives on Correlation of Nonmarine Depositional Packages in the Cretaceous Potomac Formation, Delaware Coastal Plain;" James V. Browning, **Peter P. McLaughlin, Jr.**, Kenneth G. Miller, John C. Hernandez, and Peter J. Sugarman, "Sequence Chameleons: The Miocene of New Jersey vs. Delaware;" **Robert R. Jordan**, "Citation for Kenneth N. Weaver 2001 AGI Ian Campbell Medalist," and "The Ian Campbell Medal and Medalist Kenneth N. Weaver" at the American Geological Institute Awards Reception; Howel Bosbyshell, E. LeeAnn Srogi, John N. Aleinikoff, **Margaret O. Plank**, **William S. Schenck**, Maria L. Crawford, and Michael Williams, "Tectonic Synthesis of Recent Geochronological and Geochemical Data in the Central Appalachian Piedmont of SE PA and N. Delaware."

### Other Presentations

**A. Scott Andres**, "Delaware Inland Bays Tributary TMDL and CISNet Projects-An Update on Storm Data," at the Center for Inland Bays Scientific and Technical Advisory Committee, September 14.

**Thomas E. McKenna**, "Ground-Water Discharge to the Inland Bays," to the Water Supply Division of the Delaware Department of Natural Resources and Environmental Control, Dover, Delaware, April 5.

**Peter P. McLaughlin, Jr.**, "Dinosaurs in Delaware," to Freedom Trail Cub Scout Council's day camp, Banning Park, Wilmington, Delaware, June 28; **Peter P. McLaughlin, Jr.** and **Richard N. Benson**, "Application of Palynomorph Biostratigraphy to Correlation of Aquifer Units in Non-Marine Facies of the Cretaceous Potomac Formation, Delaware Coastal Plain" and **Peter P. McLaughlin, Jr.** and **Ralph O. Orlansky**, "Do-It-Yourself Searchable Photographic Palynology

Databases-A Quick and Easy Approach Using Microsoft Access;" at the American Association of Stratigraphic Palynologists Annual Meeting, San Antonio, Texas, October 20-24.

**Robert R. Jordan**, "Geology of White Clay Creek Valley" at the annual meeting of the Coalition for Natural Stream Valleys, Inc., October 10; "North American Commission on Stratigraphic Nomenclature and Background of 1983 Code" at an international Hedberg Research Conference, Dallas, Texas, August 26-29; "DGS Anniversary, Coast Day, and Earth Science Week" at Coast Day, October 7.

**Kelvin W. Ramsey**, "Beaches as a Tool for Teaching," Workshop for Teachers, Abbotts Mill Nature Center, July 18.

**William S. Schenck**, "Dinosaurs in Delaware" to the Sussex County Cub Scout Council's day camp at Holly Lane Campground, near Millsboro, July 10.

**John H. Talley** and **Stefanie J. Baxter**, "Streams and Aquifers - The Water Supply Framework for Delaware," at University of Delaware Institute for Public Administration Public Policy Forum, Drinking Water 2001: The Issues Concerning Delaware's Most Precious Natural Resource, held at Clayton Hall, October 11.

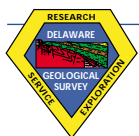
## Service and Awards

Congratulations to **Dorothy C. Windish** who celebrated 25 years of service with the DGS on September 7.

**Robert R. Jordan** was co-convenor of an international Hedberg Research Conference "Sequence Stratigraphic and Allostratigraphic Principles and Concepts," Dallas, Texas, August 26-29.

**John H. Talley** received a Presidential Certificate of Merit from the American Institute of Professional Geologists for dedication in organizing the 2001 AIPG Washington D.C., Fly-In.

**Roland E. Bounds** presided over September and November meetings of the Delaware Mineralogical Society and Pennsylvania chapter of Friends of Mineralogy Symposium and moderated "Quiz Show for Rockhounds" sponsored by the Delaware Mineralogical Society, November 12.



Delaware Geological Survey  
University of Delaware  
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Robert R. Jordan  
*State Geologist and Director*  
Stefanie Baxter  
*Editor, First State Geology*

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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  
delgeosurvey@udel.edu  
www.udel.edu/dgs/dgs.html

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