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MESSAGE FROM THE STATE GEOLOGIST

The first article in this issue of **Unearthing New Jersey** details events that most geologists view as the most recent part of geologic history - the last 150,000 years. Scott Stanford provides a fascinating history of Glacial Lake Passaic and the activity that shaped the rivers and valleys of northeastern New Jersey. This large lake and its numerous shore levels was formed by advancing and retreating glaciers that dammed and breached regional water drainages. Ultimately they were succeeded by the modern rivers, streams and wetlands of today.

Landslides move soil and rock downslope under the influence of gravity. Ted Pallis describes some that occurred in New Jersey during the nor'easter of April 15, 2007. Triggered by heavy rains, these events caused significant property damage. The most recent landslides are included in a new digital database prepared by the Survey for the New Jersey State Police Office of Emergency Management.

Providing geologic information to the public is a core mission of the New Jersey Geological Survey. Suhas Ghatge discusses a web-based mapping application, i-MapNJ Geology, that provides site-specific information about New Jersey's geology, aquifers, water quality earthquakes, abandoned mines and much more. Simply provide a street address for any location in New Jersey and you can then print out a map of the geologic features.

Ted Pallis documents the phenomena of New Jersey's "rock faces". Over the years, newspapers have written about most of them, but the majority have weathered away or been destroyed by quarry activity. Several remain and are worth a visit on your next weekend vacation.

Finally Larry Müller discusses the historic bog iron industry which provided a critical resource for the Colonies during the Revolutionary War. The familiar tea-colored waters of the New Jersey Pinelands transport a significant quantity of iron in solution from the ground to surface streams. The iron reacts with surface oxygen and significant concentrations of bog iron result. Colonial Americans mined this ore which was used for manufacturing cannons, shot and other essential implements.

The Survey welcomes your feedback on the content or format of the newsletter (http://www.njgeology.org/comments.html). Other recent geologic activities and digital publications of the Survey are noted in the newsletter and elsewhere on the Survey's Web site. Printed maps and reports are available to the public through the DEP Maps and Publications Office (609) 777-1038, PO Box 438, Trenton, N.J. 08625-0438 and a publications price list is maintained on the Web. Unpublished information is provided at cost by writing the State Geologist's Office, N.J. Geological Survey, PO Box 427, Trenton, N.J. 08625-0427. Staff are available to answer your questions 8 a.m. - 5 p.m. Monday through Friday by calling (609) 292-1185.

Karl W. Muessig
New Jersey State Geologist

GLACIAL LAKE PASSAIC

By Scott D. Stanford

LANDSCAPE CHANGE

Glaciers are powerful agents of landscape change. They can alter the course of a river and reshape valleys and mountains. In New Jersey, one area greatly affected by glacial alteration is the Passaic River Basin. The damaging floods that are common along the Passaic, Ramapo, and Pompton Rivers, including the recent flood from the April 2007 nor'easter, can be explained in part by changes made to the river system by ancient glaciers. These alterations are part of the story of glacial Lake Passaic.

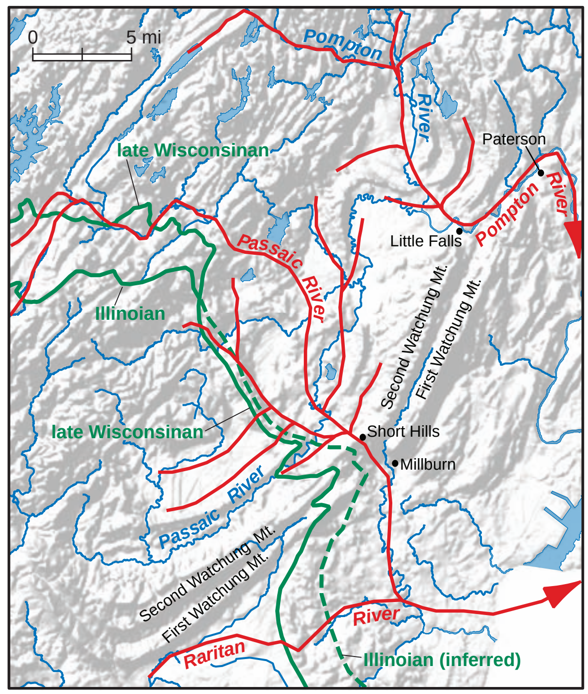

Figure 1. Glacial limits (green), pre-Illinoian river drainage (red), and modern drainage (blue) of the Passaic Valley.

This story involves two periods of glaciation: the Illinoian, about 150,000 years ago, and the late Wisconsinan, between 22,000 and 18,000 years ago. Before the Illinoian glaciation, what is now the Passaic River system was two separate systems (fig. 1). The ancestral Passaic River exited the Watchung Mountains through gaps at Short Hills and Millburn and was a tributary to the ancestral Raritan River. The outlet for the ancestral Pompton River was through gaps at Little Falls and Paterson. The Illinoian glacier deposited sediments that partly filled the gap at Short Hills and the valleys in the Passaic Basin upstream from that gap, although probably not deeply enough to alter the general course of the river after the glacier retreated.

LATE WISCONSINAN GLACIATION

About 125,000 years after retreat of Illinoian ice, the late Wisconsinan glacier advanced into the Passaic Valley. Ice to the east of the Watchung Mountains (known as the Hackensack Lobe) extended farther south than ice to the west of the mountains (the Passaic Lobe), because the Watchung ridges impeded flow of the Passaic Lobe. The Hackensack Lobe blocked Millburn Gap (fig. 2a), damming drainage from the Passaic Valley and forming the Chatham stage of Lake Passaic (different levels of a glacial lake are known as stages). The Chatham stage drained down the Blue Brook Valley within what is now Watchung Reservation in Union County. The elevation of the shore of this lake was between 250 and 300 feet and the water as much as 200 feet deep. The sluiceway eroded by the lake drainage is today the Blue Brook Valley between Surprise Lake and Seelys Pond in Watchung Reservation.

Advancing farther, the Hackensack Lobe completely covered the Blue Brook Valley and blocked drainage at Short Hills Gap. Lake Passaic rose to a higher level (Moggy Hollow stage) confined by the curving ridge of Second Watchung Mountain, with a spillway in a gap on the crest of Second Mountain near Far Hills (fig. 2b). Drainage from this spillway carved a mile-long sluiceway, known today as Moggy Hollow, down the west side of the mountain to the North Branch of the Raritan River. This sluiceway carried more water than the volume that currently drops over Great Falls in Paterson. It was no doubt an impressive sight. Lying within Moggy Hollow channel today is Leonard J. Buck Gardens, a Somerset County Park.

Moraine deposits laid down by the glacier at its terminus completely filled Short Hills Gap, obstructing drainage through the former Passaic Valley there. Thus, the Moggy Hollow stage of Lake Passaic expanded northward as the ice front retreated. The lake became as much as 500 feet deep and eventually extended to where Riverdale and Wayne are now located. The ancient shoreline is marked by flat-topped hills of sand and gravel known as deltas. These built out from the edge of the glacier into the lake, the sediments carried by meltwater streams from the retreating ice. Deltas laid down during the Moggy Hollow stage include a large one along the terminus of the Passaic Lobe between Chatham and Morristown, smaller ones along the terminus at Summit and Morris Plains, and several more deposited during retreat at Boonton, Montville, Caldwell, and the Preakness area of Wayne. The shore elevation ranged from 340 feet at its south end near Liberty Corner to about 410 feet at Riverdale and Wayne. The shoreline was originally flat, but today rises to the north because the land rebounded after the tremendous weight of glacial ice melted away.

When the retreating ice margin uncovered Great Notch, a gap in First Mountain at Clifton, the lake dropped about 80 feet and formed the Great Notch stage of Lake Passaic (fig. 2c). This lowering happened quickly, and a large flood eroded a sluiceway downstream from Great Notch. Today the sluiceway forms part of the Third River Valley in Clifton and Montclair. The lakeshore elevation at the Great Notch stage ranged from 320 feet in the Wayne area to 260 feet near Basking Ridge. Deltas were laid down in the lake at Preakness, Riverdale, and Boonton. During this stage, the lake was as much as 300 feet deep.

With further glacial retreat, the gap in First Mountain at Paterson was exposed and the Great Notch stage drained. This event, too, caused a torrent of water that eroded a sluiceway that now forms part of the Weasel Brook Valley in Paterson and Clifton. Route 19 follows part of this valley between Clifton and Paterson.

POSTGLACIAL LAKES

When the Great Notch stage of Lake Passaic drained, it marked the end of the ice-dammed phase of the lake. Several postglacial lakes persisted in the basin, confined by sediment dams left by the ice (fig. 2d). The largest of these was the Totowa stage, which was dammed by a ridge of sand and gravel that blocked the Passaic Valley at Totowa. The shore elevation of this lake ranged from 170 feet at Whippany, to 190 feet at Totowa and about 220 feet at Oakland. A large delta that forms for the Pompton Plain lying between Riverdale and Lincoln Park, was deposited in this lake. So were sand terraces found along the Rockaway, Whippany, and Passaic Rivers. As the Passaic River eroded the gravel dam, the Totowa stage gradually lowered and drained.

Farther south, terminal moraine deposits dammed the Passaic Valley between Summit and Chatham at a location formerly known as Stanley. This dam held back a shallow lake called the Stanley stage, which extended upstream into the Dead River Valley. The shore of this lake ranged from 230 feet at Stanley to 220 feet near Millington, and was no more than 30 feet deep. Like the Totowa stage, the lake drained as the river eroded through the moraine at Stanley.

The Millington stage was located in what is now the Great Swamp. Before the late Wisconsinan glaciation, this lowland was a valley draining northeastward through the Chatham area to the Short Hills Gap. Delta and moraine deposits laid down in the Moggy Hollow stage blocked this route and, in combination with the Long Hill ridge to the east, formed the basin for the Millington stage. This lake drained at a gap in Long Hill near Millington. The shore of this lake ranged from 260 feet near Basking Ridge to 270 feet at Green Village, and was no more than 50 feet deep. Great Brook, Loantaka

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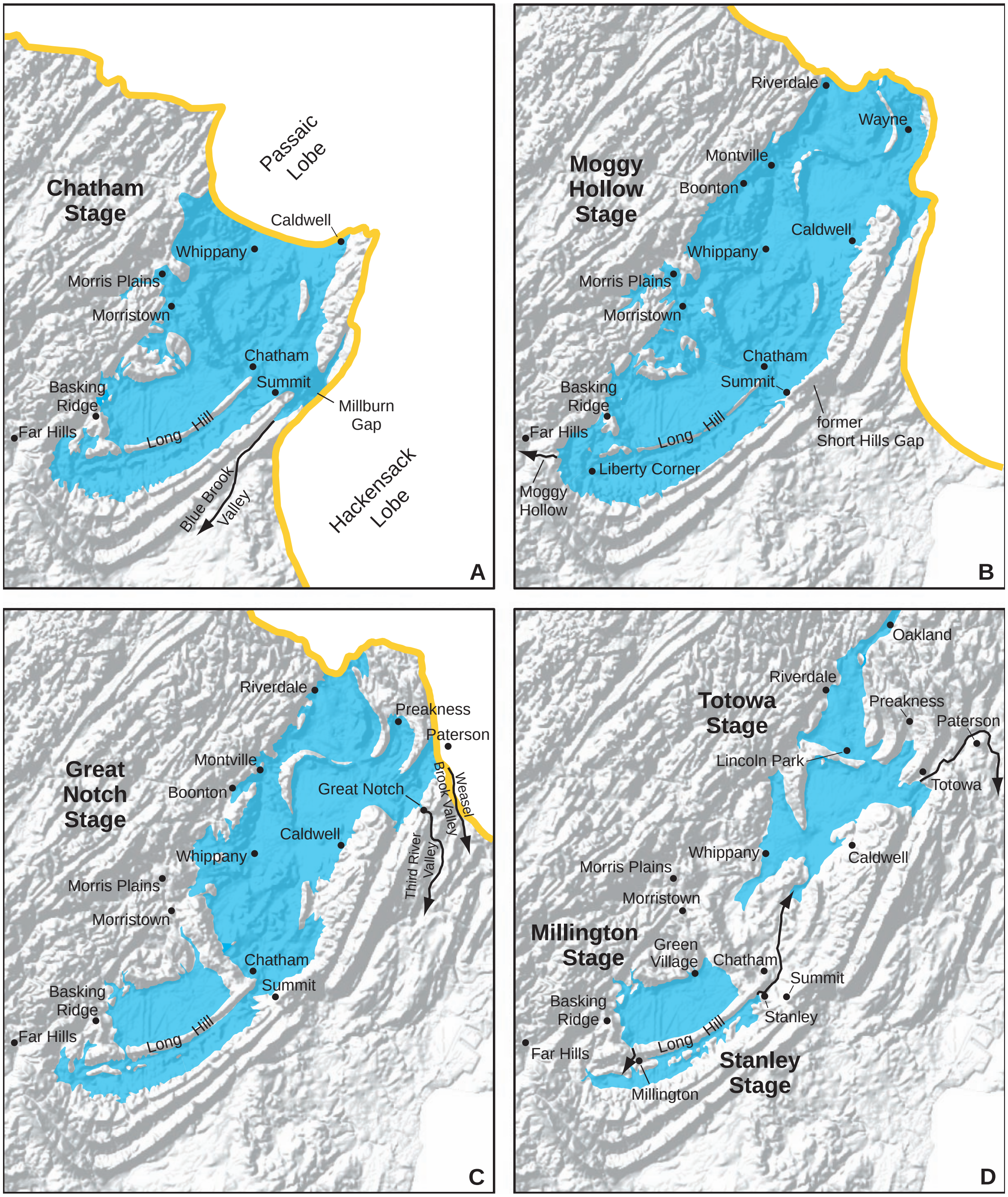

Figure 2. Maximum extent of A) Chatham, B) Moggy Hollow, C) Great Notch, and D) Totowa, Millington, and Stanley stages of Lake Passaic. Gold lines are glacier margins, black arrows are routes of lake drainage.

Brook, and the Passaic River deposited terraces of sand and silt in what is now the Great Swamp. Drainage from the spillway eroded the fractured basalt bedrock of Long Hill to form Millington Gorge. As the gorge deepened, the lake lowered and eventually drained altogether by about 14,000 years ago. Millington Gorge became the new route of the postglacial Passaic River.

Lake Passaic left a landscape legacy that affects both natural ecosystems and human society today. The large marshes, swamps, and floodplains along the Passaic River and its tributaries, including the Great Swamp, Troy Meadows, Hatfield Swamp, and the Great Piece Meadows, occupy the former floor of Lake Passaic and its postglacial successors. Beneath the several feet of peat and alluvial silt and sand in these wetland complexes, lie tens to hundreds of feet of accumulated glacial clay and silt. This was laid down over the 1500 years that glacial Lake Passaic existed and the 3000 to 4000 additional years of its postglacial stages. In places beneath the clay and silt lie sand and gravel deposited during both the Illinoian and late Wisconsinan glaciations. These sediments filled and eventually buried the ancestral Passaic river valley network (fig. 1). Today, sand and gravel in these buried valleys are important aquifers and the principal water source for a number of communities in eastern Morris and western Essex Counties.

Blockage of the Short Hills Gap and burial of the ancestral valleys, though, has also forced the Passaic to adopt a longer, flatter, northward route, and to join the formerly separate Pompton River, in order to exit the Watchung Mountains. The gentle slope of the river, the merging of two river systems into one, and an ever-expanding urban footprint of impervious surfaces, combine to create an especially flood-prone basin.

NOR'EASTER GENERATES LANDSLIDE ACTIVITY

By Ted Pallis

Several landslides occurred in New Jersey during the nor'easter of April 15, 2007 (fig. 1). These were triggered by heavy rain and caused a substantial amount of property and roadway damage. Small landslides such as these are fairly common in the state (NJGS, 2006) especially during heavy rainfall.

A landslide is a geologic process involving movement of soil and rock down a slope under the influence of gravity. A variety of triggers can make this happen. Heavy rain, earthquakes and the undercutting of slopes by natural erosion or human activity are common causes, as is natural or human removal of stabilizing vegetation and ground cover. The rate a landslide moves may be rapid or, surprisingly, very slow. It may involve large or small volumes of material which can move in nearly intact blocks or be greatly deformed and rearranged by the motion. The slope angle may be nearly vertical or fairly gentle (Delano and Wilshusen 2001).

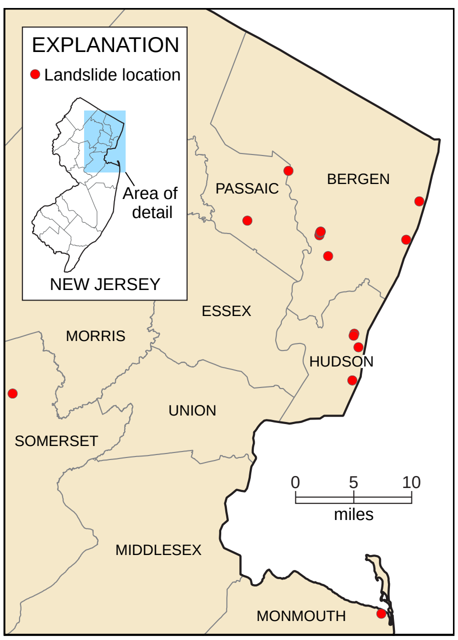

Figure 1. Locations of landslides triggered by the nor'easter of April 15, 2007.

The most destructive April 15, 2007 landslides occurred in Lodi, Bergen County. At least four were triggered by eight inches of rain and damaged homes on Farnham Avenue (fig. 2). Five houses were covered in mud, and the inside of one was completely destroyed as trees and mud smashed through the windows (Pico, 2007). A 70-foot retaining wall collapsed leaving an apartment building dangerously close to the edge of a cliff. Fifty families were displaced from six homes and the apartment building, all deemed unsafe for habitation (Travers, 2007).

As a result of the nor'easter that pummeled the area with steady winds and rain, a landslide occurred on Route 208 southbound near Lincoln Avenue in Glen Rock, Bergen County. It subsequently caused a multiple vehicle accident on the highway. There were no injuries, however police and fire personnel had to shut down the road until the vehicles and mud were cleared.

There was also a moderate sized landslide in Highlands Boro, Monmouth County. This occurred west of Waterwitch Drive on the bluff between Linden Avenue and Shore Drive (fig. 3). The slide consisted of an upper slump scar about 30 feet high and 40 feet wide and a lower debris pile of similar dimensions (fig. 4). The slump scar extends up through the top of the bluff. The slump took out part of the back lawns of two properties on the top of the bluff. The top of the scar is within 15 feet of the houses.


Figure 2. One of the four Farnham Avenue landslides. *Photo by T. Pallis*

Landslides also occurred along the Palisades Ridge in Bergen County from Fort Lee to Alpine during the nor'easter. Historically, the Palisades are the most active area for landslides in New Jersey, and one occurred between the Englewood Picnic Area and Ross Dock that was 150 feet wide. Five to six landslides were clustered in an area 200 yards wide farther north between Englewood Cliffs and the Alpine Picnic Area. Henry Hudson Drive was closed in two places because the road was made impassable by landslides (fig. 5). Damage to retaining walls and large cleanup operations for the removal of approximately 2,500

Figure 3. Location of landslide in Highlands Boro. *Map by S.D. Stanford*

cubic yards of debris kept the road closed during repairs.

In Union City, Hudson County, two large retaining walls collapsed, spilling rock and debris onto the south wing of the 14th Street viaduct and a parking lot below the road at the Doric apartment building. The 14th Street viaduct was closed for several weeks during cleanup and repairs.

Figure 4. Highlands Boro landslide. *Photo by S.D. Stanford*

Figure 5. Landslide blocks Henry Hudson Drive. *Photograph courtesy of Palisades Interstate Park - NJ Section*

These are just a few of the mid-April landslides in New Jersey. The New Jersey Geological Survey requests your assistance in keeping its list of New Jersey landslides updated. These data will be used by state, county, and local officials, to assist them in planning, regional landslide analysis, and hazard mitigation. We are looking for information on landslides of any type or size. The primary information needed is an accurate location, date and description of the slide. Any other information you can provide will be appreciated. Contact us at NJGSWEB@dep.state.nj.us.

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i-Map NJ GEOLOGY: A PRIMER

By Suhas Ghatge

i-MapNJ Geology is an interactive mapping application that provides useful information to the public about New Jersey's geology, aquifers, wellhead protection areas, earthquake epicenters, abandoned mines, 2002 aerial photos, tidal benchmark network and more. The application is accessed from the i-MapNJ Geology splash page. A link to the splash page is on the NJGS web site: www.njgeology.org under Digital Data. A tutorial for new users is available for download from the splash page.

The user interface (fig. 1) consists of the map view frame in the center, a data layers list to the left of the map view frame, map tool buttons above the map view frame, and a legend to the right of the map. Query results are displayed in a popup window. The *refresh* button is just under the data layers tabs at the top of the data layers list.

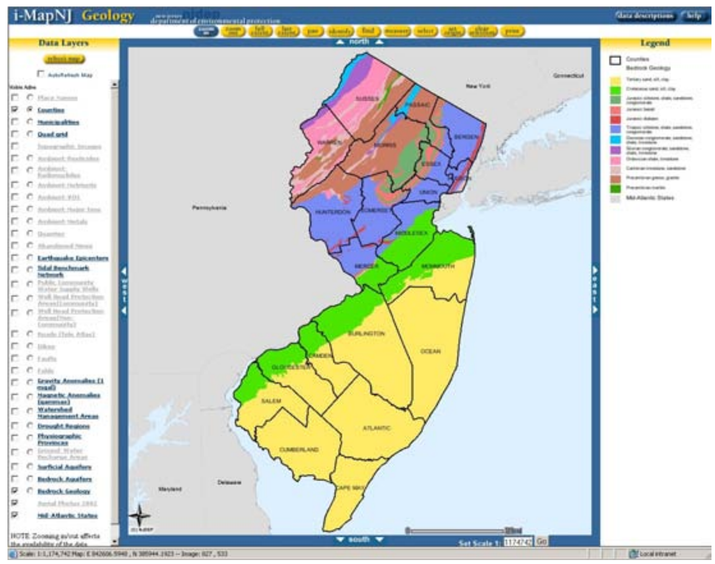


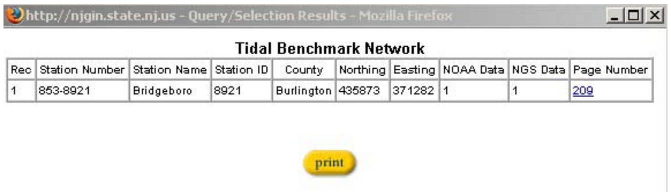
Figure 1. i-MapNJ Geology user interface.

The map tools toolbar above the map allows users to perform some basic but useful GIS analysis like zoom-in, zoom-out, pan, identify, find, etc.

The Status Bar is at the bottom of the screen below the mapview frame. It shows the scale at which you are viewing the map (Scale: 1: 13,868), the coordinates on the map at your cursor's location in New Jersey State Plane Feet (Map: E 420152.9621, N 505481.0379) followed by the image pixel values (Image: 417,373).

The defined searches for locating a point to investigate in the application are accessed by clicking on the *find* button. You can find your location of interest by street address or place name. A location of interest can be any point in New Jersey such as a home, a facility or any named place that you are interested in viewing.

While many GIS layers can be displayed at one time, the user can designate only one as *active*. A user sets the active layer by clicking on the layer's corresponding *radio* button. Significant about this layer is that some of the GIS tools act only on the active layer. For instance, if someone uses the


http://njgin.state.nj.us - Query/Selection Results - Mozilla Firefox

Tidal Benchmark Network

Rec	Station Number	Station Name	Station ID	County	Northing	Easting	NOAA Data	NGS Data	Page Number
1	853-8921	Bridgeboro	8921	Burlington	435873	371282	1	1	209

print

Figure 2. Popup window resulting from use of *identify* tool.

identify tool to acquire information on the Tidal Benchmark Network data layer, the user must first set the layer as the visible and active one, and then refresh the application before using the identify tool. Performing an *identify* on a point belonging to the Tidal Benchmark layer will produce a popup window "Query/Selection Results" (fig. 2). The page number field in the result is hyperlinked to an Adobe™ PDF document containing information about the Tidal Benchmark Station, 853-8921 in this case.

Any map displayed in the Map View Frame or a query result can be printed using the *print* button.

ANTHROPOMORPHIZE THIS!

By Ted Pallis

New Jersey has its share of rock face phenomena, though none are as well known as New Hampshire's "Old Man of the Mountain," the most famous natural face in a rock outcrop that crumbled in 2003 and is no more. In New Jersey, seven rock faces have been documented by the New Jersey Geological Survey. Figure 1 shows their approximate locations. Three still look over the landscape, but four have succumbed to weathering and blasting. Five of the seven rock faces formed in the Jurassic diabase along the Palisades cliffs. These include the "Hitler Face" and "Indian Profile", both in Alpine, Bergen County. "Indian Head" and "Washington Head" were formerly located in Fort Lee, Bergen County. A face briefly appeared in West Orange at the former O'Rourke Quarry in the Orange Mountain basalt, and was said to resemble Saint Anne, the mother of Christianity's Virgin Mary. The two remaining rock faces are "Profile Rock" located in Weehawken, Hudson County, and "Double Face," located in the Green Pond Conglomerate of Rockaway Township, Morris County.

The most famous New Jersey rock face was that of Adolph Hitler, which formed on a cliff overlooking the Hudson River following a massive landslide in Alpine on the Palisades (fig. 2). The Thirty-ninth Annual Report of the Commissioners of the Palisades Interstate Park (1938), details the landslide, "On July 23rd another major rockslide occurred immediately north of Twombley's . . ." [Landing], causing the formation of this rock face. "A large portion of the cliff broke away carrying all vegetation with it and burying both the shore path and water line." Curiously, the Hitler Face went unnoticed until sometime in 1939, around the beginning of WWII in Europe. It was said to be a good likeness of the German dictator, even including his mustache, according to ferry boat passengers on crossing the Hudson River and train travelers (New York

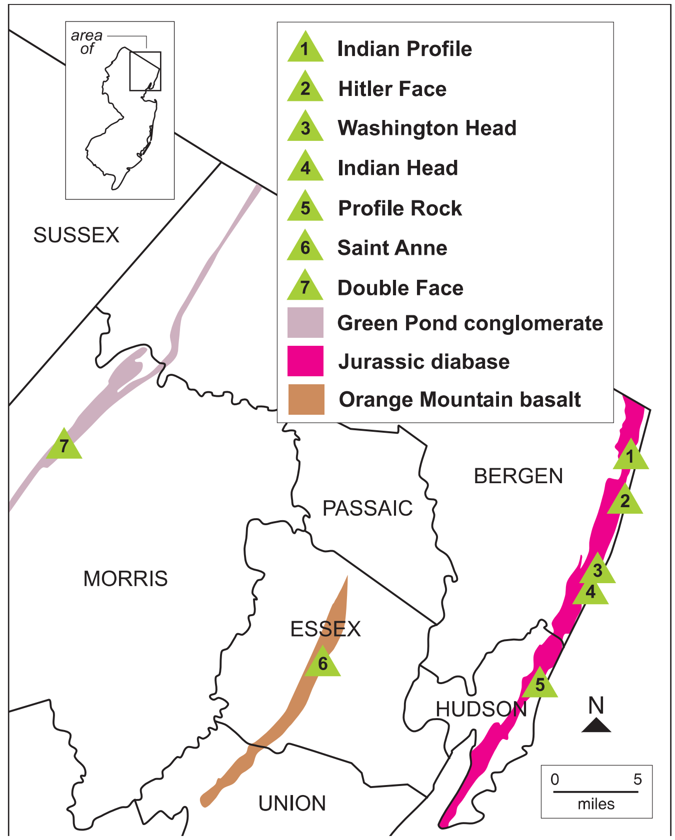


Figure 1. Rock face phenomena locations. *Map by W. Graff*

Times, 1947). The Hitler Face did not last very long. On March 16, 1947, another major landslide erased what nature had created just nine years earlier, completely removing the Hitler Face from the cliff (New York Times, 1947). On the Palisades, north of where the Hitler Face was, is another rock face. Named Indian Profile, it's the likeness of a Native American looking over the Hudson River. It can be viewed from State Line Lookout along the Palisades Interstate Parkway (fig. 3).

Two opposing massive rock face formations were once located in the Coytesville section of Fort Lee on the Palisades. One was called Washington Head, sometimes also referred to as George Washington Rocks, and the other was known as Indian Head (fig. 4). Both were located in the Carpenter Brothers

Figure 2. Adolf Hitler rock face. *Photograph courtesy of Palisades Interstate Park - NJ Section*

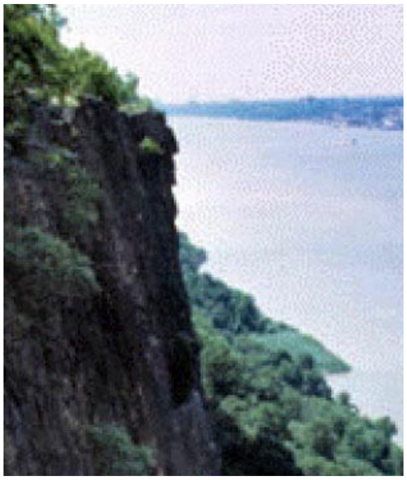


Figure 3. Indian Profile, viewed from State Line Lookout. *Photograph courtesy of Palisades Interstate Park - NJ Section*

quarry along the Palisades, where quarrying of the valuable diabase was still taking place. In September 1897, workers at the quarry blew up Washington Head in the course of normal operations (Arno, 2001). It is unknown why this face was called Washington Head, but it was located in the area where George Washington's army landed after crossing the Hudson River having been defeated by the British in New York during the American Revolution (New York Times, 1899).

A well known landmark and attraction, Indian Head was 200 feet above the Hudson River, and jutted out nearly 150 feet. An enormous and imposing feature, to the quarry owner it represented 350,000 tons of valuable diabase. By March 5, 1898, two five-foot tunnels were drilled 100 feet into the

Figure 4. Photograph of Indian Head, located in Fort Lee, Bergen County. *Photo by W. Allen*

Indian's head. Loaded with 7,000 pounds of dynamite, the expected blast was so anticipated that a contest was held to determine who would push the plunger on the detonator (NY Times, March 5, 1898). The ensuing blast yielded rock used for paving and building stone.

Profile Rock is the southernmost face on the Palisades. Located in Weehawken, it is still standing. Resembling a troubled human face, Profile Rock was the subject of a postcard around 1904 (fig. 5).

Double Face is located in Picatinny Arsenal, Rockaway Township in Morris County. The Green Pond Conglomerate is the native stone of Double Face. The two faces are seen in figure 6 looking over the valley. The face on the left is the bigger of the two and smiling. The smaller face is to the right on an egg-shaped rock and is frowning. Though still surviving, Double Face can not be visited because it is on a U.S. Army base.

The seventh New Jersey rock face was discovered in early August 1899. Soon after it was noticed, thousands of people flocked to O'Rourkes Quarry on Orange Mountain, now known as South Mountain on the First Watchung Mountain in West Orange. They gathered to see a purported likeness

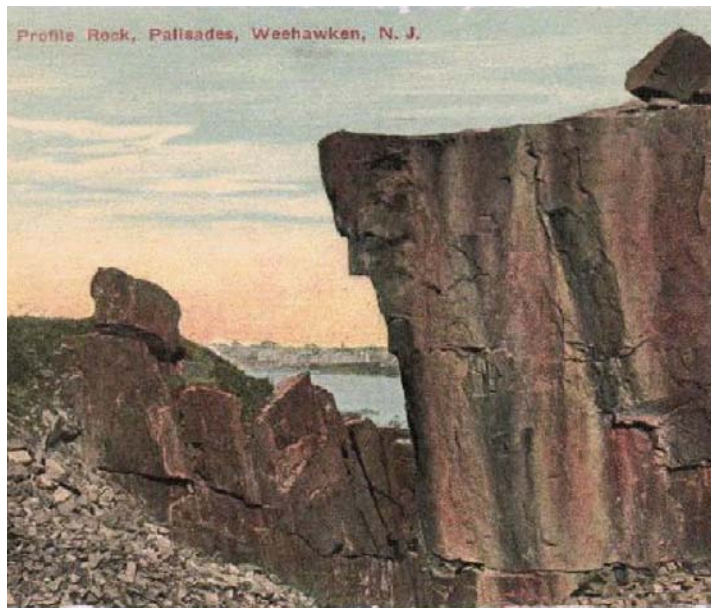


Figure 5. Postcard of Profile Rock, circa 1904. *Image courtesy of The Weehawken Time Machine*

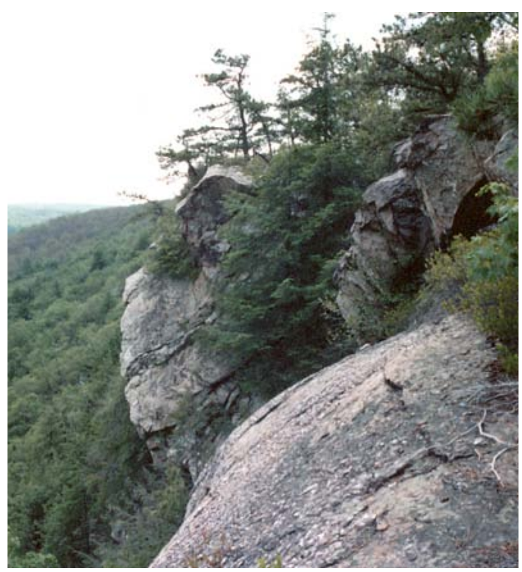


Figure 6. Double Face, 1986. *Photo by G. Herman*

of Saint Anne, which appeared in the quarry a day after a small rockslide. It was reported that the yellowish image appearing on the cliff bore a strong resemblance to the saint as depicted in ancient paintings

(New York Times 1899).

The image, said to be about one foot high, appeared on the west side of the quarry about fifty feet up the cliff wall. Newspapers reported that some of the first quarry workers to see the image called it a miracle, and that several priests visited the site. Apparently the image appeared on a solid face of rock and stood out in relief, looking like copper or brass in the sunlight (New York Times 1899). No photographs are known to have been taken of the face, and it's not known what happened to it. O'Rourkes Quarry is no longer in operation.

All but one of the rock face phenomena in New Jersey appear in igneous formations. These rocks solidified from molten or partly molten material, that is, magma. Five rock faces were located in the diabase of the Palisades Sill, a formation of Jurassic age. The image of St. Anne formed in the Orange Mountain Basalt from lava that flowed on the surface about 200 million years ago, also during the Jurassic period. The only non-igneous rock face is found in the Green Pond Conglomerate, a sedimentary rock of Silurian age (more than 400 million years old).

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The Weehawken Time Machine, www.weehawkenhistory.org/view_item.php?id=29&back=0&category

"Ooze"--A piece of soft, muddy ground, such as a mudbank; a marsh, fen, or bog resulting from the flow of a spring or brook.

--Glossary of Geology, 1997--

IRON FOR INDEPENDENCE

By F. L. Müller

Rivers and streams in Southern New Jersey purl and snake their tea-brown, cedar waters through thousands of acres of the Pinelands (fig. 1). These waters were instrumental in the formation of an industry which helped the colonies win victory in both the French and Indian War and the War for Independence. The organic-rich waters helped form bog iron which was the basis for an industry that flourished in the pinelands of South Jersey for over 100 years.

Figure 1. A cedar water river, the West Branch of the Wading River flows through Wharton State Forest in the Pinelands region of New Jersey, Washington Twp., Burlington County. *Photo by Z. Allen-Lafayette*

Thousands of acres in Southern New Jersey overlie sands and marls rich in iron minerals that dissolve as infiltrating water from the streams act on them. The activity of the organics and bacteria in the water release and mobilize the iron which then reacts with oxygen in the near surface. The resulting oxides accumulate in the pools, sloughs, bogs and banks of the streams where they harden into 'limonite', a mix of goethite and various other iron oxyhydroxides. The bog iron was mined by Colonial Americans and supplied the important iron furnaces of New Jersey.

For several reasons South Jersey was an excellent place to exploit this iron. The streams providing the bog ore renewed the iron after a little more than 20 years (Pierce, 1957). Streams were dammed to form ponds and reservoirs that provided power for bellows in the furnaces and for hammers in the stamping mills and the forges. There was ample wood to convert to charcoal. Oyster and clam houses provided shells (calcium carbonate) used as flux for the blast furnaces. Flux caused impurities in the bog iron to float to the top of the molten metal, allowing it to be drawn off while the liquid iron sank to the bottom of the furnace. The iron then flowed through a channel to individual molds placed at right angles to it. When cooled, these ingots looked like little piglets lined up at a sow's side for dinner. Thus the term used by the workers: 'pig iron'. The iron was later processed at forges and foundries into cannon, shot, stoves, pots, and many other items useful to an emerging nation.

The first furnace was the Tinton Iron Works, built in 1675. Later, furnaces were constructed at Atsion (1765), Batsto (1766), Etna (1766-67), Gloucester (1813), Martha (1793), Mount Holly (1730), Speedwell (1785), and Taunton (1766-67), to name only a few. Towns sprang up near the forges throughout the southern portion of the state. Many iron masters, such as Charles Read, John Cox, and the Richards family at Batsto, made fortunes and became the so called iron barons in this risky business (fig. 2).

Bog-iron operations lasted until the 1850's when they were gradually replaced by the iron of northern New Jersey and Pennsylvania. Magnetite ore deposits from these areas produced purer iron and were closer to the coal fields of Pennsylvania that provided better fuel for processing. The old iron works of the barrens faded back into the pines and history. However, historic Batsto Village has been restored and is a popular tourist destination within Wharton State Forest (www.batstovillage.org).

RESOURCES

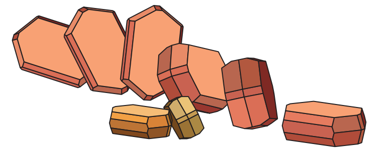
Pierce, Arthur D., *Iron in the Pines,* Rutgers University Press, New Brunswick, New Jersey, 1957.

Starky, Albert J., 1962, The bog ore and bog iron industry of South Jersey, *The Bulletin*, N.J. Academy of Science, v. 7, no. 1.

Figure 2. Bog iron pile, Batsto Village, Batsto, Burlington County. Lower section of tower in background was constructed of bog iron. *Photo by Z. Allen-Lafayette*

TITLE BANNER: Goethite (α-FeO(OH)) is a red, yellow or brown iron-oxide mineral that is a common constituent of rust. It is a common weathering product in all types of rocks and is one of the most widely occurring forms of iron-oxide in soil, sediments and ore deposits, such as bog iron. Prehistoric people used goethite as a pigment. It was first described in 1806, and was named for the German writer and philosopher Johann Wolfgang von Goethe (1749-1832).

By J.H. Dooley



Title banner photos by J. H. Dooley

NEW PUBLICATIONS

COMPACT DISCS (CD)

REPRINTED. CD 00-1, Bedrock Geology (1 to 100,000-scale) and Topographic Base Maps (1 to 24,000- and 1 to 100,000- scales) of New Jersey, 2000, reprinted 2007. $30.00

DIGITAL GEODATA SERIES (DGS)

NEW GIS DATA. DGS 07-1, Aquifer-Recharge Potential for New Jersey. PDF, metadata and ESRI shapefile data available for download at www.njgeology.org/geodata/dgs07-1.htm

GEOLOGIC MAP SERIES (GMS)

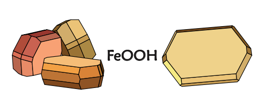
NEW MAP. GMS 07-1, Bedrock Geologic Map of the Orange Quadrangle, Essex, Passaic, Bergen and Hudson Counties, New Jersey, Volkert, Richard A., 2007, scale 1 to 24,000, size 32x33, 1 cross-section and 1 figure. $10.00. Available for download at www.njgeology.org/pricelst/gmseries/gms07-1.pdf

OPEN-FILE MAP SERIES (OFM)

NEW MAP. OFM 68, Surficial Geology of the Pompton Plains Quadrangle, Morris, Passaic, Essex and Bergen Counties, New Jersey, Stanford, Scott D., 2007, scale 1 to 24,000, size 36x47, 4 cross-sections, 2 figures and a 56-page pamphlet. $10.00. Available for download at www.njgeology.org/pricelst/ofmap/ofm68.pdf

HISTORICAL PUBLICATIONS (Printed)

NEW MAP. A Preliminary Map Showing Distribution of Archaeological Remains in New Jersey, 1912. Enlarged and printed version of map in NJGS Bulletin 9, A Preliminary Report of the Archaeological Survey of the State of New Jersey, 1913. $10.00. Report available at www.njgeology.org/enviroed/oldpubs/bulletin9.pdf



TEACHERS WANTED: EARTH SCIENCE WEEK

By Andrea Friedman

Earth Science Week 2007 is around the corner! During the week of October 14-20, bring the earth sciences to your classroom by joining in this national and international event. Since October 1998, the American Geological Institute (AGI) has organized Earth Science Week to help the public gain a better understanding and appreciation for the Earth Sciences and to encourage stewardship of the Earth. This year's theme is **"The Pulse of Earth Science"**.

NJGS EARTH SCIENCE WEEK RESOURCES

NJGS Sponsorship Program: As part of the School Sponsorship Program, the New Jersey Geological Survey will send you (free!) an AGI ***Earth Science Week Toolkit***, and will add a free ***NJ Geology Local Angle Bonus*** packet with NJ-specific materials and project ideas. The 2007 Earth Science Week Toolkit includes:

* 12-month school-year activity calendar, suitable for hanging.
* 2007 Earth Science Week poster, including an activity on the back.
* NASA "Exploring Ice" CD-ROM.
* NASA "Earth and Space Explorers Series" poster.
* ESRI "GIS Solutions for Education" CD.
* "Volcanoes of the National Parks" poster from the National Park Service.
* NOAA "Student Opportunities and Careers" flyer.
* USGS Facts on Disk CD, featuring a searchable database of geoscience fact sheets.
* USGS Education Resources Brochure
* And much, much more!

For your free ***Earth Science Week Toolkit*** and the ***NJ Geology Local Angle Bonus*** packet, send an email with your name, school, and mailing address to NJGSWEB@dep.state.nj.us with the subject line *Sponsor My Classroom!* Or, call us at (609) 292-1185 or FAX us at (609) 633-1004. Supplies are limited, so contact us early.

Unearthing New Jersey: The bi-annual online NJGS newsletter. Written for the general public, current and previous issues can be downloaded from our website at www.njgeology.org/enviroed/freepubs.htm#newsletter

EarthCaching: The geologists at NJGS have created three EarthCaches, highlighting geological treasures in the Garden State:

* Four Hundred Million Year-Old Mud Cracks www.geocaching.com/seek/cache_details.aspx?wp=gczcmw
* Glacial Garbage, Grabs, and Graffiti www.geocaching.com/seek/cache_details.aspx?wp=gczcnc
* Palisades Sill www.geocaching.com/seek/cache_details.aspx?wp=gczcha

Learn about EarthCaching at www.earthcache.org. For tips on using EarthCaching in your classroom, click on "EarthCache Sites for Teachers". Follow the teachers guide link for the new (free!) downloadable teachers guide developed by the Geological Society of America and the National Geographic Education Foundation entitled *EarthCaching - An Educator's Guide*.

i-MapNJ Geology: A web-based interactive mapping application that provides information about New Jersey's geology, aquifers, well head protection areas, earthquake epicenters, abandoned mines and more. Go to www.state.nj.us/dep/gis/imapnj_geolsplash.htm

AGI EARTH SCIENCE WEEK RESOURCES

The AGI Earth Science Week website is chock full of ways to incorporate the event into your classroom. See the ESW homepage at www.earthsciweek.org or go directly to resources for teachers at www.earthsciweek.org/forteachers/index.html. You'll find:

* Classroom Activities: Link to Earth Science classroom activities that are keyed to the National Science Education Standards.
* Contests: Have your students enter one of AGI's Earth Science Week contests.
* Participate in a Research Project: Participate in real scientific research by collecting data as part of a national research project.
* Events Near You: Find out what events are planned near you.
* Theme-Based Resources: Check out AGI's list of resources based on this year's theme, "The Pulse of Earth Science"
* Earth Science Week Network: Connect with organizations in your area.
* Purchase an ***Earth Science Week Toolkit!***: $6.95 plus tax and shipping, or get one free through the NJGS School Sponsorship Program. See above for details.
* Earth Science Week Newsletter: Subscribe to the *Earth Science Week Update*, AGI's newsletter.
* Career Resources: Check AGI resources on careers in the Earth Sciences.
* Geoscience Careers Webquest: Have your students test their knowledge of geoscience careers.

UNEARTHING NEW JERSEY–EARTH SCIENCE WEEK SPECIAL EDITION. Watch our website for a Special Edition of **Unearthing New Jersey** posting in September 2007. There will be more resources and suggestions for Earth Science Week activities.

MENTORING PROGRAM

By Karl Muessig

Rich Volkert participated in The Geological Society of America (GSA) mentoring program at its Northeast Section Meeting this past March. The Roy J. Shlemon Mentor Program in Applied Geology is a popular event, supported by the GSA Foundation through gifts from Roy J. Shlemon. It is designed to extend the mentoring reach of individual professionals to a forum for undergraduate and graduate students interested in applied geology. Rich participated in an informal conversation with students sharing his broad range of geologic education, experience, and expertise.

The GSA mentoring program and the NJGS gratefully acknowledge Rich for sharing his insights with GSA's student members.

WORD OF THANKS

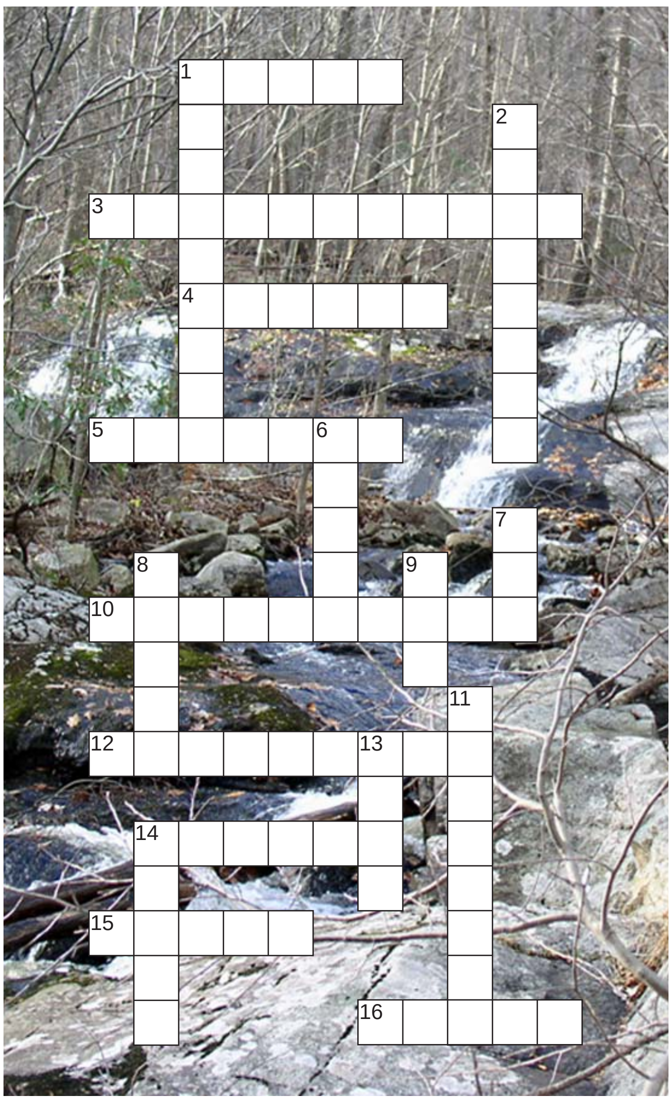
Two geologists recently retired from the Geological Survey:

Dan Dombroski worked for 37 years on mineral resource investigations of barite, lead, zinc and clays, earthquake occurrences, and information resources and public outreach efforts.

Lloyd Mullikin worked for 23 years on the stratigraphic framework of the New Jersey Coastal Plain, organizing and interpreting well records and the mineral resources of the region.

The Survey thanks both Dan and Lloyd for their long service and dedication to the State of New Jersey, its citizens and the geologic profession.

CROSSWORD CREEKS



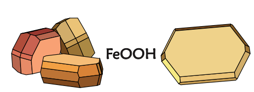
Unnamed creek on Ramapo Mountain, Wanaque Boro, Passaic County. *Photo by J.H. Dooley*

ACROSS

1. Smallest unit of information in an image
3. Wilderness area in New Jersey
4. Trusted counselor
5. Intrusive rock whose main components are labradorite and pyroxene
10. Destructive process by which earthy materials are changed by atmospheric agents
12. Downslope transport
14. Pinelands iron forge
15. Hiding place
16. Request to select features from a database

DOWN

1. Observable event
2. Conspicuous object
6. One of several levels of a glacial lake
7. Waterlogged ground containing acidic, decaying vegetation that may develop into peat
8. Flat-topped deposit of sand and gravel laid down in a glacial lake
9. Geographic information system
11. Reserve source of support
13. Fe
14. Bellows



"The marsh, to him who enters it in a receptive mood, holds, besides mosquitos and stagnation, melody, the mystery of unknown waters, and the sweetness of Nature undisturbed by man.

--Charles William Beebe (1877-1962)--
Log of the Sun, 1906

CROSSWORD PUZZLE ANSWERS. Across: (1) Pixel, (3) PineBarrens, (4) mentor, (5) diabase, (10) weathering, (12) landslide, (14) Batsto, (15) cache, (16) query. **Down:** (1) Phenomena, (2) landmark, (6) stage, (7) bog, (8) delta, (9) GIS, (11) resource, (13) iron, (14) blast.