UNEARTHING NEW JERSEY

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MESSAGE FROM THE STATE GEOLOGIST

In 1879, State Geologist George Cook wrote, "... for the proper delineation and location of the various natural products found in the State, good maps are needed, and it has been found necessary to give much attention to the construction of such maps." The Cook map included the bedrock geology and cultural features of the 1839 Henry D. Rogers map but overlaid these data layers on a topographic base. Thanks to Cook, New Jersey was one of the first states to delineate and publish its geology and topography, a nineteenth-century scientific feat.

In describing the *Geologic Map of New Jersey*, printed in 1914, State Geologist Henry B. Kümmel wrote, "The new map is a distinct advance, both artistic and scientific, over the earlier geologic maps of the State, the last of which was issued in 1888. The advance in geologic knowledge during the quarter of a century is indicated by the increase in the number of rock formations shown – from 24 on the old map to 57 on the new." Kümmel removed Cook's topography layer to allow the more intensely delineated bedrock to shine through. He also added 5 cross sections to enable New Jerseyans to see how the bedrock layers were positioned beneath the surface. His map, with a few revisions in later printings, has been our statewide bedrock map for the past 100 years.

Since its inception, New Jersey Geological and Water Survey (NJGWS) geologists have been recording the history and variety of our state's "natural products". Our current class of geologists have continued this fine tradition by creating our newest map product, *Bedrock Geologic Map of New Jersey, 2014*, described in this edition of **Unearthing New Jersey**. With its cartographic and scientific advances (71 described rock formations), we hope that, as Kümmel stated, "... teachers and students of geology in colleges and teachers of geography in normal and high schools will find this map of great educational value" in the twenty-first century.

Another avenue of research for NJGWS geologists is the quality status of shallow groundwater. The Ambient Ground Water Quality Monitoring Network (AGWQMN) was designed 16 years ago. It was installed and has been maintained since then by NJGWS. In another feature article, *Abracadabra; Where Did The Well Go?*, John Curran, Raymond Bousenberry and Gregg Steidl report on the trials and tribulations of monitoring and maintaining this network.

Karl Muessig
New Jersey State Geologist

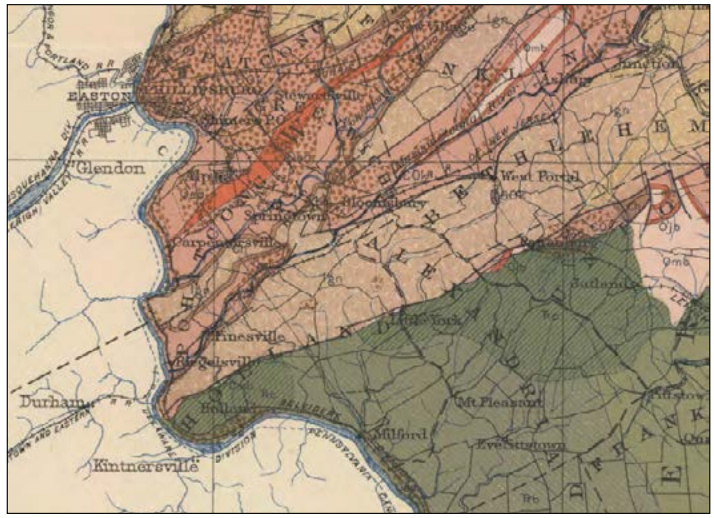

Figure 1. Atlas Sheet 40, printed in 1914, detail of the area of Phillipsburg Town area, Warren County. *Map by J.V. Lewis, H.B. Kümmel, W.S. Bayley, and R.D. Salisbury*

NJGWS PUBLISHES "BEDROCK GEOLOGIC MAP OF NEW JERSEY, 2014"

By Richard F. Dalton

The out-of-print Geologic Map of New Jersey, sometimes referred to as Atlas Sheet 40 (fig. 1), is one-hundred-years old in 2014 and will soon be replaced by an updated bedrock geologic map at the same scale. The original map (1:250,000-scale, approximately 4 miles to the inch) was received from the printer in March, 1914 and distribution began shortly thereafter (Kümmel, 1915, p. 16). It was reprinted as the Edition of 1918 and was slightly revised and reprinted by State Geologists Henry B. Kümmel (1931) and Meredith E. Johnson (1950) with the final reprinting by State Geologist Kemble Widmer in the early 1960s. Supplies of that reprinting were exhausted in 1988 and currently this map is on-line.

Lewis and Kümmel (1915, p. 7) indicated that previous statewide maps issued by the Geological Survey were at a scale of 1:316,800 (five miles to the inch) but to achieve the accuracy and detail needed for the new geologic map, a new geographic base map was prepared by reducing the Topographic Atlas Sheets from a scale of 1:63,360 (one mile to the inch) to the 1:250,000-scale. This change in scale and accuracy made the map useable for current detailed needs. Much of the original geologic mapping was prepared at scale of 1:21,120 (approximately one-third mile to the inch) and reduced to the 1:250,000-scale. The new base map was engraved and color stones prepared depicting the 57 geologic formations shown on the map. According to Kümmel (1914, p. 13), extensive changes in patterns and colors had to be made to the printer's proof which significantly delayed the finished map until March, 1914.

Recognizing the age of Atlas Sheet 40 and subsequent advances in geologic mapping, Acting State Geologist Frank J. Markewicz began discussions with the Chief Geologist of the U.S. Geological Survey (USGS) in 1982 and asked him to help the New Jersey Geological Survey (NJGS) to completely remap the state's bedrock and surficial geology. The USGS was in the process of completing a series of 1:100,000-scale planimetric and topographic maps for New Jersey, so it was decided that the 1:100,000-scale would be an appropriate one for the new geologic mapping. As a result, COGEOMAP, a cooperative geologic mapping program between the NJGS and the USGS, began in 1984. In 1993, COGEOMAP became STATEMAP, a successor cooperative geologic mapping program. The bedrock mapping was published by the USGS as *Bedrock Geologic Map of Northern New Jersey* (Drake and others, 1996) and *Bedrock Geologic Map of Central and Southern New Jersey* (Owens and others, 1998) and are some of the most detailed statewide bedrock geologic maps in the Nation.

Under State Geologist Haig F. Kasabach, after the bedrock maps were published, the Northern, Central and Southern maps of the state were digitized, merged into one map and published as a CD (NJGS, 2000) which was reprinted in 2007.

Because the merged bedrock map at the 1:100,000-scale is an impractical 5-feet x 9-feet in size, State Geologist Karl W. Muessig authorized the new mapping to be generalized to the 1:250,000-scale of Atlas Sheet 40, and followed by the printing of a single-sheet bedrock geologic map. A new geographic base map was created by combining data layers digitized from 1:24,000 scale aerial photographs (the coast, hydrography, and roads), from state boundary monuments and from NJDEP geographic information system digital database files (municipal and county boundaries).

The 37-inch x 47-inch map is intended to give the user a general overview of the bedrock geology of New Jersey. To create a legible 1:250,000-scale map, it was necessary to combine many of the geologic units shown on the 1:100,000-scale map into new units. As a result, many units of small area extent, igneous dikes and small faults could not be shown. Therefore, this new map is not be used as a source of detailed geology for a particular area. The 1:100,000-scale statewide geologic maps or the 1:24,000-scale geologic quadrangle maps can be consulted. Many of them are available on our website.

The new map differs from Atlas Sheet 40 in the greater number of bedrock geologic units, and in the absence of the Quaternary units. They are to be shown on a companion 1:250,000-scale surficial map. The cross sections on the new map were located as closely as possible to those on Atlas Sheet 40, to highlight changes in geologic interpretation.

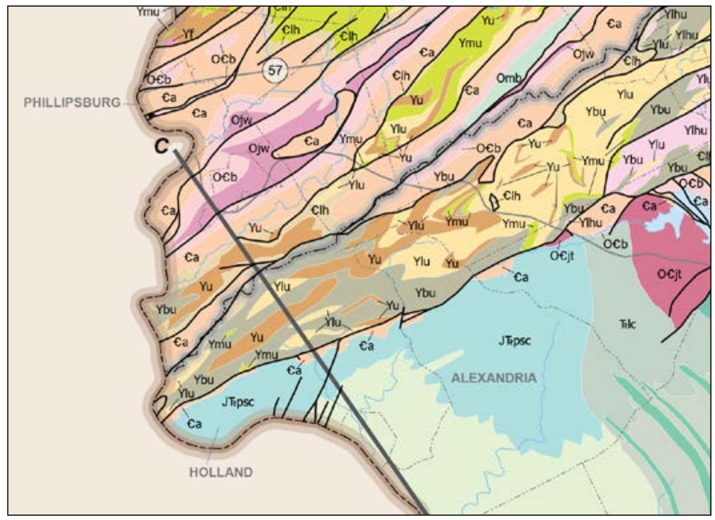

Figure 2. Detail from the new NJGWS 1:250,000-scale bedrock map. *Map by R.F. Dalton, D.H. Monteverde, P.J. Sugarman. R.A. Volkert, A.A. Drake, J.P. Owens, Z. Allen-Lafayette, M.W. Girard, W.P. Graff and R.S. Pristas.*

A few changes to descriptions of some of the units on this map update the 1:100,000-scale bedrock maps, which were based on geologic mapping completed before 1998. Moreover, subsequent work has resulted in changes to geologic nomenclature. For instance, the unnamed unit at Cape May (upper Pliocene) is currently named the Stone Harbor Formation (Sugarman and others, 2007) and the lower member of the Kirkwood Formation (lower Miocene) is now named the Brigantine Member (Sugarman, 2001). A few changes to the ages of some units shown on the 2014 map are due to a refinement of the global stratigraphic column (U.S. Geological Survey, 2010). The new stratigraphic column raises the Cambrian-Ordovician boundary, which in turn changes the age of the Beekmantown Group from Lower Ordovician, to Lower Ordovician-and-Upper Cambrian; and the age of the Allentown Formation from Upper Cambrian-and-Lower Ordovician to Upper Cambrian.

Ordering information for the *Bedrock Geologic Map of New Jersey, 2014* will be posted on our website when it is available for sale.

NJGWS
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REFERENCES:

Drake, Avery A., Jr., Volkert, Richard A., Monteverde, Donald H., Herman, Gregory C., Houghton, Hugh F., Parker, Ronald A., and Dalton, Richard F., Bedrock Geologic Map of Northern New Jersey, 1996, U.S. Geological Survey Miscellaneous Investigations Series Map I-2540-A, scale 1:100,000.

Kümmel, Henry B, 1914, Annual administrative report of the State Geologist for the year 1913, New Jersey Geological Survey, Bulletin 12, p. 7-25.

Kümmel, Henry B, 1915, Annual administrative report of the State Geologist for the year 1914, New Jersey Geological Survey, Bulletin 16, p. 7-43.

Lewis, J. Volney and Kümmel, Henry B., 1915, The geology of New Jersey, New Jersey Geological Survey, Bulletin 14, 146 p.

NJGS, 2000, Bedrock Geology (1:100,000-scale) and Topographic Base Maps (1:24,000- and 1:100,000-scales of New Jersey. Reprinted 2007. New Jersey Geological Survey CD Series CD 00-1.

Owens, James P., Sugarman, Peter J., Sohl, Norman F., Parker, Ronald A., Houghton, Hugh F., Volkert, Richard A., Drake, Avery A., and Orndorff, Randall C., Bedrock Geologic Map of Central and Southern New Jersey, 1998, U.S. Geological Survey Miscellaneous Investigations Series Map I-2540-B, scale 1:100,000.

Sugarman, Peter J., 2001, Hydrostratigraphy of the Kirkwood and Cohansey Formations of Miocene Age in Atlantic County and Vicinity, New Jersey, New Jersey Geological Survey, Geological Survey Report GSR 40, 26 p.

Sugarman, P.J., Miller, K.G., Browning, J.V., Monteverde, D.H., Uptegrove, J., McLaughlin, P.P., Jr., Stanley, A.M., Wehmiller, J., Kulpecz, A., Harris, A., Pusz, A., Kahn, A., Friedman, A., Feigenson, M.D., Barron, J., and McCarthy, F.M.G., 2007. Cape May Zoo site. *In* Miller, K.G., Sugarman, P.J., Browning, J.V., et al., Proc. ODP, Init. Repts., 174AX (Suppl.): College Station, TX (Ocean Drilling Program), 1-66. doi:10.2973/odp.proc.ir.174axs.108.2007.

U.S. Geological Survey Geologic Names Committee, 2010, Divisions of Geologic Time- Major Chronostratigraphic and Geochronologic Units, U.S. Geological Survey Fact Sheet 2010-3059, 2 p.

ABRACADABRA; WHERE DID THE WELL GO?

By John Curran, Raymond Bousenberry & Gregg Steidl

Our Ambient Ground Water Quality Monitoring Network, (AGWQMN) is 16 years old. The network (fig. 1) was designed and installed and has been maintained by the New Jersey Geological and Water Survey. The network consists of 150 monitoring wells. It was conceived to assess shallow ground-water quality status and trends statewide. The project design incorporates three types of land use: agricultural, urban, and undeveloped. A geographic information system was used to divide the State into equal-sized cells, and each cell consists of the same percentage of its particular land use. The wells were sampled in the year they were installed, and subsequently every five years.

Every appropriate well site was painstakingly selected from each of the 150 cells. Consideration was given to land use type, ownership of the parcel, and the avoidance of known contaminated sites. Visits to the sites confirmed necessary requirements for well installation and ensured that the site would be conducive to drilling and sampling. These site visits checked the absence of utility lines, natural gas, and water lines and verified that the area was large enough to accommodate staff safely. These evaluations were subsequently confirmed with the New Jersey One Call system. A significant amount of time went into the site-selection part of this project, before attempts were made to secure permission. Often permission could not be secured, at which point the entire site-selection process would begin again. To save lost time and achieve a much higher success rate, a majority of the wells were concentrated on State property, such as Wildlife Management Areas, State

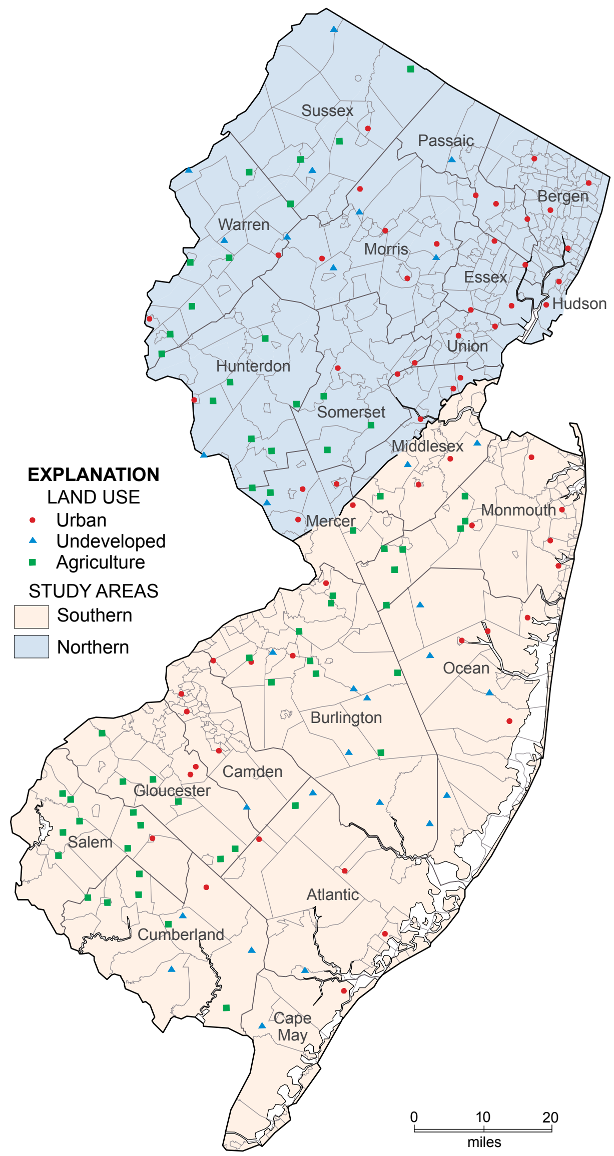


Figure 1. AGWQMN well sites were located using a stratified-random site selection process. The final distribution of wells as a function of land use is: 60 in agricultural areas, 60 in urban areas, and 30 in undeveloped land use areas.

Figure 2. Before (*above*) and after (*right)* illustrates how difficult it can be to locate a flush mounted well after 5 years. Marking paint (*right*) indicates location of well now buried under a new sidewalk. This well had to be re-drilled. *Photo above by R. Bousenberry, photo left NJGWS Archives*

Parks, State colleges and universities or NJ Department of Transportation (NJDOT) rights-of-way. However, not every cell included appropriate State property and we had to select other more time-intensive sites, including municipal, county, and private property.

Once permission was secured, applications for NJDEP well permits were completed and mark-outs were acquired. These are legal requirements for installing wells in New Jersey. These requirements, and obtaining other needed permits (for example NJDOT, county and municipal permits) added delays prior to initiating fieldwork. Installations were then scheduled, conducted and well development was completed. Well development involves preparing a well for sampling by clearing the disturbance caused by the drilling process. Development aims to reduce turbidity so the wells are readily sampled. In some cases this may take only an hour or two, in other cases it requires many hours over multiple days. Fourteen days after development is completed wells may be sampled. Wells were sampled using NJDEP accepted procedures from the *NJDEP Field Sampling Procedures Manual* and the U.S. Geological Survey *National Field Manual for the Collection of Water-Quality Data*. Field samples were delivered to analytical laboratories for analysis.

All of these steps take time. Multiply them by 30 wells monitored annually (in 2015 and 2016 the number of wells monitored will increase to 45 wells per year; from 2017 onward, 50 wells will be monitored each year) and it becomes clear that this project takes significant effort. Many hours are invested and the staff members responsible for the project take great pride in the network.

After the first 5 years the network entered the maintenance phase. It was thought the project would become significantly less time-intensive. After all, the sites had all been selected and drilling had been completed.

In year 6, when the first wells were being sampled for the second time, the new processes of recon and re-development were instituted. Recon takes place during the

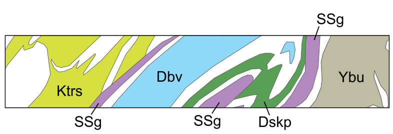
Fall, after the wells in the previous sampling set have been sampled. This step involves a field visit to each of the wells that are scheduled to be sampled the following Summer. During the 5 years between visits, site vegetation grows, grass is mowed, leaves fall, snow is plowed, and topsoil is added, all of which can complicate finding the wells (fig. 2). While wells with steel casings that extend above land surface are commonly much easier to relocate, local conditions (for example, in places where grass is mowed, in parking lots, next to plowed fields, or when requested by property managers or owners) sometimes necessitate using flush-mounted well installations. It is common to use a magnetometer (metal detector) to locate flush-mounted wells.

Once the wells are located, they are opened to check security and collect and record water levels. Issues observed are either addressed at this time or added to a list for Spring completion. Issues easily addressed include replacing inoperable locks and locking caps. Issues that are listed for Spring include reinstalling new manholes and installing replacement wells, a new part of the annual process.

There are numerous reasons for replacing a well. Sometimes local hydrology changes and the well no longer fits the project's criteria. For example, the static-water level in the area has dropped, exposing the well screen to the atmosphere, and rendering the well unsuitable for sampling based on the requirements of the project. Other wells may be damaged or just disappear. Sometimes it is easy to determine what happened, at other times it is a mystery. Wells are lost or damaged for a variety reasons, including having been hit by mowers and agricultural equipment, paved over during road-widening activities, had guardrails, fences or parking stops installed over them, and site development activity. Additionally, sites that years earlier were accessible for a drill rig and support vehicles may be no longer accessible. These sites require that staff carry all the gear in by hand to conduct maintenance and sampling events. These incidents happen more than one might think, and require additional well maintenance or re-drilling prior to the next sampling event.

Occasionally wells must be redeveloped. This is a procedure which involves making an additional site visit to each well during the Spring before sampling to pump, surge or flush stagnant and turbid well water and confirm that the well is ready for sampling. Staff then determines pump rate or yield and measures turbidity, and compares them to what they were at the time of the initial well development. This process insures a much more efficient sampling event.

From siting to sampling, each monitoring well is unique, and no single time-table is appropriate for all wells. Project staff work tirelessly to have the project run as smoothly and efficiently as possible. Additional information may be found in the New Jersey Geological Survey Information Circular: New Jersey Ambient Ground Water Quality Monitoring Network: New Jersey Shallow Ground-Water Quality, 1999-2008.



SERPENTINE: AN ABUNDANT NEW JERSEY MINERAL

By F. L. Müller

When I was very young and just starting to collect minerals, I discovered a small green slab of stone which had spalled off a building in our town. I took it to my friend Walter who informed me that it was called *verde antique,* a form of serpentine. I treasured it in my mineral collection and much later learned that serpentine is a group name for a variety of related minerals (most commonly antigorite, chrysotile, and lizardite). These minerals form most commonly from the metamorphosing of olivine, pyroxene, and phlogopite. As time went on, I became aware that this rock was sought after by builders, collectors and lapidaries. It is abundant in New Jersey and was formerly mined for building stone, ornamental stone, stone carvings, rock pulp, and jewelry.

Serpentine is a group of at least 16 hydrous silicate minerals (Gaines and others, 1997, p. 1406). Some are rich in aluminum, lithium, magnesium, nickel, zinc or calcium (Bonewitz, 2005, p. 256). Its physical properties are varied, depending on its constituents. It has a hardness of 3.5-5.5 on the Mohs hardness scale. The streak of serpentine left on an unglazed porcelain tile is white. Its specific gravity is 2.5-2.6. Its luster is varied; it may be earthy, dull, greasy, or resinous. Although supposed to have perfect cleavage, this is not generally observable. Serpentine is generally seen as a fine-grained intergrowth of crystals forming a pseudomorphous mass. It is classified in the monoclinic crystal system, but two varieties of chrysotile are orthorhombic (Bonewitz, 2005, p. 256). Its color ranges from white and gray, to yellow, green, blue, purple, and black. Serpentine may be opaque to translucent to the prized apple-green variety, williamsite.

Serpentine is commonly carved into beautiful art: the Minoans were famed for their serpentine vases, platters, and cups; and the Chinese were known for their intricate carvings of animals, human figures, and dragons. It is an industrial mineral as well. It is used in construction (*mineral pulp* is a rock flour with a variety of uses), ornamental trim, facing stone, and steps. For example, Harper (2015, p. 163) shows a photograph of the United Methodist Church of Washington, Warren County which is faced with serpentine blocks quarried in the Phillipsburg area.

Figure 1. Serpentine sample showing layered structure and associated minerals, Warne or Royal Green Quarry, Phillipsburg Town, Warren County. *Photo by J.H. Dooley*

Serpentine was mined for a variety of purposes from the Chestnut Hill Formation at the Warne or Royal Green Marble Quarry in Warren County near Phillipsburg on Marble Mountain (fig. 1). It was used as a decorative stone. Inside the Easton, PA Trust Building in 1922, for example, it was used for trim and other purposes (Bayley, 1941, p. 92). This serpentine was generally of an apple-green variety although there were abundant darker shades. Associated with the serpentine minerals was talc, dravite, white tremolite, phlogopite, muscovite, pink and gray dolomite (which contrasts nicely with the green, making attractive cutting material), uranium and thorium minerals, and molybdenite. Molybdenite is especially interesting to mineral collectors. Many other minerals are reported here but in minor amounts. The primary use of this serpentinite was for construction, and rock flour for stucco and plaster. The Warne or Royal Mine is currently filled with water and the owners do not permit collectors on the property. I have heard that there are tailings piles on Marble Mountain, but I have not visited them.

In Montville Township, Morris County, near Lake Valhalla and Turkey Mountain is the now abandoned Gordon Quarry. Here a small body of limestone was formerly mined for flux for smelting iron. This quarry produced a variety of minerals and those of the serpentine group were among them (fig. 2). This brilliant golden yellow and yellow-green, olive-green to black material was originally discarded; however, it was discovered that it took a high polish and it made an attractive stone for jewelry and carving. This material became a pleasing by-product of the limestone mining. George H. Merrill through microscopic analysis determined that the serpentine was an alteration product of pyroxene. Associated with the serpentine are dolomite, phlogopite, biotite, pyrite, tremolite, aragonite, calcite, feldspar, and diopside (Darton, 1883). Some of the diopside has been found to fluoresce in ultraviolet light. This locality is adjacent to and, partly, within a park so that it can be visited by hikers, but collecting is no longer allowed because the park managers wish to preserve this remarkable area for posterity (Harper, 2013, p. 201).

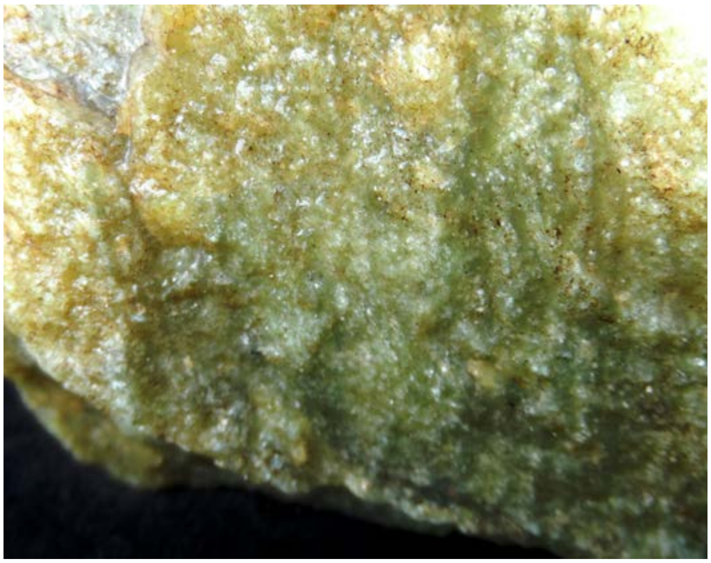


Figure 2. Serpentine, pyrite, and calcite from the Gordon Quarry, Turkey Mountain area, Montville Township, Morris County. *Photo by J.H. Dooley*

A serpentinite body crops out in Hoboken City, Hudson County, at Stevens Institute of Technology, Castle Point. Here it is a blue-green variety. It is not compact enough for general industrial use, but it was used to provide facing and trim for the Weehawken Public Library (Harper, 2013, p. 67). Associated with the serpentine here are brucite, calcite, chromite, deweylite, hydromagnesite, magnesite, and mestite, an iron-rich magnesite (Chester, 1900, p. 186-8). The chromite here occurred in minute crystals and was too sparse for mining. Harper (2013, p. 163-4) suggests that the presence of chromite points to a deep-sea origin for this body. Many years ago I was given a small piece of this serpentine, which I cut and polished. It exhibited an attractive chatoyant quality due to its translucent and fibrous character.

Other areas in the New Jersey Highlands have serpentine in places where the rock has undergone metamorphism which has altered such minerals as pyroxene, rhodonite, or phlogopite. Franklin Boro, Sussex County, is one such area. At the Buckwheat Mine, ornamental stone was cut from some of the serpentine (Palache, 1935, p. 117). Locally this mineral was called *smithsonite*, a term no longer employed for this mineral. A manganiferous variety of serpentine named *vorhauserite* (chrysotile) was found at Franklin; Palache believes that "the name is justified by the fact that the analyses of serpentine listed in *Dana's System of Mineralogy* that of vorhauserite is the only one that shows manganese oxide" (Palache, 1935, p. 117). Dunn (1995. p. 484-5) lists the important serpentine minerals of the area as clinochrysotile, lizardite and orthochrysotile. "Franklin serpentines commonly are late-stage vein minerals and accompany willemite, dolomite, and Mn carbonates" (Dunn, 1995, p. 484). Many years ago, while digging in the Trotter Mine Tailings, I found and later cut and polished a dark green variety of serpentine which had phlogopite inclusions. It had some white veins and the piece resembled *verde antique.* One may yet find specimens of serpentine at the Buckwheat Tailings, where collecting is permitted for a fee, as well as at the Sterling Hill Mine Tailings. The Hamburg Quarry is open to mineral clubs for collecting on special occasions and serpentine group minerals can be found here. Elsewhere in the Highlands it can be discovered at rock outcrops. *One must respect the rights of property owners and remember not to trespass when collecting*.

REFERENCES

Bayley, W.S., 1941, *Pre-Cambrian Geology and Mineral Resources of the Delaware Water Gap and Easton Quadrangles, New Jersey and Pennsylvania,* Bulletin 920. U.S. Geological Survey, Washington, D.C.: p. 1-98

Bonewitz, R.L., 2008, *Rock and Gem: Smithsonian Project,* ed. by J. Laing, New York: D.K. Publishing Inc., p. 256-7.

Chester, A.H., 1901, Mineral Notes and Explorations, *in Annual Report of the State Geologist for the Year 1900,* Trenton, N.J.: MacCrellish & Quigley, p. 173-188.

Darton, N.H., 1883, On the Mineralogical Localities in and around New York City, The Gem Serpentines of Montville, New Jersey, Part IV, *Scientific American Supplement.* v. XVI, no. 416. *In* Daniel Russell, 2007.

Dunn, P.J.,1995, *Franklin and Sterling Hill, New Jersey: the world's most magnificent mineral deposits*, Ogdensburg: The Franklin-Ogdensburg Mineralogical Society, part four, p. 484-5.

Gaines, R.V., H.C.W. Skinner, E.E. Foord, B. Mason, A. Rosenzweig, and V.T. King, 1997, *Dana's New Mineralogy,* 8th Ed. New York: John Wiley & Sons, p. 1415-16, 1418-20, 1428-30.

Harper, D.P., 2013, *Roadside Geology of N.J.:* Missoula, MT: Mountain Press Publishing Co., p. 67,163-4, 201.

Palache. C., 1974, *The Minerals of Franklin and Sterling Hill, Sussex County, New Jersey,* Geological Survey Professional Paper 18. Washington: United States Printing Office, 1935, reprinted by the Franklin-Ogdensburg Mineralogical Society, p. 117.

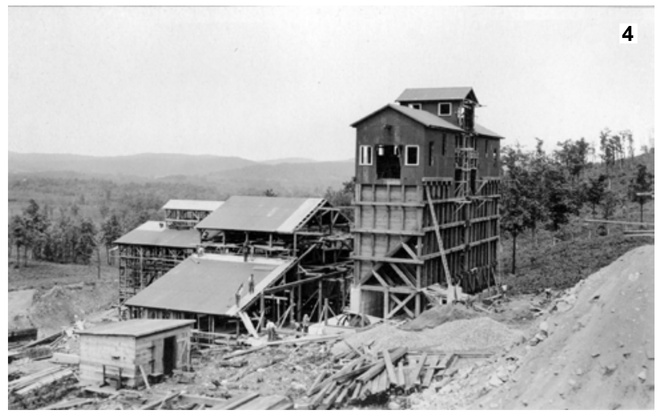
Peck, F.B., 1905, The Talc Deposits of Phillipsburg, New Jersey and Easton, Pennsylvania. *The Annual Report of the State Geologist for the Year 1904,* Trenton, N. J.: MacCrellish and Quigley, p. 161-185.

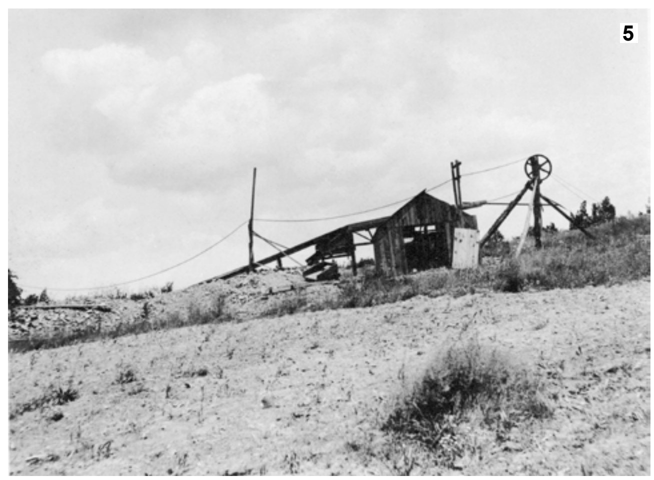
FROM THE ARCHIVES: ORE MINING IN NEW JERSEY

By Ted Pallis

The mining industry in New Jersey dates to the 1600's when Dutch settlers mined copper along the Delaware River in Warren County. One of the earliest iron mines in North America, the Mount Hope Mine, circa 1710, was located in Rockaway Township, Morris County. In the years following the American Revolution, New Jersey was a leader in the iron ore industry, ranking fourth in the nation for the amount of iron ore mined in a single year (932,762 tons in 1882). Surface-mined ores in the Mesabi Range of Minnesota made it difficult for the older, deeper iron mines in New Jersey to financially compete. In spite of this, mining continued in New Jersey for about another 100 years and finally coming to an end in 1986, with the closing of the last operating underground mine in the state, the Sterling Hill Zinc Mine.

There were approximately 600 underground mines in New Jersey, excavating eight different ores (copper, graphite, iron, lead, mica, manganese, uranium and zinc). All are now abandoned.





Photos: 1) Arlington Copper Mine entrance and smelting furnace, North Arlington Boro, Bergen County, 1927. *Photo by A. Marino*; 2) Annandale Graphite Corporation, graphite mine, Clinton Township, Hunterdon County, note vertical cleavage and hillside creep, 1928. *NJGWS archives;* 3) Largest opening of manganese mine near Annandale, 1918. *NJGWS archives;* 4) Scrub Oaks Mine showing mill, ore bins and concentrating mill, Mine Hill Township, Morris County, 1918. *NJGWS archives;* 5) Griggstown Copper Mine, surface houses, Franklin Township, Somerset County, 1905. *Photo by H.B. Kümmel;* 6) Sterling Hill Zinc Mine, Odgensburg Boro, Sussex County, 1947, *NJGWS archives*

NEW PUBLICATIONS

TECHNICAL MEMORANDUM (TM)

NEW REPORT. TM 13-3, Using the Stream Low Flow Margin Method to Assess Water Availability in New Jersey's Water-Table-Aquifer Systems, Domber, Steven, Snook, Ian and Hoffman, Jeffrey L., 2013, 76 pages., 7 figures, and 2 tables.

NEW REPORT. TM 13-4, Changes in Groundwater Recharge Resulting from Development in Atlantic, Mercer and Sussex Counties, New Jersey, 1995-2007, Thompson, Charles and Hoffman, Jeffrey L., 2013, 15 pages, 6 illus., 8 tables, and 1 appendix.

GEOLOGIC MAP SERIES (GMS)

NEW MAP. GMS 13-3, Bedrock Geologic Map of the Franklin Quadrangle, Sussex and Morris Counties, New Jersey, Volkert, Richard A. and Monteverde, Donald H., 2013, scale 1 to 24,000, size 36x60, 2 cross-sections, and 4 figures. $10.00.

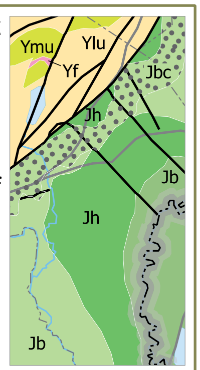
NEW MAP. GMS 13-4, Bedrock Geologic Map of the Newfoundland Quadrangle, Passaic, Morris and Sussex Counties, New Jersey, Volkert, Richard A., Herman, Gregory C., and Monteverde, Donald H., 2013, scale 1 to 24,000, size 34x60, 2 cross-sections, and 6 figures. $10.00.

NEW MAP. GMS 13-5, Bedrock Geologic Map of the Plainfield Quadrangle, Union, Middlesex and Somerset Counties, New Jersey, Volkert, Richard A., Monteverde, Donald H., and Silvestri, Shay Maria, 2013, scale 1 to 24,000, size 30x50, 1 cross-section, and 4 figures. $10.00.

NEW MAP. GMS 14-1, Geologic Map of the Hopewell Quadrangle, Hunterdon, Mercer, and Somerset Counties, New Jersey, Monteverde, Donald H., Herman, Gregory C., and Stanford, Scott D., 2014, scale 1 to 24,000, size 35x48, 1 cross-section, and 3 figures. $10.00.

NEW MAP. GMS 14-2, Bedrock Geologic Map of the Keyport Quadrangle, Middlesex and Monmouth Counties, New Jersey, Sugarman, Peter J., Stanford, Scott D., Muller, Frederick L., and Hlavaty, Corie, 2014, scale 1 to 24,000, size 34x60, 3 cross-sections, and 10 figures. $10.00

Serpentine is not a single mineral but a polymorphic group. Members of this group have the same essential chemistry but different structures. They originate in metamorphic alterations of peridotite and pyroxene. The primary division of serpentine is into two groups: antigorite, the more solid forms, and chrysotile, the more fibrous forms, especially asbestos.



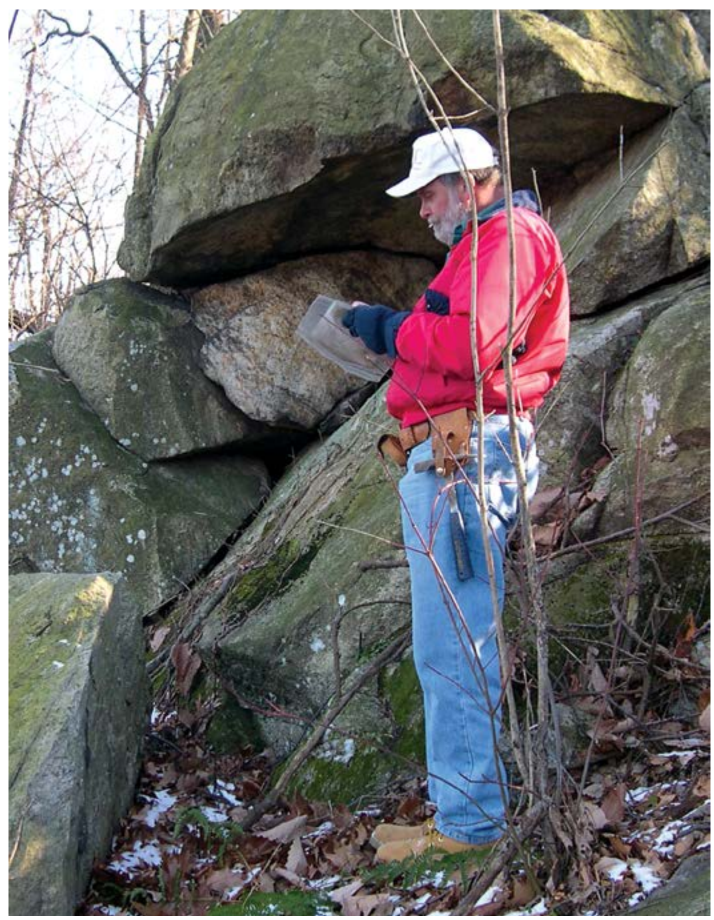
Banner photos by J.H. Dooley

FAREWELL, OLD FRIEND

Richard A. Volkert retired as a Research Scientist in June after 30 years with the New Jersey Geological and Water Survey. Rich began his career at the Survey's Bureau of Groundwater Resources Evaluation in the Spring of 1984. By Fall, he had moved into the Bureau of Geology and Topography and commenced his major work assignment: to remap in detail the bedrock of New Jersey, a project last completed in 1910.

The crystalline rocks of the New Jersey Highlands became his stomping grounds under the auspices of COGEOMAP, a cooperative mapping program with the U.S. Geological Survey (USGS) to produce a 1:100,000-scale bedrock map, published in 1996. Rich's expertise next led him to investigate the sedimentary and igneous rift deposits of the Newark Basin under the USGS-funded STATEMAP geological mapping program and produce detailed 1:24,000-scale geologic quadrangle maps. Rich's work is visible on his 31 published maps under STATEMAP funding. As a State employee, Rich was involved in many other projects owing to his geological knowledge. These included geologic hazards such as landslides, sinkholes, mine collapses, radon, asbestos and arsenic. Rich also discovered the oldest rocks in the state (1.37 billion years old) and the oldest known fossil (1.29 billion years old).

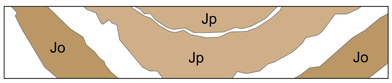
Rich is known for his ability to spread his geological knowledge and enthusiasm to the public. He gave talks to the



Rich Volkert mapping Musconetcong Mountain, Bloomsbury Boro, Hunterdon County. *Photo by Z. Allen-Lafayette*

Philadelphia Geological Society, Association of Engineering Geologists and the New Jersey Earth Science Teachers Association, to name a few, as well as leading numerous field trips for the public at the Morris County Park System, Weiss Ecology Center, and Round Valley Recreation Area. He has been a frequent trip leader for the Geological Association of New Jersey's annual field trips. Rich is well respected in the geological professional community as noted by his election as a Fellow of the Geological Society of America in 1999. He has published numerous geological articles that explain the formation and evolution of the New Jersey Highlands, a Grenville terrain that underwent diverse metamorphic and deformational events.

His retirement leaves a significant knowledge gap at the Survey.



HELLO, NEW FRIENDS

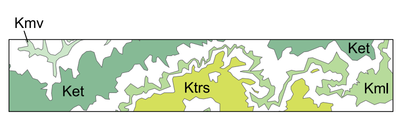
Michelle Kuhn

We are pleased to announce the addition of Michelle Kuhn into the New Jersey Geological and Water Survey (NJGWS) as an Assistant Geologist. Michelle joins NJGWS after serving nearly a decade in the Pennsylvania Army National Guard. She was honored for her service on four separate occasions. One of those honors was the *Meritorious Service Medal* for outstanding service during Operation Iraqi Freedom. In 2013, Michelle started her career at NJGWS as a part-time employee and has already proven herself to be highly effective in the field. She has been assigned to several projects, including the NJGWS-BOEM Off-shore Sand Cooperative Study, a two-year offshore sand resource project, funded in part by the U.S. Bureau of Ocean Energy Management.

Foram Desai

Foram Desai is the New Jersey Geological and Water Survey's newest employee. She started in June as an Environmental Engineer. Desai is a graduate of the Sardar Vallabhbhai Patel National Institute of Technology in Surat, India with an undergraduate degree in civil engineering and a masters in water resource engineering. She will apply her talents to modeling water-distribution-system hydraulics and other water-supply planning issues.

Foram Desai, *above*, standing next to Crystal Springs in Laurel Springs, Camden County. *Photo by J.L. Hoffman.* Michelle Kuhn, *left,* in Stockton Boro, Hunterdon County, preparing to use ground penetrating radar. *Photo by K. Vandegrift*



*The capacity to blunder slightly
is the real marvel of DNA.
Without this special attribute,
we would still be an aerobic bacteria
and there would be no music.*

*-- Lewis Thomas (1913-1993)
physician, poet*

Figure 1. NJGWS staff provided a sand-and-water workshop for the children and parents who partcipated in the *Take Our Kids To Work Day* activities sponsored by the Department of Environmental Protection. *Photo by K. Edwards*

NJGWS OUTREACH

By Karen Edwards

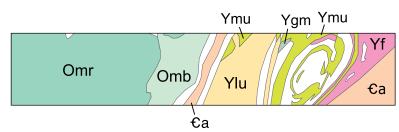
In celebration of Earth Week, NJGWS sprang into action by participating in three community outreach events: (1) *Trenton Litter March* at Ewing, (2) *Take Our Kids to Work Day*, at DEP Headquarters in Trenton and (3) the *Barnegat Bay Blitz* in Ocean and Monmouth Counties.

On April 16th, donned with gloves, and *Keeping Trenton Clean* T-shirts, members of NJGWS and NJDEP Radiation Protection Program participated in the 27th annual *Clean Communities Litter March*. The groups led by department coordinators Kathleen Vandegrift and Jennifer Daino collectively filled 22 bags of litter from the surrounding Arctic Parkway campus, placing third in the adult category for the most trash bags collected from a single site. NJGWS participants included: Zehdreh Allen-Lafayette, Jim Boyle, Laura Brachfeld, Karen Edwards, Mark Godfrey, Karl Muessig, Ted Pallis, Dave Pasicznyk, Alexandra Petriman, Jane Uptegrove and Kathleen Vandegrift.

It was *A Day at the Beach* with mini Frisbees and ice pops for more than 75 children and their parents who participated in NJGWS sand-and-water workshop during the April 24th *Take Our Kids To Work Day* at DEP (fig. 1). Clad in life guard T-shirts, Kathleen Vandegrift and Karen Edwards began the program with warm introductions. Rachel Filo and Michelle Kuhn explained the science behind sand: its origin, use and classifications, while students used sieves to sort grain size. Charlie Thompson kept things flowing with a stream table as he demonstrated water movement, sand transportation and erosion. Jane Uptegrove and John Dooley fine-tuned the groups' focus as children examined grains of sand through the lens of a microscope and also learned about NJGWS beach-replenishment efforts.

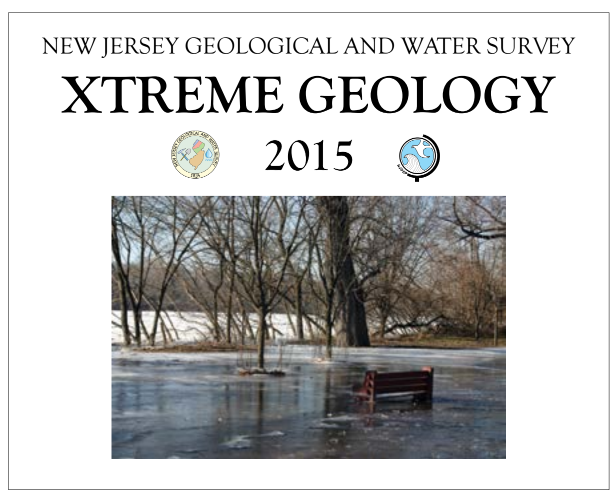
In support of the department's commitment to protect and restore the Bay area, NJDEP Assistant Commissioner, Dan Kennedy lent a hand as he, along with NJGWS staff: Karen Edwards, Rachel Filo, Bill Graff, Michelle Kuhn, Karl Muessig, and Kathleen Vandegrift picked up litter and debris on April 25th, at Ship Bottom, during the fifth annual *Barnegat Bay Blitz*, (fig. 2). Their efforts combined with those of thousands of other local volunteers covering 100 clean-up locations amounted to the collection of over 1,200 bags of garbage and recyclable material.

Figure 2. NJGWS staff participated in the fifth annual *Banegat Bay Blitz* to clean up and restore the Bay. *Photo by K. Edwards*



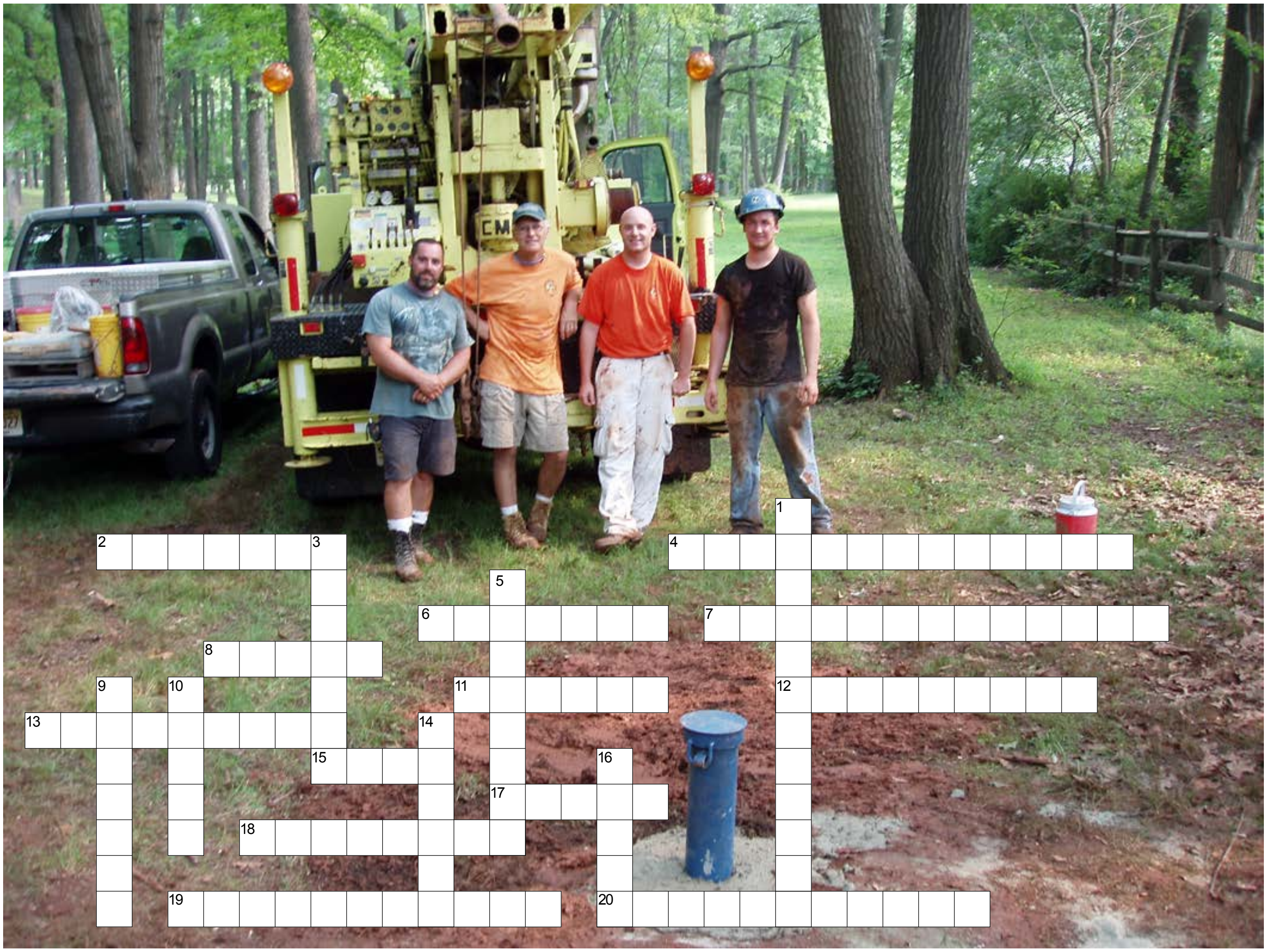
NJGWS 2015 CALENDAR

The 2015 NJGWS calendar will be month-at-a-time format and digital, available for download from our website. Part of this package will be a folder of photos from the calendar that can be run as a desktop slide show. The theme this year is *xtreme* geology; these events range from beach erosion to rockslides to volcanoes (that's right, volcanoes in New Jersey -- not currently active, of course).



The NJGWS 2015 calendar theme is *xtreme* geology. These extreme events include ice jams such as the one featured on the cover, *above*, which caused the Delaware River to flood Trenton in January 2014.

CROSSWORD WELLS



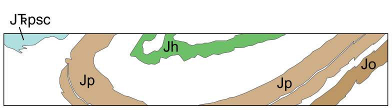
NJGWS drilling crew, *left to right*, Gregg Steidl, John Curran, Ray Bousenberry and Brian McCann, after installation of an Ambient Ground Water Quality Monitoring well (blue, in foreground), Roosevelt Park, Edison Township, Middlesex County. *Photo by M. Furco*

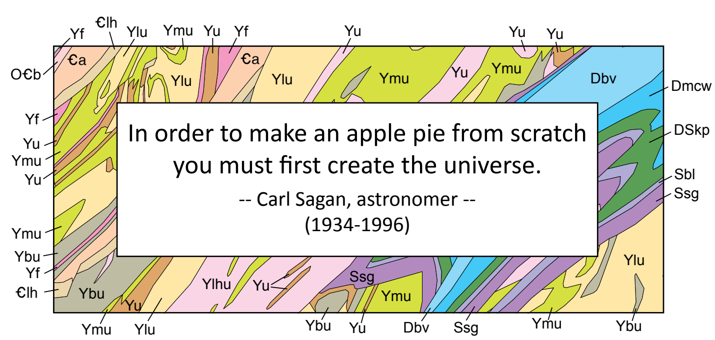
ACROSS

2. Rock solidified from magma
4. Systematic arrangement of the sequence of rock layers
6. Science dealing with the development of the earth's crust
7. Containing manganese
8. Ratio between a map and the world
11. Formal lithostratigraphic unit next in rank below a formation
12. Reduced clarity of a fluid
13. Series of actions
15. Igneous intrusion cutting across bedding
17. Book of maps
18. Geologic mapping projects program
19. Horizontal positions of natural features
20. Horizontal and vertical positions of natural features

DOWN

1. Metal detector
3. Means by which fragments are removed from rock by weather
5. Program of cooperative geologic mapping
9. Field visit to sample well
10. Preliminary survey
14. License
16. Discrete surface separating two rock masses across which one slides past the other





CROSSWORD PUZZLE ANSWERS. Across: (2) igneous, (4) stratigraphic, (6) geology, (7) manganiferous, (8) scale, (11) member, (12) turbidity, (13) procedure, (15) dike, (17) atlas, (18) STATEMAP, (19) planimetric, (20) topographic. **Down:** (1) Magnetometer, (3) spalled, (5) COGEOMAP, (9) monitor, (10) recon, (14) permit, (16) fault.