UNEARTHING NEW JERSEY

NEW JERSEY GEOLOGICAL AND WATER SURVEY Vol. 9, No. 1 Winter/Spring 2013
Department of Environmental Protection

MESSAGE FROM THE STATE GEOLOGIST

For nearly 20 years before "Superstorm Sandy" entered the consciousness of New Jerseyans, the Survey actively collected offshore sand resource information. We have described the locations and volumes of sand resources appropriate for beach replenishment activities. Contrary to common belief, all sand located under the ocean surface is not the same and all is not suitable for these publically-funded projects. As a result of this we are tasked with exploring the ocean floor in search of sand with an appropriate location, volume and grain size for onshore sand replenishment activities to last the designed 50-year-lifespans.

Under the direction of NJDEP's Office of Engineering and Construction, and in cooperation with the U.S. Army Corps of Engineers (USACE), we acquire reconnaissance-level sand resource data. Our surveys save NJDEP and USACE exploration time and money; and we develop a regional analysis which gives us predictive power about *where* to look and *what* we will find.

The program has three main components: (1) high-resolution seismic profiling; (2) drilling of shallow (20-ft-deep) offshore sediment cores; and (3) synthesis of these data for sand resource assessments to develop a geologic framework of the offshore in the form of published maps. We have identified as much as 400 million cubic yards of sand in approximately 32 shoals offshore of New Jersey. As a reference point, the total sand replenishment needs in our state, post-Hurricane Sandy, is estimated to be approximately 50-100 million cubic yards.

Offshore seismic and/or vibracore data collection occurs once every two years, with the off-year dedicated to data analysis and documentation of results. When Hurricane Sandy hit hard in late 2012, our tenth offshore seismic exploration took on a more significant urgency. From mid-June to early July, with assistance from Rutgers University, we targeted shoal features in waters extending up to about eight miles offshore along the section of the coast between Barnegat and Manasquan Inlets. Onshore communities and parks along this stretch of coastline include Island Beach State Park, Seaside Park, Seaside Heights, Lavallette, Bay Head, Mantoloking, and Point Pleasant. Over 330 line miles of high-resolution seismic data were collected, which NJGWS and the Rutgers University scientists are now beginning to analyze.

A long-term benefit of this program is development of a geologic framework for offshore New Jersey in the form of published maps. We recently published an offshore geologic map depicting data from previous voyages, the new "Geology

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KORNERUPINE: A RARE AND UNUSUAL MINERAL FROM THE NEW JERSEY HIGHLANDS

By Richard A. Volkert

Sometimes it's easy to believe that nothing new or exciting awaits discovery in the New Jersey Highlands because the rocks have been the subject of geologic study for nearly 200 years. Most days spent doing field work in the Highlands end uneventfully. But on those rare days when an unusual or extraordinary geologic feature is encountered, the realization sets in that the ancient rocks of the Highlands are giving up another of their long-held secrets.

Such was the case in January 2008 when an outcrop of gneiss in the Ringwood area (fig. 1) was about to become just another data point for the geologic map I was making. Conspicuous on the undersurface of the outcrop was a 3-inch-long group of dark greenish-gray prismatic crystals, the largest of which was about one inch long (fig. 2). Closer examination of the outcrop, and of numerous surrounding outcrops, revealed no additional crystals, making this find analogous to locating a "needle in a haystack." Preliminary field identification of the crystals with a hand lens indicated that the mineral was in the tourmaline family, but did not permit a more precise identification. Subsequent X-ray diffraction analysis, performed by New Jersey Geological and Water Survey colleagues John Dooley and Larry Müller, identified the mineral as kornerupine (pronounced "corner-oo-peen") based on the arrangement of atoms in its crystal structure.

Kornerupine, is a complex magnesium aluminum iron borosilicate that has the chemical formula (Mg, Fe^{2+})$_4$ (Al,

Figure 1. Outcrop of gneiss in the Ringwood area. Pencil points to dark-colored kornerupine crystals in the rock. *Photo by R.A. Volkert*

Figure 2. Undersurface of an outcrop showing a group of 3-inch-long dark greenish-gray prismatic crystals of Kornerupine. *Photo by R.A. Volkert*

$Fe^{3+})_6$ $(Si, Al, B)_5$ O_{21} (OH). Kornerupine is used as both a specific mineral name, and as a name for a group of borosilicate minerals such as prismatine and grandidierite that have a kornerupine-like orthorhombic crystal structure. Characterization and refinement of the chemical crystallography of kornerupine was accomplished by the work of Paul Moore and colleagues (Moore and Bennett, 1968; Moore and others, 1989). The name kornerupine is typically applied to minerals in this group that have a boron content of less than 0.5 atoms per formula unit. Prismatine and grandidierite both contain considerably more boron than kornerupine, so they have more than 0.5 atoms per formula unit of boron in their crystal structure.

Kornerupine is not a common mineral, but it is known from about 70 locations worldwide in Australia, South Africa, Canada, Asia, Scandanavia, India, and the United States. The type locality is in southwest Greenland, at Fiskenaes, in the Nuuk area. In the U.S. it is known only from localities in Utah, and the Adirondack Mountains in New York and in New Jersey. It has been found in only two locations in New Jersey, both of which are in the Highlands Province (fig. 3). Because the of high temperature required for its formation, it would not be expected in rocks outside of the Highlands.

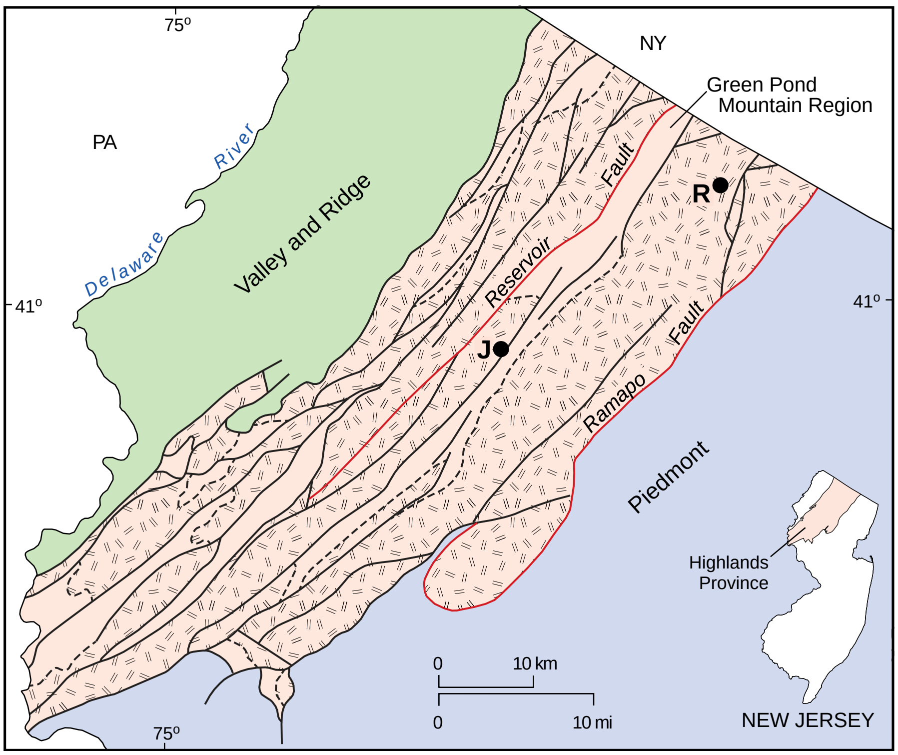

Figure 3. Kornerupine has been found in two locations in New Jersey, "J" and "R". Both are in the Highlands Province.

The first find of kornerupine in New Jersey was in 1969 at Mase Mountain in Jefferson Township by Davis Young during field work for his PhD dissertation. Both kornerupine and prismatine were observed in the gneiss from Mase Mountain. The details of this occurrence were eventually published (Young, 1995). The second find was in 2008 in Ringwood Township during bedrock geologic mapping by the author. Thus far only kornerupine has been recognized from this locality.

Kornerupine is of considerable interest to geologists because it occurs only in rocks that have undergone metamorphism at high temperature and moderate pressure. The kornerupine-bearing gneiss at both New Jersey localities was formed initially from sediments that were deposited about 1,250 to 1,300-million years ago. Metamorphism of the original sandy sediments, the protolith of the gneiss, took place 1,045 to 1,023 million years ago (Volkert and others, 2010), at which time the sediments were converted into a new mineral assemblage that includes quartz, feldspar, biotite, garnet, magnetite, and kornerupine.

The source of the boron in the gneiss that was ultimately responsible for the formation of the kornerupine is a question that is not easily answered. However, the answer would provide a tantalizing glimpse into the environment of the Highlands more than 1 billion years ago. But, as with most things in science, the answer to important questions is seldom straightforward. The boron may be from a source outside the host rock. That is, it may have been introduced into the permeable sediments of the gneiss protolith via a boron-rich fluid, possibly from a hydrothermal source. The presence of magnetite deposits close to the Ringwood locality provides some support for this interpretation because the ore in these deposits contains metals that suggest they

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may have formed from a hydrothermal fluid. Alternatively, the boron may have been derived from a source internal to the rock. Dravitic tourmaline occurs in some gneiss in the Highlands formed from metamorphosed sediments. Breakdown of the tourmaline by chemical reactions related to partial melting of the gneiss during metamorphism would produce kornerupine as part of the new mineral assemblage. This interpretation is supported by the fact the kornerupine is mainly in the coarser-grained part of the rock that was formed during metamorphism through partial melting of finer-grained gneiss. Either of these interpretations adequately accounts for the origin of the kornerupine. Future work might involve the use of boron isotope analysis that would provide information on the source of the boron and enable a choice to be made from among these two interpretations. At least for now, however, the origin of the rare and unusual mineral kornerupine in the Highlands will have to remain a mystery.

Just how many additional secrets the ancient rocks of the New Jersey Highlands will continue to share is unknown. One thing is certain, and that is that more discoveries will likely await those who have the patience and persistence to seek them out. Or, in the words of the fifth century Greek dramatist Euripides, "leave no stone unturned."

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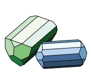

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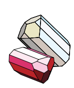

NJGWS STUDIES NEW JERSEY SPRINGS

By Ted Pallis and Steven Domber

Springs are discrete areas where groundwater discharges to the land surface. They range in size from small drips to large streams. Some flow only intermittently after heavy rains, others flow throughout the year. Springs can discharge clear cold water or warm mineral-rich water depending primarily on the local geology. In New Jersey, springs are small to moderate in size and the largest discharge as much as 16 million gallons per day. The temperature of spring water is about 50°F. Water chemistry varies depending on the local geologic setting. Springs "collect" water to discharge so they are good indicators of shallow-ground-water quality.

Despite the small size of their source areas and discharge volumes, springs are an important part of the New Jersey landscape. They served as some of the first water supplies for Native Americans, European explorers, early settlers and towns. Today, sometimes the spring house or stone pool is the only sign that a farmstead once stood nearby. Currently, there are no public water systems using springs as a water supply source.

Figure 1. Schooley's Mountain Spring before road expansion. *Photo courtesy of Washington Township Historical Society*

Because springs can appear almost magically out of nowhere, they commonly developed a folklore about them. One of the more infamous springs is the Blue Hole at Inskeep, in Monroe Township, Gloucester County, in the heart of the New Jersey Pinelands. Here children were warned not to swim in the cold blue water so different from the adjacent tannic-stained creeks, because the Jersey Devil was said to swim up from its underground lair to capture unsuspecting swimmers.

Another spring with a more respectable reputation was Schooley's Mountain Spring, in Washington Township, Morris County (fig. 1). It was reported to be a very small iron-rich or chalybeate spring that was thought to treat ailments such as anemia (Moorman, 1873). Native Americans told the local settlers of the healing powers of the spring water and word soon spread to the nearby cities of Newark, Paterson, New York, and beyond. It became so popular in the late 1700s and 1800s that a resort industry developed in the area. The Heath House opened its doors in 1793 near the spring and is one of the first summer resorts in North America (N.Y. Times, July 13, 1890). The spring and spring house are gone, a victim of a road-widening project in the 1930's. And all that's left of the many hotels are a few stone foundations.

By the early 1900's, New Jersey's mineral springs and associated resorts were all gone, but bottled spring water was in great demand. A belief that public-drinking-water supplies of many of New Jersey's and New York's cities were polluted fueled the remarkable growth of the mineral-water trade. Springs at this time were considered a practically guaranteed source of safe-to-drink water. In 1923, 13 New Jersey spring waters were being bottled and sold (fig. 2) for a total output of 507,680 gallons (Twitchell, 1924). Today, there

Figure 2. Water bottle from the Palisades Spring Water Company, c. 1890. *Photo by Z. Allen-Lafayette*

are five springs where water is actively being bottled and sold under various labels.

Springs typically are unique habitats that support a broad range of ecologic features. Many provide a consistent source of cold water to nearby surface-water bodies and a refuge during warm weather; others are a seasonal source of water for breeding or refuge. Some of the largest springs were utilized for raising trout, such as those at the Musky Trout Hatchery, Asbury (fig. 3) the Musky Trout Hatchery, Alpha, and the Charles O. Hayford Hatchery in Hackettstown. All three are in Warren County. Also, there once was a small spring fed hatchery near the Manasquan River in Howell Twp., Monmouth County. Other springs are known to support rare and endangered plant and animal species. Some, such as a hanging garden spring (fig. 4), Alexandria Twp., Hunterdon County, are interesting because of their particular geologic setting. All springs are important features for watersheds because they serve as sources of fresh water to headwater wetlands and streams.

Figure 3. Spring-fed pools filled with golden trout at the Musky Trout Hatchery, Asbury, Franklin Twp., Warren County. *Photo by T. Pallis*

Figure 4. Water sample taken at a hanging garden spring by Research Scientist Steve Spayd. *Photo by G. Herman*

Traditionally, springs were either characterized by their discharge rate or water chemistry; for example, mineral springs. One of the more elaborate mineral-spring classifications was devised by A.C. Peale in 1894. He classified springs using terms such as; chalybeate: containing iron, saline, sulfur, lime, gypsum, borax, and oil. Cures for ailments where often associated with one or more of these mineral spring types. In 1927, O.E. Meinzer published a report on “Large Springs in the United States” in which he classified spring discharge using Spring Magnitude; sometimes referred to as order (table 1). Despite these longstanding reports it was not until the late 1990s that classification schemes developed that encompassed the large range of functions that springs provide (Alfaro and Wallace, 2004; Springer and others, 2008).

Magnitude	Discharge Rate
1st Magnitude	> 100 cfs
2nd Magnitude	< 100 to > 10 cfs
3rd Magnitude	< 10 to > 1 cfs
4th Magnitude	< 1 cfs to > 100 gal/min
5th Magnitude	< 100 to > 10 gal/min
6th Magnitude	< 10 to > 1 gal/min
7th Magnitude	< 1 gal/min to > 1 pint/min
8th Magnitude	< 1 pint/min

Table 1. Meinzer’s spring-discharge-magnitude classification. (cfs = cubic feet per second)

It’s surprising that with such a broad spectrum of historic and current uses, so little has been written about or done to formally characterize and document springs in New Jersey. To address this shortfall, the New Jersey Geological and Water Survey (NJGWS) has undertaken a three-phase project to identify and classify springs and seeps (areas, generally small, where water percolates slowly to the land surface) in New Jersey. The primary goals of this research are to document their presence and identify and characterize their geologic, hydrologic, ecologic and socio-cultural importance. The project is part of a larger “Wetland Condition Assessment and Monitoring Study in New Jersey” funded by an EPA Region 2 Wetland Program Development Grant. Phase 1 of the project consists of identifying the location of springs and seeps in NJ from a review of reports, databases, and local knowledge. Phase 2 of the project consists of developing a classification scheme that recognizes the diverse hydrologic, ecologic, and socio-cultural role that springs serve and a database to archive the information collected in Phases 1 and 3. Phase 3 of the project is a detailed assessment and monitoring of a subset of springs covering a range of geologic and geomorphic settings.

To date, the NJGWS has identified more than 500 known or possible springs and seeps in New Jersey based on a search of reports, databases, and websites; and on contacts with geologic, hydrologic, and ecologic professionals as part of Phase 1. The list continues to grow. For Phase 2, the New Jersey Springs Database continues to develop, maintain, and manage the information that NJGWS collects as part of this study. The database contains a “Site” table that

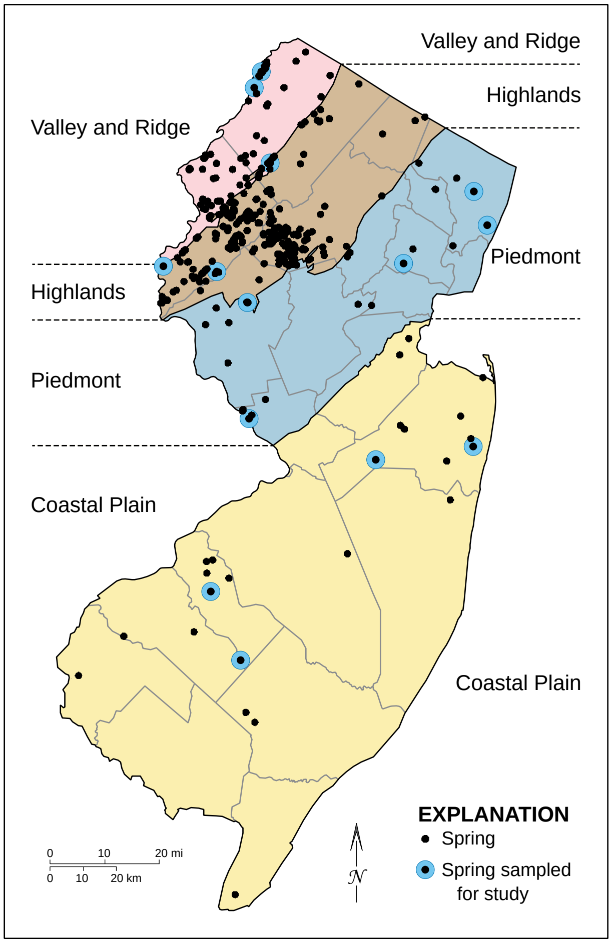

Figure 5. Map of New Jersey showing known springs and springs sampled by the NJGWS.

records the location, general description, and other basic information on each spring. Each spring in this table is also linked to one or more detail tables that contain more specific information, if available, such as discharge rate, discharge characteristics, ecology, geology, geomorphic setting, and socio-cultural development. The database structure is loosely based upon the concepts developed by the Springs Stewardship Institute in Flagstaff, Arizona. Field visits to more than 40 springs provided the more detailed information for the tables in the New Jersey Springs Database. Currently, 14 springs have been selected for quarterly monitoring as part of Phase 3 of the study (fig. 5). These one-year detailed assessments include hourly temperature-data collection, quarterly water-quality measurement of temperature, pH, specific conductivity, total dissolved solids, dissolved oxygen and periodic flow.

With a few exceptions and despite their obvious significance to geology, hydrology, ecology, and cultural and economic well-being, springs have been broadly ignored as research subjects. The lack of scientific attention to springs has contributed to inadequate management and education about these important ecosystems, and has helped lead to their under-appreciation and even degradation.

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$Na\,(Li,Al)_3Al_6(BO_3)_3Si_6O_{18}\,(OH)_4$

TOURMALINE IN NEW JERSEY

By Larry Müller

When typical mineral enthusiasts hear talk of tourmaline, their thoughts usually travel to Brazil, the Carolinas, New England, or California where brilliant gem-quality tourmalines are found. The student of geology knows, however, there is abundant tourmaline in New Jersey. Tourmaline is found in the contact-metamorphic rocks of the Piedmont and the metamorphic rocks of the Highlands Province. The significant deposits of heavy minerals (those minerals of a higher specific gravity than quartz) in the New Jersey Coastal Plain contain abundant tourmaline. Most of New Jersey tourmalines are small and semi-lucent rendering them unsuitable for jewelry.

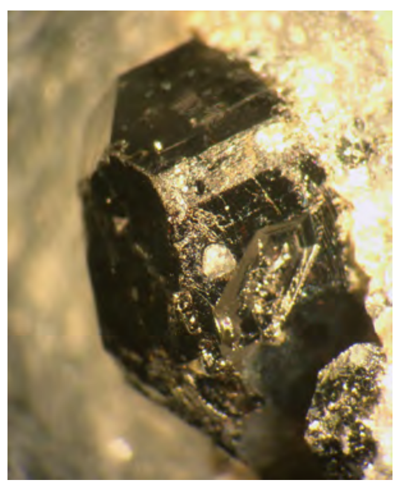

Figure 1. Tourmaline from Moore's Station, Hopewell Twp, Mercer County, adjacent to contact with the intrusive diabase. The long axis of the crystal is approximately 1 centimeter in length. *Photo by J. Dooley*

Tourmaline is the name of a group of borosilicate minerals of slightly differing chemical compositions. Dana and Dana (1977, p. 1264) shows that all contain boron, silica and hydroxide combined with different ions. These differences account for variation in physical properties such as color and hardness (a hardness range of 7.0-7.5 on the Mohs' scale where 1 is the softest minerals and 10 is the hardest). The tourmaline group consists of five subgroups: alkali-deficient, calcic, ferric, lithian, and sodic tourmaline.

The dominant tourmalines found in New Jersey are sodic: *dravite,* $NaFe_{2/3}Al_6(BO_3)_3Si_3O_{18}(OH)_3(OH)$, *shorl*, $NaMg_3(Al_6(BO_3)_3(OH)_3OH$, and a calcic tourmaline, *uvite*, $CaMg_3(Al_5Mg)(BO_3)Si_3O_{18}(OH)_3OH$. Minor amounts of *elbaite*, a lithian tourmaline, have been found in the heavy mineral sands of the Coastal Plain.

Tourmaline color is varied with many hues and intensities. For example, the lithian tourmaline *elbaite* may be colorless *achroite;* blue, *indicolite;* pink and green *elbaite* and *rubellite*; and *shorl*, black; whereas *dravite* and *uvite* are various shades of brown. The luster of tourmaline is vitreous to oily. The variety of colors and the mineral's hardness make it a desirable semi-precious gemstone. Tourmaline's hardness and specific gravity make it a common constituent in heavy-mineral sands. It has a conchoidal fracture (shell-like). Tourmaline occurs as a massive mineral; however it is commonly crystalline. The crystals are in the hexagonal system, and commonly are striated along the C-axis. Although most tourmaline does not fluoresce, *uvite* with low iron content, fluoresces a yellow to an orange-yellow in shortwave ultraviolet light (Dana and Dana, 1977, p. 1258).

The mineral is a common constituent in several of New Jersey's physiographic provinces. *Dravite,* a member of the sodic tourmaline subgroup, is prevalent in the Highlands Province in the Chestnut Hill Formation at an iron mine on Marble Mountain in Warren County. It occurs as clots in the tuffaceous sediment and hematite bands, and as layers in the hematite-rich rock (Volkert and others, 2010, p. 6). Southeast of this material, in the Bloomsbury Quadrangle, Warren and Hunterdon Counties, a pegmatite adjacent to a cornfield has *dravite* crystals, some of which have C-axis measuring four centimeters or more. To the north, in Sussex County, two tourmaline species are found in pegmatites. In the Franklin Mines and at Sterling Hill Mine, *dravite* is the common tourmaline whereas *shorl* is rarer. *Uvite* is found in the carbonates of Limecrest Quarry in the Sparta area (Dunn, 1995, p. 424-426). Here the tourmaline may occur as massive material or as fine euhedral crystals.

Tourmaline of the Piedmont Province occurs in vugs and vesicles, or in fissures in the contact metamorphic rock (hornfels) adjacent to the flows and intrusions of igneous rock. At Moore's Station, Mercer County, tourmaline occurs in both hornfels and syenite. In the voids, the crystals are euhedral and commonly equant. Elsewhere, fine acicular crystals with albite and chloritic minerals fill the voids. The tourmaline is found associated with zeolites and datolite (another borosilicate mineral). At abandoned copper prospects here, voids in the hornfels are completely infilled and some pop out of the rock, resembling double-O buck shot. The same occurrence and structure has been noted in hornfels at the Colonial Griggstown copper mine, Somerset County. Here tourmaline occurs in veins and along fracture surfaces. In heavy mineral suites of the Coastal Plain, tourmaline occurs as warm brown to black, fine sand grains. Many of the grains are translucent when viewed on a glass slide in transmitted light; other grains are opaque. They consist largely of *dravite* and *shorl*. These were studied in a heavy-mineral project at the New Jersey Geological and Water Survey. (My lab partner even discovered a "watermelon" *elbaite* euhedral crystal; I was not so fortunate).

Tourmaline is also helpful in gauging the maturity of heavy-mineral sands. If the heavy mineral suite is made up primarily of zircon, tourmaline and rutile, one can feel certain that one is dealing with mature sediment because these are the minerals most resistant to abrasion and chemical weathering. Geologists also use tourmaline to discover the history of the rock. The chemistry of tourmaline indicates the temperature and pressure under which the rock formed. The chemical composition of tourmaline crystals can also be indicative of the chemistry of the melt from which it was derived.

The foregoing is a brief summary of some of the sources which are relevant to the occurrence of tourmaline in New Jersey and its importance. The mines and their locations are all on private property. The Sterling Hill Mine and Franklin site are open to the public. Contact them for information before you plan your visit.

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Na $(Li,Al)_3Al_6(BO_3)_3Si_6O_{18}(OH)_4$

NJGWS OUTREACH

By Kathleen Vandegrift

The NJGWS continued its long tradition of outreach this April by participating in two events: "Science Day" at Dutch Neck School in West Windsor Township and "Bring Your Child to Work Day" at the DEP Headquarters in Trenton. At the April 12th Science Day event, NJGWS employees Helen Rancan, Corie Hlavaty, and Kathleen Vandegrift focused on teaching the science behind bubbles to about 80 eager third graders. Despite the dreary conditions outside, the

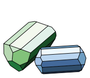
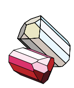
Figure 1. Corie Hlavaty (*left*) and Helen Rancan (*center*), of NJGWS, and a parent volunteer at Dutch Neck School, West Windsor Township, Mercer County, for Science Day. *Photo by K. Vandegrift*

Figure 2. Rachel Filo (*right*), of NJGWS, works with one of the Take Your Child to Work Day participants. *Photo by K. Vandegrift*

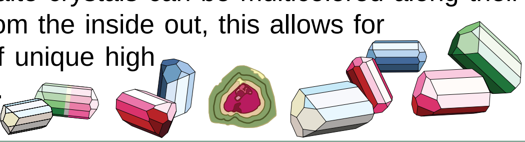
kids' enthusiasm to learn, experiment and ask questions was not dampened. The students not only learned about bubbles, but also about the scientific process as they began their research by formulating a hypothesis, conducting an experiment, and then drafting their conclusions.

On April 25th, NJGWS staff members Scott Lyons, Rachel Filo and Kathleen Vandegrift joined many of their DEP counterparts teaching workshops for "Take Your Child to Work Day". More than 75 children and their parents attended a class entitled "Rock and Roll: Travel Through the Lifetime of a Rock". Children were taught about the three major kinds of rocks, the rock cycle, and the makeup and structure of the earth. To help kids better understand how rocks are formed, the students used chocolate to create igneous, metamorphic and sedimentary rocks. Eating their newly created "rocks" was easily the most popular part of the day. Thanks to all NJGWS employees for lending the rock samples, tools and knowledge to our presenters.

NJGWS will continue its outreach by participating in the Barnegat Bay Blitz, in May.

 Na $(Li,Al)_3Al_6(BO_3)_3Si_6O_{18}(OH)_4$ 

All tourmalines have the same crystal structure, but each species has a unique chemical composition. Elbaite [Na $(Li,Al)_3Al_6(BO_3)_3Si_6O_{18}(OH)_4$] is the primary source for tourmaline gems. It was discovered on the Island of Elba, Italy, in 1913. It has been found in many parts of the world since then, including New Jersey. Elbaite exists in a variety of colors including green, blue, pink, red and colorless. Additionally elbaite crystals can be multicolored along their lengths or from the inside out, this allows for the cutting of unique high quality gems.



Jeff Waldner, *left*, and Jane Uptegrove, *right*, deploy high-resolution marine seismic source and hydrophones offshore Cape May. *Photo by A. Quant*

JEFF WALDNER SAILS ON TO BOEM

Research Scientist Jeff Waldner started working at the NJGWS in 1984. During his 28 years in the Survey's Geophysics Section, the focus of his work was on conducting subsurface investigations.During his early years, Jeff worked in the new field of high-resolution geophysics. Working with Survey geologist Jeff Hoffman, he developed HRASSED (High Resolution Analysis of Shallow Seismic Data), a computer program used in the analysis of high resolution seismic data. Jeff was also instrumental in organizing a *Seismic Shootout* in conjunction with other geophysicists from around the country, Canada and the Society of Exploration Geophysicists. The "shootout", the first of its kind, compared the effectiveness on seismic sources for high-resolution surveys, using such varied sources as weight-drops, explosives, and 8-gage and 50-caliber guns shot into the subsurface to generate seismic signals.

In response to State and Federal interest in offshore sand resources, Jeff, became part of NJGWS' Offshore Resource Exploration (ORE) group, tasked with locating and characterizing offshore sand resources. The ORE team conducted high-resolution marine seismic surveys and collected shallow vibracores along the New Jersey's Atlantic Coast.

Jeff's technical contributions include the technology-driven transformation of NJGWS' shallow marine seismic acquisition, processing, and archiving. Recently, this has included digital seismic processing and analysis and recovery/reformatting of older seismic data to our current processing platform. These advances support expedited sand resource characterization and public access to data.

Jeff was the lead in onshore geophysics investigations which the Survey started in the 1990's.

As manager of the NJGWS Intern program, Jeff felt strongly that interns should work on a wide array of geologic projects, to give them a competitive edge in the job market and more experience to draw on as they started their careers. Always a proponent of creating "win-win" situations, Jeff worked to combine the intern's talents to the needs of the Survey.

Jeff has taken a position with the U.S. Department of Interior, Bureau of Ocean Energy Management (BOEM), Marine Minerals Program in Herndon, VA.

$Na\ (Li,Al)_3Al_6(BO_3)_3Si_6O_{18}\ (OH)_4$

LAURA NICHOLSON PAINTS ON

Research Scientist Laura J. Nicholson retired from the New Jersey Geological and Water Survey after 25 years of public service. Laura's NJDEP career began in 1988 in the Wastewater Facilities Management Element. In 1989 Laura began her career at NJGWS working on the hydrogeologic framework of the Lamington Groundwater Model area, a cooperative Water Bond study with USGS. Following, Laura served as project chief and principal investigator for the Germany Flats Groundwater Model, a Water Bond project conducted by NJGWS. The Germany Flats model was later used to provide recommendations on the issuance of groundwater allocation permits and to predict impacts of quarry de-watering. Later in her career, Laura studied uses of temperature data from aquifer tests to better understand the site hydrogeology and she also studied soil and geologic factors leading towards the failure of stormwater control structures in areas underlain by limestone and dolostone. In her retirement Laura plans to pursue her hobbies including tennis, piano, and oil painting.

Laura Nicholson plans to spend part of her retirement time honing her painting skills. *Photo by S. Johnson*

NEW PUBLICATIONS

OPEN FILE REPORTS (OFR)

NEW MAP. OFR 13-1, History of Passing Flows in New Jersey, with Contemporary and Future Applications, Hoffman, Jeffrey L. and Domber, Steven E., 2013, 62 p, 6 illus., 7 tables, and 4 appendices. Available for download.

TECHNICAL MEMORANDUM (TM)

NEW MAP. TM 13-1, New Jersey Water Supply Planning Activities in 2012, Hoffman, Jeffrey L., 2013, 24 p., 8 illus., 5 tables. Available for download.

GEOLOGIC MAP SERIES (GMS)

NEW MAP. GMS 12-3, Geology of the New Jersey Offshore in the Vicinity of Barnegat Inlet and Long Beach Island, Uptegrove, Jane, Waldner, Jeffrey S., Stanford, Scott D., Monteverde, Donald H., Sheridan, Robert E., and Hall, David W., 2012, scale 1 to 80,000, sizes 33x50 and 36x51, 3 cross-sections, 22 figures, 5 tables, and a 13-page pamphlet. $10.00. Available for download.

NEW MAP. GMS 13-1, Aquifer Correlation Map of Monmouth and Ocean Counties, New Jersey, Sugarman, Peter J., Monteverde, Donald H., Boyle, James T., and Domber, Steven E., 2013, scale 1 to 150,000, 3 plates each size 36x48, 11 cross-sections, 2 figures, and 2 tables. $10.00. Available for download.

OPEN-FILE MAPS (OFM)

NEW MAP. OFM 96, Surficial Geologic Map of the Milford Quadrangle, Sussex County, New Jersey and Part of Pike County, Pennsylvania, Witte, Ron W., 2012, scale 1 to 24,000, size 35x45, 2 cross-sections, 2 tables, 5 figures and a 18-page pamphlet. $10.00. Available for download.

NEW MAP. OFM 97, Geology of the Chatsworth Quadrangle, Burlington County, New Jersey, Stanford, Scott D., 2012, scale 1 to 24,000, size 36x48, 2 cross-sections, 2 tables and 5 figures. $10.00. Available for download.

NEW MAP. OFM 98, Bedrock Geology of the Morristown Quadrangle, Essex and Morris Counties, New Jersey, Volkert, Richard A., 2013, scale 1 to 24,000, size 29x48, 2 cross-sections and 2 figures. $10.00. Available for download. **This map supersedes GMS 88-4.**

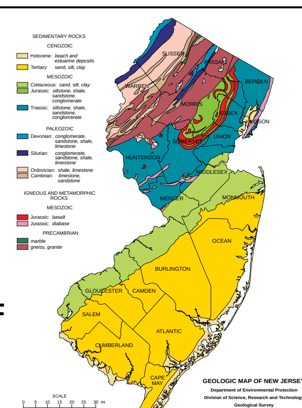
$Na\ (Li,Al)_3Al_6(BO_3)_3Si_6O_{18}\ (OH)_4$

Mark your calendar:

EARTH SCIENCE WEEK
October 13-19 2013

GEOLOGIC MAPPING DAY
October 18, 2013

For a free 8.5" x 11" copy of **GEOLOGIC MAP OF NEW JERSEY**, *right*, click here.



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of the New Jersey Offshore in the Vicinity of Barnegat Inlet and Long Beach Island" (Uptegrove, et al., GMS 12-3). Other maps depicting sand shoal areas offshore of Cape May and Monmouth Counties are under development.

The Survey welcomes your feedback on the content or format of the newsletter. All Survey publications are available as free downloads from the web site. Hard copies of some maps and reports are also available for purchase by check. Our order form has more information. Unpublished information is provided at cost by writing the State Geologist's Office, N.J. Geological Survey, P.O. Box 420, Mail Code 29-01, Trenton, NJ 08625-0420. Staff are available to answer your questions 8 a.m. - 5 p.m. Monday through Friday (609-292-1185) or by e-mail at njgsweb@dep.state.nj.us.

Karl W. Muessig
New Jersey State Geologist

$Na\ (Li,Al)_3Al_6(BO_3)_3Si_6O_{18}\ (OH)_4$

CROSSWORD SURGE

Structure pushed off its foundation by Hurricane Sandy storm surge, Sea Bright Boro, Monmouth County. *Photo by Z. Allen-Lafayette*

ACROSS

3. Grain bounded by perfect crystal faces
4. Drainage basin
7. Spring that discharges periodically
11. Mineral commonly found in granitic pegmatites
14. Principal gem of the tourmaline group
15. Grouping like things within a system
17. Geologic structure that appears at the surface of the Earth
18. Area where water percolates slowly to the land surface

DOWN

1. Group of ferromagnesian minerals in igneous rock
2. A solid homogeneous body with a repeating arrangement of atoms and often of external plane faces
5. The coherent scattering of X-rays by electrons of atoms in crystals
6. Mountainous province
8. Rate of flow of ground water at a given moment
9. Coarse-grained igneous rocks, with interlocking crystals
10. A foliated rock formed by regional metamorphism
12. Naturally occurring materials from which a mineral can be extracted at a reasonable profit
13. Having the appearance and luster of glass
16. Place where water flows naturally from a rock

$Na\ (Li,Al)_3Al_6(BO_3)_3Si_6O_{18}\ (OH)_4$

CROSSWORD PUZZLE ANSWERS. Across: (3) Euhedral, (4) watershed, (7) intermittent, (11) tourmaline, (14) elbaite, (15) classification, (17) outcrop, (18) seeps. **Down:** (1) Clots, (2) crystal, (5) diffraction, (6) Highlands, (8) discharge, (9) pegmatites, (10) gneiss, (12) ore, (13) vitreous, (16) spring.