Phacops rana (Green), the State Fossil of Pennsylvania (see article on page 3). The scale is in inches.

—Photograph by John H. Barnes
EDITORIAL

One of Life’s Great Pleasures
George E. W. Love, State Geologist
Pennsylvania Geological Survey

Working for the Pennsylvania Geological Survey is, for me at least, one of life’s great pleasures. Let me tell you why.

We all value different things in different ways, perhaps as a function of how we were raised; what we saw and experienced as children; the influence of some friend or academic advisor; or maybe because of some life-altering experience such as that love-at-first-sight meeting with your significant other. I myself derive an immense amount of pleasure from my association with intelligent, interesting people whose diverse interests astound me. This issue of Pennsylvania Geology is a case in point. It deals with fossil designations, snowball earth, and the metaphysical contemplation of “sand,” and allows us to share a few minutes with young, enthusiastic students who want a career in the geologic field. What could be more rewarding?

While working for the Bureau may be “fun,” the work of the Bureau is valuable to the public at large, to the industries of Pennsylvania, and to the future of our commonwealth. The addition of a seasoned geologist, Robin Anthony, to our Pittsburgh office demonstrates the commitment our department (the Department of Conservation and Natural Resources) has to continuing the mission of the Bureau, which is, in part:

To serve the citizens of Pennsylvania by . . . disseminating impartial information on the Commonwealth’s geology, geologic resources . . . in order to contribute to the understanding, [and] wise use . . . of its . . . resources.

Ms. Anthony’s experience is a valuable resource for us as we move forward with the petroleum resources that promote our economic well-being; her studies of the characteristics of produced water will inform our efforts to mitigate any negative impacts on the environmental resources which sustain the ethereal aspects of our lives here in Penn’s Woods. Geologists are fortunate that we can cross the bridge between natural resources as minerals to develop and exploit for our life style and natural resources as the beauty of Mother Nature’s gifts to our tranquility and sanity.

Lastly, I want to call your attention to our “Geologic Mystery.” This is an example of the type of activity in which we sometimes engage. Our mission includes collecting information to contribute to the understanding of our Pennsylvania rocks. This little exercise will not only stimulate discussion and debate, it will focus attention on the myriad of opinions and theories we geologists have. I suspect there are several “right” answers, depending on the assumptions applied to the rock. I hope we get numerous responses, and can summarize them in an exposé of the history of Reese Hollow. Who knows what those Reeses were doing in the dim and distant past?

All joking aside, the Pennsylvania Geological Survey is a resource to the people of the commonwealth. It is one that provides data and insight. The value of the survey is enhanced by the relationships our staff has with others. Please do not hesitate to engage in this little, perhaps seemingly insignificant, exercise. We will all benefit from our shared knowledge.
Reflections on *Phacops rana* (Green), Pennsylvania’s State Fossil

John Harper
Pennsylvania Geological Survey, Retired

Introduction

Jacob Green first described and illustrated *Calymene bufo* var. *rana* from New York in 1832. One hundred fifty seven years later, the Pennsylvania legislature designated Green’s “variation” the official state fossil of Pennsylvania. What a long, strange trip it has been!

*Phacops rana* (cover photograph and Figure 1) is a handsome critter that can be found in the Middle Devonian rocks cropping out in the central part of the state. It is a trilobite (pronounced TRIlobe-ite, not TRILL-oh-bite, as I’ve heard many folks say it), a member of an extinct group of arthropods related to insects, spiders, millipedes, crabs, and lobsters that once dominated the seafloors of the world for hundreds of millions of years. Despite their long and remarkable history, trilobites went extinct at the end of the Paleozoic Era.

The General Assembly of the Commonwealth of Pennsylvania enacted House Bill 2171 designating *Phacops rana* the official state fossil in 1988. The legislation was sponsored by Edward Burns, then the representative from the 18th district in Bucks County, on February 8, 1988, and it became law on December 5 of that year. The legislation, House Bill 2171, Session of 1988, was short and sweet; it stated:

Designating the Phacops rana, a trilobite, as the official State fossil of the Commonwealth of Pennsylvania.

The General Assembly of the Commonwealth of Pennsylvania hereby enacts as follows:

Section 1. Official State fossil.

Phacops rana is a specific type of trilobite, a small sea creature. Trilobites were rulers of the sea during the Cambrian Period, 515 to 600 million years ago. Trilobites are so named because their bodies are divided lengthwise into three parts or “lobes.” Phacops rana means “frog eyes” because of the large holes for eyes on the fossil. Fossils of Phacops rana are found in many parts of Pennsylvania, and, therefore, the Phacops rana is selected, designated and adopted as the official State fossil of the Commonwealth of Pennsylvania.

Section 2. Effective date.

This act shall take effect immediately.

Burns reported in a subsequent interview (Mays, 2006) that a teacher in the Bensalem school district contacted him because the kids in his elementary class wanted to introduce a bill in Harrisburg. After meeting with the children and seeing their work, he introduced the bill in the house. The bill initially met with derision; the legislature did not want to deal with it. Even so, it was finally placed on the agenda and passed. Burns said, “... of all the things I voted on in Harrisburg over the years, that was the bill that got me more press” (Mays, 2006).

Despite some obvious flaws in the language of the bill (e.g., *Phacops* is Devonian, not Cambrian, as implied), *Phacops rana* (Green) is the official state fossil for Pennsylvania, for good or ill. There are numerous reasons why this trilobite is not the most appropriate ancient life form to act in that capacity. For one thing, although found within the Hamilton Group shales and limestones cropping out in central
Pennsylvania, good specimens are difficult to come by (Ellison [1965] illustrated a beautiful specimen of an enrolled _P. rana_ from the Frame Shale Member of the Mahantango Formation in Blair County on his Plate 18, Figures 4 and 5). Also, inasmuch as the commonwealth has a geologic period named in its honor, would it not be more appropriate to have a Pennsylvanian-aged life form designated as the state fossil? How about either of the following:

1. A leaf or stem from one of the many plants that grew profusely in the deltaic swamps across the state 300 million years ago¹ (Figure 2). From these plants came the peat that was compressed into coal, the mineral resource that made Pennsylvania famous; or

2. _Worthenia tabulata_ (Figure 3), an elegant marine snail shell described and named by Conrad (1835) from the Brush Creek marine zone (Conemaugh Group, Glenshaw Formation) at Inclined

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¹In 1988, State Representatives Sarafini, Tigue, Cappabianc, Battisto, and Trello introduced House Bill 2362, “An Act designating the _Alethopteris serlii_, or ‘seed-fern,’ fossil as the official fossil of the Commonwealth of Pennsylvania.” The bill was referred to the House Committee on State Government. To date, no further action has been taken, and no votes have been cast.
Many other fossils come readily to mind that could have been designated as the state fossil and, similar to the aforementioned plant fossils, would have been more appropriate than the relatively rare intact *Phacops rana*. Some of these are:

1. Any of the numerous trilobites that can be found in the Devonian rocks of Pennsylvania (and there are a lot of them) (Figure 4);

2. A Late Devonian fish or tetrapod from the Catskill Formation at Red Hill, Clinton County;

3. A dinosaur whose footprints can be found in the Triassic rocks of the Gettysburg area (Figure 5); or

Plane No. 3 on the Allegheny Portage Railroad in Cambria County. This was one of the very first invertebrate marine fossils described from North America.

![Typical Pennsylvanian plant fossils commonly found in the coal-bearing rocks of eastern and western Pennsylvania. A. Pecopteris Brongniart, the leaves of the marattialean fern tree *Psaronius Cotta* (from Edmunds, 2002). B. Neuropteris Brongniart, the leaves of a pteridiosperm (“seed fern”) called *Medullosa Cotta* (from Edmunds, 2002). C. Large terminal pinnule of *Neuropteris Brongniart* (from Hoskins and others, 1983). D. Alethopteris Sternberg, the leaves of another pteridiosperm (from Edmunds, 2002). E. Portion of a stem of the giant scouring rush, *Calamites Suckow* (from Hoskins and others, 1983). F. Annularia Sternberg, the leaves of *Calamites Suckow* (from Hoskins and others, 1983). All bar scales = 1 cm.](image-url)
4. Any of numerous Ice Age mammal fossils found in sinkholes and ancient lake bottoms around the state.

Pennsylvania’s First(?) Fossil Description

It appears that the first fossil described from Pennsylvania was a plant stem. Amos Eaton, the famous New York naturalist of the early 1800s, published a “geological communication” in Professor Benjamin Silliman’s American Journal of Science and Arts in 1831 that arguably is the earliest naming and description of a fossil from the commonwealth. A Dr. Rose, of Montrose, Susquehanna County, found the specimen in sandstone on his property and sent it to Eaton. Eaton called the fossil “Crotalus reliquus or Arundo? Crotaloides.” Why the double name? Because he wasn’t certain if it represented an animal (Crotalus is a genus of snakes) or a plant (Arundo is a genus of canes). It appeared to have the characteristics of both. Eaton (1831, p. 122) even stated, “It is true, that these may be the mineral substitutions for the veins of lateral leafy appendages; it is truly wonderful, that a reed should present so many of the characteristics of the modern rattlesnake.” Lesley (1876) pointed out that the advanced knowledge of paleobotany by the late 1800s indicated that the specimen was, indeed, a plant fossil. As any fossil collector in Pennsylvania’s coal fields will testify, Eaton’s illustration leaves no doubt that it represents a specimen of the scale tree, Lepidodendron (Figure 6).

Quo Vadis, Phacops rana?

The first specimens of what would eventually become known as Phacops rana were originally described by Jacob Green in 1832. Green, who graduated from the University of Pennsylvania at the age of 16, was a man of many talents; he was a lawyer and physician, a chemist and astronomer, and a naturalist with a decided bent toward paleontology. He taught chemistry, philosophy, and natural science at Princeton before moving on to teach at the Jefferson Medical College (now Thomas Jefferson University) in Philadelphia. His father and grandfather were both theologians, so he was brought up in religious surroundings that caused him some trouble later in life as he tried to reconcile his beliefs with his scientific studies (Charwat, 2009). His interest in trilobites was spurred by meeting some of the more famous European naturalists of the time. In 1832, he published a 95-page monograph on North American trilobites illustrated with colored drawings of numerous plaster casts that he had made, which now reside at the Paleontological Research Institution in Ithaca, N.Y. (Charwat, 2009). Over the next eight years, he published numerous reports on trilobites. One of those trilobites was Calymene bufo var. rana.

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Figure 3. Worthenia tabulata (Conrad), an elegant Pennsylvanian-aged snail commonly found in the marine zones of the lower Conemaugh Group in western Pennsylvania and contemporaneously deposited strata throughout the United States. A. Conrad’s (1835) original illustration. B. Modern reproduction (from Hoskins, 1999). Bar scale = 1 cm.
I’ve heard many people complain that paleontologists spend too much time changing the names of fossils. It seems that every paleontologist with a bent toward taxonomy has to change the generic name of at least one critter before passing on to that great collecting locality in the sky. Why can’t they leave well enough alone and stick with the original name, you might ask? One of my paleontologist friends in graduate school was so annoyed by taxonomists that he told everyone he wanted his epitaph to read, “He never described a single species.”

**A Phacops By Any Other Name . . .**

Figure 4. Some representative Devonian trilobites that can be found in Pennsylvania. A. Odontocheilus micrurus (Green) from the Lower Devonian limestones of the Helderberg Group. B. Odontocephalus aegeria (Hall) from the Middle Devonian Onondaga Limestone. C. Dechenella haldermani (Hall) from the Middle Devonian Marcellus Formation. D. Greenops boothi (Green) from the Middle Devonian Mahantango Formation. E. Dipleura dekeyei (Green) from the Middle Devonian Mahantango Formation. F. Pseudodechenella rowei (Green) from the Middle Devonian Mahantango Formation. G. Monodechenella macrocephalus (Hall) from the Middle Devonian Mahantango Formation. H. Constantina pulchra Cisne from the Upper Devonian (probably Chadakoin Formation). All bar scales = 1 cm.
As a whole, taxonomists (or systematists, if you want to be snobbish about it) tend to be either “splitters” or “lumpers” when it comes to describing fossil taxa. Splitters see hundreds of genera and species in every museum drawer, whereas lumpers see only multitudes of morphological variety within one or a few genera or species. As someone who has dealt with the morphological conservatism of certain kinds of fossil snails, I probably tend to be more of a lumper than a splitter, but I also try to be objective enough to find the middle ground. I prefer that there be a scientifically valid reason for separating two similar fossils, rather than wanting to name a new taxon because one of the fossils is larger, or has a slightly different shape, than the other. I like to kid my paleontologist friends who specialize in brachiopods that they tend to name a new superfamily every time they find a specimen with one or two extra ribs on the exterior of the brachial valve. (This is, of course, just a gross exaggeration. One or two extra ribs will only rate a subfamily of brachiopods, not an entire superfamily!)

Figure 5. Triassic dinosaurs. A. Photograph of the fore and hind footprints of a small ornithischian dinosaur called Atreipus preserved in sandstone at Gettysburg, Pa. The rainwater helps them stand out in the photograph. Bar scale = 5 cm. B. Reconstruction of the fore and hind footprints of Atreipus as they would appear if the preservation were better. Bar scale = 5 cm. C. Possible reconstruction of the Atreipus dinosaur (based on Olsen and Baird, 1986). Bar scale = 10 cm.
Jacob Green (1832) originally described *Phacops rana* as a member of the genus *Calymene*, a common name for *Phacops*-like trilobites in the early days. New York’s great geologist Ebenezer Emmons (1860) was the first to consider this species a member of the genus *Phacops*, which was erected by Emmrich (1839) for a German trilobite, *Calymene latifrons* Bronn. Since that time, *Phacops* has been widely known and recognized from Devonian strata in Europe, Africa, and North America. This has not stopped paleontologists on two continents from splitting the genus into a multitude of new genera. For example, Maximova (1972) assigned *Phacops logani* Hall, a common form from the Lower Devonian Helderberg Group limestones, to her new genus *Paciphacops*, and Eldredge (1973) reassigned *Phacops bombifrons* Hall and Clarke from the Middle Devonian Onondaga Limestone to *Viaphacops* Maximova, 1972.

Something similar happened to *Phacops rana*. Struve (1992) reexamined *Phacops* species from Europe and North America and declared that *P. rana* (Figure 1A) and several other American species of *Phacops* were different enough from the type species, *P. latifrons* (Bronn) (Figure 1B), to require a new generic name. He called it *Eldredgeops* in honor of Niles Eldredge, the American Museum of Natural History’s expert on trilobites. Several years ago, I asked Eldredge, who is one of the world’s leading authorities on phacopid trilobites, for his views on this name change. It was his opinion that the new generic name was unnecessary, and that the species *rana* fell within the generic concept of *Phacops*. I don’t know if he has changed his mind more recently or not, but the name *Eldredgeops rana* seems to have become a permanent part of the paleontological literature (e.g., Whiteley and others, 2002; Alroy, 2011).

**Conclusion—What’s In a Name?**

So it is with apologies to the Pennsylvania legislature and an elementary school in the Bensalem school district of Bucks County that I must say: *Eldredgeops rana* is the most elegant and common trilobite found in the Middle Devonian rocks of central Pennsylvania. It is widely distributed throughout the Hamilton Group shales and limestones and has even been reported from the Upper Devonian rocks of New York (Whiteley and others, 2002).
But, regardless of scientific accuracy, personal or professional opinions, and the vagaries of paleontological systematics, by legislative act, Pennsylvania’s state fossil is *Phacops rana*, whether the paleontological community likes it or not. Take THAT, taxonomists!

**References**


Green, Jacob, 1832, A monograph of the trilobites of North America, with coloured models of the species: Philadelphia, Joseph Brano, 95 p.


BOOK REVIEW

“Sand,” An Entertaining and Enlightening Book

A book with the simple, almost boring title of “Sand” (by Michael Welland, published by the University of California Press in 2009) could not possibly be interesting. Or could it? The answer is a resounding yes! This book is eminently readable; so much so that it was awarded the John Burroughs Medal for distinguished writing in natural history in 2010. The book is sort of a geology text, and yet it is so much more.

The author was determined to cover every facet of sand that he could think of, and he did an admirable job of doing so. He was able to make seamless transitions from the main subjects of his chapters to interesting tidbits, stories, and nongeological subjects. For example, the reader could suddenly find himself immersed in a section concerning arenophilia (sand collecting), forensic geology, eighteenth century France, or a poem that relates to sand. Along the way, Welland discussed many historical figures and how their studies related to sand, including Antony van Leeuwenhoek, Ralph Bagnold, and James Hutton.

Welland started by approaching sand grains as individuals. He considered what sand grains are made of and the implications of “a single grain of sand.” He then went on to consider sand grains in groups, and in this topic, he covered angle of repose and the size distribution of sand grains, a painless introduction to sedimentology.

Next is a section on how sand behaves when water is added, including following the travels of a single grain of sand. This example featured a grain that traveled through Pennsylvania on its way to the Chesapeake Bay, and in doing so covered what rivers are like at work and how they respond to various types of change.

The topic of another chapter is sand in the ocean, including a discussion of waves, tides, and beaches, and thus of coastal geomorphology. Welland considered the origin and movement of waves, how beaches are formed and destroyed, and how the tropics differ from more temperate coastal areas.

In the section about sand in the desert, we learn about Ralph Bagnold’s accomplishments as he studied how sand moves in this environment. One of the tangents in this chapter was an excerpt from the writings of Mark Twain. Another section concerned music in the dunes, a discussion of how some areas of sand dunes seem to play musical notes in certain circumstances.
How sand becomes rock is next. We are introduced to the concept of geologic time and the principles of historical geology. Continental drift and mountain building also get their turn. The author considered tsunamis, Hurricane Katrina, and Triassic rift valleys, among other phenomena.

A whole chapter is devoted to the idea of sand art; what cultures use it and what meaning it has for them. The chapter included sand art in the digital age, and sand’s role in the topic of telling the future.

This planetwide discussion of sand concludes with an alphabetical listing, from aggregates to zen gardens, of the ways in which humans use sand. These included such topics as making glass, nanotechnology, and how vineyards are influenced by the ground they grow on.

That might seem to be a good way to end the book, but there’s still more. Welland didn’t restrict his attention just to the earth. The book would not have been complete without a section about sand on other planetary bodies, and in this section, the author included discussions of sand on Titan, Mars, and Venus.

One can learn much about geology and also about humans in this enticing treatment of a seemingly simple subject. The book includes many illustrations and a section of color photographs. The stunning range of subjects considered in the book is only hinted at in this review. I highly recommend the book; whether you have a degree in geology or just an interest in natural history, there is something for everyone.

—Anne B. Lutz

SURVEY NEWS

New Employee

The Bureau of Topographic and Geologic Survey welcomes its newest member of the staff, Robin Anthony (Geologic Scientist 1), to the Pittsburgh office. Robin has more than 20 years’ experience as a petroleum geologist, first with Consolidated Natural Gas and then as an independent consultant. She also has experience as a project manager and publications editor in the nonprofit sector. Most recently, Robin has worked on projects involving the management of produced water from oil and gas wells, gas storage, coalbed methane, and unconventional reservoirs. Welcome, Robin!
Summer Interns Invade!

We always look forward to the influx of summer students, and this year is no exception. We took advantage of a visit by the Pittsburgh-based interns to the Middletown office by snapping a photograph of 13 of the 14 students. The caption identifies each person, his or her school, and the project each is associated with (except staff geologist Kristin Carter, second from the right in the first row). Below that information is a description of the projects. Of course, “other duties as assigned” always applies!

American Association of State Geologists (AASG) Geothermal Project. In this project, interns performed the following: (1) examined geophysical logs from oil and gas wells for relevant temperature and depth information to develop a database of geothermal gradients across the state; (2) compiled groundwater chemistry and physical data from state, federal, and academic sources;
(3) examined drilling and geophysical logs from water and scientific investigation wells; (4) assisted in the evaluation of groundwater and water well records from the Pennsylvania Groundwater Information System; and (5) assisted in the development of regional groundwater statistics for water wells.

**MRCSP (Midwest Regional Carbon Sequestration Partnership) Project.** These interns assisted with three main functions relative to the Bureau’s project responsibilities under Phase III of the Midwest Regional Carbon Sequestration Partnership: (1) subsurface geologic data collection, management, and interpretation; (2) petrographic/petrologic evaluations of rock thin sections and other samples; and (3) rock-brine geochemistry evaluation. Specifically, the interns assisted the Pittsburgh office with the collection of geologic, location, and reservoir characterization data from all partner states in the Appalachian, Illinois, and Michigan basins; were trained to extract and interpret geologic data from Pennsylvania’s Wells Information System; compiled appropriate databases for use in digital mapping and reservoir characterization work; assisted staff geologists with thin section and other analyses using our petrographic microscope; and assisted in the evaluation of brine geochemistry data as it pertains to geologic sequestration calculations.

**Utica Shale Consortium Project.** The Utica Shale interns assisted with (1) subsurface geologic data collection, scanning, interpretation, and data entry; (2) preparation of rock cuttings and/or core samples for laboratory analysis of total organic carbon, bitumen reflectance, mineralogy and/or porosity; (3) petrographic evaluations of rock thin sections and reflectance samples, as necessary; and (4) collection of shale outcrop samples and field trip preparatory work.

**Great Lakes Geologic Mapping Coalition Project.** The interns on this project updated the Pennsylvania GroundWater Information System backlog for the glaciated counties of northwestern Pennsylvania, including locating wells and completing data entry for partially entered well records.

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**Eat Popcorn, Learn About Groundwater**

Bureau geologist Stuart Reese has made an interesting video for DCNR (Department Of Conservation and Natural Resources) explaining the state’s groundwater resources. The video covers many interesting facts concerning groundwater. Did you know, for example, that if all of the state’s groundwater was pumped to the surface, it would flood the entire state to a depth of 8 feet?

The role that groundwater plays in the water cycle is examined, as are the nature of groundwater, the effects that development have on it, and the importance of protecting this valuable resource.

This video is designed for a nontechnical audience. It was produced and edited by Kirk Felix of the Office of Education, Communications, and Partnerships (DCNR) and written by Stuart with assistance from Gale Blackmer, Gary Fleeger, Helen Delano, and Victoria Neboga of the Bureau. It runs for 8 minutes and can be seen online at [www.youtube.com/watch?v=vT39LIUlmzo](http://www.youtube.com/watch?v=vT39LIUlmzo).
An Interesting New Idea—
The Snowball Earth Hypothesis

Ion Simonides
Pennsylvania Geological Survey Intern

This summer there were four interns working in the Mineral Resources Division at the Pittsburgh office of the Bureau of Topographic and Geologic Survey; they are Alex Ceschini (Allegheny College ’14), Julianne Gmys (Marietta College ’15), Dilyn Stevenson (Edinboro University ’16), and Ion Simonides (Allegheny College ’14). In addition to working on their respective MRCSP, Utica, or geothermal projects (see article on p. 13, “Summer interns invade!”), these interns were required to put together a poster presenting a geologic hypothesis of their choice and display the poster in the lobby of the office building.

The interns did research into a variety of earth science topics, and they settled on a little-known idea that has been gaining publicity in recent years known as snowball earth. This hypothesis interested the interns because it is not well known by the public, and if it is proved, it would seriously affect our understanding of the earth’s climatic history.

The idea of snowball earth is that during Neoproterozoic time (~750–580 Ma), the earth experienced four cycles of alternating periods of global freezing, where glaciers completely covered the earth, and rapid global warming, where huge amounts of melting caused significant sea-level rise. During the snowball earth period, the continents were clustered around the equator, forming the hypothesized supercontinent of Rodinia. Geologic activity at this time consisted almost exclusively of extensive glaciation and intense volcanism. These contrary
processes dominated earth’s Neoproterozoic climate and defined the glaciation-melting cycles of snowball earth.

The freezing periods of snowball earth could have been triggered by high volumes of volcanic ash that clouded the atmosphere, preventing solar radiation from warming the planet and starting a volcanic winter. In addition to volcanic ash, glaciers have a high albedo and would have caused solar light to reflect off the earth’s surface instead of being absorbed. A volcanic winter combined with the albedo of existing glaciers prevented solar radiation from reaching the earth and created a positive feedback loop that caused global temperatures to plummet. As global temperatures decreased, glaciers grew to cover a large portion of the earth’s surface; the precise percentage that they might have covered is still heavily debated today. Over hundreds of thousands of years, greenhouse gases built up in the atmosphere to the point where a rapid climatic reversal occurred and global temperatures began to rise. As continental glaciers melted, they released huge volumes of water, which caused rapid sea level rise and climatic changes throughout the globe.

Some hard evidence that supports the snowball earth hypothesis has been found in Neoproterozoic sedimentary rocks in locations around the world from Namibia to Australia to China to the United States. These locations are all known to have existed within tropical latitudes during the Neoproterozoic, yet geologists have found extensive glacial tillite deposits dating from that geologic time period at these locales. In addition, mixed in with the glacial till are unusual deposits of iron-rich rocks that only could have formed in an anoxic atmosphere. Conformably overlying the glacial tillites are beds of cap carbonates that reflect the rapid melting, sea-level rise, and climatic changes that characterized the switch between freezing and warming in the snowball earth cycles.

A major component of the snowball earth hypothesis is that simple single-celled organisms survived the frozen climate in confined areas of open water or in close proximity to volcanic hot springs where they had access to sunlight and the necessary nutrients to support life. After snowball earth ended about 580 Ma, these single-celled organisms evolved, and multicellular life exploded as the Cambrian period began.

ANNOUNCEMENT

The 78th Annual Field Conference of Pennsylvania Geologists, “A Tale of Two Provinces: the Nippenose Valley and Route 15 Corridor,” will take place on September 26 through 28, 2013. Pre-conference trips will be held on Thursday, September 26, and the main field trip will occur on Friday and Saturday, September 27 and 28. The headquarters hotel is the Holiday Inn in Williamsport, Pa.

The conference attendees will explore two areas. On day one, they will examine the Great Amphitheater of Pennsylvania, the Nippenose Valley of Lycoming and Clinton Counties, inside and out. The floor of this breached anticline exposes Middle to Upper Ordovician Bellefonte through Reedsville Formations. Just outside of the amphitheater are great exposures of the Marcellus, Tully, and Mifflintown. On day two, the geologists will travel along the U.S. Route 15 corridor. There they will examine excellent exposures of the stratigraphic succession from the Devonian Brallier/Harrell/Lock Haven into the Pennsylvanian Bloss coal complex of Pottsville/Allegheny age, only to return back to the Lock Haven. It will be a wild roller coaster ride from Williamsport to the New York border as they cross six “time zones” trying to figure out if it is half past the Devonian or a quarter after the Mississippian. For more information and registration materials, visit the conference website at [http://fcopg.org/](http://fcopg.org/).
A GEOLOGIC MYSTERY

One can frequently discover interesting-looking rocks in Pennsylvania. Many times, we know immediately what they are; at other times, we can only guess. Staff geologist Stuart Reese discovered the rock that is pictured here on the family farm in Reese Hollow, Centre County, probably a sandstone from the Lock Haven Formation. Its origin is something of a mystery, and we present it here for your perusal and suggestions as to what it might be.

Several geologists, with diverse backgrounds and training, have inspected the rock, and a number of hypotheses have already been presented. Two of our favorite hypotheses are the following: (1) the rock contains Liesegang rings (colored bands of cement that cut across bedding), and (2) the rock consists of boxwork structures that had soft-sediment loads deposited within each box cavity, similar to rocks on Mars whose image can be seen at http://spaceref.com/mars/curiosmars-box-shaped-martian-features-and-deep-water-lake-deposits-offer-new-rover-destinations.html.

Now it is your turn! We will consider publishing the most interesting comments from our readers in the next issue. Please send your comments to RA-pageology@state.pa.us. We look forward to a multitude of explanations.
# Department of Conservation and Natural Resources

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## GEOLOGIC MAPPING

### Stratigraphic Studies

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### Groundwater and Environmental Geology

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## MINERAL RESOURCES

### Mineral Resource Analysis

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### Petroleum and Subsurface Geology

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