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Slab of sandstone from the Lock Haven Formation (Upper Devonian) of north-central Pennsylvania littered with natural internal and external molds of fossils, mostly the elongate brachiopod *Cyrtospirifer chemungensis* (Conrad) (U.S. quarter dollar for scale). This is one of the many species of *Cyrtospirifer* that used to be called *"Spirifer disjunctus."* From the collections of the Carnegie Museum of Natural History, Pittsburgh, Pa. See article on page 11.

EDITORIAL

Isn't Pennsylvania Already Mapped?

Gale C. Blackmer, Acting State Geologist
Pennsylvania Geological Survey

How many of us have been asked some version of this question: "What's left for you geologists to do? Isn't Pennsylvania all mapped?" I'm always puzzled by this line of thinking, because I'm willing to bet no one asks a physicist, "Haven't you discovered all the different kinds of particles in the universe yet?" or a chemist, "Haven't you identified all the chemical elements and investigated all their possible combinations?" Perhaps it is because the objects of geologic investigations—rocks, dirt, and water—seem so mundane that it is difficult for many people to imagine that there is much to learn about them.

The answer to the question is, of course, "There's plenty left to do!" Surprisingly, for a state so dependent on mineral and energy resources for a significant part of its economy, much of Pennsylvania has not been mapped beyond the most general reconnaissance scale. Some areas were mapped more than 100 years ago. While it is true that the rocks don't change, our ways of understanding them (think plate tectonics) and our methods of investigation do change. We have high-tech analytical methods that our predecessors never imagined, from high-precision digital elevation models and surveying techniques to sophisticated chemical and geochronological analysis to something as basic as better microscopes. New technologies that allow us to exploit geologic resources in different ways also require us to go back to those rocks to investigate characteristics that were not previously viewed as important. New rock exposures opened by natural processes, construction, or resource extraction can provide a look at geologic structures and stratigraphic relationships that may lead us to revise previous interpretations. Human interactions with the landscape can initiate new instances of geologic hazards that must be investigated and mitigated. And in some cases, we simply have several generations of additional observations to bring to bear on a particular geological problem. The articles in this issue are good examples. You will read about rockfalls on a road in central Pennsylvania, a dangerous and expensive situation. The authors take a detailed look at geologic structures to identify causal factors. Although these rocks had been previously mapped, they had not been analyzed with an eye toward rockfall potential. A second article illustrates how careful work and much discussion by paleontologists over more than 140 years has been necessary to sort out species identification among Late Devonian brachiopods, work that probably is not yet completed. A third article explains a cooperative project between our bureau and the U.S. Geological Survey to monitor an unstable slope along a highway in Pittsburgh, a good example of the need for ongoing geologic hazard investigation as we alter the landscape with roads, houses, and other structures.

You, dear reader, have probably thought of half a dozen more geologic questions that need to be answered in the time it took you to read this column. So get out there and study some rocks! There's a whole world of geology left to do!

Gale C. Blackmer

Editor's note: The Pennsylvania Geological Survey welcomes Gale Blackmer as Acting State Geologist in the wake of George Love's retirement.

The Role of Rock Cleavage on Mass Wasting in the Hamilton Group (Middle Devonian), Sunbury, Pennsylvania

Derrek Reitz and Jennifer M. Elick[1]
Susquehanna University[2]

Introduction

Rockfalls and rockslides are a common winter/spring occurrence in the Ridge and Valley physiographic province of Pennsylvania (Figure 1). Though weather conditions are commonly a cause of physical disturbance, loosening rock so that it can eventually move downslope (Delano and Wilshusen, 1999; Elick, 2002), there are other factors that promote mass wasting in this region. Many of the recent mass-wasting events south of Sunbury, Pa., have occurred at several locations along the same stretch of road (Pa. Route 147) (Figure 1) and have involved the same rock unit, the Hamilton Group (Middle Devonian). Here, the rock is chiefly a heterogeneous mix of shale, shaly siltstone, and sandstone, with a cleaved fabric that makes the rock inherently weak. The abundance of structurally weak shaly rock along clifflike exposures that have little to no shoulder makes Pa. Route 147 south of Sunbury extremely dangerous. The objective here is to provide evidence of how these factors, and, in particular, rock cleavage, promote mass wasting south of Sunbury, Pa., along this road.

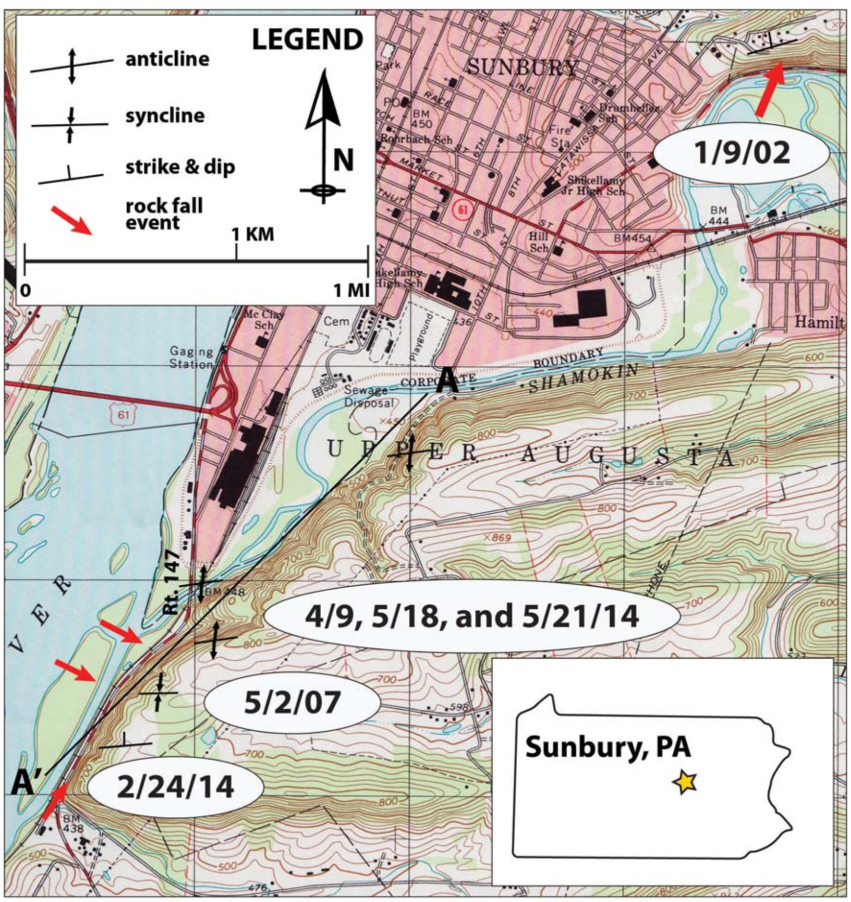

Figure 1. Map showing the locations of recent mass-wasting events south of Sunbury on Pa. Route 147. The map also shows the geologic structures (locations and types of folds) and general orientation of the bedrock in the region. A cross section of the geology from A to A' is delineated here and depicted on Figure 4.

[1] elick@susqu.edu
[2] Earth and Environmental Sciences, Susquehanna University, 514 University Avenue, Selinsgrove, PA 17870.

Site Description

Road signs and large boulders located along Pa. Route 147 identify the potential for falling rock, a phenomenon that has been known to cause temporary road closures south of Sunbury, Pa. Road closure may result from rock falling on the northbound lane, the lane closest to the exposure. This exposure is a naturally steep, northwest-facing incline that was widened to accommodate two lanes of traffic. The rock face varies in height from 18 to 20 meters and has a slope that is approximately 75° to near vertical in some locations. The distance from the exposure to the shoulder of the road varies from 1 to 3 meters. On the exposure, vegetation is observed growing on rock ledges and from cracks in the bedrock. Running parallel to the road and located between the road and the Susquehanna River is a single-track railway line. There is no room for either expansion of the road or its relocation, due to the narrow nature of the site.

Recent Mass-Wasting Events

Some of the information on the mass-wasting events described in this section was reported by a local radio station (Newsradio 1070, WKOK) and newspapers (*The Daily Item* and *The News Item*). Weather data were obtained from archives located on the National Oceanic and Atmospheric Administration (NOAA) website (www.ncdc.noaa.gov/cdo-web/datasets/) from weather station GHCND:USC00368668 in Sunbury, Pa.

The largest of the recent events to close Pa. Route 147 occurred on May 2, 2007, when two slides (one at 4:30 a.m. and a second at 10:00 a.m.) dropped an estimated total of 3,500 tons of rock and mud across both traffic lanes and the southbound shoulder. As a result of this event, the Pennsylvania Department of Transportation (PennDOT) closed the road for a week and a half. The debris that fell was composed of boulders of siltstone and sandstone that were nearly 2 meters long in addition to abundant shale, and it was largely composed of rock from the Fisher Ridge and Montebello Sandstone Members of the Mahantango Formation (Figure 2). During this event, temperatures were above the freeze-thaw range, and heavy rain before and on the day of the event likely triggered the mass movement. As a result of this rockslide, PennDOT installed a rock retention fence with Jersey barriers (modular concrete barriers) along part of the highway.

More recently, on February 24, 2014, a rockslide closed Pa. Route 147 for nearly seven hours. During this road closure, local fire companies used water to spray loose rock and debris from the exposure to prevent future rockfalls. Northumberland County 911 Coordinator and Upper Augusta Township Fire Chief William Brown said that melting snow over the weekend likely eroded the cliff face and loosened the rocks. More specifically, from February 14 through 18, 2014, the daily high temperatures were consistently below freezing, and the total accumulated snowfall reached a maximum of 16 inches. Beginning on the 19th, the daily high temperature rose above freezing and continued to increase during the five days leading up to the 24th, while nighttime temperatures remained below freezing (in the 20s). Over the course of five days, the cumulative effects of daily freeze-thaw activity led to this mass-wasting event.

Later that spring, three additional rockslides/rockfalls occurred in nearly the same area along the road, and chiefly involved the Marcellus Formation and Fisher Ridge Member of the Mahantango Formation. After a moderate rainfall (0.45 inches) on April 8, followed by overnight freeze-thaw conditions, a rockslide occurred on April 9. Some of the debris slid across the northbound lane and covered the southbound lane. This small slide closed the road for two hours. On May 18, an extremely rapid and heavy rainfall event (1.82 inches) associated with a supercell thunderstorm caused a minor rockfall event. As a precautionary measure, PennDOT temporarily closed the road for inspection of the

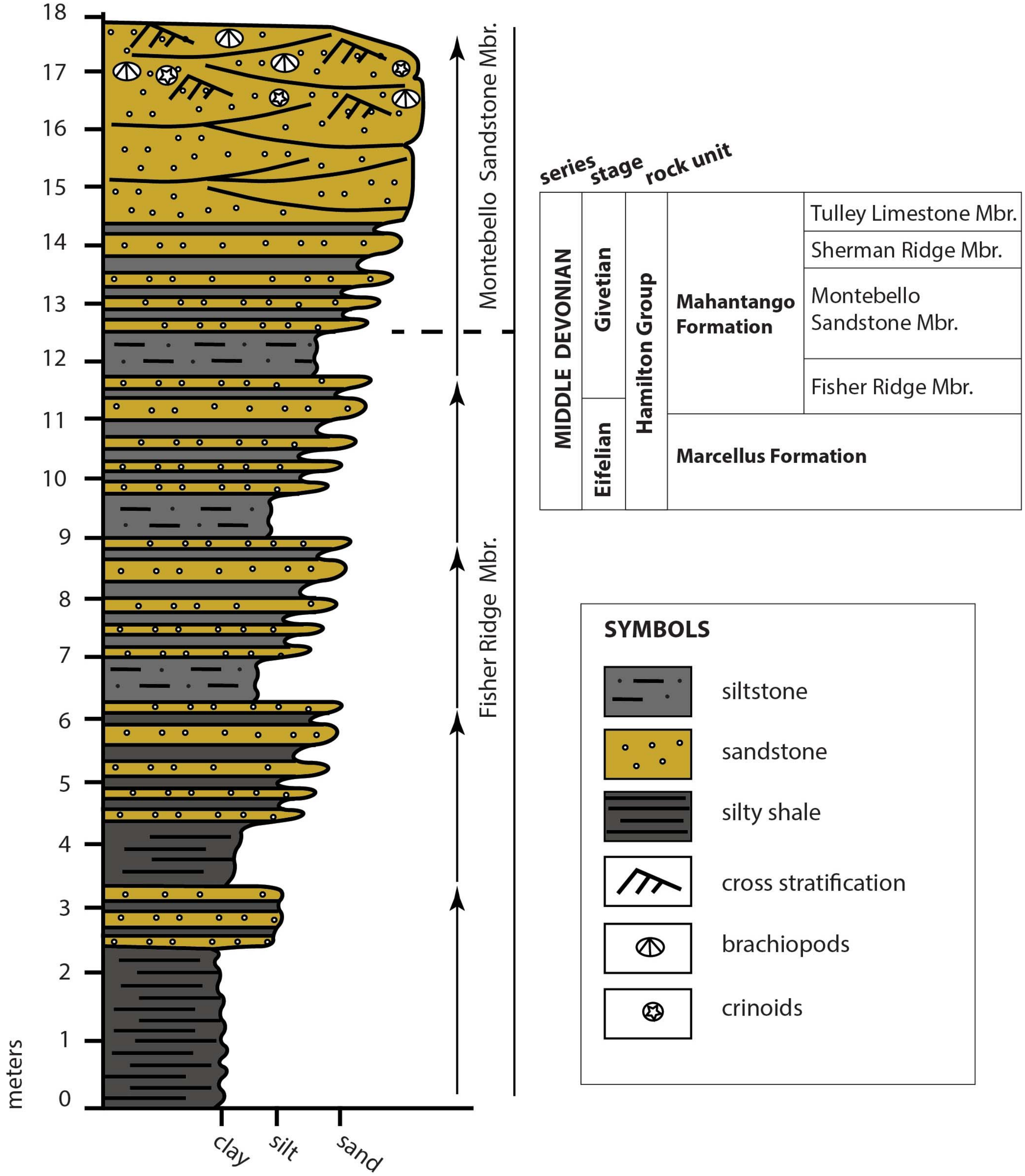

Figure 2. Generalized measured section of the rock along Pa. Route 147, depicting rock types and features and showing how the Hamilton Group (Middle Devonian) is subdivided in this region. Arrows to the right of the measured section represent coarsening-upward cycles similar to those described by Faill and others (1978).

exposure. Again on May 21, a small event occurred, closing the road until May 22. During this road closure, PennDOT officials examined the embankment and installed Jersey barriers along the exposure. This event accelerated the plans for the extension of the rock retention fence along Pa. Route 147. When it was built, the fence cost $991,000, and it expanded the protective barrier along Pa. Route 147 by 76 meters.

Geologic Background

The bedrock exposed along Pa. Route 147 belongs to the Hamilton Group. In this area, the Hamilton has been subdivided into the coarsening-upward Marcellus and Mahantango Formations (Lower Middle Devonian) (Figures 2 and 3A) (Hoskins, 1976; Berg and others, 1980; Elick and Frank, 2001). Both of these rock units are argillaceous, due to the environments in which they formed. The Marcellus Formation was likely deposited in a very deep, sediment-starved, anoxic trough that formed as a result of tectonic activity. The Mahantango Formation is composed of asymmetrical, coarsening-upward cycles interpreted to represent a shallowing-upward deltaic succession (Figure 2) (Faill and others, 1978).

In this region, the Hamilton Group is located on a large, regional, eastwardly plunging and eroded structure known as the Selinsgrove anticlinorium (Elick and Frank, 2001). The trend of this structure is approximately N75°E. Smaller secondary folds are superimposed on this large fold, and several reverse faults cut through the bedrock along the road (Figure 4) (Elick and Frank, 2001). Here, the rock exhibits a highly cleaved fabric due to deformation of abundant, clay-rich rock layers in the lower part of the Hamilton Group (Figures 3 and 4) (Nickelsen, 1986). The cleavage consists of both pencil cleavage

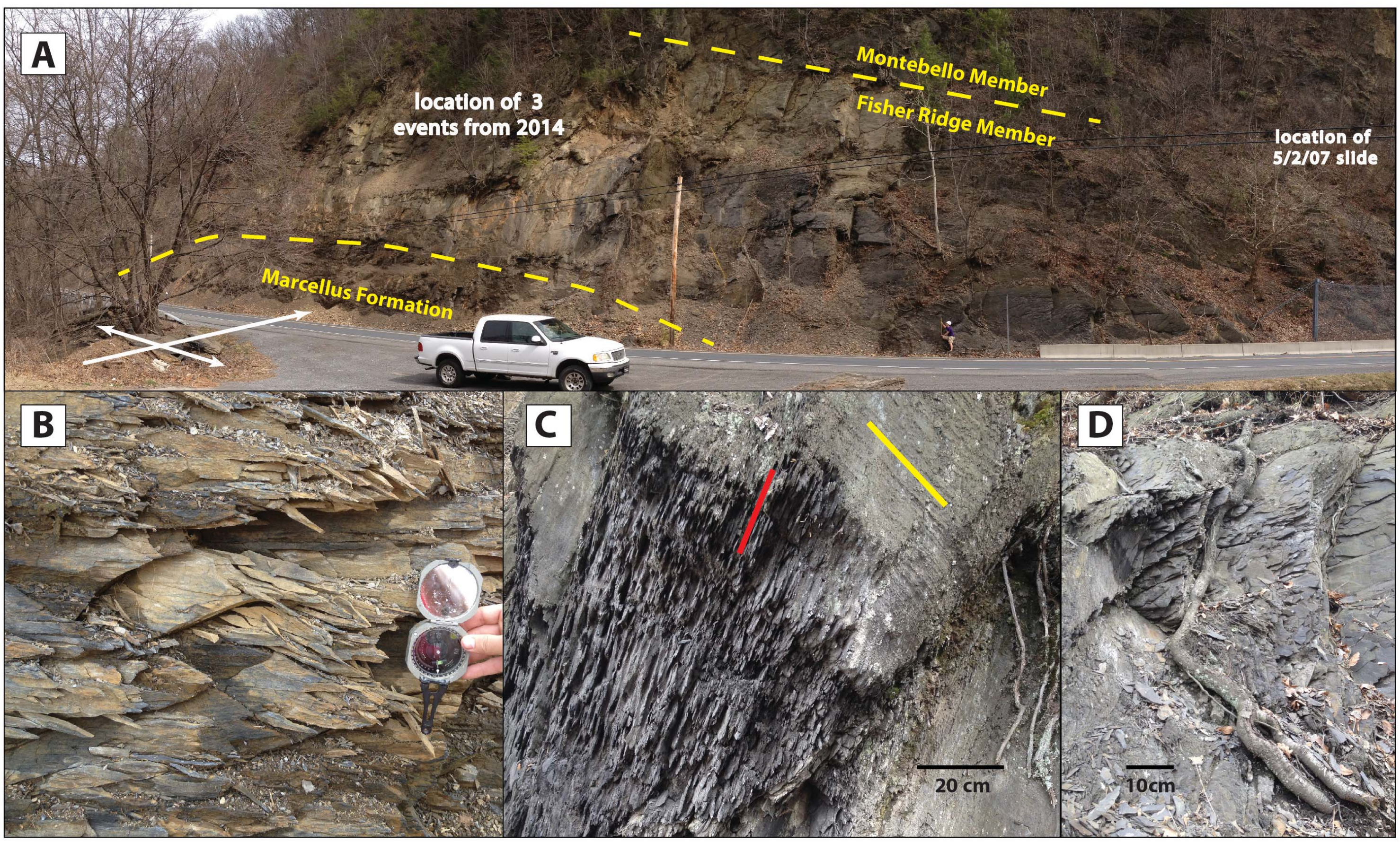

Figure 3. A, Panoramic view of the site of the most recent rockfall to affect Pa. Route 147. There is a small asymmetrical fold at this location. The longer white arrow indicates the trend of the fold, and the shorter arrow shows the orientation of the limbs of the anticline. B, A view of coarse pencil cleavage in the upper part of the Marcellus Formation. C, A view of fine slabby cleavage in the Fisher Ridge Member of the Mahantango Formation. The red line depicts the cleavage plane direction, and the yellow line represents the dip angle and direction of the bedrock. D, A large plant root extending between and over slabby cleavage planes of the Fisher Ridge Member.

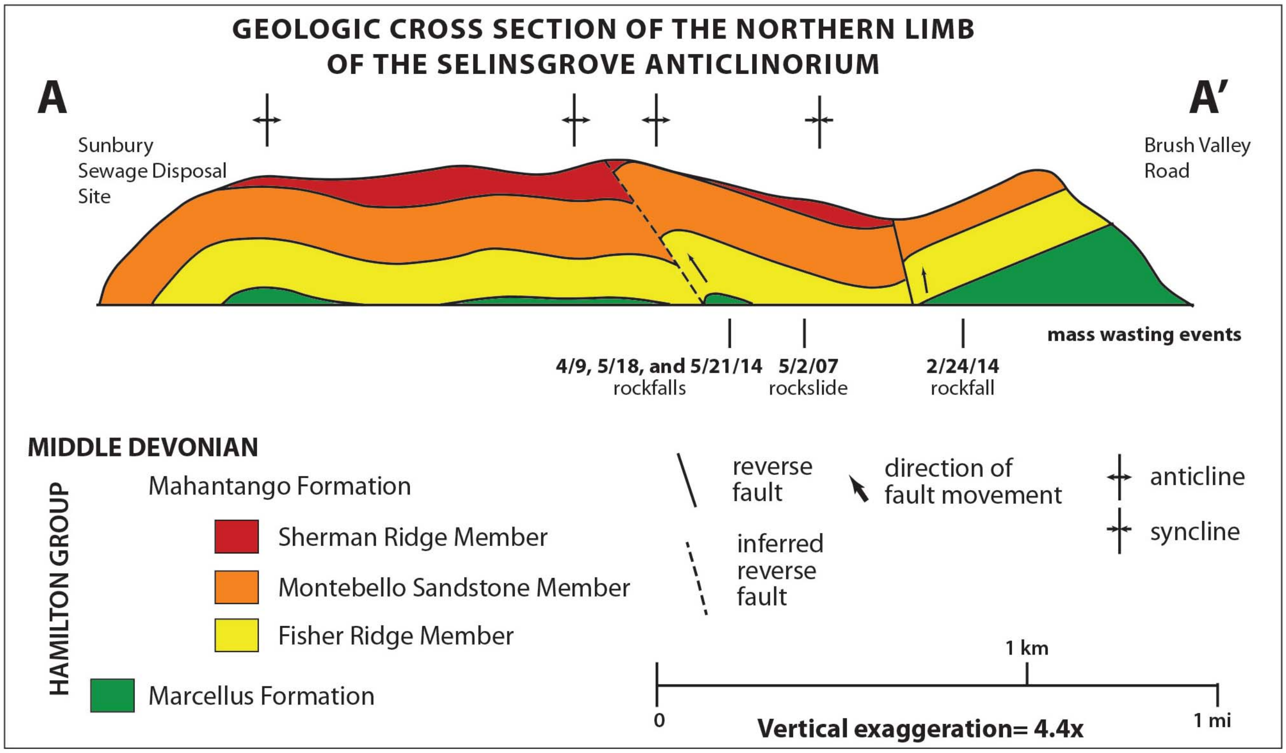

Figure 4. Geologic cross section of the northern limb of the Selinsgrove anticlinorium, located between the Sunbury sewage disposal site and Brush Valley Road (A–A' from Figure 1). Locations of mass-wasting events along Pa. Route 147 are depicted at the base of the cross section.

(Figure 3B), mostly observed in the Marcellus Formation (Geyer and Wilshusen, 1982; MacLachlan and others, 1995), and slabby cleavage, also described as breaking into a blocky pattern (Geyer and Wilshusen, 1982) (Figures 3C and 3D), mostly observed in the Mahantango Formation. The slabby fabric is nearly perpendicular to bedding (Figures 3C and 5).

Cleavage is a type of primary foliation that produces a linear to planar fabric that develops as a result of deformation in fine-grained rocks that experienced compressional stress. Pencil cleavage refers to the fracture pattern that produces long, slender pieces of rock that resemble pencils (Figure 3B) (Nickelsen, 1986). The pencils can be very fine, a few centimeters long, or they can be coarse, up to 40 centimeters long. A slabby cleavage, where the rock breaks apart along larger, weak planes, can produce large, angular blocks up to 20 centimeters thick. When abundant fine-grained rock is removed, some of the sandstone from higher in the section (Figure 2) may be undercut and collapse, producing even larger debris that can be up to 2 x 2 square meters. Both pencil and slabby cleavage tend to have the same strike as the local bedrock, but the direction of the cleavage dip is toward the northwest, nearly N345°W and at a steep angle (Figure 5).

Summary of Factors Affecting Slope Stability

Weather. Many rockfalls and rockslides in central Pennsylvania occur in the winter/spring part of the year, when there may be changes in daily temperature, precipitation (rain and snow) is readily available, and when freeze-thaw activity and growing vegetation can disturb rock (Elick, 2002). Temperature changes such as those associated with the events of 2014 are known to cause rock and the water within the rock to expand and contract. This pressure, along with the additional weight of the precipitation, adds to instability. When temperatures are above freezing and water is present, the water

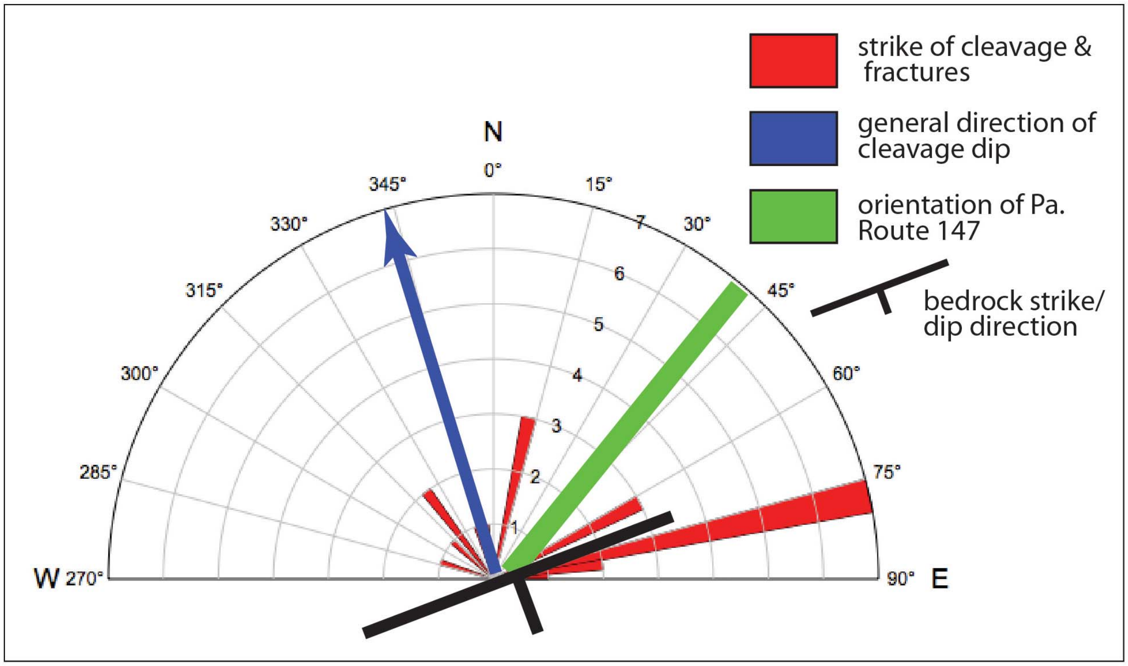

Figure 5. Rose diagram depicting the intersection of planar features that are associated with mass wasting at the most recent site of rockfall (May 21, 2014). The bedrock (black symbol) is trending to the northeast and dipping to the southeast. The cleavage planes (red) have the same trend as the bedrock, but the cleavage planes dip to the northwest (blue arrow) at very steep angles (75° to vertical). Pa. Route 147 is depicted in green, trending N40°E; it is right below the cleaved rock and is the accumulation site for fallen rock.

may flow through cleavage planes and other fractures. When the temperatures reach freezing, ice can form, forcing the rock apart. Rock on steep slopes becomes unstable, and ultimately, gravity pulls it down in a rockfall or rockslide. Rock falling from above may impact rock downslope, resulting in even more debris, which can cause a small event to evolve into a larger one.

Cleavage. In addition to the effects of weather, the orientation of the rock cleavage contributes to mass wasting. The most recent mass-wasting events took place along a small anticline, composed of the Marcellus Formation and Fisher Ridge Member (Figures 1 and 4). At this location the bedrock exhibits a general strike of N73°E to N75°E, with the limbs of the anticline dipping to the northwest and southeast at angles no greater than 10° (Figures 3A, 4, and 5). The cleavage intersecting the bedrock strikes at N76°E, nearly identical to the bedrock strike, but cleaves to the northwest at angles ranging from 75° to vertical. Smaller iron-stained fractures also crosscut the bedding to the north at N14°E and to the northwest, further weakening the rock. Since the road at this location is oriented at N40°E, rock from the steep exposure simply breaks away along cleavage and fractures and falls to the road.

Vegetation. Vegetation growing on the steep slope that has extended roots into the cleaved rock may also influence mass wasting. The cracks and spaces produced by cleavage (Figure 3) provide a location for plant growth, and a potential water source. As the roots grow and expand, they may promote rockfalls and rockslides by exerting force on the rock, pushing it to unstable positions. Eventually, heavy precipitation or freeze-thaw activity can loosen the rock, allowing gravity to pull it to the road below.

Rock Attributes. Rock strength is also important when considering how and why mass wasting occurs; Geyer and Wilshusen (1982) noted that the Hamilton Group is moderately to poorly resistant to weathering and breaks easily into plates and block fragments. Fine-grained rock, such as shale, breaks more easily than coarser grained sandstone (Delano and Wilshusen, 1999), especially when falling from a distance. This is particularly true if the fine-grained rock contains abundant fractures or cleavage. Furthermore, rock units having cleavage planes oriented in an unstable position may be prone to increased mass wasting (Hearn, 2011). At any given location, due to the folding of the rock units along Pa. Route 147 (Figure 4), there is variability in the orientation and lithology of rock units that can potentially fall or slide onto the road. The variable bedrock orientation in the Hamilton Group (Figures 3, 4, and 5) along this road may place cleavage planes in positions of instability, and the rock is more likely to experience wasting. The lower part of the Hamilton Group is more argillaceous than the upper part, accounting for the greater cleavage in the Marcellus Formation and Fisher Ridge Member (Figures 2, 3, and 4). This cleavage causes rock to rapidly weather and undergo mass wasting. Much of the fallen debris produced by these rock units is composed of small fragments. Delano and Wilshusen (1999) described how rock containing abundant, closely spaced fractures breaks apart into small fragments. We contend that cleavage can enhance fragmentation in a way similar to fractures. Ultimately, the larger angular debris from the coarser, thicker beds of the Montebello Sandstone Member is incorporated into mass-wasting events when much of the underlying shale has been undercut.

Another local rockslide described by Elick (2002) provided an example of how intersecting joint sets from a nearby exposure of Trimmers Rock Formation contributed to a very large rockslide along Snydertown Road (the January 9, 2002, event indicated on Figure 1). There, an estimated 6,000 tons of debris moved across a two-lane road and into Shamokin Creek. The biggest difference between the two Sunbury locations was that the Trimmers Rock Formation did not exhibit cleavage. This slide was composed of large blocks of sandstone and shale, versus the highly fragmented debris from the cleaved Hamilton Group. The cleaved fabric found in the fine-grained rocks from the lower part of the Hamilton Group made the rock weak, which may have amplified the effects of freeze-thaw activity in triggering small mass-wasting events, which may be precursors to occasional larger slides. The Pa. Route 147 Hamilton Group mass-wasting events near Sunbury represent an example of how rock cleavage may influence rockslides in Pennsylvania.

Recommendations

Though a rock retention fence now extends along approximately 100 meters of Pa. Route 147, limiting the amount of rock that reaches the road in some places, this particular exposure of rock should continue to be monitored for potential future rockfalls. Additionally, the regions along this stretch of road that are not fenced should be periodically examined. We also suggest monitoring the amount of traffic using the road to determine if other actions should be taken. Though there have been no instances of vehicular damage or injury from the rockfalls/rockslides, this location continues to pose a threat to travelers in this region.

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Reflections on "Spirifer disjunctus," a Group of Late Devonian Brachiopods Useful for Correlation in Pennsylvania

John A. Harper
Pennsylvania Geological Survey (retired)

Albert D. Kollar
Carnegie Museum of Natural History

Introduction

Paleontologists and rock hounds digging around in the Upper Devonian of Pennsylvania and New York are going to be very familiar with the subject of this fourth paper dealing with "reflections" on relevant fossils found in Pennsylvania. *"Spirifer disjunctus"* was the name broadly used for a group of significant brachiopods now referred to the genus *Cyrtospirifer* Nalivkin (in Frederiks, 1924). *Cyrtospirifer* is a very important worldwide Late Devonian index fossil—meaning that if you find a specimen in a rock layer you are guaranteed that the unit is Late Devonian in age.

Many paleontologists and stratigraphers have referred to *"Spirifer disjunctus"* in Pennsylvania's Upper Devonian rocks over the past 140+ years, although, as Willard (in Willard and others, 1939) critically pointed out, the geologists of the Second Geological Survey of Pennsylvania, which operated from 1874 to 1895, commonly either failed to recognize or incorrectly identified the brachiopod in their numerous reports. But that actually was only a minor problem. In reality, *"Spirifer disjunctus"* is endemic to Europe; it does not occur in North America. So what is *Spirifer disjunctus,* and why was the name used so regularly in this country?

In the Beginning: *Spirifera disjuncta* Sowerby, 1840

In 1840, J.(ames) de C.(arle) Sowerby (1787–1871) illustrated the cast of a brachiopod shell from the Devonian of England that he named *Spirifera disjuncta* (Sowerby, in Sedgwick and Murchison, 1840) (Figure 1). Sowerby (Figure 1), the eldest son and namesake of the eighteenth century naturalist and artist James Sowerby, loved natural history as a child. His main interest was analytical and experimental chemistry (he and Michael Faraday both studied under Sir Humphrey Davy), and he became a great chemist in his own right. But he also worked with his father on *Mineral Conchology of Great Britain,* a series of volumes on natural history. After his father's death in 1822, Sowerby continued that work with his brother George. Like his father before him, he was an artist who illustrated his and other naturalists' works with drawings and engravings of fossil plants and animals, illustrations that, despite his prominence as a chemist, are considered his most valued work in science (Woodward, 1871). His contributions to the study of paleontology led such nineteenth-century geological luminaries as Roderick Murchison and Adam Sedgwick to seek his assistance in describing, naming, and illustrating the fossil shells they collected in their geological explorations of the British Isles.

Two years after Sowerby described and illustrated *Spirifera disjuncta,* Timothy Abbott Conrad (Conrad, 1842) described *Delthyris chemungensis,* a new brachiopod from the Upper Devonian at Chemung Narrows in New York. Conrad was one of the earliest American invertebrate paleontologists, and is generally regarded as a paleontological pioneer for his work, especially on Cretaceous, Tertiary, and Recent mollusks (see Harper, 2014). Conrad's description of *D. chemungensis* was very short. For

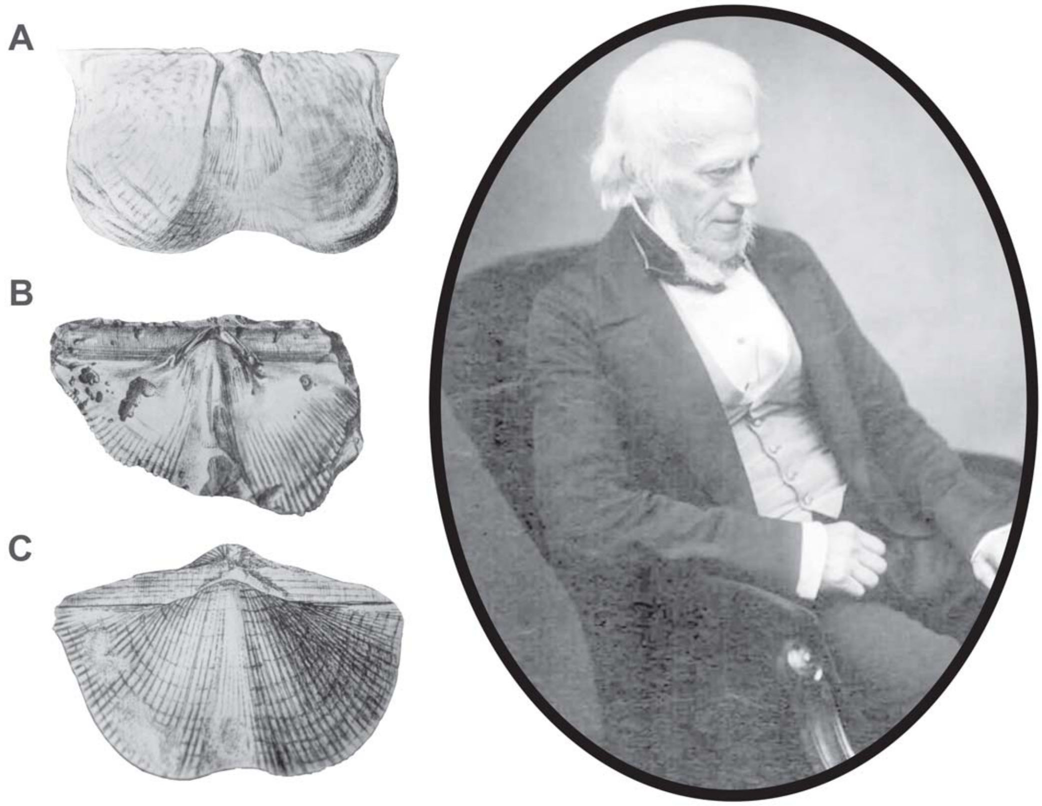

Figure 1. Illustrations of Spirifera disjuncta *and the person who drew them. Left, Sowerby's illustrations (from Sowerby, in Sedgwick and Murchison, 1840). A, Interior of the brachial valve. B, Interior of the pedicle valve. C, Exterior of the pedicle valve. Right, Portrait of J. de C. Sowerby (modified from Anonymous, 2014a).*

its time, it was probably an adequate description, but by today's standards, it is woefully lacking in detail:

> "Triangular, ventricose, with numerous slender ribs; upper valve with the mesial fold wide, convex or rounded and ribbed like the sides, except that the ribs bifurcate, about thirteen in number; area of inferior valve very wide; mesial fold profound. Length, one inch; width, one inch and a half" (Conrad, 1842, p. 263).

Unfortunately, Conrad did not illustrate his new species, so this insufficient description is all paleontologists had to go on for 25 years.

At the time of Conrad's publication, the New York Geological Survey was setting the standard for paleontological research in North America. The New York Survey's most famous paleontologist, James Hall (Figure 2), established the validity of Sowerby's species in North America, but he joined it to Conrad's generic name, thus creating the combination *Delthyris disjuncta* (Hall, 1843, p. 269). Hall's fossil differed somewhat from the British version, but he apparently felt it was not distinctive enough to consider it a separate species. Fifteen years later, he provided the first really significant work on *"Spirifer disjunctus"* in North America. Following the lead of European paleontologists, he lumped together 18 European and North American species, including Conrad's species and three of his own, and described them all as *Spirifera disjuncta*[1] (Hall, 1867, p. 243). In his opinion, there were no important

[1] Although the name had been amended to *Spirifer disjunctus* in 1845, Hall ignored the update in favor of Sowerby's original nomenclature.

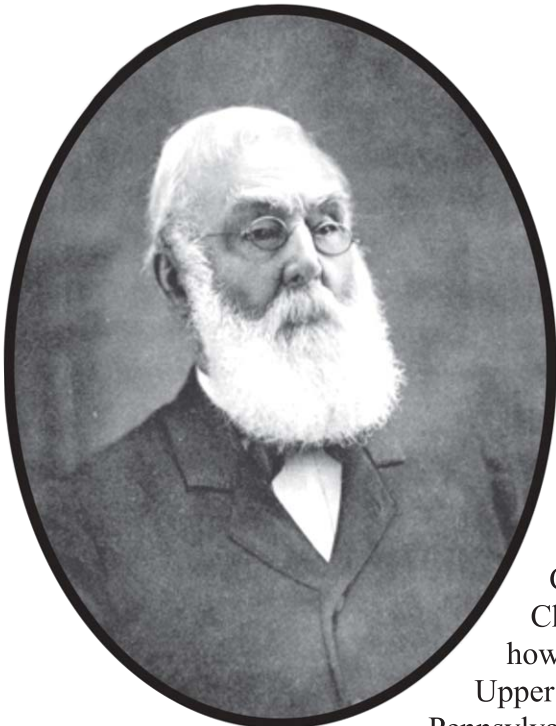

Figure 2. Portrait of James Hall (modified from University of Iowa, 2010).

distinctions between the European and North American forms. Figure 3 illustrates some of the morphological varieties Hall considered to be *Spirifera disjuncta.*

With Hall's work prominently leading the way, *"Spirifer disjunctus"* began to be documented from all over North America—as far away as Nevada and western Canada—and from other parts of the world as well (e.g., in China by Grabau, 1931). Not everyone fully agreed with Hall, however. For example, Caster (1934, p. 35), who detailed the Upper Devonian and Mississippian stratigraphy of northwestern Pennsylvania, found that:

> ". . . most stratigraphers are not willing to look closely enough at their 'index fossils' to catch the significant variations. Hence the longe [sic] range and wide distribution of certain species of Upper Devonian Brachiopods, such as *Sprifier* [sic] *disjunctus* in the literature on the Upper Devonian. What has previously been called the species *S. disjunctus* is actually a whole group of species, subspecies and mutants . . . which are perfectly recognizable when carefully studied. Heretofore they have never been subjected to sufficiently detailed study."

"Spirifer disjunctus" occurs throughout approximately 5,000 feet of marine Devonian rocks in Pennsylvania and adjacent states. That is a lot of rock representing a very long stretch of geologic time (about 20 million years)—too long for a single species to thrive. Something had to be done to correct this anomaly, but it took a great deal of time and work to get it all straightened out.

Cyrtospirifer Nalivkin (in Frederiks) 1926

While western paleontologists and stratigraphers continued to refer to *"Spirifer disjunctus,"* their counterparts in the Soviet Union (USSR) were quietly doing significant work on describing and illustrating numerous new brachiopod genera and species. Frederiks (1924) first published the name *Cyrtospirifer,* citing an unpublished manuscript by Nalivkin bearing the date 1918, but he used the name without defining it. According to Greiner (1957, p. 15), "Fredericks' description of the genus is most inadequate, as he was more anxious to fit it into the proper pigeon-hole in his taxonomic grid, which was based on a few shell features, than to adequately describe the generic characteristics." It is clear from Frederiks' paper that Nalivkin was responsible for both the name and definition of *Cyrtospirifer,* as well as designating *Spirifer verneuili* Murchison[2] as the type species. Nalivkin (1930) later published a more complete description of the genus. Paleontologists acknowledge this by giving Nalivkin full credit

[2]It should be noted that many paleontologists in Europe and elsewhere considered the names *Spirifer verneuili* and *S. disjunctus* to be synonymous, that is, they are different names for the same species. Usually, the first name to be used is considered to be the correct one. A synonymy is a presentation of names that have been applied to an organism. It is a history of the naming of that particular species.

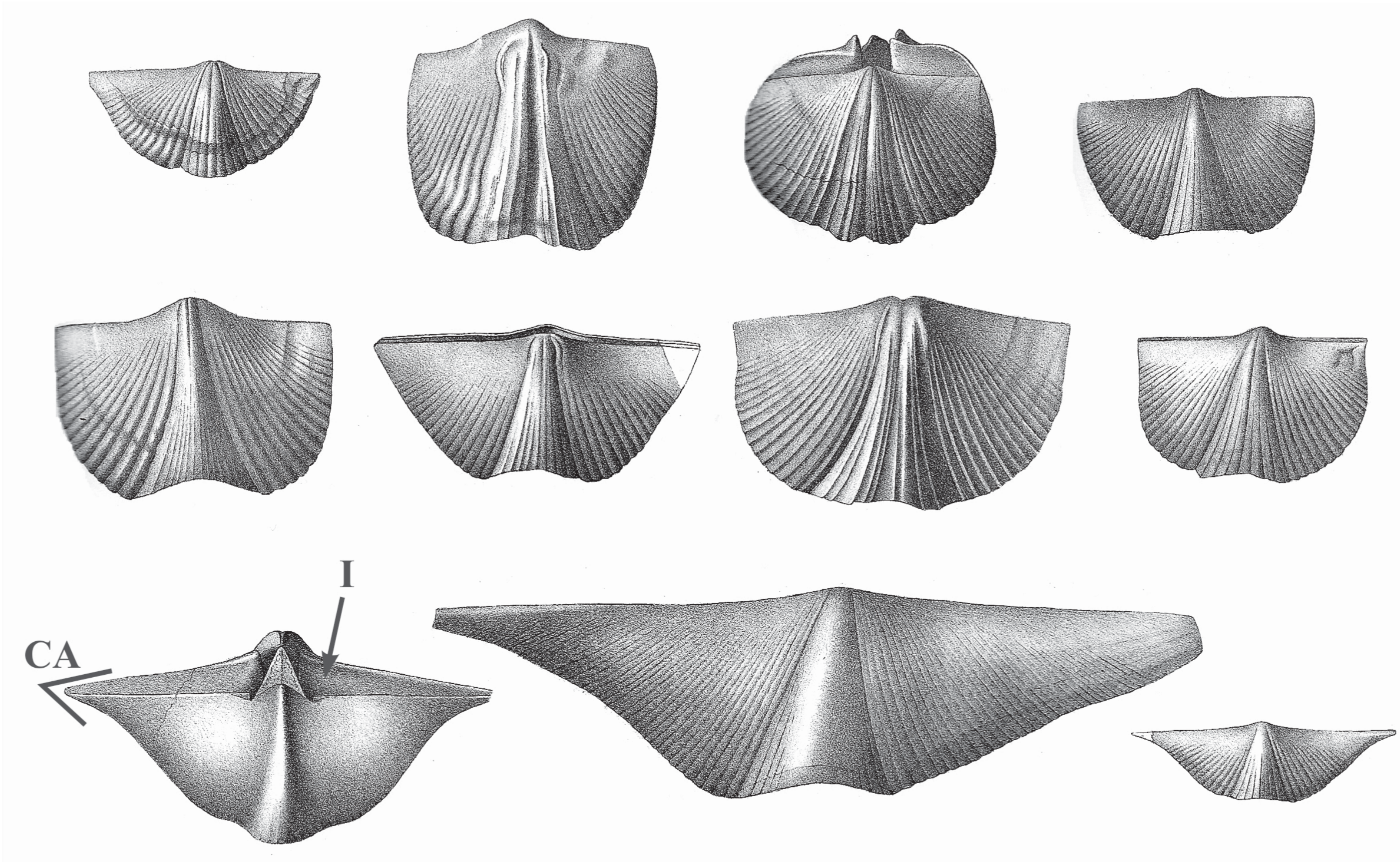

Figure 3. Some of the many morphological varieties James Hall (1867) referred to "Spirifera disjuncta" *(not to scale). The widest form is probably Conrad's (1842)* "Delthyris chemungensis." *Compare these forms with Sowerby's illustrations of the type specimens in Figure 1. Abbreviations added by Harper and Kollar (see text): CA, cardinal angle; I, interarea.*

within Frederik's publication (e.g., Johnson, 2006, p. 1726). Nalivkin's and Frederiks' work generally was quite good, but unfortunately, their lives, at least Frederiks', were a living hell.

Dimitri Vasil'evich Nalivkin (1889–1982) (Figure 4, left) was the more fortunate of the two paleontologists. The son of a mining engineer from St. Petersburg, Russia, Nalivkin attended the Mining Institute in St. Petersburg and began teaching there even before completing his degree in 1915. Throughout his long and illustrious career, his main research interest was in Devonian and Carboniferous stratigraphy and paleontology of the Russian platform, the Urals, and Central Asia. From 1917 until his death, he worked for the Geological Commission, mapping in many parts of the USSR, especially for coal, oil, and various ores. Although he was never a member of the Communist Party, his friendships with high-ranking Soviet officials played a major role in his survival during the 1930s, a time when intellectuals were being purged by the Stalinist regime. Nalivkin won the Stalin Prize in 1946 and was elected a full member of the Soviet Academy of Sciences. In 1957, he won the Lenin Prize for completing a geological map of the USSR. But perhaps his most significant contribution was the creation of a set of geological maps of the USSR and adjacent regions that attracted international interest. Today, a Russian research vessel named for him carries out seismic surveys in Russian Arctic waters—a long way from his beloved Central Asia and Caucasus (Anonymous, 2013; Find A Grave, 2014).

Unlike Dimitri Nalivkin, Georgy Nikolaevich Frederiks (1889–1938) (Figure 4, right) was part of the Russian nobility, having inherited the title of Baron in the early 1900s. He was a well-known

Russian geologist who specialized in stratigraphy, paleontology, and structural geology. After receiving his training in mineralogy and geology from the Kazan Imperial University prior to the Russian Revolution, he was employed by the Geological Committee, mapping and describing the Carboniferous and Permian stratigraphy and paleontology of Russia. A skilled linguist, he maintained contacts with foreign scientists at a time when the Soviet Union disparaged any foreign scientific thought. He was purged from the Geological Committee in 1931, arrested in 1935, and exiled to "corrective labor camps." Unremittingly persecuted for his intellect, nobility, and belief that science should be separate from politics, he continued to be harassed until 1937 when the Soviet Union charged him with deliberately misinterpreting the structural geology of an oil field in the Ural Mountains. In addition, he became the victim of trumped-up charges of conspiracy to assassinate Soviet leaders. Like many Soviet intellectuals during the Stalinist purge, Georgy Frederiks was executed in 1938. He was posthumously granted "full exoneration" (i.e., rehabilitation) in 1956 (Talent and others, 1995).

It took some time for the name *Cyrtospirifer* to gain recognition outside the Soviet Union. G. Arthur Cooper, an internationally known brachiopod specialist from the Smithsonian Institution in Washington, D.C., was probably one of Frederiks' outside contacts. Cooper seems to have been the first North American paleontologist to use the name *Cyrtospirifer* in a report to the National Research Council:

> "In the Upper Devonian of New York the writer has seen large lenses of brachiopod shells consisting almost wholly of the ventral valves of *Cyrtospirifer*" (Cooper, 1937, p. 34).

Other geologists and paleontologists slowly followed suit (e.g., Merriam, 1940), but by and large, they continued to lump most North American cyrtospiriferids under the species name *"disjunctus."* Even the authoritative Cooper cited *Cyrtospirifer disjunctus* as an important index fossil of Late Devonian strata

Figure 4. Portraits of early twentieth-century Russian paleontologists. Left, Dmitryi Vassil'evich Nalivkin (modified from Anonymous, 2014b). Right, Georgy Nikolaevich Frederiks (modified from Greene, 1995).

in North America in the widely referenced *Index Fossils of North America,* although he admitted that it was "a loosely drawn species and that the name probably should not be used for many post-Chemung types now placed here [see below]" (Cooper, 1944, p. 321 and pl. 122, Fig. 1–3).

Since that time, many new genera of the Family Cyrtospiriferidae, and species of *Cyrtospirifer,* have been added to the growing list of fossil names. For example, a new generic name, *Eurytatospirifer,* was erected in 1949 with *Spirifer disjunctus* as its type species. That name, however, has been rejected and is now considered to be a synonym of *Cyrtospirifer* (Carter and others, 1994; Ma and Day, 2007). Carter and others (1994, p. 335), in a revision of the Cyrtospiriferidae, placed six genera in synonymy with *Cyrtospirifer* and recognized ten others within the family as valid. They diagnosed *Cyrtospirifer* and its relatives as having wide interareas and acute cardinal angles (Figure 3), and this diagnosis now appears in the *Treatise of Invertebrate Paleontology* (Johnson, 2006). These features can be seen in the rock specimen shown on the cover of this magazine.

Unscrambling *"Spirifer disjunctus"*

Bye (1949) first attempted to unravel the complexities of *"Cyrtospirifer disjunctus"* in the Appalachians, separating it into three distinct species, including two new ones. She continued to recognize *"disjunctus"* as a valid species in North America, however, and failed to recognize Conrad's *"chemungensis."* Unfortunately, Bye never published her thesis, so her new names are invalid.

Greiner (1957) produced the most extensive and important work on *"Spirifer disjunctus"* in North America, having collected and named numerous recognizable species from Late Devonian rocks in New York, Pennsylvania, and Ohio. He described and illustrated 17 species (Figure 5), including *Cyrtospirifer chemungensis* (Conrad), verifying that Conrad (1842) described the first North American species of *Cyrtospirifer.* Of Greiner's species, two were originally described by Hall, two were questionable or difficult to adequately assess, and the remaining 13 were new to science. His work proved indisputably that *"Spirifer disjunctus"* was not a single variable species but rather a group of related species having well-defined characteristics, distinct habitats, and limited stratigraphic ranges (Figure 6). Greiner's monograph stood for 47 years as the "bible" for cyrtospiriferids from eastern North America. Only recently has some of his work been called into question. Ma and Day (2003, 2007) restudied Greiner's type and stratigraphic collections, and concluded that: (1) two species described by Hall, *C. sulcifer* and *C. inermis,* Greiner's new species, *Cyrtospirifer angusticardinalis,* and one of Greiner's questionable species, *"C. chemungensis* (variants)*,"* most likely are not species of *Cyrtospirifer* but belong in related genera; (2) another new species, *C. altiplicus,* is synonymous with *C. chemungensis;* (3) five species occur in the Frasnian (early Late Devonian) and 12 occur in the Famennian (late Late Devonian) (see Figure 6); and (4) although most of the Famennian species are valid, they might not be species of *Cyrtospirifer* (see below).

Time, Rocks, and Ecosystems

Cyrtospirifer has long been recognized as a Late Devonian genus. Generally speaking, if you find it in the rocks, the rocks are Late Devonian in age. Even when all of the "*disjunctus* group" was referred to a single species, it was known to have been restricted to Late Devonian strata. Thus, the occurrence of *Cyrtospirifer* in the Corry Sandstone of northwestern Pennsylvania (Greiner, 1957), and in the Cussewago Formation of southwestern Pennsylvania and northern West Virginia (Carter and Kammer, 1990) (Figure 7), was one of the main reasons the Pennsylvania Geological Survey shifted the Corry and correlative rocks from the Mississippian to the Devonian (see discussion in Harper, 1993).

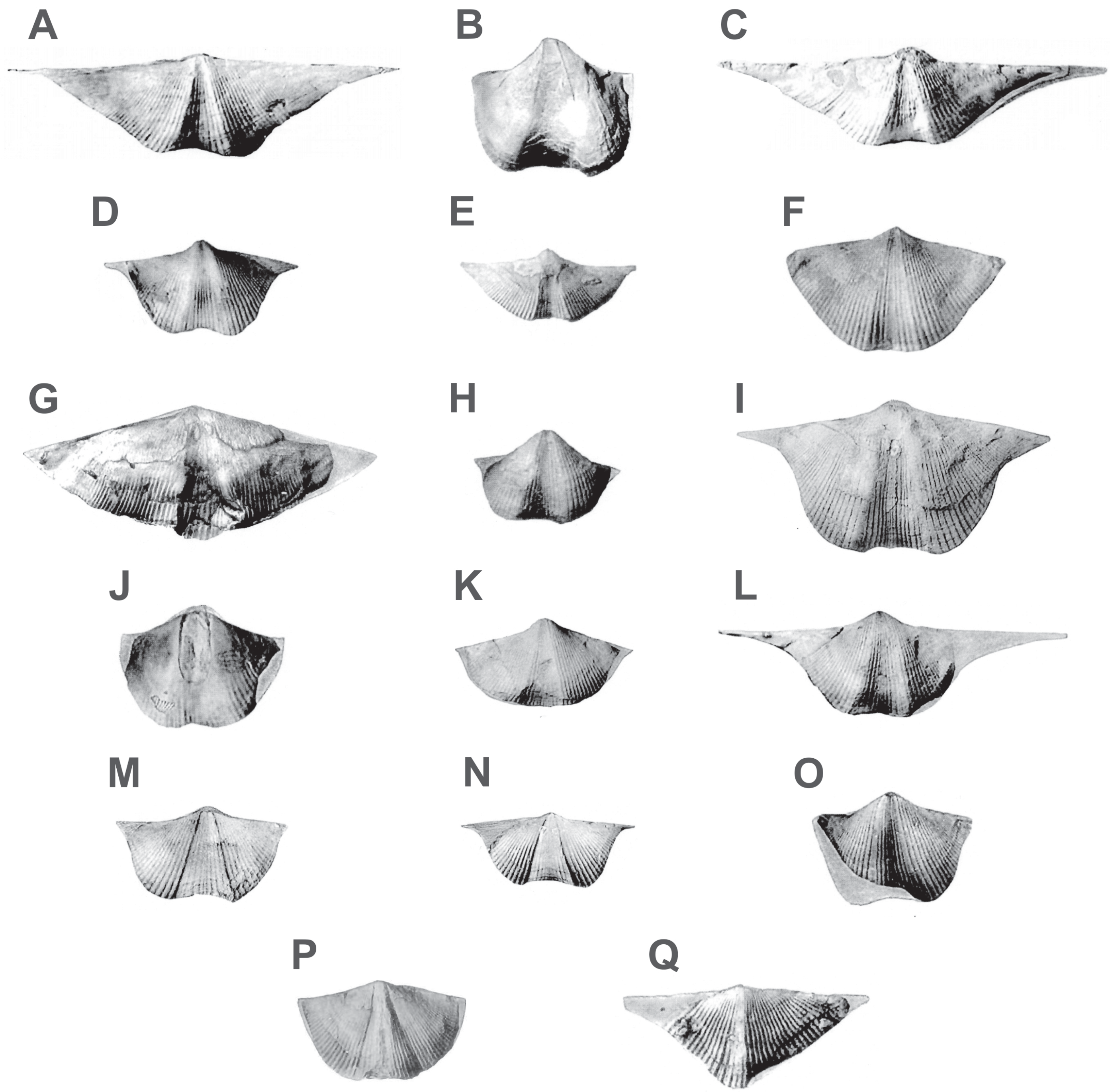

Figure 5. Greiner's (1957) species of the "disjunctus group" in the Late Devonian of the Appalachian basin (not to scale). A, Cyrtospirifer chemungensis *(Conrad). B,* C. preshoensis *Greiner. C,* C. altiplicus *Greiner [=* C. chemungensis*]. D,* C. inermis *(Hall). E,* C. hornellensis *Greiner. F,* C. sulcifer *(Hall). G,* C. vandermarkensis *Greiner. H,* C. nucalis *Greiner. I,* C. tionesta *Greiner. J,* C. leboeufensis *Greiner. K,* C. corriensis *Greiner. L,* C. spicatus *Greiner. M,* C. warrenensis *Greiner. N,* C. oleanensis *Greiner. O,* C. lobatimusculus *Greiner. P,* C. angusticardinalis *Greiner [=* Uchtospirifer? angusticardinalis*]. Q, "*C. chemungensis *variants" [=* Regalia occidentalis *(Whiteaves)].*

Bradford Willard, a member of the Pennsylvania Geological Survey and geology professor at Lehigh University in the first half of the twentieth century, found *"Spirifer disjunctus"* very useful for defining formation boundaries:

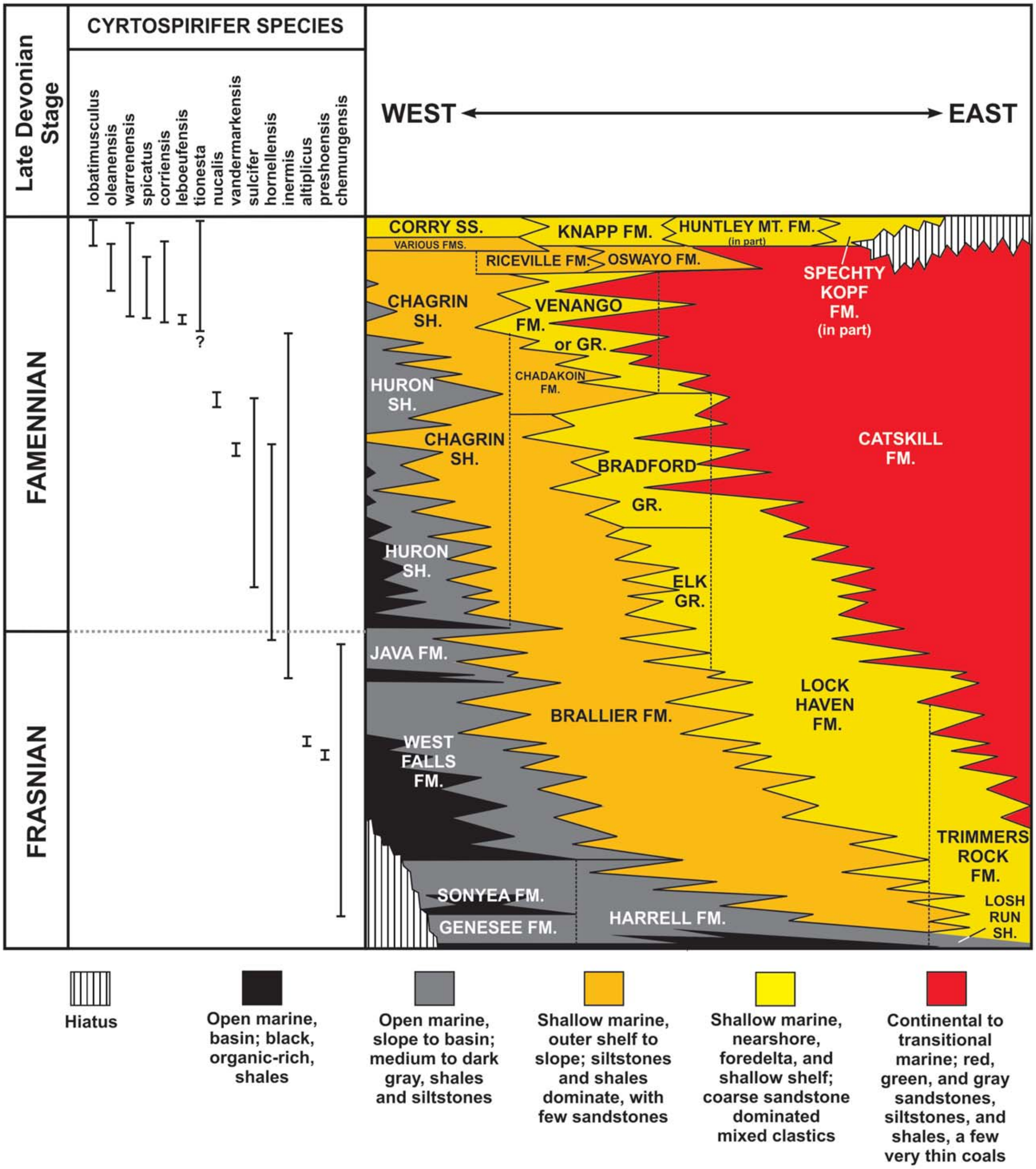

Figure 6. Generalized correlation diagram of the Late Devonian strata of Pennsylvania (no horizontal or vertical scale), with ranges of 15 species of "Spirifer disjunctus" *(*= Cyrtospirifer*) described by Greiner (1957). The Frasnian-Famennian boundary occurs about 6.5 feet below the base of the Huron Shale, according to Day and Over (2002).*

> "*'Spirifer disjunctus'* is common in our Chemung and later marine Devonian, but unknown from the Portage. Therefore, wherever possible the top of the Portage group is drawn beneath the lowest occurrence of this brachiopod" (Willard, in Willard and others, 1939, p. 209).

(Chemung and Portage are obsolete stratigraphic names. Generally speaking, "Portage" encompassed gray to black slope and basinal rocks such as the Harrell Shale and Brallier Formation, whereas

"Chemung" included near-shore to outer-shelf sandstones, siltstones, and shales such the Lock Haven Formation, shown in Figure 6).

> "Everywhere, the base of the Chemung group in Pennsylvania is drawn at the lowest appearance of *'Spirifer' disjunctus*. This and only this criterion is generally available, since in most sections there is no marked lithologic change upon which to separate the Chemung and Portage groups. While *'Spirifer' disjunctus* ushers in the Chemung, it may not be designated a Chemung guide fossil, for it is known that its vertical range extends well above the group" (Willard, in Willard and others, 1939, p 248).

As a result, Willard relegated the Trimmers Rock Formation (Figure 6) in central Pennsylvania to the "Portage group" because *"Spirifer disjunctus"* first occurred in the rocks above it, despite the fact that the Trimmers Rock Formation falls lithologically into his "Chemung" definition. This was stratigraphy at its best in the 1930s when many formations were based on paleontology. With the publication of the newly compiled *Code of Stratigraphic Nomenclature* (North American Commission on Stratigraphic Nomenclature, 1961), however, a formation became defined as a mappable lithologic unit. Therefore, it became necessary to separate lithostratigraphy (based on the physical characteristics of the rocks) and biostratigraphy (using the occurrences of stratigraphically restricted organisms). Thus, stratigraphic names such as Portage and Chemung are no longer valid because they were based as much on biostratigraphy as on lithostratigraphy.

Greiner (1957), like Willard, documented the "*disjunctus* group" in various formations, but he argued that the various species preferred marine environments consisting of the littoral and sublittoral sand, silt, and mud found at the front of the Catskill delta system. They were, therefore, defined more by depositional systems than by formation names.

The Upper Devonian of the Appalachians consists of an interfingering and coarsening-upward sequence of clastic rocks produced by the prograding Catskill deltaic system in the east as it spread sand, silt, and mud westward across the basin into the shallow sea in western Pennsylvania, Ohio, and beyond. This resulted in five broadly defined depositional and lithologic facies (represented by the five colors in Figure 6). Each facies remains grossly consistent despite differences in provenance, transport system, and depositional setting. Since they are time-equivalent facies, rather than nice layer-cake strata, for almost any given time period during the Late Devonian, each of the five facies occurs laterally across the basin. Based on Greiner's (1957) observations, no species of the "*disjunctus* group" should be

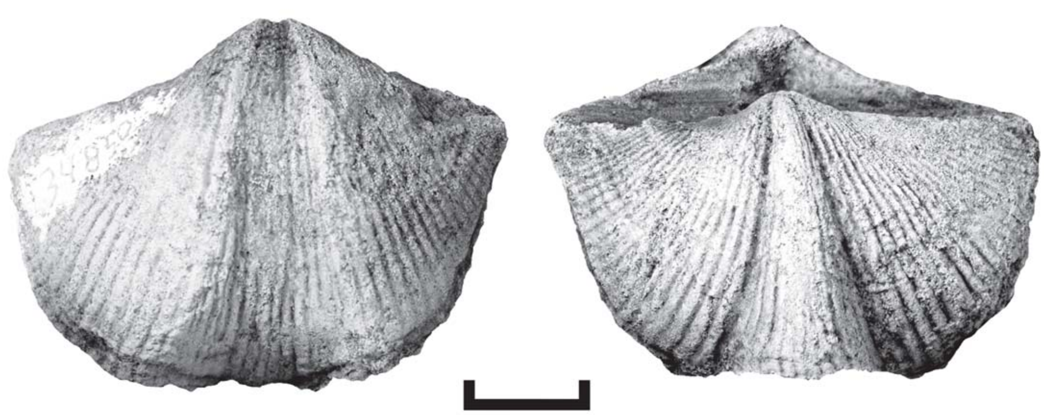

Figure 7. "Spirifer disjunctus" *(=* Cyrtospirifer *sp.* A *of Carter and Kammer, 1990) from the "Cussewago Sandstone" of Fayette County, Pa., in the collections of the Carnegie Museum of Natural History, Pittsburgh (CMNH 34850). Left, Ventral view of a natural external mold (pedicle valve). Right, Dorsal view (brachial valve) of the same specimen.*

expected to occur in either the continental and transitional redbeds of the Catskill Formation (red in Figure 6) or the dark-gray to black, lower-slope and basinal shales of the Harrell and lithologically related formations (dark gray and black in Figure 6). They should, and do, occur in the shallow-marine, nearshore to shallow-shelf mixed-clastics facies, such as the Lock Haven and Venango formations (yellow in Figure 6). *Cyrtospirifer spicatus* Greiner and *C. leboeufensis* Greiner occur in the upper portion of the Chagrin Shale of Ohio, and *C. hornellensis* Greiner occurs in the muddy offshore environment of the Wiscoy Member of the Java Formation, so at least some portion of the shallow-marine, outer-shelf to slope facies, represented by the Brallier Formation in Pennsylvania (orange in Figure 6), also proved to be satisfactory habitats for *Cyrtospirifer.*

In the Long Run . . .

We now know the brachiopod formerly referred to as *"Spirifer disjunctus"* in the Appalachian basin includes many species of *Cyrtospirifer,* but ironically, not *C. disjunctus* (Sowerby), because that species is restricted to Europe. Just how many species occur in the basin has not yet been decided by the experts. They are still working on it. Ma and Day (2007, p. 290, 293) suggested that many, if not most, of Greiner's (1957) Famennian species might not even be genuine *Cyrtospirifer:*

> "For example, in our opinion the 'aberrant variety of *Cyrtospirifer*(?)' illustrated by Greiner (1957, pl. 10, figs. 1–3 . . .) is a specimen of *Hispidaria posterogranulosa* Cooper and Dutro, 1982. The occurrence of *H. posterogranulosa* in the Famennian of New York suggests a stratigraphic correlation between the Amity Formation of New York[3] and the Middle Famennian Box Member of the Percha Formation in the Silver City area of western New Mexico. However, Johnson, 2006 points out that the genus *Hispidaria* is in the family Echinospiriferidae and is restricted to the Upper Devonian (Famennian) of western North America."

So stay tuned. Perhaps the experts will work all the kinks out of the Late Devonian cyrtospiriferids and have every species relegated to its proper genus before *"Spirifer" disjunctus* Sowerby celebrates its 200th anniversary. Just don't hold your breath.

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Continuous Monitoring of Meteorological Conditions and Movement of a Deep-Seated, Persistently Moving Rockslide Along Interstate Route 79 Near Pittsburgh

Francis X. Ashland
U.S. Geological Survey

Helen L. Delano
Pennsylvania Geological Survey

Introduction

A large inventory of landslides exists for Allegheny County, Pa., and historical movement of many of these has resulted in considerable damage to property, roads, and infrastructure. Along Interstate Route 79, a subset of the landslide inventory includes deep-seated rockslides, two of which reactivated during construction of the highway in the late 1960s (Gray and others, 2011). Following the initial movement of the rockslides, slope-stability investigations were conducted (Hamel, 1969; Hamel and Flint, 1969), and measures were taken to reduce their impacts to the highway, but movement of at least one of the rockslides persists even today. Long-term continuous monitoring of such landslides provides critical data used to assess how the state of activity and velocity of movement (when the landslide is active) change with rainfall and snowmelt. Currently, we are continuously monitoring meteorological conditions and movement of a rockslide along the northbound side of Interstate Route 79 in Aleppo, Pa. (Figure 1). The project is intended to extend over many years (approximately 5 to 10) in order to collect sufficient data to assess how extreme storms, prolonged wet periods, and melting of the snowpack affect the landslide. The rockslide is an ideal location for such long-term monitoring because the land is owned by the Pennsylvania Department of Transportation (PennDOT), and movement is not directly impacting the highway; therefore no stabilization measures are necessary in the short term.

Background

Periodic movement monitoring began in April 2011 and was conducted with simple tape measurements of a line of survey stakes that crossed the toe bulge at two locations. The initial monitoring confirmed that the rockslide remained active and showed that the average velocity gradually decreased throughout the 2011 calendar year. Beginning in January 2012, movement at the toe of the rockslide was monitored by surveying using a total station (an electronic/optical instrument integrating a theodolite with an electronic distance meter) (location 3 in Figure 1). A third survey location was added in November 2013 across a graben feature in the head of the rockslide (location 2 in Figure 1). In November 2013, after finalization of a right-of-access agreement between PennDOT and the Pennsylvania Department of Conservation and Natural Resources, instrumentation was installed to continuously monitor meteorological conditions and movement (Figure 2). Whereas the weather station has been collecting data continuously since installation, continuous movement monitoring has been interrupted by tree fall and other technical issues partly related to the initial attempt to span most of the distance across the graben. By May 2015, a reconfigured station at the head of the rockslide was continuously monitoring movement.

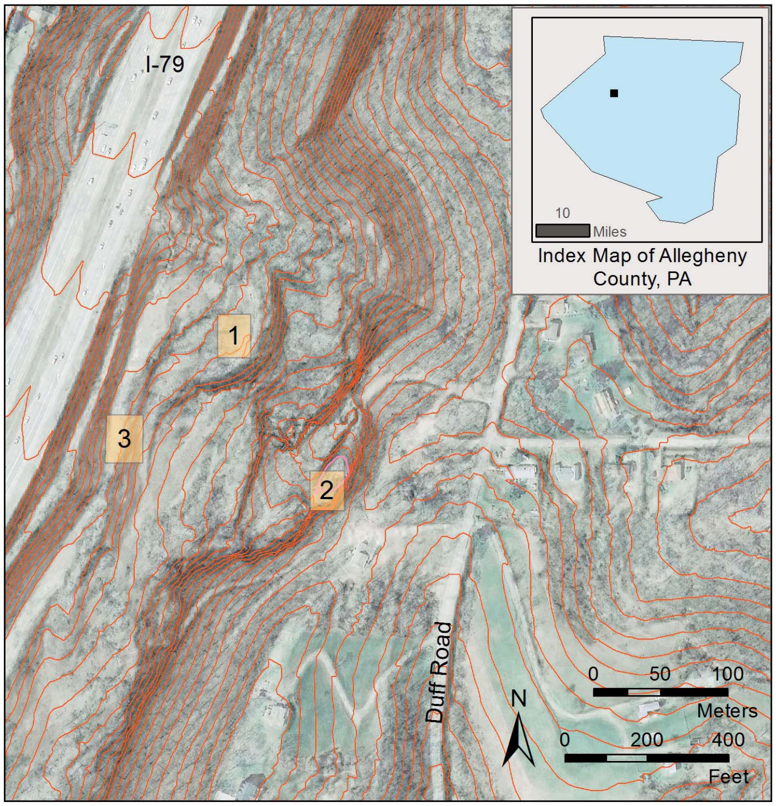


Figure 1. Location map for the monitoring site. Contour interval is 10 feet. The base is a 2010 orthophoto with slopeshade from a 2007 lidar data overlay. Darker areas shown by slopeshade are steeper; steepness is also indicated by contours. The graben at location 2 is a depression between the in-place rock above and a large block moved westward by the rockslide. Numbered rectangles are general locations of the following: 1, weather station; 2, cable extension transducer spanning the scarp graben; 3, toe bulge surveying site.

Methods and Instrumentation

Total station surveying tracks movement at two locations along the toe bulge where the rockslide overrides a rock bench created during highway construction and movement-related deformation across the graben feature in the head of the slide. Sheet-type reflective survey targets are either mounted on wooden stakes or stainless steel pipes that are grouted into the shallow soils or epoxied directly onto exposed rock. Two reflective sheet targets are typically mounted on the same stake or pipe to assess tilting. At the toe, survey hubs and control points were made in the rock bench downslope of the rockslide and are inferred to be stable. At the graben, the hub was located near the crest of an antithetic scarp that bounds the graben on its downslope side, and thus, the hub is inferred to be moving. Station-specific coordinate systems were established at each survey location based on compass measurements of the trend of the line connecting the hub to the control point. At the toe bulge locations, off-site targets were also created to confirm the stability of the hubs, but with limited success. Surveying at the graben is limited by the lack of off-site stable control points, but two targets are epoxied to the stress relief joint face that is also the main scarp of the rockslide and are inferred to be "stable" reference points used to determine movement of survey targets and the hub on the rockslide.

Two independent instrumentation stations on the rockslide continuously monitor meteorological conditions and movement, respectively. Data are stored on a datalogger powered by a 12-volt battery that is recharged by a 40-watt solar module. The weather station measures rainfall, snow depth, and air temperature. Rainfall is measured by a rain gauge that has a collection capacity of 2.0 inches per hour (51 mm/hr). Snow depth is measured by a sonic ranging sensor and is checked at least once by manual measurements in excavated snow pits. Movement is continuously monitored using a cable extension transducer (CET) having an accuracy of about 0.06 inch (1.5 mm) over its full range of 60 inches (1.5 m). The CET is mounted on a stainless steel pipe grouted into the uppermost part of the graben. Movement or rotation of the uppermost graben causes the cable to extend or shorten. The CET cable is

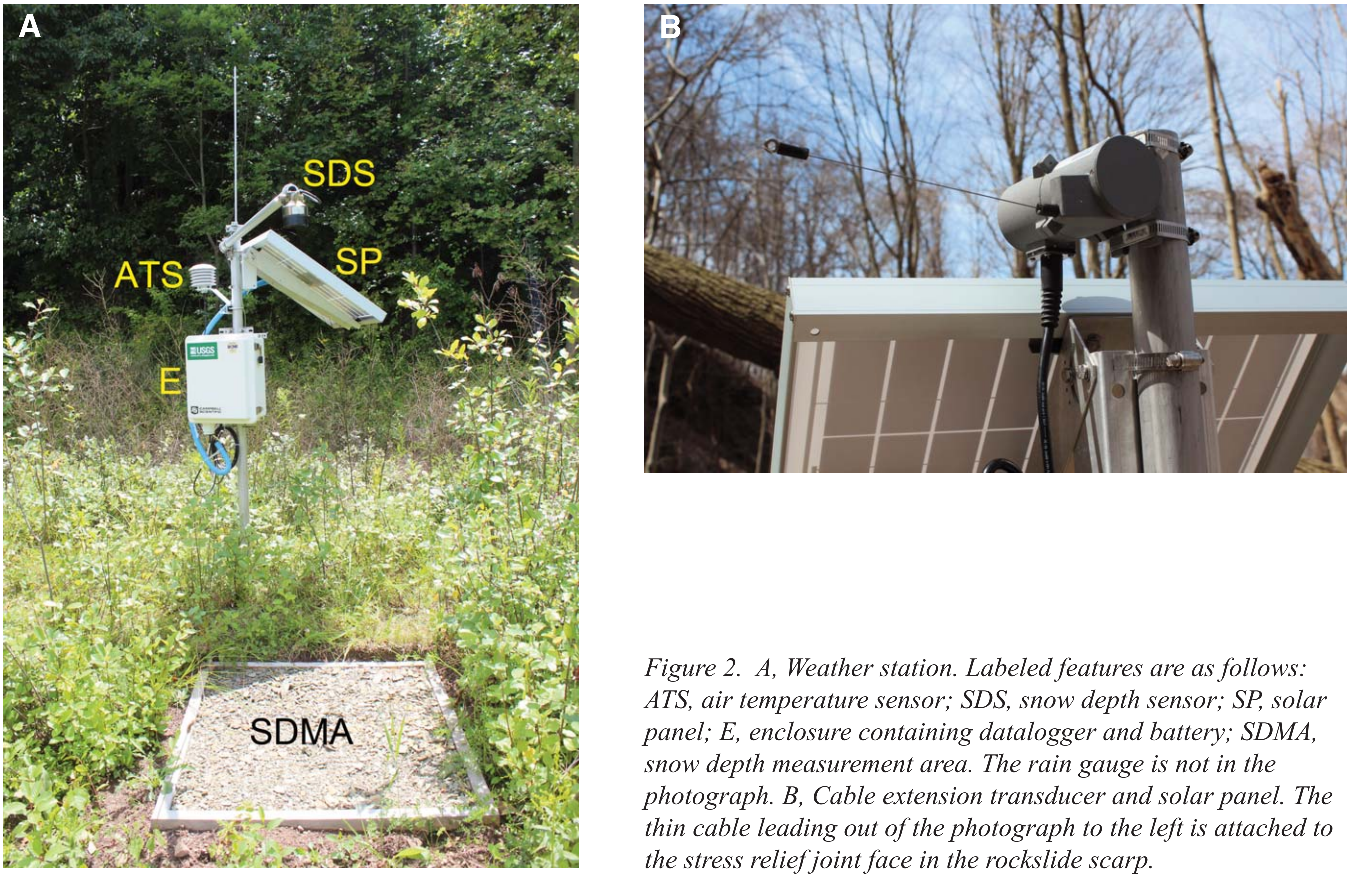


Figure 2. A, Weather station. Labeled features are as follows: ATS, air temperature sensor; SDS, snow depth sensor; SP, solar panel; E, enclosure containing datalogger and battery; SDMA, snow depth measurement area. The rain gauge is not in the photograph. B, Cable extension transducer and solar panel. The thin cable leading out of the photograph to the left is attached to the stress relief joint face in the rockslide scarp.

attached to the joint face wall by a second nickel alloy cable that has a low thermal coefficient to reduce temperature-related deformation effects on the measurements.

Preliminary Results

Collection of continuous data on meteorological conditions and movement during a near-record wet June in 2015 provided some initial insight into how heavy rainfall may affect the rockslide's movement. On June 15, the daily rainfall totaled 1.92 inches (49 mm), the highest daily rainfall amount recorded at the rockslide to date, and the three-day rainfall bracketing that date totaled 2.78 inches (71 mm). The CET recorded about 5 mm (0.2 in.) of movement (stretching) within slightly more than 10 hours on June 15 that corresponded with the heavy rainfall (Figure 3). Movement appears to have been suspended prior to the three-day storm, suggesting a rapid change in both the state of activity and the velocity.

Snow depth measurements indicated a relatively thin snowpack on the rockslide in the last two winters, but relatively rapid snowmelt. Peak snow depth was only about 9.9 and 12.7 inches (25 and 33 cm) in 2014 and 2015, respectively. In 2014 about 7.0 inches (18 cm) of the snowpack melted in just 5 days in late February. In 2015, most of the snowpack melted relatively rapidly in about 10 days in early March (Figure 4).

Survey results indicate persistent but not continuous movement of the rockslide since January 2012. Total movement at the toe bulge exceeded 3.6 inches (9.1 cm) by May 2015 (Figure 5). The rockslide moves fastest during measurement intervals spanning the winter and spring, and movement had suspended at the toe bulge by August 2014 before resuming sometime after November 2014. Survey

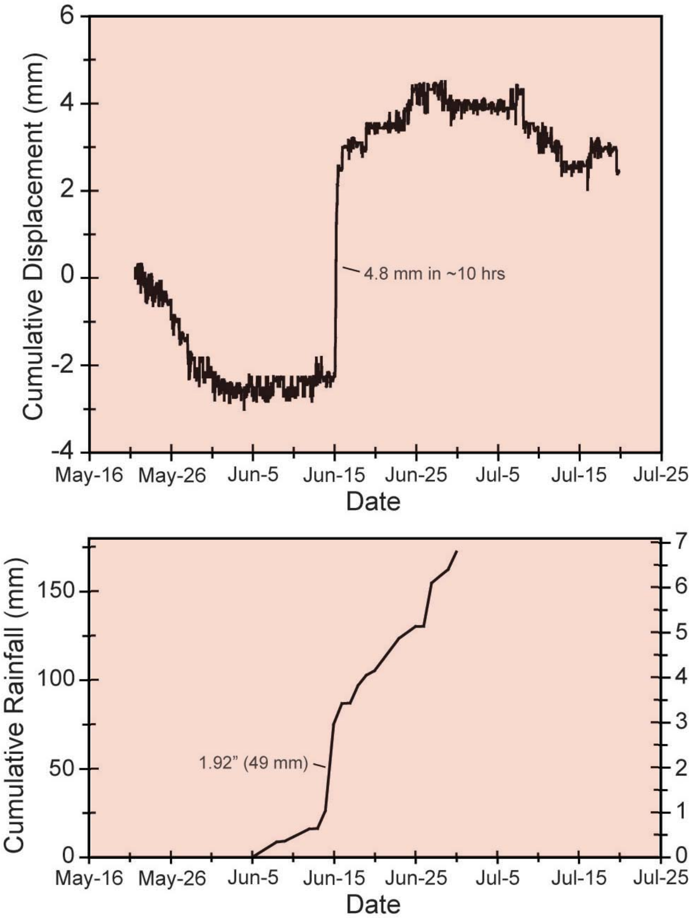
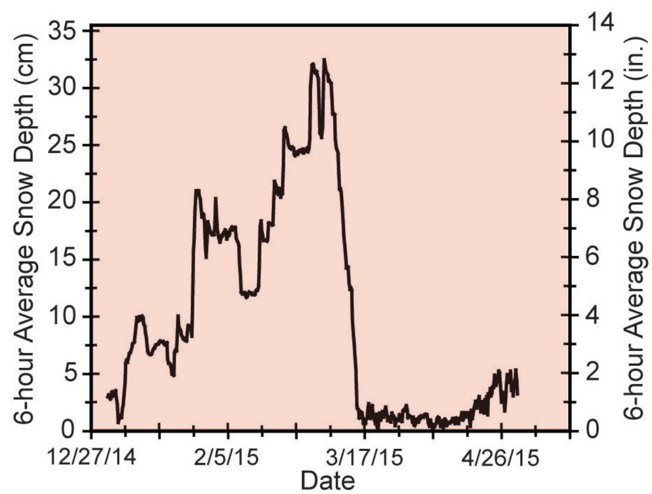


Figure 3. Plots showing the correspondence between the small displacement episode (~5 mm in 10 hours) and the heavy rainfall on June 15, 2015.

Figure 4. Plot showing relatively rapid melting of thin snowpack in March 2015.



results from across the head graben reveals cyclic stretching and shortening across the upslope part of the graben but continuous stretching across the entire graben (Figure 6). The apparent shortening suggests that possible rotation of the graben block may follow periods of horizontal displacement. The timing of the shortening in late 2014 corresponds with suspension of movement at the toe bulge of the rockslide.

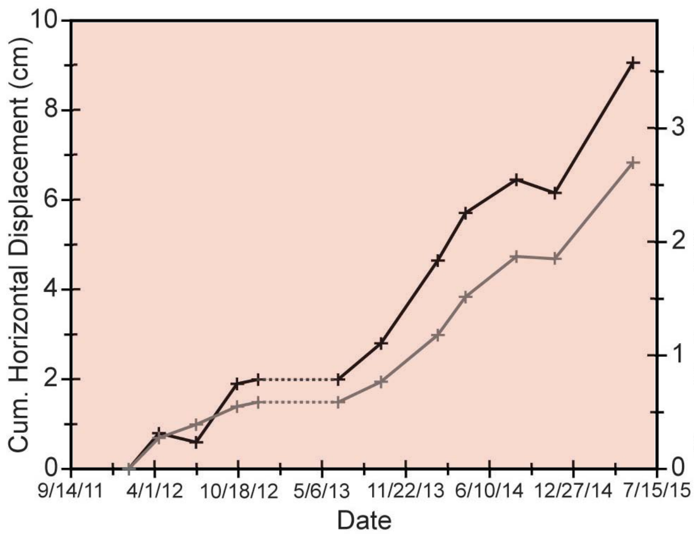


Figure 5. Plot showing cumulative horizontal displacement at station A on the rockslide toe bulge between January 2012 and May 2015 based on total station surveying. Dotted lines indicate missing data due to vandalism of survey targets sometime between late 2012 and early 2013. Landslide movement temporarily suspended in late 2014. Survey targets are grouted directly on the face of the toe bulge (black line) and in the colluvium directly below (gray line).

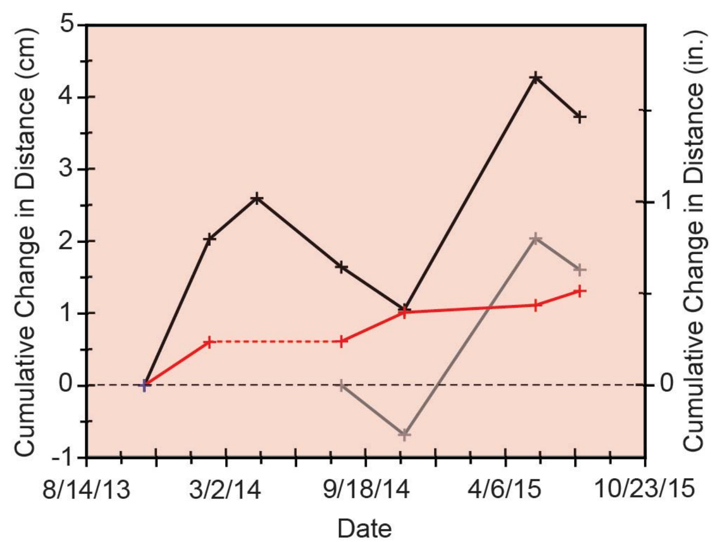


Figure 6. Plot showing the change in the distance between survey targets in the head of the landslide based on total station surveying. The distance between the base station and two targets (black line and gray line for second target placed later) on the main scarp joint face cyclically lengthen and shorten but cumulative lengthen over the measurement period. The distance between the hub located on the ridge bounding the graben on its downslope side and a target on the main scarp joint face (red line) gradually lengthens, but at slower rate.

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ANNOUNCEMENT

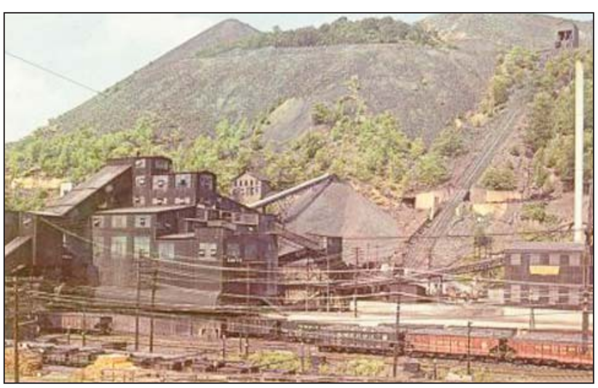
The 80th Annual Field Conference of Pennsylvania Geologists, October 8–10, 2015

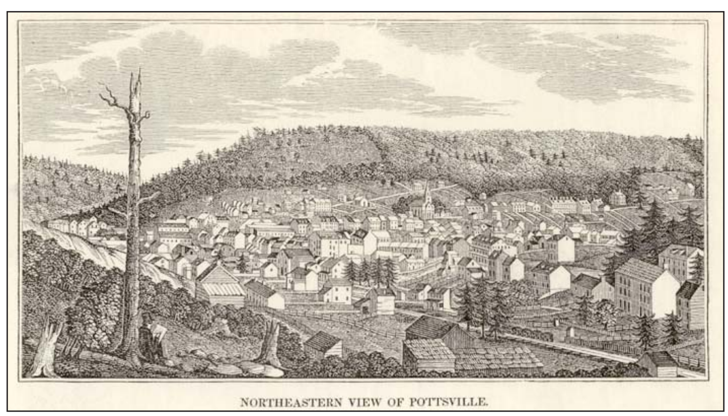
Conglomerate, Coal, and *Calamites:* Geology, Mining History, and Paleontology of "The Region," Schuylkill, Northumberland, and Columbia Counties, Pennsylvania

The 80th Annual Field Conference of Pennsylvania Geologists will be headquartered at MainStay Suites, Barnesville-Mahanoy City, Pa., and it will emphasize the stratigraphy, structure, and mining history of the Southern and Western Middle Anthracite fields, particularly in the vicinities of Pottsville and Shamokin. Stops will include the Pa. Route 61 cut in the Pottsville Conglomerate at Pottsville, Wadesville anthracite stripping, St. Clair fossil site, Pottsville Aggregates quarry at Wadesville, Centralia mine fire, Blaschak Coal Corp. strippings near Mount Carmel, the Whaleback, and Bear Gap quarry north of Shamokin. Hosts will be the Pennsylvania Geological Survey, Pennsylvania Department of Environmental Protection, Bloomsburg University, Kutztown University, Penn State University, Susquehanna University, St. Clair Community and Historical Society, Schuylkill County Historical Society, Blaschak Coal Corp., Reading Anthracite Company, Pottsville Materials (H&K Group), and Corson Quarries, Inc. Numerous pre-Conference field trips are also planned, including the Pioneer Tunnel mine tour in Ashland, a bicycle tour in the Tremont-Tower City area, cropfalls on Sharp Mountain at Pottsville, a Yuengling brewery tour, and a walking tour of historic Pottsville.

Registration for this Field Conference is already full. A waiting list has been established, and if desired, you can ask that your name be added to that list. More information about this and previous conferences can be obtained at http://fcopg.org/, or you can ask to be put on the distribution email list by emailing Rose-Anna Behr.

Contacts: Rose-Anna Behr, 717–702–2035, rosbehr@pa.gov, and Kristen Hand, 717–702–2046, khand@pa.gov.



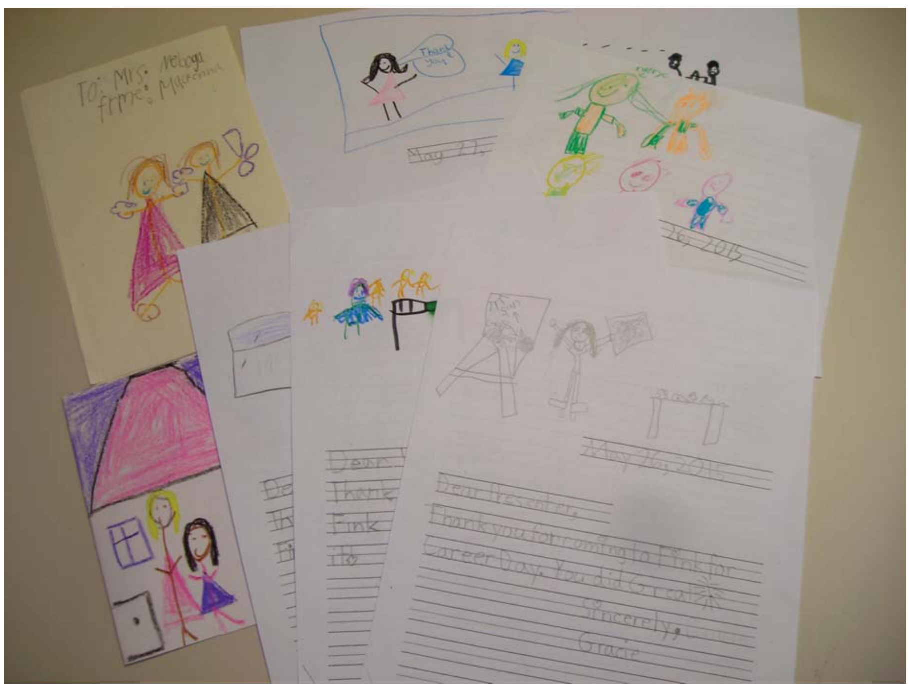


Postcard view of the Glen Burn breaker (coal processor) at Shamokin (left) and postcard view of old Pottsville (right).

BUREAU NEWS

Career Day at Lyall J. Fink Elementary School

On May 21, 2015, Fink Elementary School in Middletown, Pa., held its annual Career Day. Staff geologist Victoria Neboga participated as a guest speaker, and talked about Pennsylvania's rocks and minerals with an emphasis on groundwater as a precious natural resource. Kids from kindergarten through 5th grade learned about the water cycle and why it is important to save water in everyday activities. Neboga also involved them in hands-on activities using an EnviroScape model (one of several demonstration kits designed to help students learn about various environmental topics). The children learned how different human activities can introduce contaminants to nearby parks and streams, and what they can do to prevent these sources of pollution. They asked questions about the "awesome career" of geologist, and also about water use and conservation of water resources in their local watershed.



Some of the thank-you notes and drawings that Neboga received after her participation in Career Day.

Pennsylvania Geological Survey Photograph Collection Now Online

Our library personnel have started scanning the Survey's photograph collection, and we are making it available online at http://contentdm1.accesspa.org/cdm/search/collection/spgsl-photo. Here, you can view and download photographs taken by Survey geologists and staff members dating as far back as the 1920s that cover a wide range of topics relevant to the geology of Pennsylvania. These topics include geologic features; cities and towns; and the state's quarrying, mining, and oil and gas industries. The collection is a part of POWER Library: Pennsylvania's Electronic Library, which is funded by the Office of Commonwealth Libraries of Pennsylvania/Pennsylvania Department of Education. This collection is not yet complete and will continue to grow as additional images are added. Each online image is accompanied by a title, subject, description, and other pertinent information, such as the photographer and the date taken, if known. The example below shows an unidentified individual setting up camp in Analomink, Monroe County. How things have changed! No cell phone to keep in touch with the office during the day. No Wi-Fi-equipped motel in the evening. Not even a solid roof to sleep under.

A photograph from the Pennsylvania Geological Survey files; one of many that are now online for viewing or downloading.

RECENT PUBLICATIONS

Open-File Miscellaneous Investigation: **(June 2015)**

- Water depth of Lake Arthur—Moraine State Park, Butler County, Pennsylvania

Open-File Miscellaneous Investigation: **(May 2015)**

- Geology guide to the Yellow Breeches Creek from Messiah College to McCormick Road

Calling All Authors

Articles pertaining to the geology of Pennsylvania are enthusiastically invited. The following information concerning the content and submission of articles has been abstracted from "Guidelines for Authors," which can been seen in full on our website at www.dcnr.state.pa.us/topogeo/publications/pageolonline/pageoolguide/index.htm.

Pennsylvania Geology is a journal intended for a wide audience, primarily within Pennsylvania, but including many out-of-state readers interested in Pennsylvania's geology, topography, and associated earth science topics. Authors should keep this type of audience in mind when preparing articles.

Feature Articles: All feature articles should be timely, lively, interesting, and well illustrated. The length of a feature article is ideally 5 to 7 pages, including illustrations. Line drawings should be submitted as CorelDraw (v. 9 or above) or Adobe Illustrator (v. 8 or above) files.

Earth Science Teachers' Corner: Articles pertaining to available educational materials, classroom exercises, book reviews, and other geologic topics of interest to earth science educators should be 1 to 2 pages in length and should include illustrations where possible.

Announcements: Announcements of major meetings and conferences pertaining to the geology of Pennsylvania, significant awards received by Pennsylvania geologists, and other pertinent news items may be published in each issue. These announcements should be as brief as possible.

Photographs: Photographs should be submitted as separate files and not embedded in the text of the article.

Submittal: Authors may send their article and illustrations as email attachments to RA-pageology@state.pa.us if the file sizes are less than 6 MB. For larger sizes, please submit the files on CD–ROM to the address given below. All submittals should include the author's name, mailing address, telephone number, email address, and the date of submittal.

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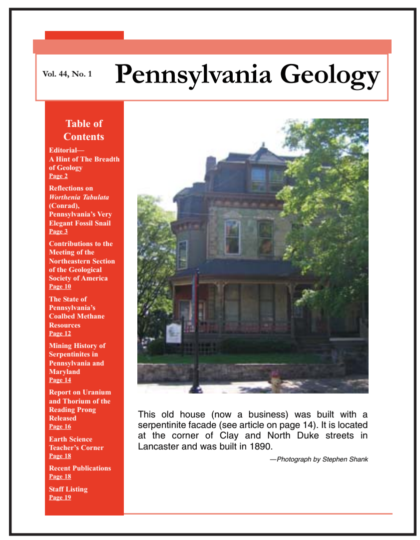
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This old house (now a business) was built with a serpentinite facade (see article on page 14). It is located at the corner of Clay and North Duke streets in Lancaster and was built in 1890.

—*Photograph by Stephen Shank*

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Main Headquarters
3240 Schoolhouse Road
Middletown, PA 17057–3534
Phone: 717–702–2017 | Fax: 717–702–2065

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