

The History and Geology of Sweet Arrow Lake County Park and A Fossil Expedition to East Brunswick Township, Schuylkill County, Pennsylvania



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Pre-Conference Field Trip for the 80th Annual Field Conference of
Pennsylvania Geologists

2015

Schedule

- 10:05 Depart Country Inn and Suites
 10:35 Stop 1. Mahantango Formation Outcrop – 387 Sweet Arrow Lake Rd., Pine Grove, PA
 10:50 Depart
 11:00 Stop 2. Sweet Arrow Lake County Park – 108 Clubhouse Rd., Pine Grove, PA
 12:00 Lunch at the Pavilion
 12:40 Depart
 1:20 Stop 3. East Brunswick Township Shale Pit – 2231 Summer Valley Rd., New Ringgold, PA
 3:15 Depart
 4:00 Arrive at Country Inn and Suites

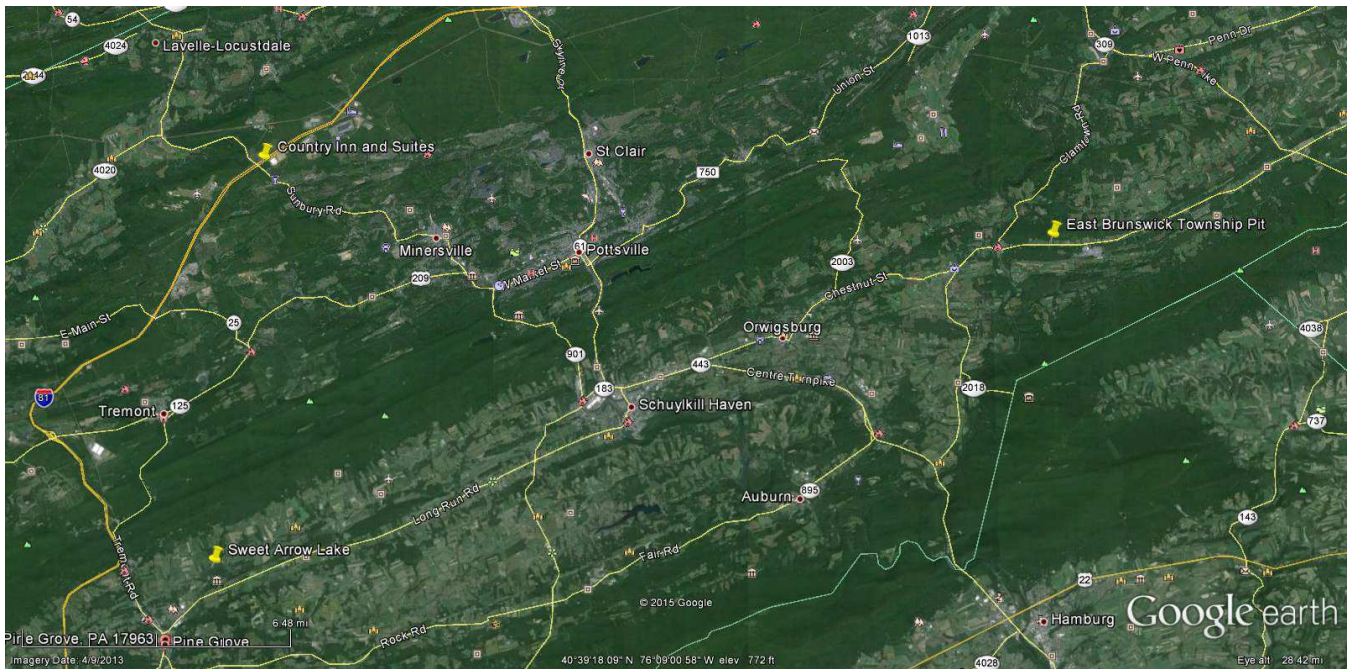


Fig. 1. Map showing locations of Field Trip. North is up.

Stop 1. Mahantango Formation Exposure – Sweet Arrow Lake Road

Welcome to this pre-conference field trip! Our theme for the day is the Mahantango Formation since it underlies the majority of Stop 2 and where plenty of fossils will be found at Stop 3. Here at Stop 1, you are able to acquaint yourself with the shale portion of the Middle Devonian formation. This is one of the best exposures of the Mahantango shale in this area. Outcrops are few and far between of the shale in Sweet Arrow County Park. The Appalachian Mountain Section of the Ridge and Valley Province is characterized by plunging and overturned folds interrupted by thrust faults. Here we are situated on the northern limb of the Roedersville Anticline. (Fig. 2). The anticline is plunging toward

the west-southwest and is overturned to the northwest. We will walk across the fold axis during our walk to the waterfall at Stop 2. The shale here is overturned and has a dip of 55° at $S.20^\circ W$.

Stop 2. Sweet Arrow Lake County Park

History

On June 20, 2001 the Schuylkill County Board of Commissioners entered into an Agreement of Sale with the Borough of Pine Grove to acquire the Sweet Arrow Lake property for use as a public recreational area. This 183.47 acre site is comprised of roughly 60 acres of water and 123.47 acres of land.

The Sweet Arrow Lake property is located in Washington and Pine Grove Townships, Schuylkill County. Major access routes include Sweet Arrow Lake Road along the northern border of the lake and State Route 443 which provides access to the southern portion of the site via Clubhouse Road.

The park is open to the public to enjoy the natural beauty, hiking, fishing and boating that people have enjoyed for generations. Other activities include playgrounds, pavilions, gazebo, disc golf and geocaching. More improvements are planned for the future.

Grants have been used to improve the driveway to and parking area of the Clubhouse. A playground, additional picnic pavilions, better fishing access and north side parking is now available. A picnic pavilion and gazebo are available for free use at the Waterfall Parking lot. A hiking trail that nearly encircles the entire park is partially constructed. Fishing and boating access for everyone has been improved with an emphasis on providing for those with special needs. The lake is also an approved trout water open to year-round fishing.

The lake has a rich history, beginning in the 19th century when it served as a water supply for the Union Canal. It brought prosperity to the region by supporting the lumber and coal industries. It also provided recreation for residents of that time; one popular activity was Ascension Day fishing. The dam was destroyed during the flood of 1862 and later a new dam was built to support an electric generation plant operated by the East Penn Electric Company in the 1920's and later, PP&L. In 1972 the lake was purchased by the Borough of Pine Grove. Many generations of residents of Schuylkill County have pleasant memories of fishing, swimming, picnicking, boating, and relaxing in the serene beauty of the lake.

The Lake

The reservoir was constructed along the Upper Little Swatara Creek. The lake holds 81,462,857.97 gallons of water, give or take. Normal discharge is between 1 – 1.5 million of gallons per day. In a drier period, both the capacity and discharge are lower. The deepest point of the reservoir is 22 feet in depth at the east end of the dam. The shallowest non-sedimented area is at the west end of the dam in the area of the overflow. The original stream channel snakes in front of the clubhouse and heads

east in front of the amphitheatre (Fig. 3). The channel is between 7-10 feet deep. 33% of the open water is about 3 feet deep. On the north bank it is 6-10 feet deep. Between the amphitheatre and boat launch the water is about 12 feet deep.



Fig. 2. Map showing location of Sweet Arrow Lake. North is up.



**Fig. 3. Sweet Arrow Lake being drained in 2001.
View looking west.**



Fig. 4. Installation of Roller Compacted

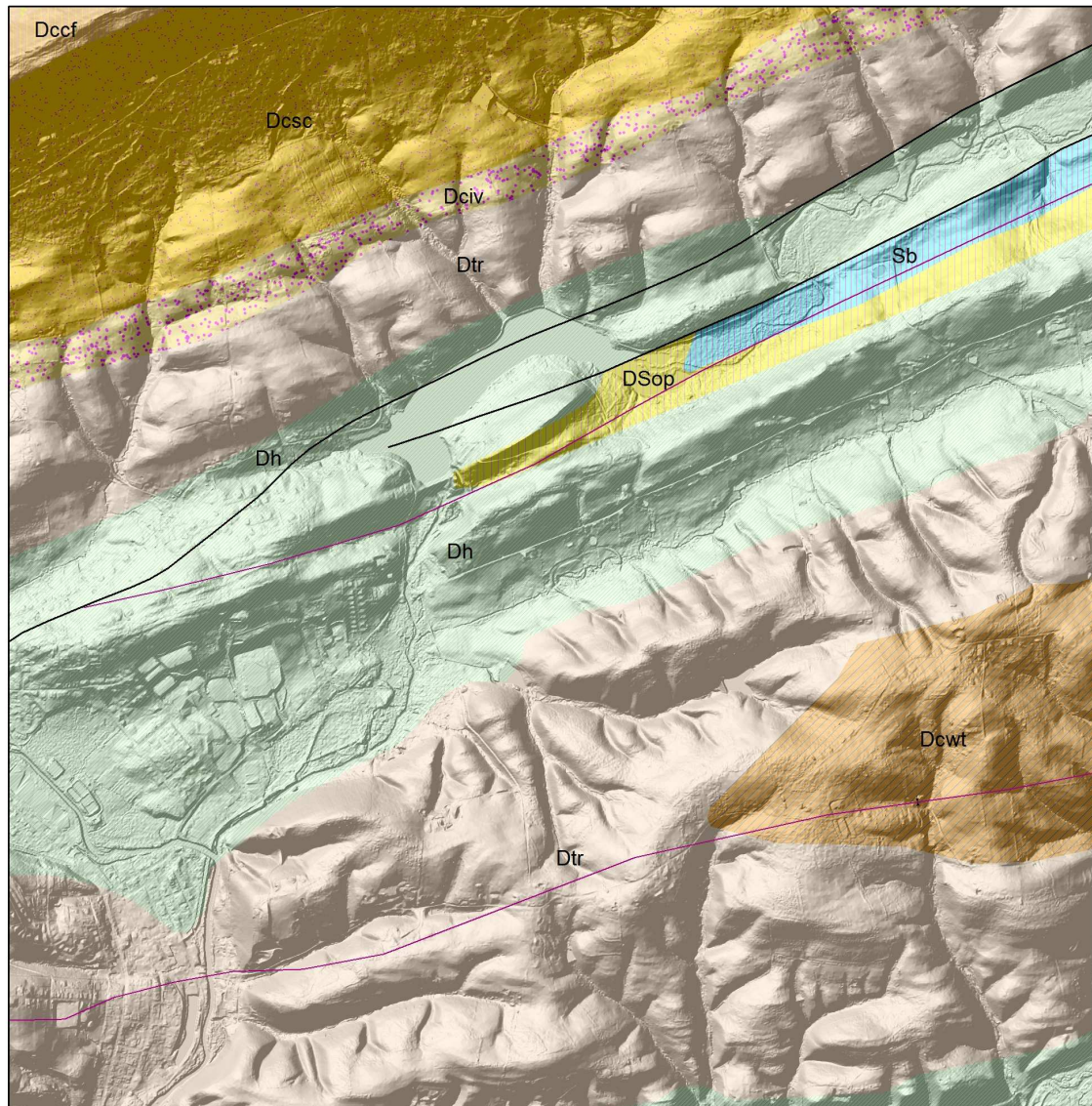
Concrete in 2001

In 2001, Pine Grove Borough was given the option to fix the lake, breach the dam or pay a \$1,000/day fine until something was done. The borough sold the property to the County who acquired grants to clear the dam of trees, cover the face with rip rap, run a barrier of concrete down the centerline of the dam and put RCC (Roller Compacted Concrete) on the backside. RCC is a type of concrete that has very little water added, placed in steps or lifts and compacted with a roller (Figs. 3 and 4). The idea is if the water ever overtops the dam, it the concrete would serve as a safe spillway without tearing out the breastwork. A new drain valve was also installed to replace the old tower and plywood sheet covering a hole that the borough used. The RCC is covered with about a foot of topsoil with grass growing on it. If the water does ever overtop the dam, Pine Grove will already be gone. No storm including Agnes has ever filled the dam beyond halfway up the dam's freeboard. This dam has a very large amount of freeboard compared to most. The spillway increases capacity the higher the water goes.

Geology

There are Silurian and Devonian sedimentary rocks in the area of Sweet Arrow Lake (Fig. 5). The majority of the rock within the park is underlain by the Middle Devonian Mahantango Formation, unit composed of gray, brown and olive shale, siltstone and sandstone. Outcrops of fossiliferous shale is found just below the waterfall in the southern portion of the park. The highly resistant Montebello Sandstone member underlies the ridge to the south of the clubhouse which the entrance road travels over (Wood and Kehn, 1968). The fine-grained, light-to-olive-gray sandstone is well exposed in the small ravine below the lake's outflow and is best seen as you walk the waterfall trail. The waterfall is developed on the sandstone at the contact with the Mahantango shale (Figs. 6 and 7). The shale is a much softer rock thus creating the vertical drop of about 15 feet to bedrock. Jointing in the sandstone at the waterfall strikes N.65°E.

The axis of the Roedersville Anticline transverses through the park in an east-northeast-to-west-southwest direction within the Montebello Sandstone. The anticline is plunging to the west-southwest and is overturned toward the northwest (Wood and Kehn, 1968). The Devonian-aged Onondaga Formation to Poxono Island formation (undivided) occupies the core of the anticline as far west as the waterfall trail. The sandstone in the ravine has a near vertical dip (Fig 8). Two thrust faults striking parallel to the elongation of Sweet Arrow Lake have been mapped. The North Sweet Arrow Lake fault underlies the lake and is found within the shale unit. Sweet Arrow Lake Fault is found along the southern shores of the lake in the eastern end of the park, extending westward near the clubhouse and terminates near the boat rental. The Silurian-aged Bloomsburg Formation has been brought up by the fault at the eastern end of the lake (Pennsylvania Geologic Survey digital file).



0 1,000 2,000 3,000 4,000
Feet



Geologic Map of Sweet Arrow Park and vicinity.
Geology from Pennsylvania Geological Survey digital file 1:250,000 scale
Base is hillshade image from PAMAP lidar digital elevation model.

Fig. 5. Geologic map of the Sweet Arrow County Park vicinity
Dccf – Clarks Ferry Member - Catskill Fm.; Dcsc – Sherman Creek Member - Catskill Fm.;
Dciv – Irish Valley Member – Catskill Fm.; Dtr – Trimmers Rock Fm.;
DSop – Onondaga to Poxono Island Formations (undivided); Dh – Mahantango Fm.;
Dcwt – Walcksville – Towamensing Member
Sb – Bloomsburg Fm.



Fig. 6. The waterfall at Sweet Arrow Lake on the contact between the Montebello Sandstone Member (right) and Mahantango Formation shale



Fig. 7. The “dry” waterfall in 2007 when the outflow was closed showing the Montebello Sandstone Member

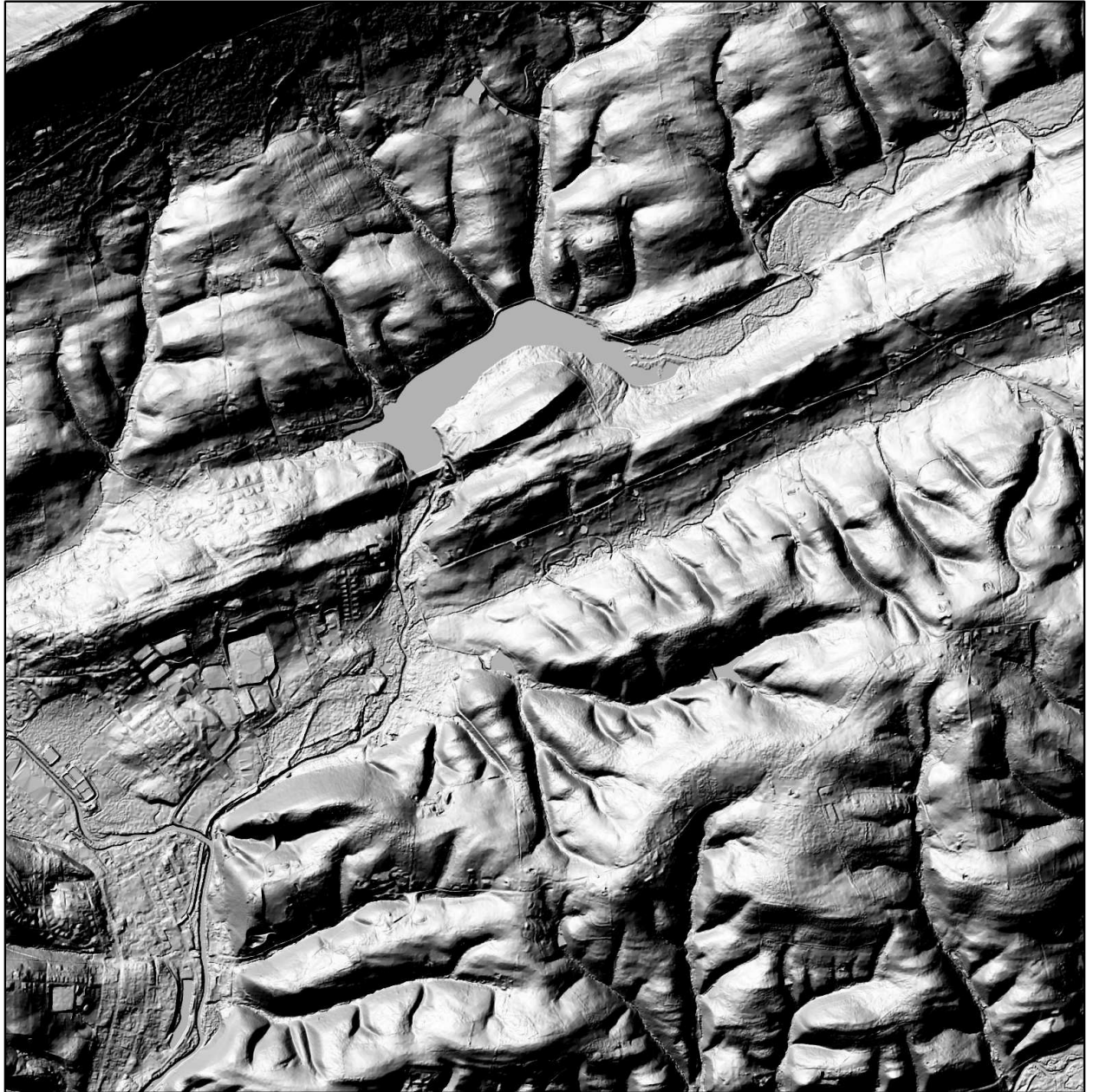


Fig. 8. Vertical Bedding in Montebello Member Sandstone north of the Waterfall

The riprap on the banks below the waterfall, in the area of the amphitheatre and in gabion baskets along the southern shore of the lake is that of the Llewellyn Formation, the rock unit where much of the coal measures are found. Sandstone and conglomerate are commonly seen. In the large riprap section on the cut bank, several sandstone blocks contained casts of petrified wood.

A Lidar View

We thought that the Lidar (Light Detection and Ranging) view of the park would be fascinating, particularly the southern portion (Fig. 9). When the stream improvement work was complete, the channel of the stream was rerouted using a new path southward through the valley. Just north of Pa. Rte. 443 does the old and new channels converge. A close-up view of the Lidar distinctly illustrates the old channel on the east side of the valleys compared to the new channel (Fig. 10). A walk down the Water Fall trail past the riprap cut bank below the waterfall, one will find examples of meander scars, oxbow lakes (during the wet period) and the old channel. The channel of the stream feeding Sweet Arrow Lake in the wetlands area also shows up well. Pa. Rte 443 shows up as the straight white line in an east-west direction just south of the channel convergence.



0 500,000 2,000 3,000 4,000
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Map of Sweet Arrow Park and vicinity.
Base is hillshade image from PAMAP Lidar digital Elevation Model.

Fig. 9. Lidar Map of the Sweet Arrow Lake Vicinity

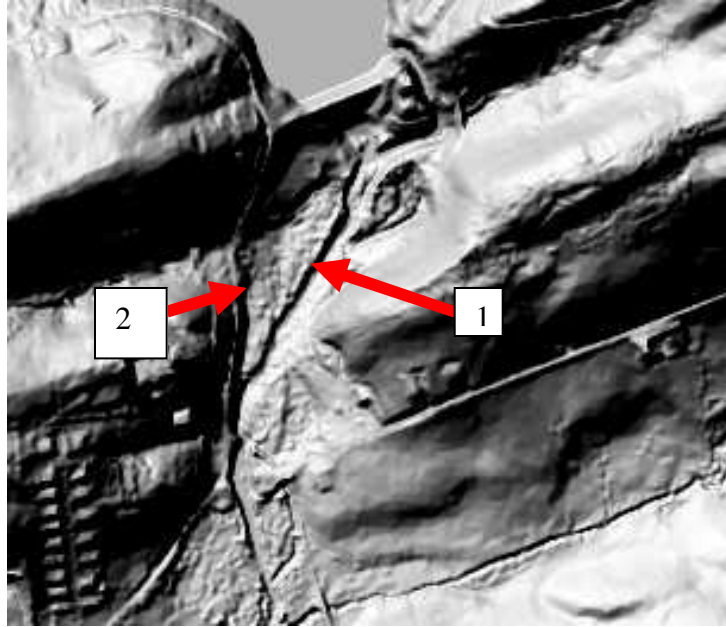


Fig. 10. Closeup view of Fig. 7 showing old stream channel (1) and present channel (2). White line below “1” is Pa. Rte. 443.

Stop 3. East Brunswick Township Shale Pit

At this stop you will see the Mahantango Formation in all of its glory (Fig. 11). You will see the shale and siltstone ranging in color from light-green, grayish-green to gray with most of the layers containing Middle Devonian marine fossils. This has been an active excavation site since about 2011 as the township uses the shale for road base material and fill. Today the pit measures about 450 feet east-to-west and 350 feet north-to-south. The dip of the shale in the southeastern quadrant of the pit is 71° at $S.10^\circ E$. One major joint strikes $N.80^\circ E$. Another joint at the bottom of the pit shows a strike of $S.25^\circ E$. Both joints have a vertical dip.

The Mahantango Formation is proclaimed as the most fossiliferous rock unit in Pennsylvania. The age has been placed between 392 – 385 (+/- 3 million years) during the Givetian stage (Berg, 1983). The Mahantango represents a terrestrial to marine transition zone that went through many transgressive-regression sequences. The fine-grained rocks represent a shallow sea environment and accounts for many of the fossils. Coarser grained sediments represent near-shore environments, beaches, or possibly delta lobes. These environments were tide-dominated and often had violent storms. The Montebello Sandstone member is an example of a storm dominated rock unit (Prave and others, 1996).

So what is the big question that will be asked by participants? “Where should I look for fossils”? To make it simple, almost every boulder in the middle of the pit contains fossiliferous layers. Look for some yellow or yellowish-orange color on the rock as these are either casts or molds of fossils. There are obvious layers of only brachiopods or pelecypods only as in a present-day low-tide zone. There are many layers representing what Jeri Jones calls “graveyard rock.” This is a rock that contains a little of everything all jumbled together, possibly another example of a tidal zone.

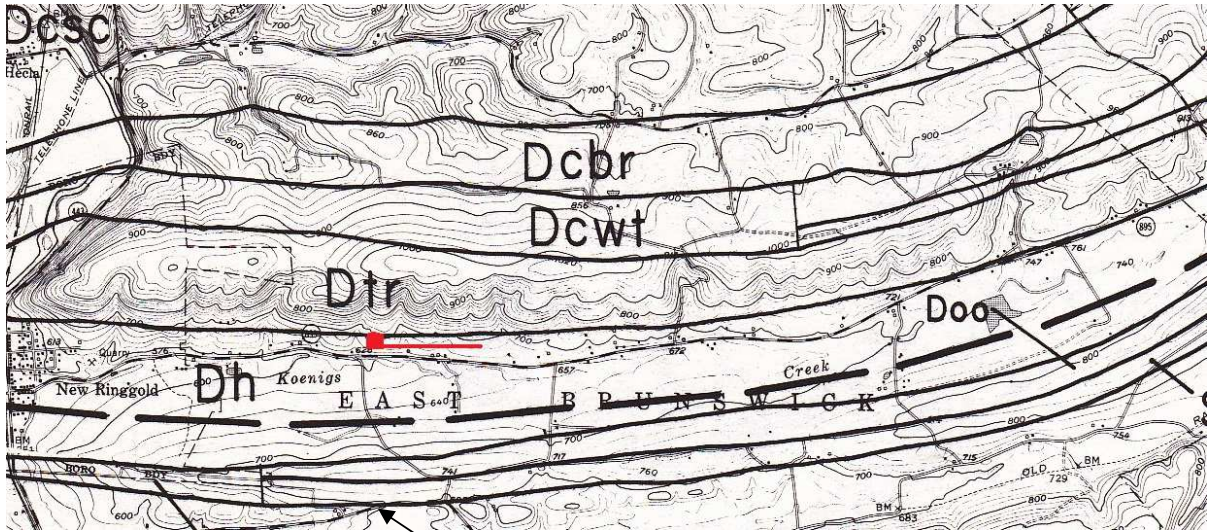


Fig. 11. Geologic map of the East Brunswick Township Slate Pit
(from Berg and Dodge, 1981)

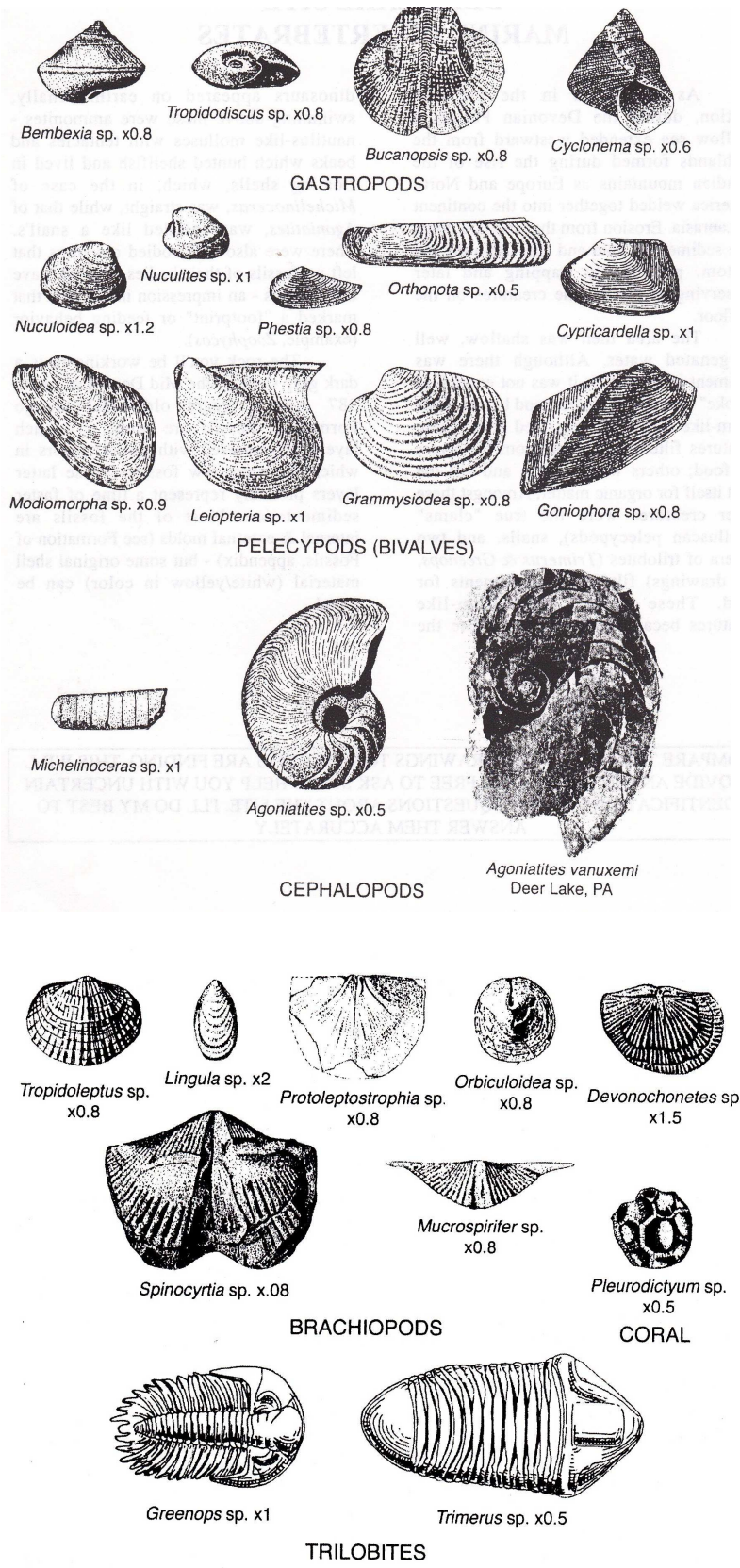
Dh – Mahantango Fm.; Doo – Onondaga and Old Port Fm.;
Dtr – Trimmers Rock Fm.; Dcwt – Walcksville and Towamensing Mbrs, Catskill Fm.;
Dcbr – Beaverdam Run Mbr., Catskill Fm.; Desc – Sherman Creek Mbr., Catskill Fm.

On the northern slope of the pit, a grayish calcareous rock belonging to the overlying Trimmers Rock Formation contains occasional *Phacops* trilobite fragments, but not much else. The contact between the Mahantango and Trimmers Rock formation is conformable (Berg, 1983). As a side-note, the Mahantango Formation conformably overlies the Marcellus Shale. Both of these units belong to the Hamilton Group with the Marcellus Shale being the lowest member of that group. In August, at the top of the entrance ramp to the right in the newly cleared area, a Millersville University psychology professor found several very nice *Phacops* cephalons (head) with well preserved eye structure present. If there are fossils on the outside of the rock, they are also usually present inside the rock.

So what can you find? During the Middle Devonian, the seas were near or at its peak with marine life. Being located in the tropics of the Southern Hemisphere, ocean water was warm allowing a variety of life to thrive. Groups such as brachiopods, pelecypods, gastropods, crinoids, bryozoan and trilobites are found here. One fairly common group usually found in the Mahantango rocks is coral, however, Jeri Jones has never collected coral at this site. Figures 12 and 13 show some of the more common species found here. For additional help in identification, check out these websites:

Views of the Mahantango – <http://viewsofthemahantango.blogspot.com/p/mahantango-formation-fossils.html>

The Mahantango – A View of a Slice of a Middle Devonian Reef in Pennsylvania –
<http://www.fossilguy.com/sites/mahantango/index.htm>



**Fig. 12. Typical fossils found at Stop 3.
(all illustrations from Hoskins and others, 1983)**



**Fig. 13. *Phacops rana*, Pennsylvania's State
official fossil**

(from https://en.wikipedia.org/wiki/Phacops#/media/File:Phacops_rana_crassituberulata_dorsal.jpg)

References

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- Prave, A.R., Duke, W.L., Slattery, W. (1996). A depositional model for storm- and tide-dominated prograding siliciclastic shorelines from the Middle Devonian of the central Appalachian foreland basin, USA. *Sedimentology*, 43, 611-629.
- Wood, G.H. and Kehn, T.M., 1968. Geologic map of the Swatara Hill Quadrangle, Schuylkill and Berks Counties, Pennsylvania. U.S. Geol. Survey, Geol. Quad. Map GQ-689.