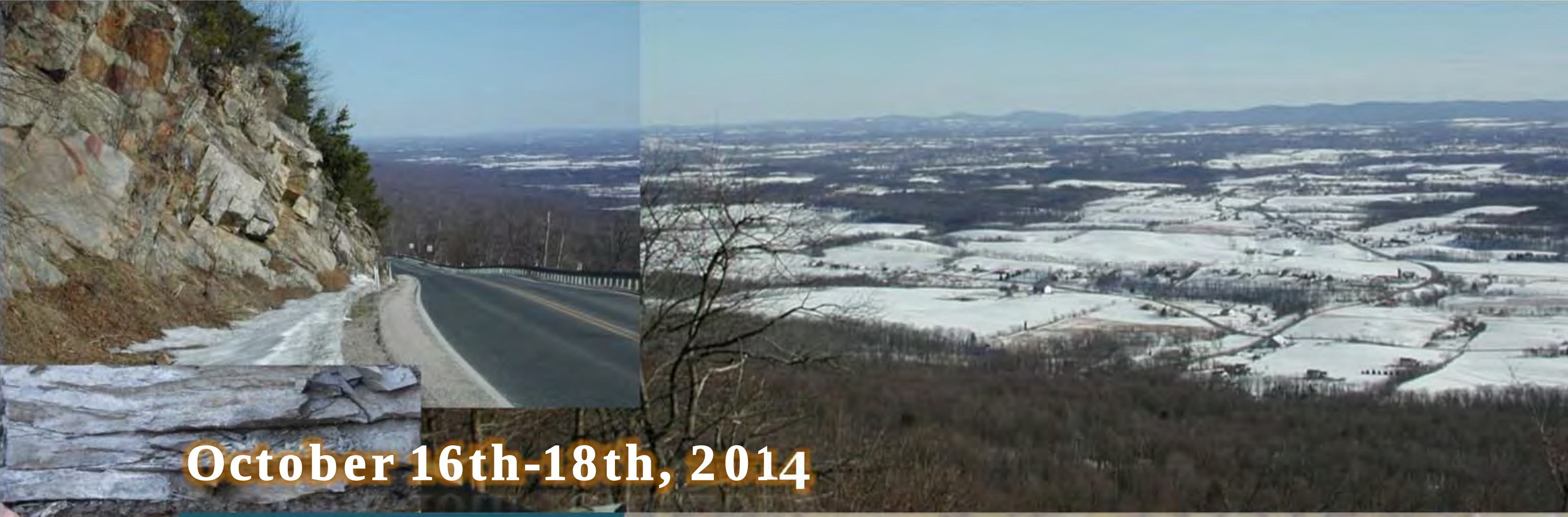
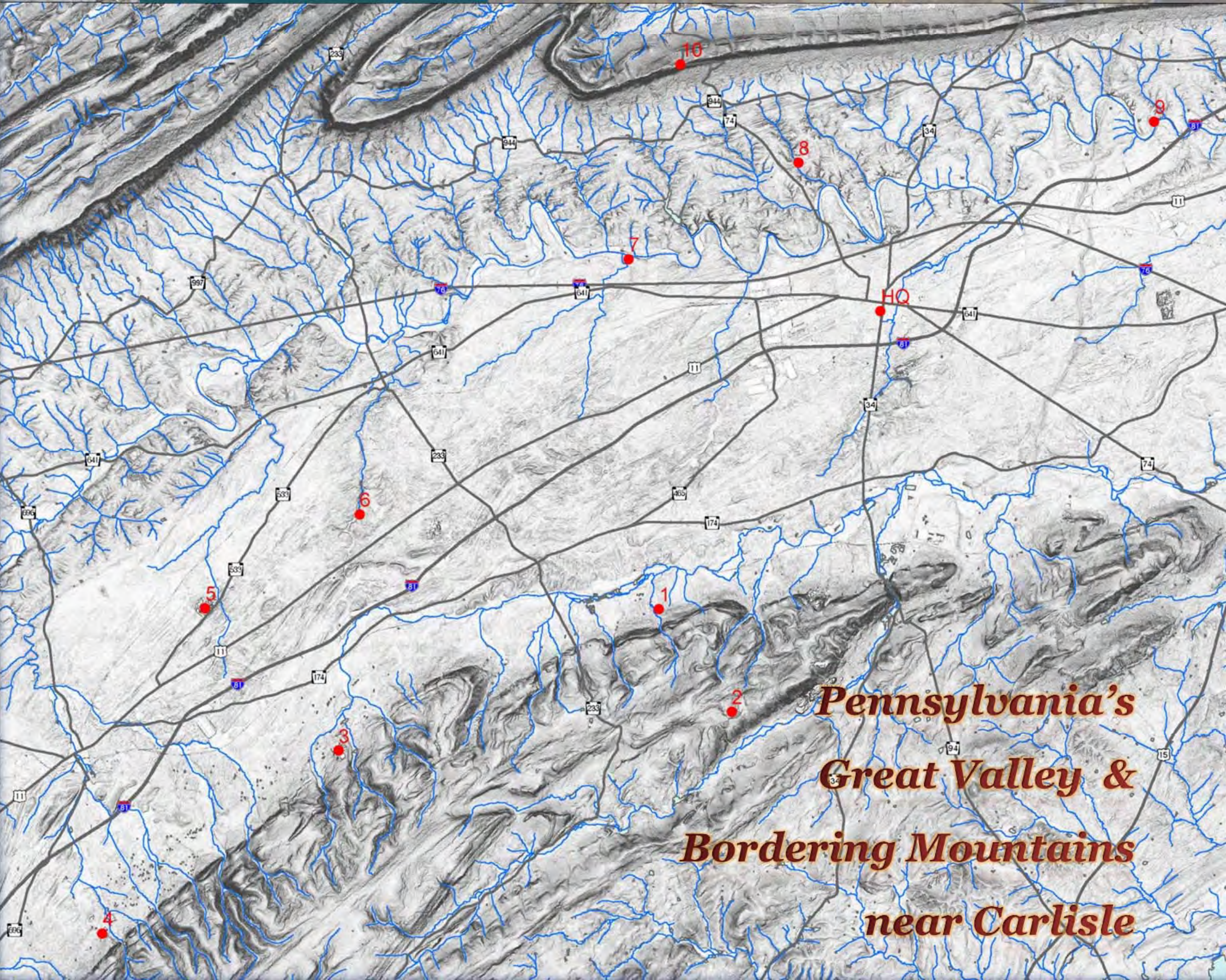


October 16th-18th, 2014

Hosts:
Pennsylvania Geological Survey &
Dickinson College

79th Annual Field Conference of Pennsylvania Geologists



Pennsylvania's Great Valley & Bordering Mountains near Carlisle

Guidebook for the

79th ANNUAL FIELD CONFERENCE OF PENNSYLVANIA GEOLOGISTS

October 16 — 18, 2014

PENNSYLVANIA'S GREAT VALLEY & BORDERING MOUNTAINS NEAR CARLISLE

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Cover: LiDAR slope compilation image of the Great Valley near Carlisle, PA and scenic photographs of the Great Valley viewed from Waggoner's Gap courtesy of Thomas Whitfield (PaGS)

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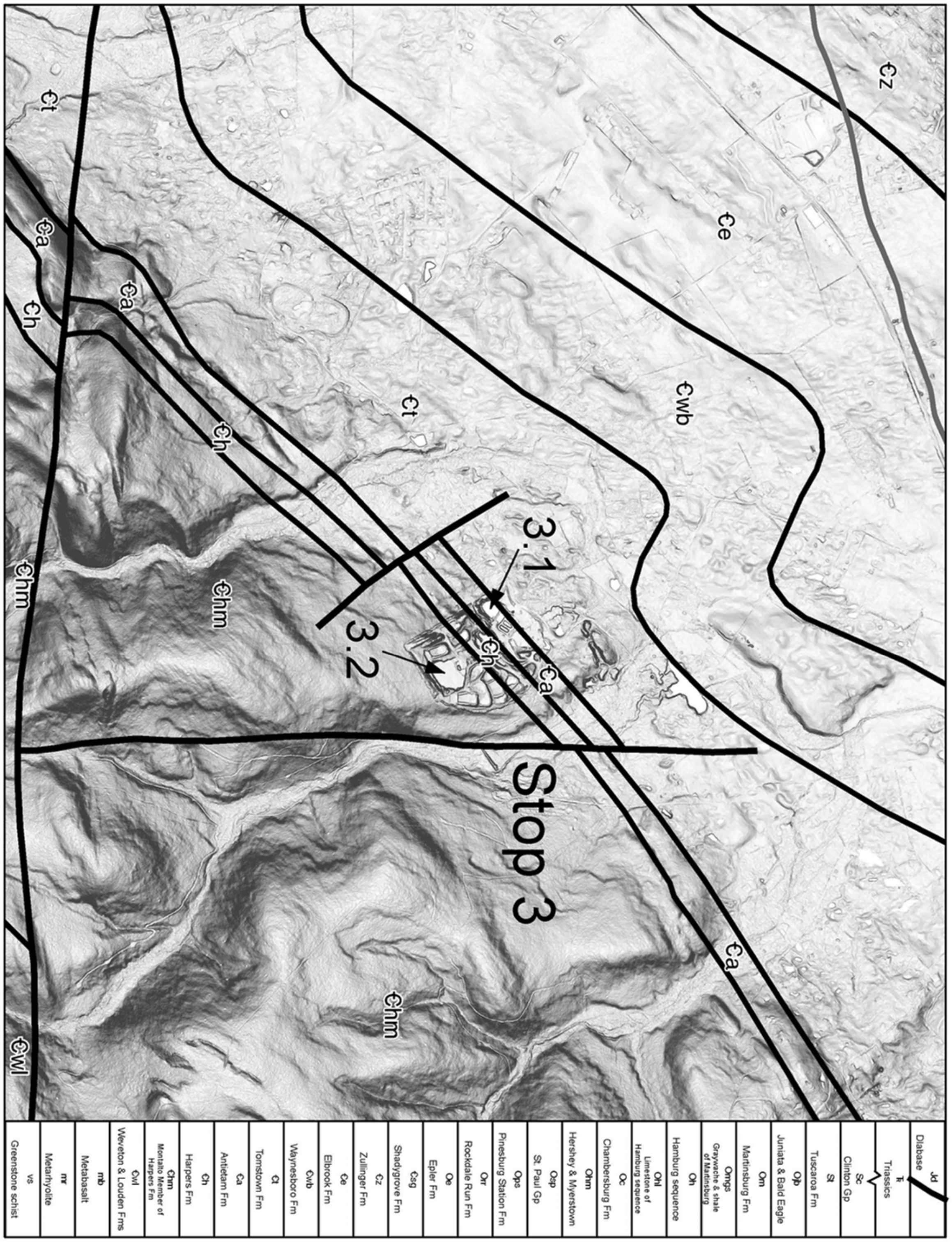

Figure 1. LiDAR image of Stop 3 – Mt. Cydonia Sand Plant III area, with geologic contacts overlain. Note processing plant at 3.1 and upper bench at 3.2

STOP #3. VALLEY QUARRIES, INC., MT. CYDONIA III QUARRY

(Entrance requires signed liability waiver)

Stop Leader: Marcus M. Key, Jr., Dickinson College

Entrance to Valley Quarries, Inc. Mt. Cydonia III Quarry

3.1 Processing Plant, Latitude = N40°03.238', Longitude = W77°24.926'

The quarry is located in the southwest corner of Cumberland County and is owned and operated by Valley Quarries. A small sand and clay mining interest existed at this location adjacent the Michaux State Forest for many years prior to its acquisition by Valley Quarries in 1999. Following this acquisition, the processing scheme was upgraded and a bench quarrying plan was implemented to allow for the blending of various areas of the deposit. The upper level of the pit is developed primarily in the Harpers Quartzite and the lower lifts transition into the Antietam. The quartzite throughout has been highly weathered to significant depths and as a result, large amounts of clay and silt must be processed out of the shot and quarried material in order to meet specifications. Since significant quantities of water are needed to scrub and wash the sand products, a fairly sophisticated treatment plant and fines recovery system has been employed to recycle all process water and allow for more efficient handling of the clay and silt by-products.

Valley Quarries sells stone, aggregate, blacktop, and ready-mix concrete in the Mid-Atlantic region. Mt. Cydonia Sand Plant III is their most recent commercial quarry in the Valley Quarries' family, and it produces four main aggregate products. 1) Washed concrete sand, also known as PennDOT Type A sand, which meets ASTM standard C33.

2) Washed masonry sand, which is a fine grade of sand also used as a bedding material in free stall dairy operations. 3) DEP sand that is certified for use in septic sand mounds. 4) A special "Ballfield Mix" of sand and clay with a rich red color. It is used in the infields of baseball and softball diamonds and also in the construction of horse racing tracks. This special mix is sold as far away as Staten Island, NY. As the main contributor to the price of aggregate is shipping costs, this product has a high value per unit weight than the more ubiquitous concrete and masonry sands which are only sold more locally.

3.2 Upper bench, Latitude = N40°03.016', Longitude = W77°24.688'

The upper bench is located on the south side of the Cumberland Valley on the northwest flank of the Blue Ridge Anticlinorium in the South Mountain Section of the Ridge and Valley Physiographic Province. The quarry is on the boundary between the Antietam and Harpers Formation *(Fig. 1–LiDAR)*, the youngest formations of the Chilhowee Group. The Antietam is conformably overlain by the dolostones of the Tomstown Formation and the Harpers is conformably underlain by the meta-conglomerates of the Weverton Formation (Stose, 1909; Freedman, 1967; Fauth, 1968; Root, 1968; Key, 1991; Smoot and Southworth, 2014).

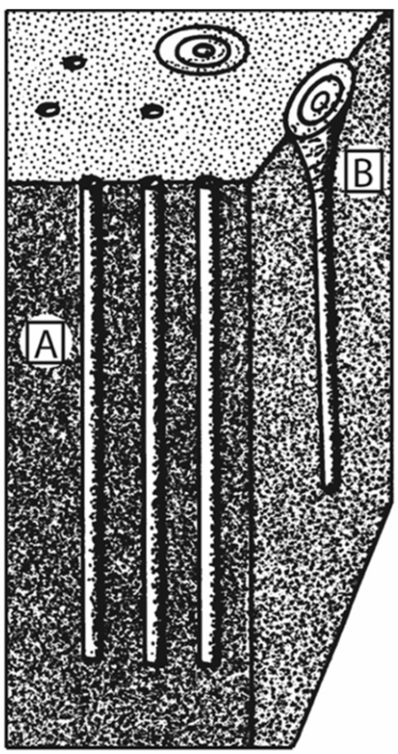

Figure 2. Schematic representation of (A) Skolithos and (B) Monocraterion trace fossils in plan and cross section view. Modified from Frey and Pemberton (1984, fig. 10).

The age of the Antietam and Harpers is constrained by a variety of paleontologic, radiometric, and stratigraphic evidence as 516.5-539 Ma in the Lower Cambrian (Smoot and Southworth, 2014). Following the Ediacaran to earliest Cambrian breakup of the supercontinent Rodinia and the opening of the Iapetus Ocean, they were deposited on the prograding shelf of the eastern-facing, passive, continental margin of Laurentia (Tull et al., 2010; Smoot and Southworth, 2014). Paleocurrent data indicate the primary terrestrial source was to the exposed Laurentian craton to the northwest (Dickinson et al., 1983; Tull et al., 2010). The Antietam Formation is a medium-to coarse-grained, white to grayish quartzite with *Skolithos* trace fossils present, whereas the Upper Harpers Member is a green to greenish-gray, quartzose phyllite, distinct from the underlying *Skolithos*-rich Montalto Quartzite Member (Fauth, 1968). *Skolithos* is a pipe-like cylindrical trace fossil *(Figure 2A)* (Key, 2014).

The eight numbered stops on this bench begin with 3.2.1 – 3.2.2 on the west side, 3.2.3 – 3.2.5 on the north side, and 3.2.6 – 3.2.8 on the south side *(Figure 3)*. You are welcome to collect hand samples. Feel free to examine the outcrop behind the berm; just make sure you have your hard hat on in case any loose pieces fall off the highwall. I will also pass around six vials containing *Skolithos linearis* tubes that have weathered out of their surrounding matrix. You are welcome to take one of these tubes as well.

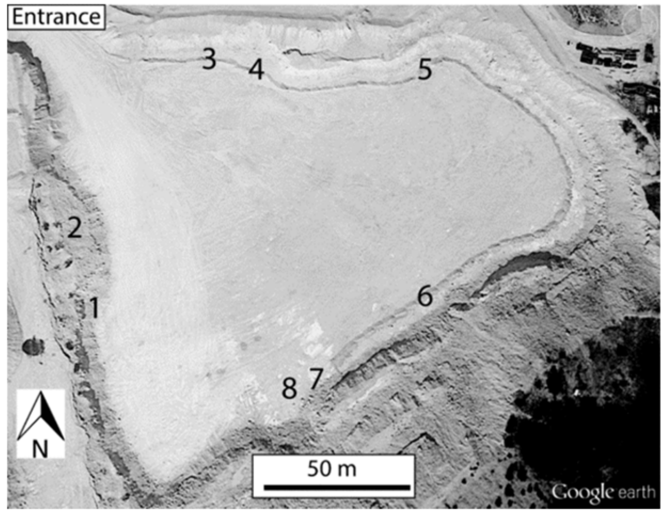

Figure 3. Google Earth image of Mt. Cydonia Sand Plant III's upper bench showing the 3.2.X stop numbers referenced in the text.

On a clear day, there is a good view across Cumberland Valley to Blue Mountain, 14 mi to the north through the entrance to this bench between stops 3.2.2 and 3.2.3. The finer-grained interbeds make it easy to see the bedding, especially at Stop 3.2.3. The *Skolithos* tubes are roughly perpendicular to bedding which also helps. Standing back from the highwall and looking around the bench, one can see that the beds strike parallel to the mountain and dip southeast toward the mountain indicating we're on the northwest limb of an overturned anticline. This is typical on the northwestern limb of the Blue Ridge anticlinorium, locally known as South Mountain, where the beds often dip to the southeast (Cloos, 1971).

The bedding exposed in this upper bench of the quarry strikes ~N51°E. But which way is stratigraphic up? Due to intense bioturbation by *Skolithos* and the overprinting of the Alleghanian subgreenschist metamorphism (Tull et al., 2010), it is hard to tell which way is up. The best evidence I found is concave up bedding at Stop 3.2.6 indicating stratigraphic up is to the northwest into the valley. That implies these beds are overturned, with a dip of ~61°SE. This makes sense as the more easily eroded dolostones of the overlying Tomstown Formation are to the northwest in the valley and the underlying more resistant quartzites and phyllites of the Harpers Formation are to the southeast in the ridge crest.

This southeast dip is in contrast to the online state geologic map (Figure 1) which is based on Berg's (1978) compilation which is based on Freedman's (1967) map to the northeast and Fauth's (1968) map to the southwest, both of which show the Antietam dipping to the northwest. The faults in Figure 1 are from Becher and Root (1981), and if the location and throw of the faults are correct, but the dip backwards, then the Antietam should be displaced to the south as indicated in the quarry, not the north. I also question the mapped geology in Figure 1 due to the disconnect between the outcrop pattern of the overlying carbonates (esp. the Waynesboro Fm.) which shows a fold immediately north of the quarry but which is absent in the underlying Chilhowee siliciclastics.

I think the upper bench penetrates through the Antietam Formation into the underlying Harpers Formation. This is supported lithologically by the mapping of Fauth (1968) who reported a finer-grained upper member of the Harpers Formation immediately below the Antietam. He termed it the Upper Harpers Member and described it as a green to greenish-gray, fine-grained quartzose graywacke, distinct from the overlying *Skolithos*-rich Antietam and the underlying *Skolithos*-rich Harper's Montalto Quartzite Member (Fauth, 1968). I picked this lithologic break in the upper bench of the quarry by the presence-absence of *Skolithos*. Walking up section (i.e., to the north toward the valley) along the western highwall of this bench, you do not start to see *Skolithos* until Stop 3.2.1. Walking down section (i.e., to the south toward the mountain) along the opposite eastern highwall, you do not see *Skolithos* after Stop 3.2.5. Stops 3.2.1 and 3.2.5 are roughly along strike, and I interpret this as the contact between the younger, *Skolithos*-rich, cleaner, better sorted, whiter, metasandstone of the Antietam to the north and the older, *Skolithos*-poor, muddier, more poorly sorted, darker (browner/redder), metasandstone Harpers to the south.

For those of you with more paleontologic interests, at Stop 3.2.2 I have pulled out several samples of *Skolithos* tubes in the matrix and placed them on the berm in front of the highwall. Bedding planes are not well exposed on this bench; the best ones are at Stop 3.2.3. Do you see the *Skolithos* bottom end of the tubes (2-5 mm diameter) or the *Monocraterion* top end of the tubes (>5 mm diameter)? *Monocraterion* is a trumpet-like trace fossil *(Figure 2B)* (Key, 2014). The longest tube I found (i.e., 42 cm) was at Stop 3.2.4. Can you find one longer? At Stop 3.2.4 you are will find the Antietam quite weathered so the tubes become free from their matrix.

For those of you with more structural geology interests, I recommend you visit Stops 3.2.7 and 3.2.8. In contrast to the bedding, the jointing (which is best seen at Stop 3.2.7) runs roughly north-south and is basically vertical (strike: ~N155°E; dip: ~84°E). At stop 3.2.8 look at a different joint surface and see the undulating minor folds whose hinges are oriented ~N44°E and plunging ~9°NE. They parallel the general strike of the beds and the regional fold axis. Look for the quartz-filled extension veins with tapered ends that are exposed on the same surface.

The deformation of these beds is reflected by the normally circular transverse cross-sectional shape of the *Skolithos* burrows being distorted into an ellipse (Key, 2014). I measured the long (L) and short (W) axes of 13 *Skolithos* tubes and calculated the L/W (i.e., Rf strain) ratio as 1.9. This is less than the 2.2-2.8 values that Potter et al. (1991) measured on pebbles in the Weverton Formation at Hammonds Rocks, but more than the 1.6 that Key and Sims (1991) calculated in the Antietam Formation exposed in the Mt. Holly Pennsy Supply quarry. Gourley and Key (1996) measured the same ratio in the underlying Montalto Member of the Harpers Formation at Pole Steeple and reported a ratio of 1.5. See if you can find any deformed *Skolithos* tubes, especially at Stop 3.2.4.

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