Self-Guided Geology Walk:  
Valley Green to the Magargee Dam

Written & Photographed by Sarah West and Lisa Myers - June 2020
(Adapted from Bruce Goodwin, Guidebook to the Geology of the Philadelphia Area, Pennsylvania Geological survey 1964)

The Wissahickon Gorge has been used for many years by area schools and colleges for the study of geology and ecology. Its rock formations supply visual evidence of the amazing process of plate tectonics. The equipment you need to carry is simple and inexpensive. A steel nail will allow you to observe the relative hardness of rock layers and a hand lens or magnifying glass will allow you to examine small mineral crystals within the rocks. Look for freshly broken, un-weathered surfaces. The Wissahickon's rock exposures must be preserved and not intentionally broken by the public. However professional geologists with Park Commission permission often leave a freshly broken surface allowing others to study the mineral structures within the rock.

This self-guided walk includes five sites found within a half mile along the east side of the creek just north of Valley Green. Recommended parking is in the upper parking lot off Valley Green Avenue on the east side of the creek in Chestnut Hill. Follow the path at the end of the parking lot that parallels the road. At the orange/white trail marker intersection, turn right and immediately cross over wooden bridge and head upslope. This hike is over rough, uneven ground and there several large, potentially slippery, exposures that you must cross. Please be sure you are comfortable hiking on this type of terrain, willing to accept the risks, and have the proper footwear and gear.

SITE 1: ALTERNATING LAYERS OF SCHIST AND QUARTZITE:

As you approach the top of the incline leading north from Valley Green Road, look for a prominent exposure just opposite a small shelter where the pathway turns sharply. This rock contains alternating layers of schist and quartzite which have become tilted almost vertically. You can easily distinguish the two rock types by the presence or absence of layering and the hardness or tendency to crumble. Hardness can be assessed by using an ordinary steel nail to see how easily the rock can be scratched. The schist is the layered rock that scratches very easily while the quartzite forms step-like blocks of uniform consistency and is more difficult to scratch. The schist contains numerous small garnets and mica. Furthermore, layers within the schist have tiny waves or ridges called crenulations which make the rock look crinkled while the quartzite surface looks more even. A close examination of the schist will tell you much about the rock's history.

In numerous places in the Wissahickon we find interlayering of schist and quartzite suggesting that the original shale and sandstone sediments were sorted by particle size during a long period of deposition. Fine clay particles settle out in still, almost motionless water, but heavier sand particles can be deposited in moving water. If the motion of water in a given location differed over time the structure of the resulting sedimentary rocks could show alternating layers of sandstone and shales.
During an ancient period of mountain building shales and sandstones were buried deep in the crust. Heat and compression converted the shales first into slate and then into schist. Deformation produced the folds and minute crinkles, crenulations, seen within layers of schist. Simultaneously the sandstone was converted into quartzite.

The layering within schist and mica is perpendicular to the direction of compression during deformation long ago. The types of minerals present can indicate the temperature-pressure conditions during metamorphism. For example this rock contains garnet but not staurolite so that we can hypothesize that its temperature rose as high as about 500°C - high enough to produce garnet, but not high enough to produce staurolite. The rusted appearance of freshly broken rock at this site indicates the presence of iron compounds. This site may contain some freshly broken sections which show how weathering can alter the appearance of a rock. For accurate identification we must look at an unweathered surface. Crystals should not be removed from rocks, but you may find garnets lying in the soil along the path at the base of this rock.

The blue-green or gray-green crusty covering over much of this formation is lichen composed of a symbiotically growing fungus and green alga. The alga may also colonize rock on its own forming a thin, green layer. The bright green spongy clusters are moss. The moss and lichens colonizing this rock serve as pioneer plants critical in the long process of soil formation. Carbon dioxide from their rhizoids forms carbonic acid in the wet rocks dissolving the minerals and starting the conversion of rock into soil. After they die their organic remains mix with grains of rock to form the complex, vital substance we call soil. In many places this rock seems to have crumbled to the consistency of soil. The specific mineral content of a rock as well as its hardness and permeability to water influence the types and amount of covering vegetation. Acid rain also contributes to the process of rock weathering and erosion.

In some places an inch of soil can form in a decade, while in other areas, such as on steep slopes subjected to constant water runoff, it may take 100 years for an inch of soil to accumulate. In the Wissahickon soil loss has become a major conservation problem. Although all rooted plants help hold topsoil in place, people walking on the hillside off the established pathways contribute to the loss of soil that is so apparent in the muddiness of the creek after rainfalls.

Through out time geological processes have helped determine the evolution of life on this planet. Since continental bedrocks are the primary source of essential mineral nutrients for both plants and animals the specific minerals available along with the topography of the land determine which organisms will be found in the Wissahickon.

**SITE 2: THE ROCK WITH THE MISSING WEDGE:**

Keep walking upstream along the path that will go down a rocky slope and then level off. After about 450 feet from Site 1, look for the largest rock formation rising high above you on the right side of the descending path.

Near the top it looks as though a large triangular piece of rock has fallen out. (See Black Arrow in photo below) There is now a tree growing in this wedge and there are two spray painted circles. This formation is particularly interesting for its fractures. Near the middle you will see two fracture lines that cross to form an 'X', a conjugate joint set. (See Red Arrow)

When rocks are deeply buried and very hot they are pliable and fold as they undergo compression, but when they cool they become brittle and crack when compressed. If there has been no movement of pieces on opposite sides of the crack, the fracture is called a joint. If movement has occurred, the
crack is called a fault. You can see that along almost all the fractures the bedding planes of schist and quartzite have not moved relative to each other.

Notice that the schist beds are inclined at an angle of about 45 degrees downward toward the path giving us evidence of the deformation and uplift of sedimentary rock that had been laid down vast ages ago. The direction from which pressure was applied to this rock is revealed by the fine layering within the schist and mica layers perpendicular to the direction of the stress. Closest to the path you will find a large block of grayish quartzite which has been folded over. This quartzite is an example of a semi-recumbent fold. (See the yellow arrows in the photo above showing the two sides of the quartzite fold and the top of the fold)

Quartzite veins may form within schist if superheated steam carrying dissolved silicates flows through a crack within the schist while it is still deep below the surface. With slow cooling the minerals gradually precipitate within the crack to fill the space. Under different circumstances the same kind of slow mineral deposition can lead to fossil formation. Once exposed at the surface the schist formation is subjected to physical and chemical weathering. In time the quartzite veins stand out on the cliff face because they are much harder than the surrounding schist which has eroded away. Vein quartz can be narrow or quite thick. It may vary in color from white to gray to rusty orange depending in the minerals flowing with the silicates. Since it is harder than the schist around it, it resists erosion and can be found in chunks in many places in the Wissahickon. Because the schist and quartzite are metamorphosed shale and sandstone, any fossils that may have existed in the parent sedimentary rock would have been destroyed during metamorphosis.
SITE 3: THE STRIPED ROCK, UPPER EXPOSURE:

Continue north to signed trail junction. Bear right to follow the white trail across the wooden footbridge. Look in the water flowing under the bridge. There are schist, quartzite, gneiss and vein quartz distributed throughout here. Notice how the flowing water has eroded and smoothed out the surfaces of the different rocks. Follow the path up a hill for about 550 feet. This exposure is a beautiful example of folding, uplifting, and metamorphosis.

Notice the igneous intrusions of pegmatite that form white wavy bands through the rock. As the original schist layers were deformed by plate movement pegmatite flowed between them. The lighter colored pegmatite which is predominantly feldspar melts at a lower temperature than the darker colored rock so the igneous pegmatite could slowly flow between the darker layers. The hot pegmatite caused contact metamorphosis, in the surrounding parent rock producing finely banded gneiss in the areas closest to the pegmatite bands. Then as the pressure continued both rock types folded together. You can get a surface view of folding on the top of this rock which has very obvious synclines (troughs) and anticlines (crests), the geological terms for different parts of a rock fold. Gneiss, made of finely banded alternating dark and white layers, is visible in the exposure close to the pegmatite flows. At the base of one of the trees next to this exposure, notice a pile of rocks with fine examples of a pegmatite band with pieces of mica in gneiss, vein quartz, and rust colored schist with garnets.

While you are still at this location, continue north for about 50 feet and look for a flat, rectangular schist rock right in the middle of the trail. Examine this rock closely to see pieces of tourmaline (Black narrow rectangular pieces) and garnet, which is small, dark, and roughly spherical shaped.
SITE 4: THE STRIPED ROCK, LOWER EXPOSURE:

Retrace your steps back the way you came to the signed trail junction and follow the lower Orange Trail continuing north. Soon you will come upon a large low exposure of rock which extends across the path out into the creek. The uphill end contains two intersecting fractures where a large wedge of rock is missing. On the fracture face you can see prominent lineations from crenulations.

This site can be challenging to navigate. Please be sure you are confident about climbing off the trail and then over the exposure before you attempt it and willing to accept the risk.

First carefully climb down to the creek. There you will see a free-standing block made of dark gray rock with vertical wavy white bands which you will recognize as layered schist and coarse grained pegmatite. Since both rock types are folded together we have evidence that the pegmatite flowed between the schist layers before the major folding occurred. Notice how the pegmatite bands in the freestanding rock match those in the main formation.

Next carefully climb over the main exposure. Notice the bands of pegmatite within the schist. This rock has been smoothed by water flowing over it, but it will still show the same general pattern you saw in site 3 up the hill. Sites three and four are part of the same very large formation not yet completely revealed by erosion.

SITE 5: THE CLIFF HANGER

This is a towering exposure of pegmatite, schist, and quartzite that extends across the path close to the Margargee Mill dam. In addition to the usual embedded "gems" this formation has a number of interesting features.

Look first at the south end (downstream end where you entered). Notice the thick alternating rock layers. These layers are inclined slightly downward toward the north. The bottom dark layer is quartzite, the middle, light colored layer with the tree growing out of it is predominately pegmatite with a thin layer of schist embedded and the dark layer above the pegmatite is schist. Because these layers are parallel to each other they are called sills. Pegmatite is composed of feldspar, quartz and
mica, a composition similar to granite but with a very rough texture. Notice the large size of the white feldspar crystals. Large crystal size suggests a high water content in the pegmatite magma. The high proportion of water enhances diffusion and allows crystals to grow larger than they would with lower proportions of water. The darker schist will show characteristic layering (schistosity) while the quartzite will appear uniform and may be broken into blocks. Because the igneous pegmatite formed in bands parallel to the bedding of the quartz and schist it is called a sill. If the pegmatite had cut across the bedding planes of the other rocks it would be a dike. Near the creek are found numerous lose pieces of schist. Needle like crystals of tourmaline may be found in some of these fragments.

Look up at the horizontal overhangs at the top of this formation. These overhangs are produced by fractures between different types of rock layers. Rock beneath these fractures has fallen out making at least two flat areas where you can stand and look closely at the rock face. Follow the path about halfway up the slope in front of the formation but stop at one of the flat areas well below the top. Look closely at the cliff vertical face. Find the prominent quartzite fold underneath a band of schist and a band of quartzite that shows two small folds.

To the left of this region you can see a three-inch pegmatite band cutting across the top of a quartzite fold. Because it cuts across the other layers it is classified as a dike. We can conclude that it appeared during an ancient period of plate movement after the quartzite had folded.
Pegmatite intrusion (dike):
Black arrow-cuts across 2 folded quartzite layers, a layer of schist.
The red arrow is pointing to the lower quartzite fold.
The blue arrow indicates the upper double quartzite fold.
The rock surrounding the 2 quartzite folds is schist.

This ends the self-guided walk between Valley Green Bridge and the Magargee Dam. You have been looking at some of the oldest rocks in Pennsylvania forged over 600 million years ago in the Precambrian period and beginning to read the story they tell.