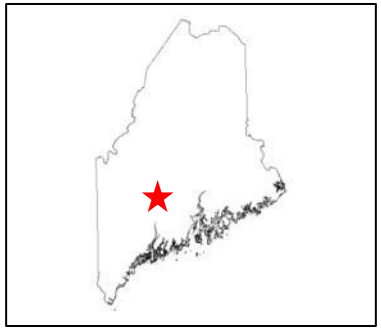
Geologic Site of the Month

November, 2013

The Big Eddy of the Kennebec, Skowhegan, ME



44º 46‘ 18.747"N, 69º 42‘ 23.515“ W

by
Henry Berry

Introduction

The Big Eddy in Skowhegan is a wide place in the Kennebec River below a straight set of rapids, less than a mile downstream (northeast) of the bridge in Skowhegan. This geologic site will describe the bedrock outcrops on the left bank of the river, above and below the Big Eddy.

Photo by Henry Berry

Figure 1. Looking down the main channel of the Kennebec River by the Big Eddy, Skowhegan. The Big Eddy itself is off to the left. Video of the Big Eddy of the Kennebec River looking east

Location Map

From Skowhegan, follow Route 2 East. Stop 1 is just east of Coburn Park; Stop 2 is east of the Big Eddy. As the main channel of the river makes a sharp right bend, an eddy of slack water is caught in a swirl to the left. Route 2 hugs the Big Eddy, affording views of the river.

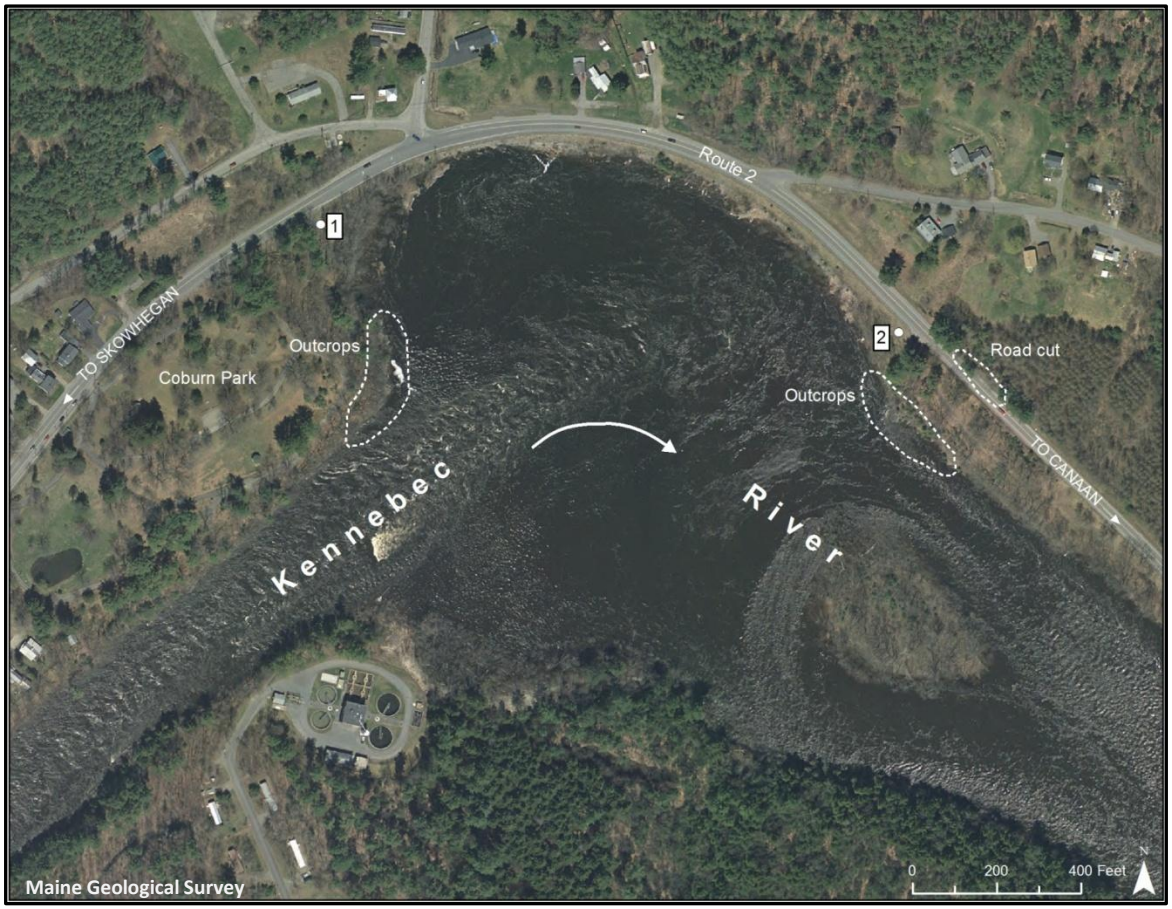


Figure 2. Air photo of the Great Eddy. The two geologic stops are shown by white dots.

Stop 1 - Access

Heading east from Skowhegan, Route 2 goes downhill after Coburn Park. *Carefully* pull off the road to the right at the west end of the guardrail into a small parking area. If you drive by the Big Eddy, you've missed it.

Figure 3. Small parking area for Stop 1. In this October view, the Big Eddy is visible through the trees.

Stop 1 - Access

Photo by Henry Berry

Figure 4. There is enough room for a car to turn around. Park here and follow the path on foot. When leaving, please drive forward onto the paved road (don't try to back out!).

Stop 1 - Access

Figure 5. Head toward the river. The buried bedrock is not exposed along the first part of the trail.

Stop 1 – Perry Mountain Formation, outcrop

The first bedrock outcrops exposed above ground are where the path nears the river. They are light gray rocks with streaks visible on the surface, indicating their internal layering. These rocks belong to the Perry Mountain Formation.

Figure 6. Outcrop of the Perry Mountain Formation at the Big Eddy. The streaks on the upper rock surface in the patch of sunlight are caused by the layering.

Stop 1 – Perry Mountain Formation, layers

Photo by Henry Berry

Figure 7. View looking parallel to the layering in the Perry Mountain Formation. The different colored rock layers have different mineral compositions. The layers are nearly vertical, tilted steeply down toward the northwest (to the left in this photo).

Stop 1 – Perry Mountain Formation, beds

The layers represent different sediment types, mainly sand and mud, that were deposited in beds, have been hardened to rock, and were subjected to heat and pressure in the earth before being exposed by erosion. The original sediment that now forms the Perry Mountain Formation was deposited approximately 430 million years ago, in the Silurian Period of geologic time.

Figure 8. The pencil is pointing to a thin layer of dark colored phyllite (originally mudstone) that separates layers or beds of white quartzite (originally sandstone). This part of the Perry Mountain Formation has much more quartzite than phyllite, a feature inherited from its sedimentary origin.

Stop 1 – Perry Mountain Formation, beds

Photo by Henry Berry

Figure 9. This close-up shows the preservation of sedimentary features. Each layer or bed of sand was deposited on the previous one, eventually accumulating to a significant thickness. The individual beds can be recognized by subtleties of their internal features, such as shades of color, or style of very thin lamination. The beds range from about an inch to four inches thick. Flip to the next page to see them highlighted (Figure 10).

Stop 1 – Perry Mountain Formation, beds (continued)

Figure 10. Same as Figure 9, but with beds highlighted. Notice that the beds under the penny are gray and have thin internal laminations, the bed above it is more even-textured and whiter, and the next three beds are thinner with a rusty weathering stain. These delicate sedimentary features are preserved, even though the sediments have been turned to rock and subjected to heat and pressure.

Stop 1 – Perry Mountain Formation, cross-beds

Thin laminations within a bed that are not all parallel to each other are called cross-beds. Cross-beds indicate that the sand was deposited by moving water. Cross-bedded white sandstone (now quartzite) is characteristic of the Perry Mountain Formation. Careful analysis of cross-beds can sometimes indicate the direction in which the current was moving.

Photo by Henry Berry

Figure 11. Cross-bedded white sandstone of the Perry Mountain Formation. Flip to the next page to see highlights (Figure 12).

Stop 1 – Perry Mountain Formation, cross-beds

(continued)

Figure 12. Same as Figure 11, with some cross-beds highlighted.

Stop 1 – Smalls Falls Formation, outcrop

Continue across the outcrop to the edge of the river. The bedrock here is different. It is generally dark gray or black rather than light gray, it is massive rather than well-bedded, and it has a rusty-weathered surface coating. These rocks belong to the Smalls Falls Formation.

Photo by Henry Berry

Figure 13. Bedrock outcrop of the Smalls Falls Formation on the north bank of the Kennebec River, looking eastward across the Big Eddy. The main channel is to the right. The outcrops of Stop 2 are on the bank in the distance, to the right of the white house.

Stop 1 – Smalls Falls Formation, massive

Photo by Henry Berry

Figure 14. Quartzite beds are uncommon in this part of the Smalls Falls Formation. There is one bed of rusty-weathering quartzite about 2 inches thick just below the hammer head. The rest of the outcrop is rusty-weathering crumbly black slate or phyllite.

Stop 1 – Smalls Falls Formation, weathering

Photo by Henry Berry

Figure 15. The Smalls Falls Formation contains small amounts of iron sulfide minerals (mainly pyrrhotite and pyrite), which weather when exposed to air and water. The weathering reactions produce a range of yellow, orange, and brown iron hydroxides (limonite and goethite), generally known as rust.

Stop 1 – Map view of formation contact

The contact between the formations at Stop 1 can be drawn on an air photo and projected to the northeast, where the bedrock is covered. The Smalls Falls Formation is southeast of the Perry Mountain Formation along the contact. The rocks at Stop 2 are in the Smalls Falls.

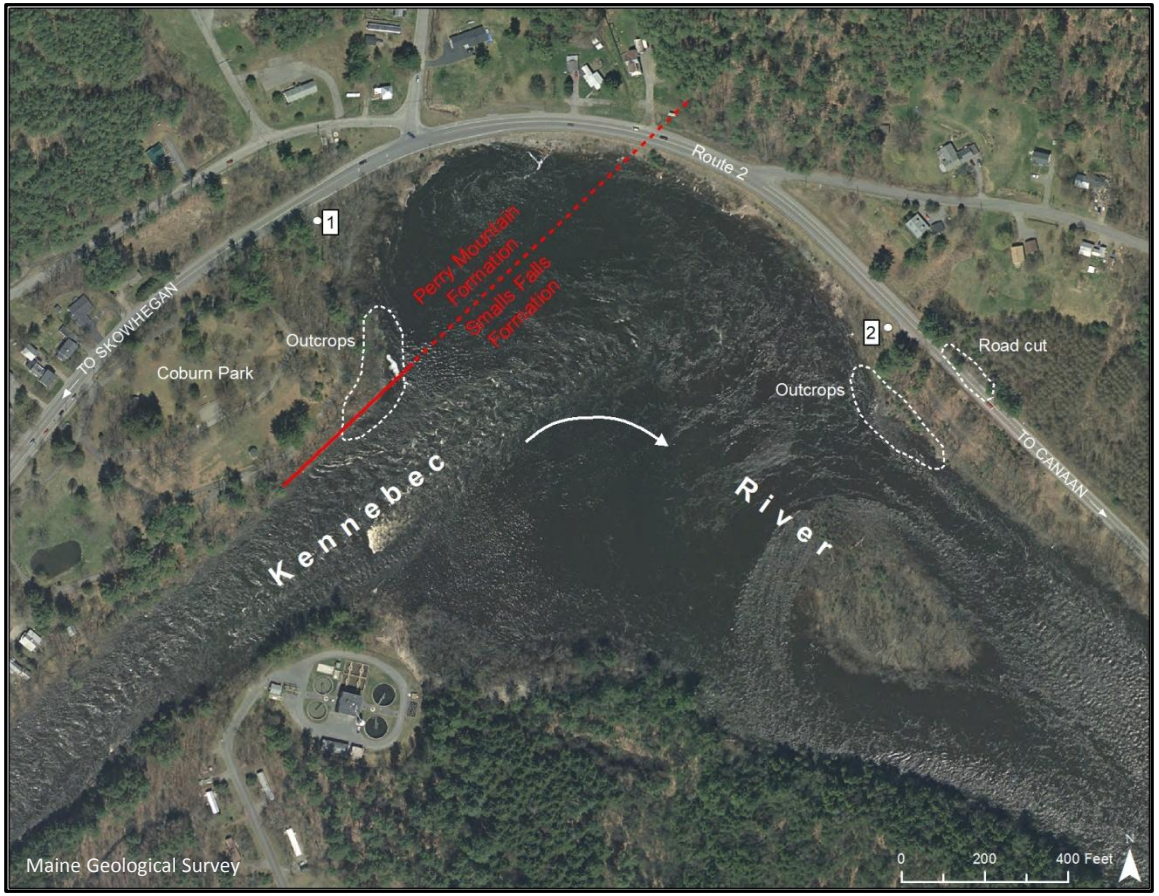


Figure 16. The contact is exposed in the outcrops at Stop 1. This bedrock structure controls the location of the northeast-flowing river segment from Skowhegan down to here.

Stop 1 – Structural Geology, downward facing beds

Beds in the Perry Mountain Formation were deposited in horizontal layers. The layers are now tilted steeply, indicating that the bedrock mass has been dramatically affected by heat and pressure. An astounding feature of the rock in this photo is that the cross-bedding shows that the layers have been rotated by more than 90° so the tops of the beds are now underneath. The description and interpretation of features related to rock deformation such as this is known as structural geology.

Figure 17. Overturned beds in the Perry Mountain Formation at Stop 1.

Stop 1 – Structural Geology, original orientation

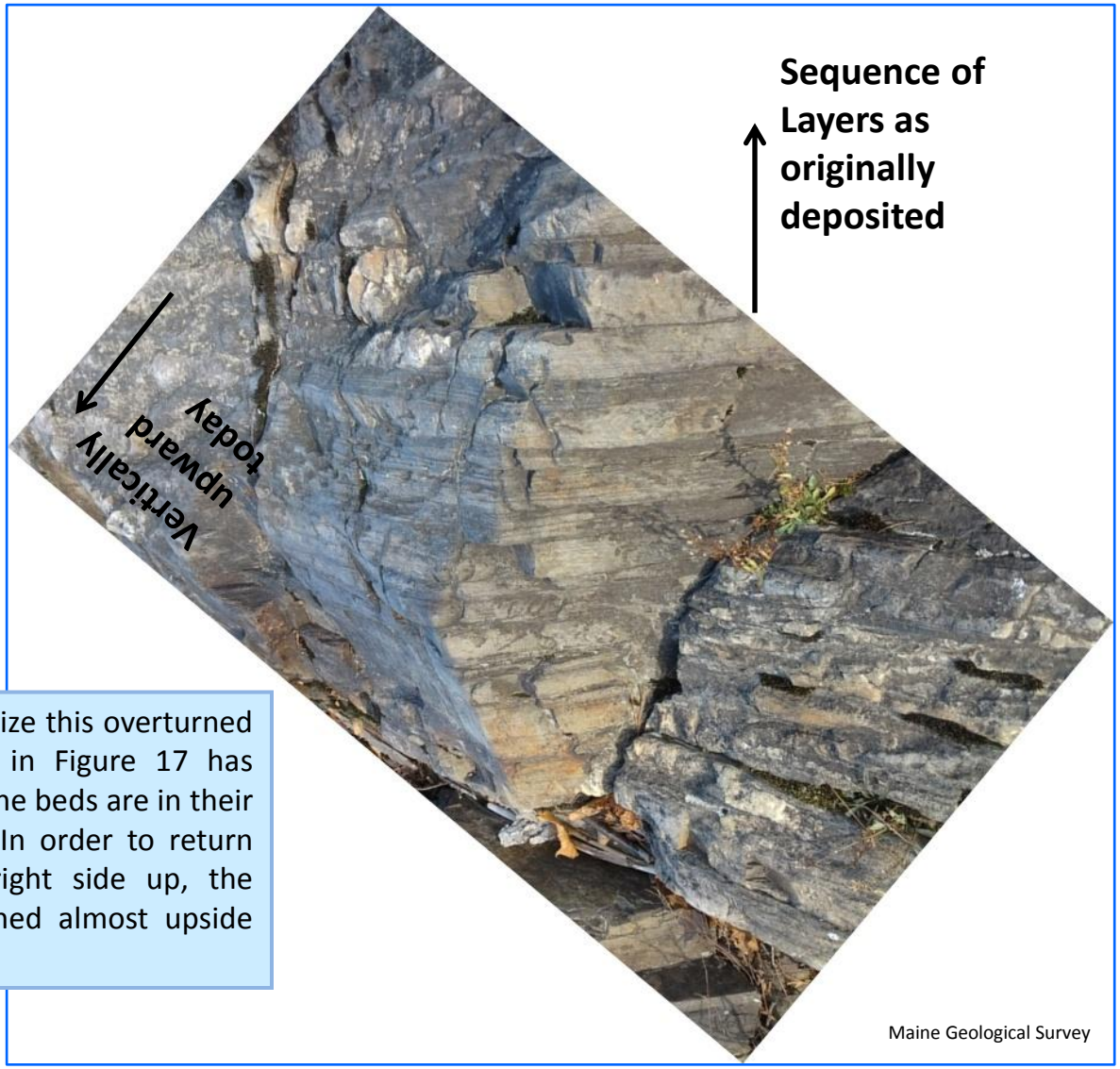
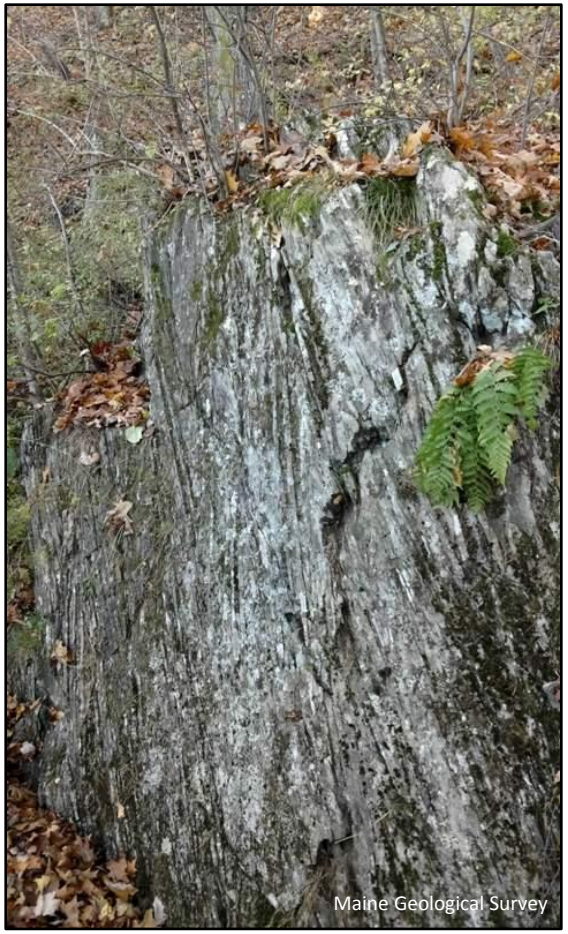


Figure 18. To emphasize this overturned structure, the photo in Figure 17 has been rotated so that the beds are in their original orientation. In order to return the beds to being right side up, the photo has to be turned almost upside down. Mind-boggling!

Stop 1 – Structural Geology, folds

Another type of structural feature in the rock at Stop 1 is folds. Not only have the layers been tilted, their shapes have been contorted. By looking at distinctive beds we can trace the distortion which has occurred. The following three figures show close-ups of folds on this rock surface.



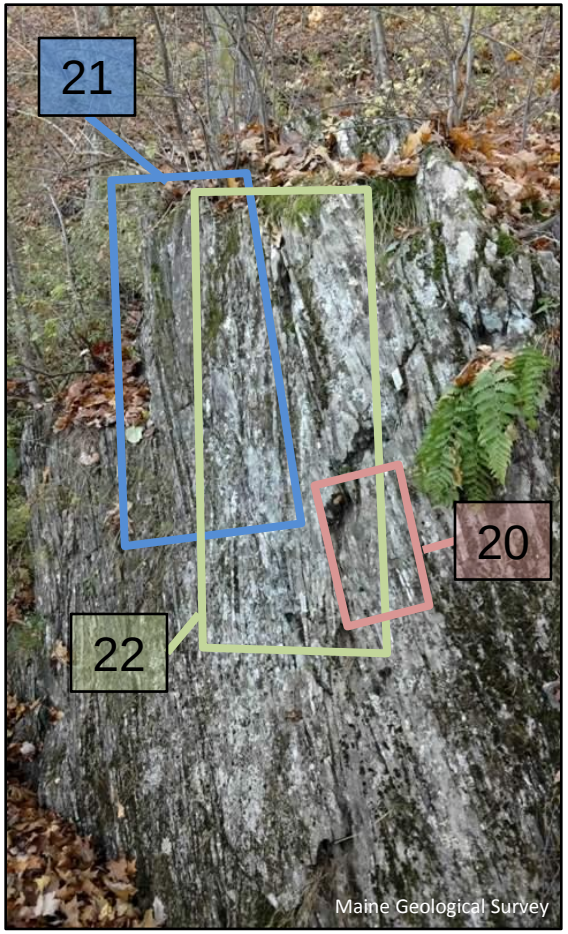


Figure 19. A rock with folded layers. Areas outlined by rectangles are shown in figures 20, 21, and 22.

Stop 1 – Structural Geology, folds

Figure 20. Thin quartzite beds, originally straight and flat, are now folded and nearly vertical. The beds can be difficult to follow because of the moss and lichen on the rock, so some have been traced in the second photo.

Stop 1 – Structural Geology, folds

Figure 21. The folds have various shapes and sizes.

Stop 1 – Structural Geology, folds

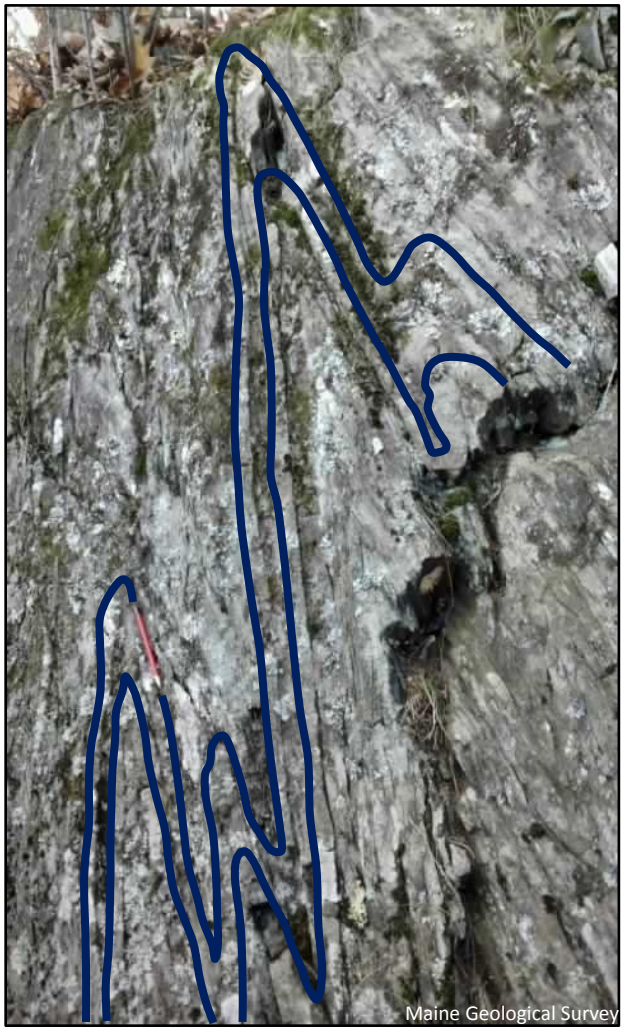


Figure 22. The entire rock mass is deformed into folded shapes. (Red pencil for scale.)

Stop 1 – Structural Geology, folds

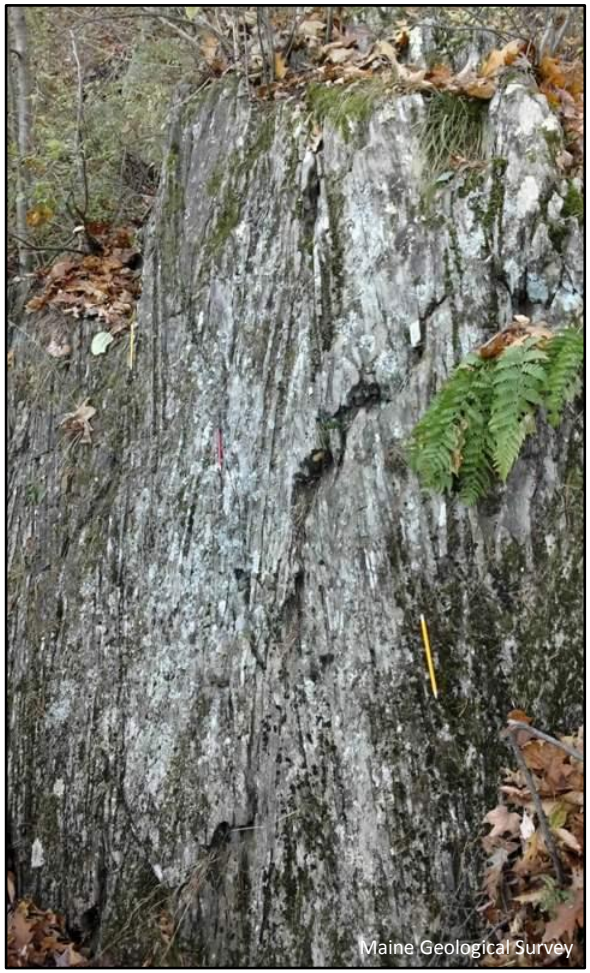


Figure 23. The whole rock face. The three pencils are along one folded bed. Two points on this bed that were 12 feet apart (measured around the folds) are now only 3 feet apart (measured in a straight line). The folding indicates significant horizontal shortening of the rock mass in response to immense pressure during continental motion.

Structural Geology, regional cross-section

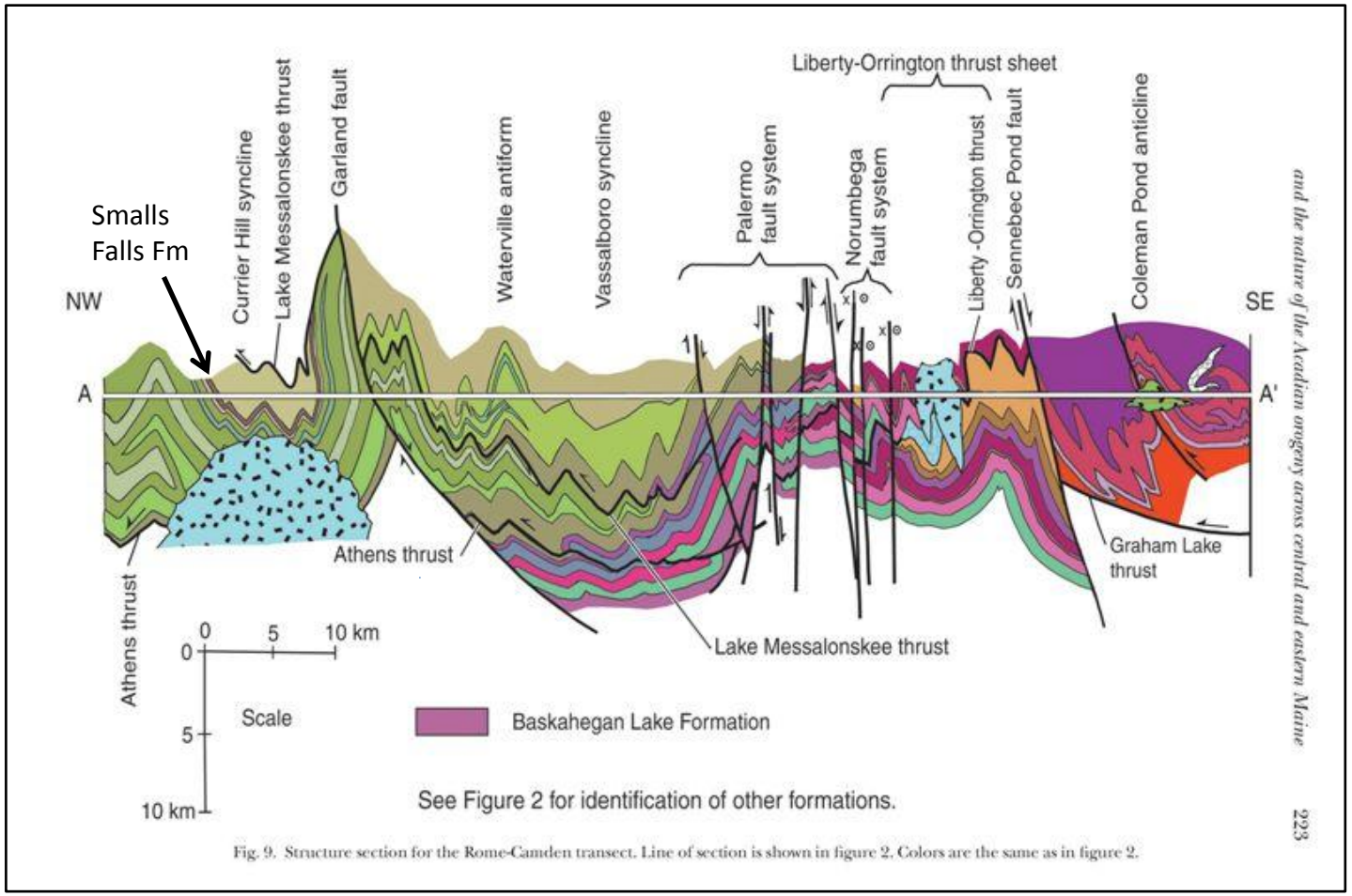


Figure 9 of Tucker, Osberg, and Berry, 2001, American Journal of Science.

Figure 24. In fact, the entire upper crust of the earth was affected by the movement of continent-sized masses. This interpretive geologic cross-section from Skowhegan (A) to Camden (A'), Maine, shows entire formations are folded and faulted as a consequence of horizontal compression. The Smalls Falls Formation at Stop 1 is indicated in brown. Blue masses are igneous intrusions. The horizontal line is the present ground surface, upper parts long since eroded here.

Structural Geology, regional map

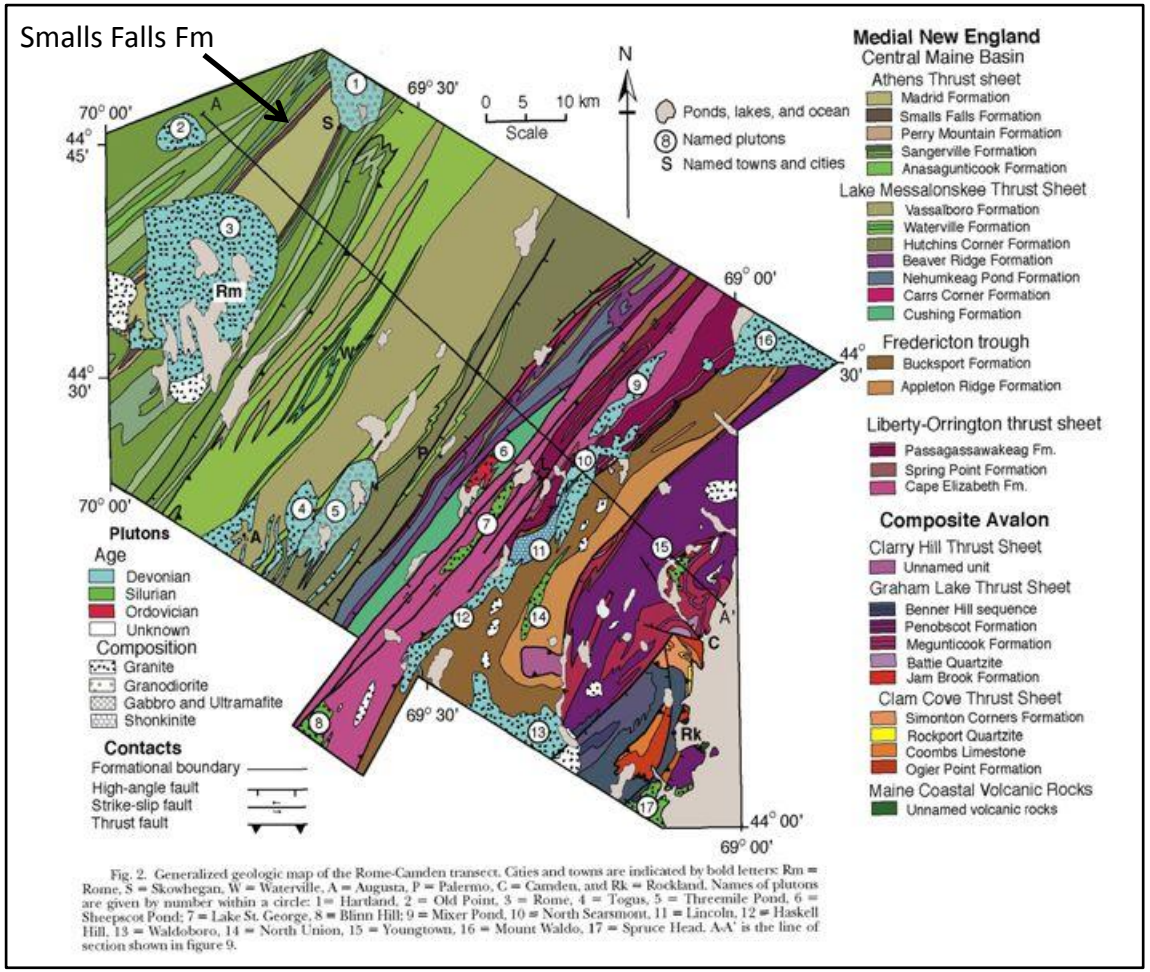


Fig. 2. Generalized geologic map of the Rome-Camden transect. Cities and towns are indicated by bold letters: Rm = Rome, S = Skowhegan, W = Waterville, A = Augusta, P = Palermo, C = Camden, and Rk = Rockland. Names of plutons are given by number within a circle: 1 = Hartland, 2 = Old Point, 3 = Rome, 4 = Togus, 5 = Threemile Pond, 6 = Sheepscot Pond; 7 = Lake St. George, 8 = Blinn Hill; 9 = Mixer Pond, 10 = North Searsmont, 11 = Lincoln, 12 = Haskell Hill, 13 = Waldoboro, 14 = North Union, 15 = Youngtown, 16 = Mount Waldo, 17 = Spruce Head. A-A' is the line of section shown in figure 9.

Figure 2 of Tucker, Osberg, and Berry, 2001, American Journal of Science.

Figure 25. Geologic map from Skowhegan (S) to Camden (C), Maine. Colors show various rock formations. The formations trace out huge folds on the ground, similar in style to the ones in the outcrop at Stop 1 (Figure 23), but tens or hundreds of times larger. Location of cross-section A-A' (Figure 24) is shown.

Stop 2 - Access

Leave Stop 1 and head east on Route 2. The Big Eddy will be to your right. Just past the end of the guardrail is a small parking spot for Stop 2.

Figure 26. The small parking spot for Stop 2, just past the guardrail on the south side of Route 2.

Stop 2 - Road Outcrop

Photo by Henry Berry

Figure 27. Across the road from the parking spot at Stop 2, is an exposure of bedrock that was blasted during road construction. If you wish to visit this road cut, wear high visibility clothing and be vigilant of the high-speed traffic.

Stop 2 – Smalls Falls, bedding

Figure 28. Road cut in the Smalls Falls Formation at Stop 2. The rock is dominated by thick beds of quartzite (originally sandstone), now steeply inclined. Because these rocks have only been exposed to the weather for a relatively short time (less than 50 years), the rusty surface crust found on natural surfaces is not well developed. (Compare with Figure 30.) Dark splotches are shadows.

Stop 2 – Access to River

Photo by Henry Berry

Figure 29. Follow the path between the boulders, then clamber down the bank to the edge of the river. This used to be a picnic area, now abandoned.

Stop 2 – Smalls Falls, natural outcrop

Photo by Henry Berry

Figure 30. Natural outcrop of the Smalls Falls Formation on the bank of the Kennebec River. Beds of blocky-weathering quartzite and splintery slate or phyllite are nearly vertical. This is the same rock as that in the road cut (Figure 28), but the natural weathering of sparse iron sulfide minerals has produced a pronounced rusty surface.

Stop 2 – Smalls Falls, weathering

Photo by Henry Berry

Figure 31. Broken piece of Smalls Falls Formation. The inside, protected from weathering, is gray and contains tiny flecks of shiny iron-bearing minerals. The outside, weathered surface is rusty.

Summary

- There are two bedrock formations at Stop 1: The Perry Mountain and Smalls Falls formations.
- Sedimentary features such as bedding and cross-bedding are well preserved in the Perry Mountain. They formed in the Silurian Period of geologic time.
- The Smalls Falls Formation contains iron sulfide minerals which produce a rusty weathered surface stain or crust.
- Continent-scale movement during Silurian and Devonian time (370 to 420 million years ago) caused folding and faulting of the earth's crust, including folds and inverted beds in the outcrops at Stop 1.
- The contact exposed at Stop 1 can be projected across the map. The Smalls Falls at Stop 2 is southeast of that contact.
- While the Smalls Falls Formation is susceptible to extreme chemical weathering, the weathering is best developed where the rock is exposed to air and water.

Acknowledgments and References

Acknowledgments

The locality described in this web site was originally mapped by Allan Ludman as part of his dissertation work in the Skowhegan 15' quadrangle (Ludman, 1969; 1977). A detailed description of this locality in particular was presented as Stop 4 of a field guide by Ludman and Philip Osberg in 1987. That field guide is recommended to the reader (Ludman and Osberg, 1987). Without the discovery field work and the insight provided by these the pioneers of central Maine geology, this web site would not have been possible.

References and Further Information

Coburn Park Commission Association web site: http://www.skowhegan.com/coburnpark

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