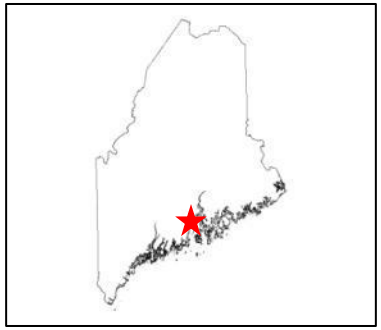
Geologic Site of the Month

July, 2001

The Bedrock Geology of Mount Battie, Camden, Maine



44 13‘ 15.40“ N, 69 4‘ 5.10“ W

Text by
Henry N. Berry IV

Introduction

One of the best loved views on the Maine coast is from the summit of Mount Battie (Figure 1). The allure of the mountain derives not from its size (shy of 800 feet high), but from its prime location above the town of Camden and its bare summit ledges affording outstanding panoramic views of Penobscot Bay.

Figure 1. View toward the south from Mount Battie summit. Battie Quartzite in foreground; town of Camden in middle; Owls Head on horizon.

Introduction

Mount Battie is a rounded, rocky knob that juts from the south end of the Camden Hills (Figure 2). Its rocky cliffs rise above Megunticook Street in Camden, an easy walk from downtown, forming a backdrop to the town and its harbor.

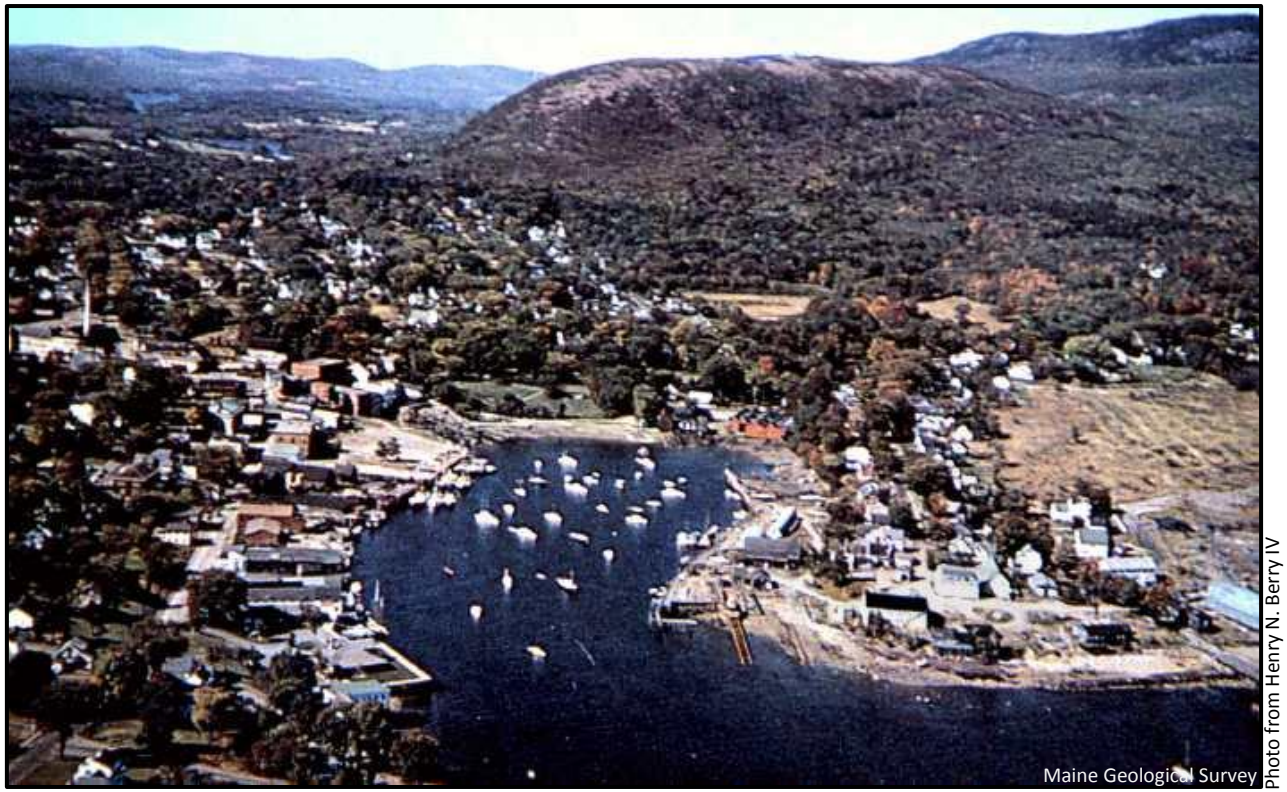


Figure 2. Camden Harbor with Mount Battie in background. View from the air toward the northwest. (Photo from postcard, source unknown)

Introduction

The Mount Battie Trail heads up the steep south side ending at a stone lookout tower on the summit.

Figure 3. Stone tower on Mount Battie summit.

Directions

The trail is a popular hike with both "locals" and tourists, although most visitors take the auto road up the north side, maintained by the Camden Hills State Park.

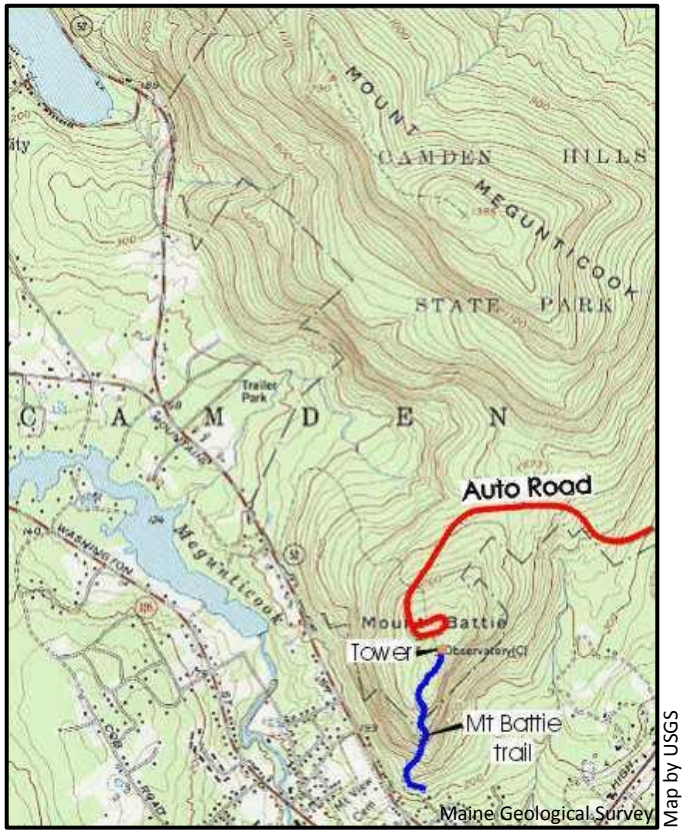


Figure 4. Map of Mount Battie showing the Mount Battie Trail on the steep south side of the mountain and the Auto Road climbing the more gradual north side, meeting by the summit tower. Higher mountains of the Camden Hills are to the north.

The Battie Quartzite

While the breathtaking views naturally command attention, the rocks underfoot display a beauty and history also worth looking into. The rocks of Mount Battie are a kind of rock called quartzite. The Battie Quartzite was originally described by Edson Bastin in his U.S. Geological Survey report of 1908. The Battie Quartzite is well known by students of New England geology.

Quartzite is a metamorphic rock composed mostly of the mineral quartz. Metamorphic rocks have been subjected to heat and pressure at depth in the earth, which over time actually changes their crystalline structure. For most rocks, like quartzite, metamorphism causes the rock to become much harder, similar to the way that clay changes to ceramic by baking. The reason that Mount Battie is such a prominent knob is that the quartzite is more resistant to erosion than the surrounding rocks. Through millions of years of erosion, the surrounding rocks have been worn down deeper, leaving Mount Battie standing above them. (There is a different, thin layer of quartzite at the summit of Mount Megunticook, but that is a different story.)

Clues to Its Origin

The quartzite of Mount Battie is very interesting because many features are preserved from before the metamorphism. From the summit area down the south side of the mountain, the rock is packed with small white shapes that were originally pebbles. The pebbles are embedded in light gray quartzite that used to be quartz sand. The light gray quartzite has microscopic bits of black mica, so it is not quite as pure as the quartzite that makes up the pebbles. In lichen-covered outcrops it is difficult to see the pebbles; they show up best on weathered surfaces (Figure 5).

Figure 5. Quartzite conglomerate on Mount Battie. Note that pebbles are white, while the rock between the pebbles is light gray.

Clues to Its Origin

There are excellent exposures along the Mount Battie Trail (Figure 6). A rock composed mainly of pebbles is called a conglomerate. Conglomerates are sedimentary rocks that accumulated at places like pebble beaches or in offshore basins or channels where small stones might accumulate.

Photo by Henry N. Berry IV

Figure 6. Quartzite conglomerate on Mount Battie.

Clues to Its Origin

A geologic map shows that the conglomerate underlies the southern side of the mountain (Figure 7). The northern slope is underlain by bedded conglomerate and quartzite. Across the Auto Road, the rocks are mostly bedded quartzite with only minor quartzite conglomerate.

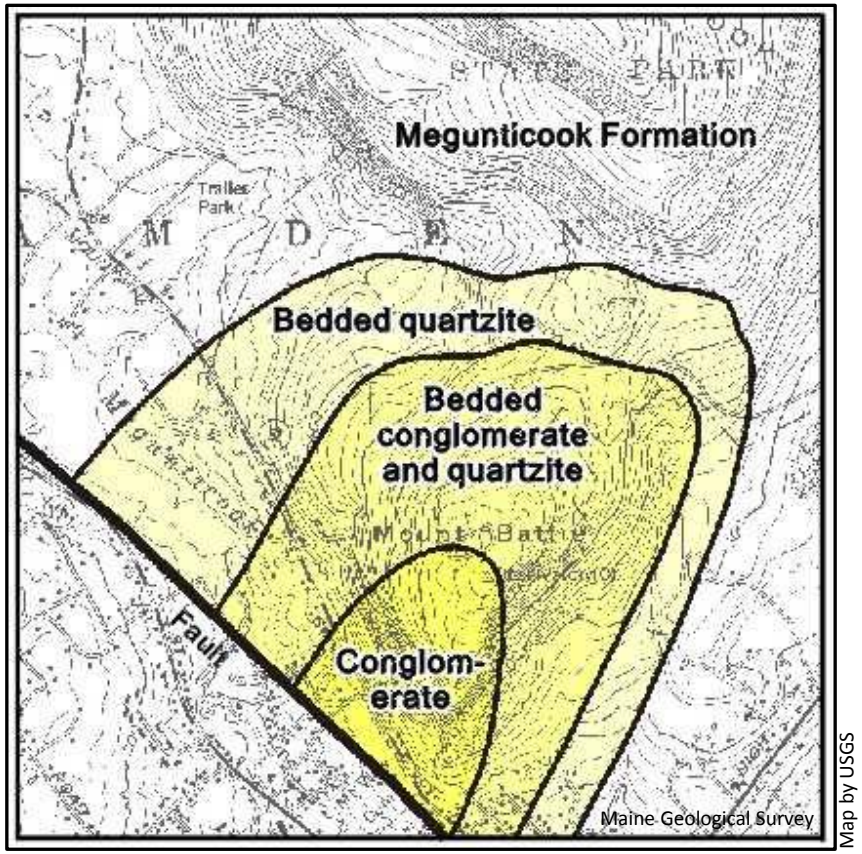


Figure 7. Bedrock geologic map of the Battie Quartzite.

Clues to Its Origin

To the north and east, starting about at the parking area at the summit, the Battie Quartzite is a layered rock, with layers of conglomerate alternating with layers of quartzite. One nice exposure of this layered rock is along the Tablelands Trail between the Mount Battie summit and the Auto Road. In this exposure the layers are not horizontal, but are tipped about 20 degrees toward the north (Figure 8).

Figure 8. Bedded quartzite conglomerate and quartzite by Tablelands Trail, north side of Mount Battie. Beds are tilted down to the left (north).

Clues to Its Origin

The shape of the outcrop surface reflects the rock layering. A close-up shows a quartzite layer 5 or 6 inches thick between two conglomerate layers (Figure 9). While these rocks now consist of the metamorphic rock quartzite, the layers indicate that the rock was originally a sedimentary rock that accumulated in layers or beds. In this photo, the lower conglomerate would have been deposited first, then a bed of sand, then the upper bed of conglomerate.

Figure 9. Close-up of bedded quartzite conglomerate and quartzite in Figure 8. Lichen obscures rock in lower left of photo, but lower conglomerate layer is visible in lower right. Layers are nearly horizontal. The nearly vertical white streaks are quartz veins, which cut across the layers and formed during metamorphism.

Clues to Its Origin

About where the Tablelands Trail crosses the Auto Road, the character of the Battie Quartzite changes again (Figure 7). From here to the north and east, conglomerate beds are much less common. The rock consists mainly of quartzite beds, representing layers of sand that have been hardened by metamorphism. In some places, there are even thin laminations that indicate the sand was deposited in water affected by currents. In rare instances one lamination cuts across the one beneath it, showing that the sand surface was slightly rippled and channeled when the next layer was deposited (Figure 10).

Figure 10. Cross-laminations in bedded quartzite. Thin black stripes represent thin layers that were deposited in sequence from bottom to top. In center of photo, upper layers cut across lower layers, indicating that some of the lower layers had been eroded by currents before the upper layers were deposited.

Long Ago and Far Away

The sequence of rocks that comprise the Battie Quartzite, from conglomerate to bedded conglomerate and quartzite to bedded quartzite, suggests they were deposited in an ocean basin. This was not the Atlantic Ocean, because the sediments in the modern Atlantic have not yet been hardened to stone. It was an older ocean that existed before the Atlantic had opened and before the Appalachian Mountains had formed.

Fossils are not usually preserved in metamorphic rocks like the Battie Quartzite, but there is indirect evidence from surrounding areas that suggests its age of formation to be Cambrian, over 500 million years old. This is the time at which the conglomerate and sand were deposited. Current estimates of the positions of continents at that time suggest that the ocean we are talking about is the Iapetus Ocean (predecessor of the Atlantic), and that the sediments of this part of Maine accumulated near the south margin of that ocean, not far from the South Pole.

The metamorphism which turned the rock into quartzite probably occurred in the Silurian Period, about 430 million years ago.

The Modern Landscape

Mount Battie itself is a relatively young geologic feature. That is to say, the shape of the land surface has been continually (and continues to be) modified by erosion. Since the time of metamorphism, over a mile of rock has been eroded from above the rocks we now walk on. The most recent major episode of erosion at Mount Battie, sculpting by continental ice sheets of the last great Ice Age, ended about 14,000 years ago.

It is the combination of Cambrian sediment accumulation, Silurian metamorphism, and subsequent erosion that together have produced the unique form and setting of Mount Battie on the Maine coast.

References and Additional Information

Bastin, Edson S., 1908, Description of the Rockland quadrangle, Me.: U. S. Geological Survey, Geologic Atlas of the United States, Folio 158, 15 p.

Berry, Henry N., IV, 1987, Bedrock geology of the Camden Hills area, central coastal Maine: Maine Geological Survey, Open-File Report 87-26, 27 p. (2 maps, scale 1:16,400)

Osberg, Philip H., and Guidotti, Charles V., 1974, The geology of the Camden-Rockland area, in Osberg, Philip H. (editor), Guidebook for field trips in east-central and north-central Maine: New England Intercollegiate Geological Conference, 66th Annual Meeting, October 12-13, 1974, Orono, Maine, p. 48-60.

Berry, Henry N., IV, and Osberg, Philip H., 1989, A stratigraphic synthesis of eastern Maine and western New Brunswick, in Tucker, Robert D., and Marvinney, Robert G. (editors), Studies in Maine Geology: Volume 2 - structure and stratigraphy: Maine Geological Survey, p. 1-32.

Paterson, J. R., 1983, A comparison of methods used in measuring finite strains from ellipsoidal objects: Journal of Structural Geology, v. 5, no. 6, p. 611-618.

West, David P., Jr., Guidotti, Charles V., and Lux, Daniel R., 1995, Silurian orogenesis in the western Penobscot Bay region, Maine: Canadian Journal of Earth Sciences, v. 32, no. 11, p. 1845-1858.

Osberg, Philip H., Tucker, Robert D., and Berry, Henry N., IV, 1995, Is the Acadian suture lost?, in Hussey, Arthur M., II, and Johnston, Robert A. (editors), Guidebook to field trips in southern Maine and adjacent New Hampshire: New England Intercollegiate Geological Conference, 85th Annual Meeting, October 6-8, 1995, Brunswick, Maine, p. 145-171.

Berry, Henry N., IV, and Osberg, Philip H., 2000, The Megunticook Formation, in Yates, Martin G., Lux, Daniel R., and Kelley, Joseph T. (editors), Giudebook for field trips in coastal and east-central Maine: New England Intercollegiate Geological Conference, 92d Annual Meeting, Orono, Maine, p. 54-70.

Other Links:
Continents through Geologic Time

Camden Hills State Park

Camden, Maine, Chamber of Commerce