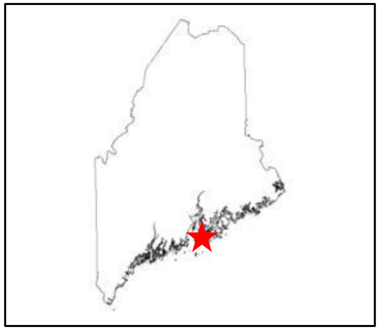
Geologic Site of the Month

June, 2011

Settlement Quarry, Stonington, Maine



44 10‘ 31.27“ N, 68 38‘ 23.11“ W

Text by
Henry N. Berry IV

Introduction

Between Penobscot Bay and Mount Desert Island on Maine's mid-coast lies the island of Deer Isle. It can be reached by car on Maine Route 15, almost an hour south of Route 1. Most of the island, including the town of Stonington, and many of the smaller islands to the south and east are underlain by a large body of granite known as the Deer Isle pluton. Over the past two centuries, a large amount of granite has been quarried from several places in this pluton. One quarry, no longer active, is the Settlement Quarry, on Oceanville Road. In 1996, the Island Heritage Trust purchased the quarry property and has developed a network of walking trails and informational signs that make this a wonderful place to learn about the geology and history of Maine granite.

Photo by Henry N. Berry IV

Figure 1. Entrance to Settlement Quarry.

Settlement Quarry

A small dirt parking area (Figure 2) accommodates several cars. A kiosk at the entrance provides a trail map, information about the site , and a guest book for visitors.

Photos by Henry N. Berry IV

Figure 2. Dirt parking area at Settlement Quarry, Oceanville Road and the kiosk with brochures.

Settlement Quarry

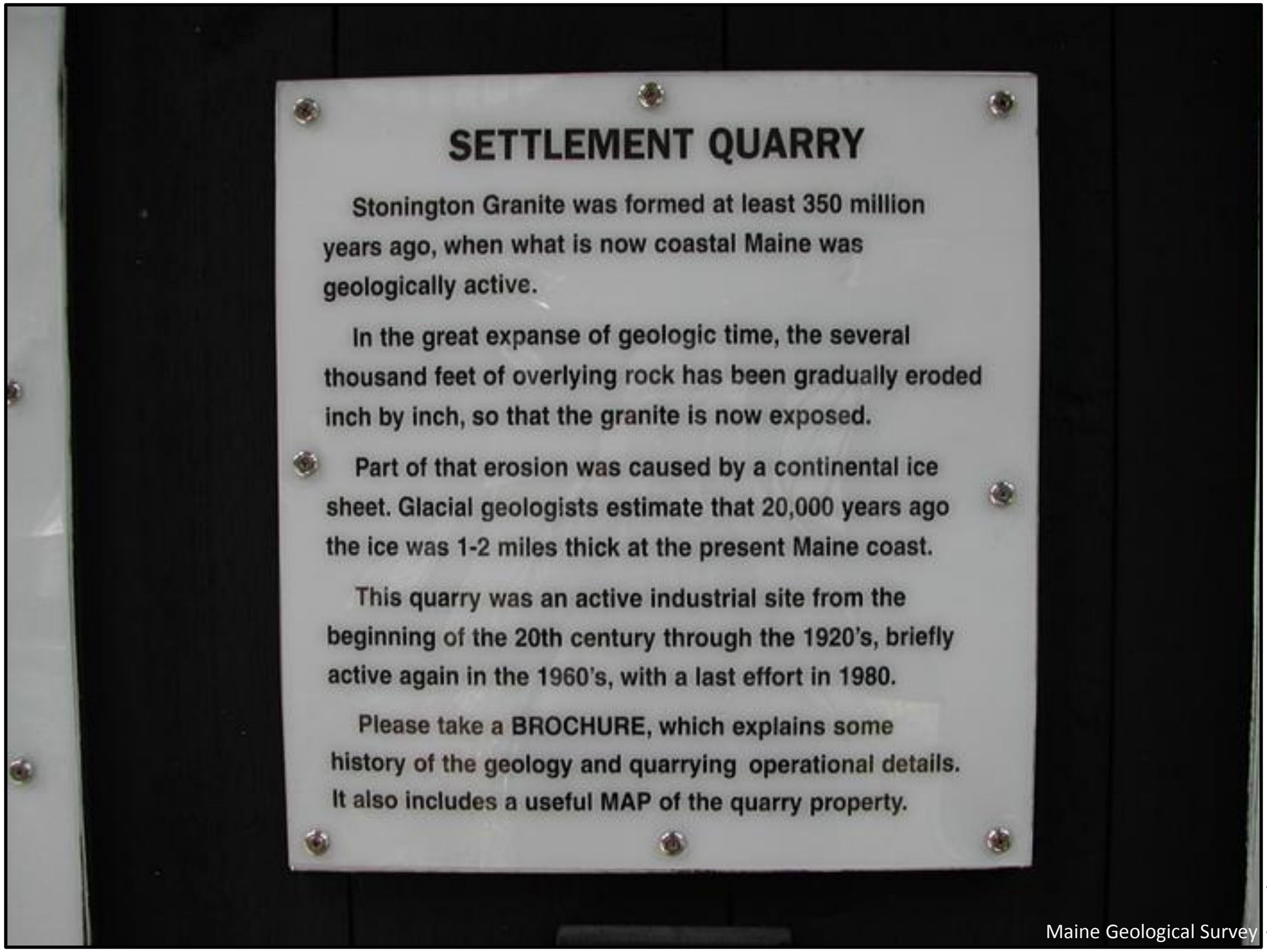


Photo by Henry N. Berry IV

Figure 3. Interesting facts about the site, posted at the entrance kiosk. High resolution PDF image of the Island Heritage Trust brochure and trail map (473 Kb).

Glacial Geology

During the last Ice Age (about 15,000 to 25,000 years ago), a continental glacier covered the whole of New England, and moved slowly across the landscape far into the Gulf of Maine. Evidence of this glacier activity is preserved at the Settlement Quarry site. The Glacial Erratic Trail (Figure 4) leads over the north slope of the hill, which is still in its natural state, unaffected by the quarrying on the south side of the hill. Most of the exposed bedrock and loose stones are made of pink granite like the rock in the quarry. A few stones, however, are not.

Photo by Henry N. Berry IV

Figure 4. Beginning of the Glacial Erratic Trail.

Glacial Geology

One rounded boulder in the trail (Figure 5) consists of a fine-grained igneous rock called hornblende diorite.

Photos by Henry N. Berry IV

Figure 5. Rounded boulder in the Glacial Erratic Trail and a close up of the texture of the rock (hornblende diorite).

Glacial Geology

Another, very large, angular boulder near the far end of the trail is marked by a sign (Figure 6). It is made of a rock with a strong layered or foliated fabric, very different from the uniform texture of granite. This is not an igneous rock, but a metamorphic rock which belongs to the Ellsworth Formation. This large boulder is out of place; it did not come from the bedrock here. Such an out-of-place boulder is called an "erratic." The nearest bedrock outcrop of the Ellsworth Formation is about 4 miles away, at the northern side of Deer Isle. This erratic was frozen into the ice of the glacier and carried for many miles until the ice finally melted, leaving this erratic resting on granite.

Photos by Henry N. Berry IV

Figure 6. A large, angular boulder on the Glacial Erratic Trail and a close-up of the boulder showing the horizontal layering in the rock.

Glacial Geology

Closer to the parking area, off the main quarry road, a sign directs you to an area of flat bedrock whose surface is marked with grooves and scratches (Figure 7). These are natural features caused by stones frozen in the base of the ice being slowly dragged along the underlying rock surface. The direction of the grooves and scratches indicate the direction that the glacier ice was moving, in this case about 30 degrees East of South, which is typical for the ice flow directions measured along this part of the coast.

Figure 7. Flat rock surface with gouges and scratches (parallel to the pencil), which were made by rocks frozen in the base of the overriding glacier. The pencil points to the east-southeast, which is the direction that the glacier moved.

Glacial Geology

Another remnant of the last Ice Age is the stony, gravelly deposit which rests upon the bedrock and beneath the topsoil (Figure 8). This deposit, which blankets the region, is called "till." Till is the rocky material that was left behind when the ice melted, and is characterized by a wide variety of rocks of different shapes, sizes, colors, and rock types.

Photo by Henry N. Berry IV

Figure 8. A stony deposit, called "till," left behind by the continental glacier when it melted. Notice the wide variety of shapes, sizes, and types of stones. The thin soil layer is developed on top of this glacial deposit.

The Quarry

The excavation at the top of the hill, and which extends toward the south, mimics the original natural shape of the hill. The blocks of rock were removed primarily in layers, which has left broad flat areas separated by vertical steps. Proximity to the ocean was important in allowing the large, heavy blocks to be shipped to market. For us, this combination of broad, open quarry near the ocean makes for splendid views of Webb Cove in the foreground, and Isle Au Haut on the horizon (Figure 9). It also provides many large, smooth surfaces for looking closely at the rock.

Photo by Henry N. Berry IV

Figure 9. View toward the south from the Settlement Quarry. Isle Au Haut is on the horizon.

The Granite

The granite of the Settlement Quarry is a light pinkish color, which is characteristic of the Stonington area quarries. The color and texture have made this stone distinctive and desirable around the world. A typical view at arm's length (Figure 10) shows that the individual mineral grains are about the size of a dime, with a few larger ones scattered about.

Photo by Henry N. Berry IV

Figure 10. Representative view of the pink granite in the Settlement Quarry. The mineral grains are about the size of the dime.

The Granite

A close-up (Figure 11) shows the three main minerals of granite - two types of feldspar and quartz - in roughly equal proportions. The pinkish color of the rock comes from the pink feldspar.

Photo by Henry N. Berry IV

Figure 11. Close-up of the granite, showing pink feldspar, white feldspar, and gray translucent quartz. These three minerals, in approximately equal proportions, are the main constituents of true granite.

The Granite

White feldspar occurs both as separate grains and also as thin overgrowths on pink feldspar (Figure 12). Quartz is gray and transluscent. A small amount of black mica (biotite) is sprinkled through the rock, nestled between the other minerals.

Photo by Henry N. Berry IV

Figure 12. White feldspar occurs as thin overgrowths on pink feldspar (as indicated by the pencil point), and also as separate grains (the white grain just to the right).

The Granite

A few of the white feldspar grains have tiny bits of biotite and quartz inside them, suggesting they had a more complicated history of formation as the molten granite was solidifying (Figure 13).

Figure 13. The long grain of white feldspar to the left of the dime has many blebs of mica and quartz inside it. This suggests a more complicated growth history than for some of the other feldspar grains.

Enclaves of Dark-colored Rock

At several places in the quarry, small blobs of dark-colored rock are embedded in the granite (Figure 14-15). These have been called "enclaves" because they have a different composition from the granite, and are scattered through the granite, but retained their identity and did not become mixed with the granite.

Figure 14. A grayish blob of very fine-speckled rock inside the ordinary granite. This sort of blob is called an "enclave."

Enclaves of Dark-colored Rock

These enclaves were called "knots" by early quarry workers, because they can cause the rock to split unevenly, much like a knot in wood. It is only recently, however, that their origin has been understood as remnants of a different magma that intruded into the granite magma when they both were still molten.

Photo by Henry N. Berry IV

Figure 15. Another enclave, with an interesting shape.

Enclaves of Dark-colored Rock

Compelling evidence that they were both molten at the same time is provided by the presence of feldspar grains of the granite being completely engulfed within enclaves (Figure 16). This could only happen if the enclave was not yet completely solid at the time the granite minerals had formed.

Figure 16. This enclave has a pink feldspar inside it. This indicates that enclave was still molten at the time the feldspar was mixed into it.

Aplite Dikes

Another type of rock in the Settlement Quarry is a fine-grained, smooth-looking pink rock called "aplite." It occurs in long, thin sheets, called “dikes”, that cut through the granite (Figure 17).

Photo by Henry N. Berry IV

Figure 17. A dike of aplite cutting granite, from upper left to lower right.

Aplite Dikes

The aplite is composed of the same minerals as the granite, but the mineral grains are very much smaller, less than a millimeter across (Figure 18). Aplites are interpreted to represent the final stages of crystallization of the pluton, when small pockets of remaining molten rock were injected through the mass of granite which had mostly crystallized.

Figure 18. Close-up of aplite. This rock contains the same minerals as the granite, but the individual grains are much, much smaller - only a fraction of a millimeter. Compare with the size of the grains in Figure 11.

Aplite Dikes

Some aplites, especially the larger ones, can affect the quarrying, not only because the rock looks different from the granite, but also because the aplites can be more strongly fractured and difficult to work (Figure 19).

Figure 19. A wide aplite dike cuts through granite from lower left to upper right. The aplite is much more intensely fractured than the granite, making the rock unsuitable for quarrying large blocks.

Joints and Fractures

For generations, the quarrying of granite blocks was done by splitting the rock along natural fractures or planes of weakness. While modern quarrying methods may include actually cutting through solid rock with wire saws or torches, much of the stone in the Settlement Quarry was removed by drilling and blasting along natural fractures, or joints. The most important joints are the horizontal ones, which break the rock into sheets (Figure 20).

Photo by Henry N. Berry IV

Figure 20. A natural, horizontal "sheeting" joint.

Joints and Fractures

The spacing of the sheeting joints determines the thickness of blocks that can be removed (Figure 21). Workers then drill sets of vertical holes a certain distance back from the quarry face, and in the direction of the rock's grain.

Photo by Henry N. Berry IV

Figure 21. The step-like shape of the quarry is due to the natural spacing of horizontal sheeting joints.

Joints and Fractures

Small explosive charges in the holes then break the blocks free. At many places in the quarry, sets of three drill holes can be seen, both in the quarry wall, and in blocks that were excavated (Figure 22).

Photo by Henry N. Berry IV

Figure 22. Drill holes in the side of an excavated block.

Joints and Fractures

Many other blocks left at the site have irregular shapes where the rock did not split evenly (Figure 23).

Photo by Henry N. Berry IV

Figure 23. The grass and trees follow natural joints in the granite. Blocks that did not split evenly or straight, were left behind as unsuitable for market.

Joints and Fractures

The pier at the waterfront, visible from the Settlement Quarry, is still used for transportation of granite from other active quarries in the area (Figure 24).

Photo by Henry N. Berry IV

Figure 24. The pier at the foot of the Settlement Quarry has been used for over a century, and is still used today for granite stockpiling and transportation. Most of the granite is now hauled overland by truck.

References and Additional Information

Stewart, David B., and Tucker, Robert D., 1998, Geology of northern Penobscot Bay, Maine: U.S. Geological Survey, Miscellaneous Investigations Series Map I-2551, 2 sheets, map scale 1:62,500. [Shows extent of Deer Isle pluton, and reports the Devonian age of the granite as 371 ±2 million years old.]

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