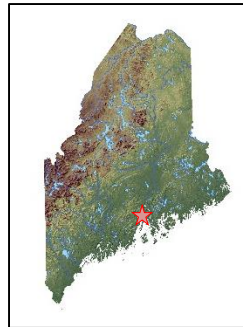


Maine Geologic Facts and Localities
February, 2018

Sears Island, Searsport, Maine



44° 26' 41.7" N, 68° 52' 52.6" W

Text by
Ryan P. Gordon

Introduction

At the northern end of Penobscot Bay, close to the mainland in Searsport, lies the uninhabited island now known as Sears Island (Figures 1 and 2). Owned by the State of Maine, the island is currently a preserve open to the public, with 601 of the total 937 acres held under a conservation easement by the Maine Coast Heritage Trust. A trail network that crisscrosses the island allows visitors to observe several layers of natural and human history, including bedrock geology, glacial geology, and the history of 19th through 21st Century agricultural settlement and industrial development. The island is open year-round to non-motorized recreation, including hiking, skiing, bicycling, and horseback riding.



Figure 1. The northwest shore of Sears Island at low tide, with the pier in Searsport showing from across the water to the west.

Directions

Sears Island can be reached by a causeway that was built in 1980 over the preexisting natural sandbar. To access the Sears Island trail network from downtown Searsport, head east 2.1 miles on Main Street (US Route 1), then turn right on the Sears Island Road. The trail network begins 1.2 miles to the south at the end of the road. For more information and a printable trail map, visit the [Friends of Sears Island website](#).

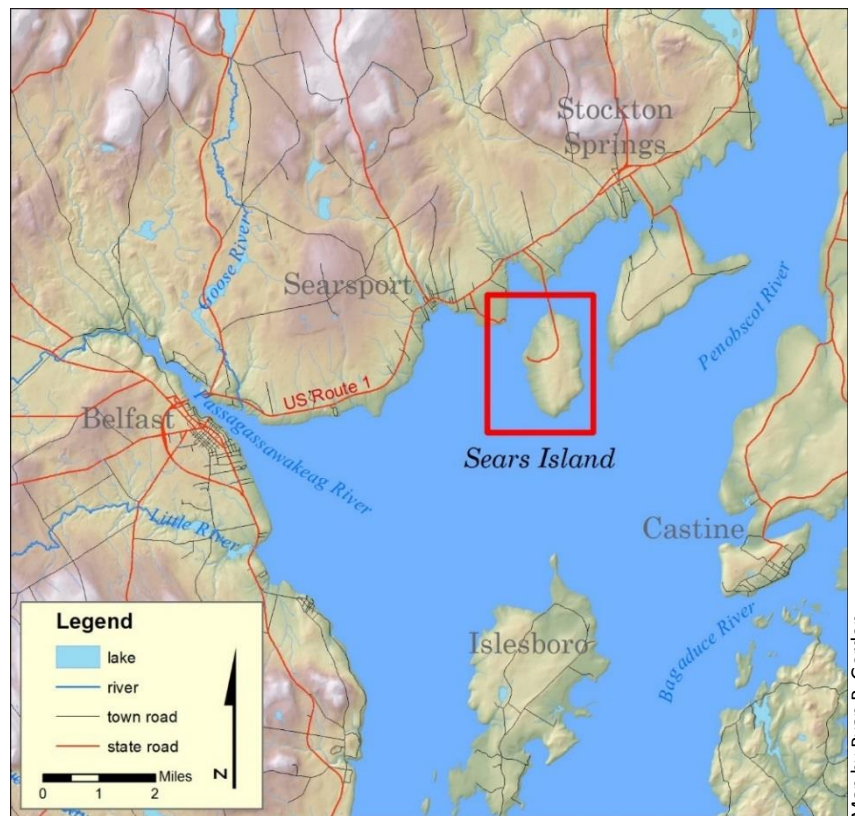


Figure 2. Location of Sears Island in Searsport, Maine, at the head of Penobscot Bay. The red rectangle indicates the approximate area shown in Figure 3.

Multiple Histories

Sears Island preserves the physical evidence of several very different periods in the history of the coast of Maine. The lineage of the bedrock extends back in time as far as half-a-billion years; however, the bedrock records very little of the geologic history beyond the Late Devonian Period (approximately 350 million years ago). The gap in age between the bedrock and the sediments that lie directly on top of them is therefore millions of years. These sediments were mainly affected by the most recent glacier to cover Maine, which moved, deposited, and shaped them within the last 20,000 years. The imprint of human hands is even more recent, extending from just before the colonization of Maine by Europeans to the present, a mere 500 years or so. All of these histories can be observed during a short walk around the north and east sides of the island. Some of the features and locations discussed below are noted on the map shown in Figure 3.

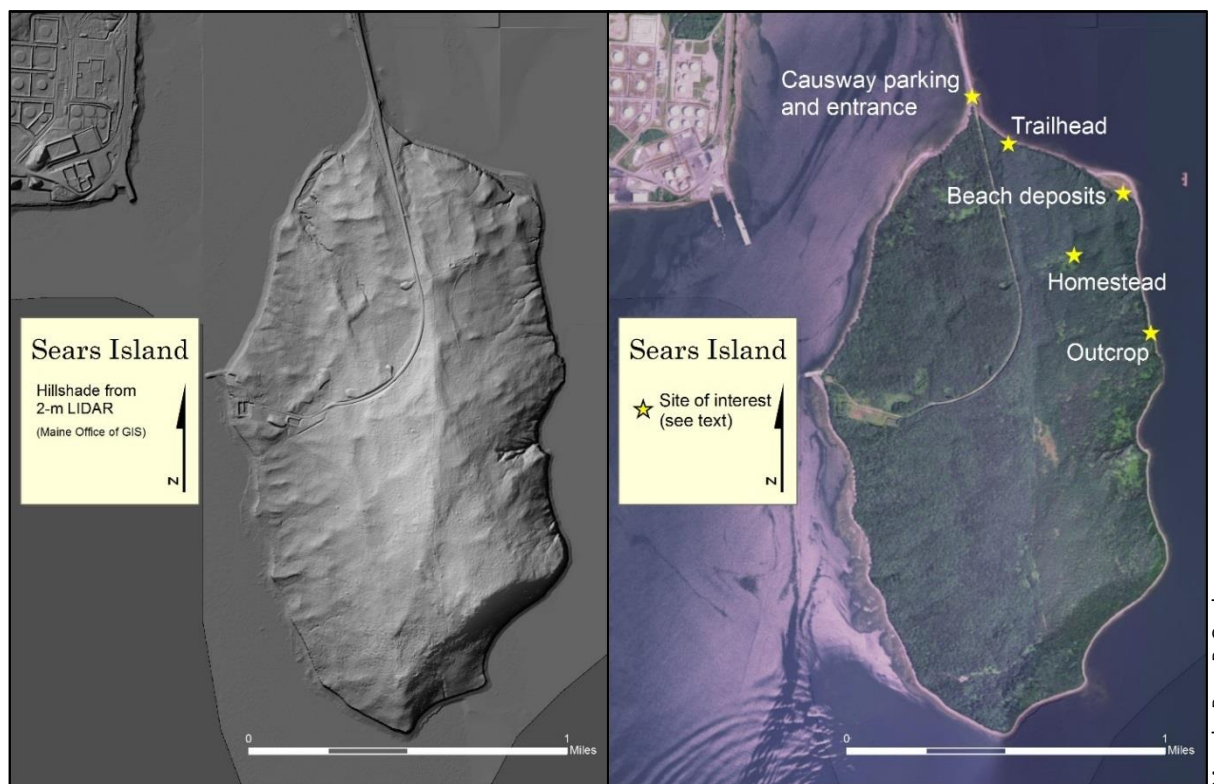


Figure 3. A topographic shaded relief map (left), and an aerial image of Sears Island (right), with the locations of some sites of interest mentioned in the text.

Seen from the Beach

Beginning at the gate and entrance area at the southern end of the causeway, the beach is easy to access by a wooden stairway next to the kiosk on the eastern side of the road. The wide, gravelly beach at low tide (Figure 1) is composed mostly of gravel, sand, and mud, with a wide variety of cobbles and boulders of varying lithologies (Figure 4). Most of these rocks are not the same as the underlying bedrock, meaning that they were carried to Sears Island by surficial processes. Many of the rocks have been rounded, either during glacial transport or by wave action on the modern beach.



Figure 4. A variety of boulders and cobbles found on the beach: (clockwise from top left) a granitic boulder with large (>1 cm) grains of feldspar and mica, a grey fine-grained meta-sedimentary rock, a gneiss with layers of varying resistance to weathering, and a rusty-weathering schist containing garnets.

Seen from the Beach

Not far from the staircase down to the beach is a beautiful old apple tree on the shore. This tree marks the entrance to the Homestead Trail (Figure 5). Later in this visit we will come back here to walk the trail and discuss the glacial history of the island—but first, let's continue walking down the beach to find an exposure of the intact bedrock.



Photo by Ryan P. Gordon

Figure 5. The beginning of the Homestead Trail beneath an apple tree near the beach. The sediments here just beyond the beach edge are glacial till.

Seen from the Beach

Walking south along the shore, stop and look at a section of modern (Holocene Epoch) shore deposits (Figure 6, location in Figure 3). This flat area covered in dune grasses and other shore plants is mostly made of coarse to fine sand that was deposited and moved by waves and wind during the modern period. These sediments are still being moved and reworked by contemporary shore processes; in fact, there is a chance that they might look very different, or be gone altogether, during your next visit!



Photo by Ryan P. Gordon

Figure 6. Holocene beach deposits that have been reworked by wind and wave action on the modern shoreline. These sediments are still being actively shaped by these processes, so they may look different in the near future.

Bedrock Geology

Farther down the beach, the bedrock outcrop appears on the shore as a low wall on the beach's edge (Figure 7). The rock is a dark gray schist that looks rusty-brown where it has been weathered. This is an outcrop of the Penobscot Formation, a metamorphic rock derived from fine silty mud that accumulated in an ocean basin ([Stewart and Tucker, 1998](#)). Schist is defined by its sheet-like metamorphic fabric called a foliation, which is composed of elongated, platy minerals that are mostly oriented in the same direction (Figure 8). These layers are not the original bedding layers of the sediment, but are a fabric that was created later by the direction of stress during metamorphism.



Photo by Ryan P. Gordon

Figure 7. The bedrock outcrop on the eastern shore of the island (location shown in Figure 3).

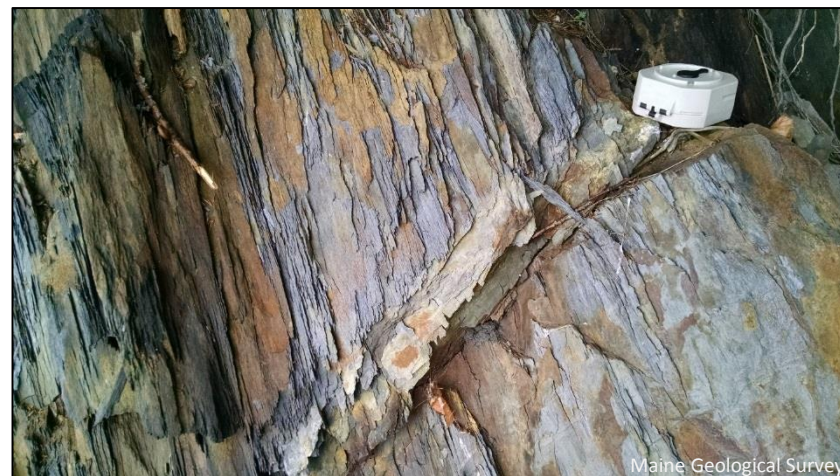


Photo by Ryan P. Gordon

Figure 8. A closer view of the sheet-like metamorphic foliation in the schist.

Bedrock Geology

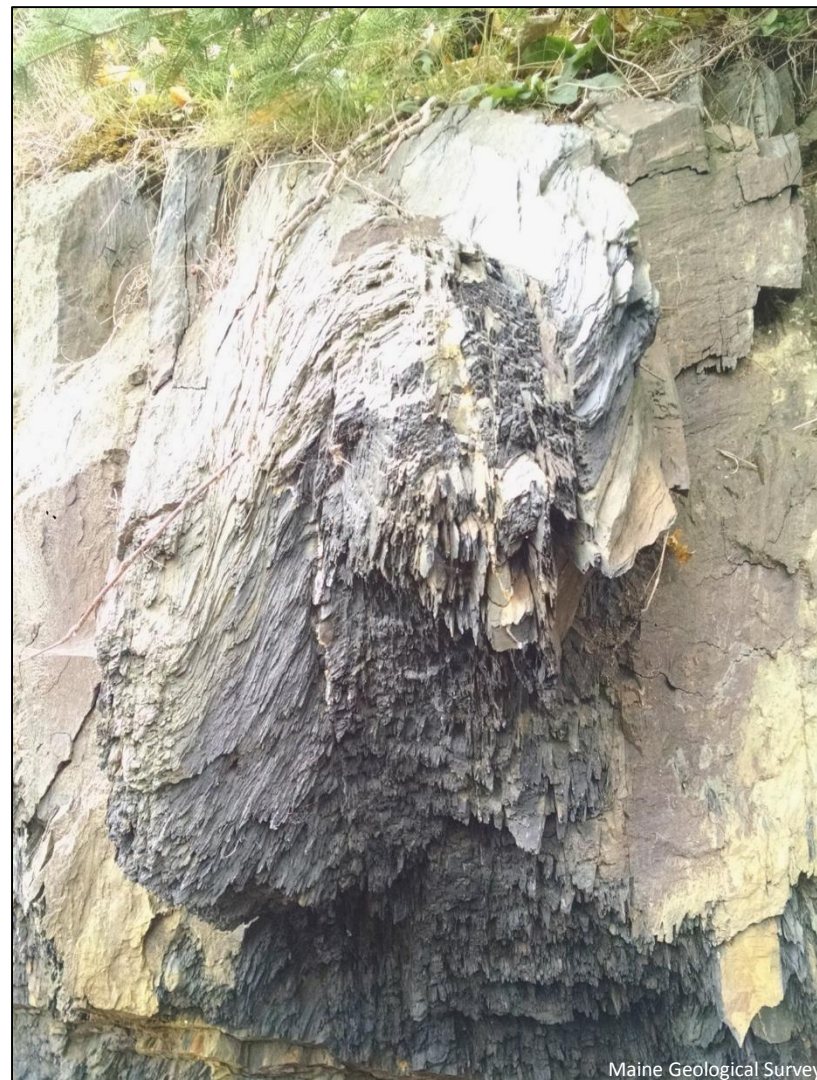
All of the outcrops that have been mapped on Sears Island are of this same rock, so we can conclude that the entire island is underlain by Penobscot Formation, as is the mainland to the west, north, and east of Sears Island ([Stewart and Tucker, 1998](#)). The Penobscot Formation was originally laid down as layers of sandy mud on the continental slope of a large island arc in an ancient ocean, likely in the late Cambrian to early Ordovician Periods. Later, during the Silurian Period, a collision between island arcs in the ocean metamorphosed and uplifted these mudstones, emplacing the Penobscot Formation on top of rocks of the Fredericton Belt, which is exposed to the northwest of Searsport and Belfast. The boundary between the Penobscot and Fredericton rocks is the Sennebec Pond Fault, a fault line that runs northeast-southwest, to the northwest of Penobscot Bay. This collision event also folded the Penobscot Formation into tight folds with axes that are roughly parallel with the Sennebec Pond Fault.

The Penobscot Formation has been described in more detail in a previous Geologic Site of the Month ([Loiselle, 2007](#)), and a detailed investigation of the bedrock on Sears Island has been made but not published (Rand and Gerber, 1976). The youngest age for bedrock on Sears Island (283 ± 12 million years, K-Ar method on sericite) comes from an unmetamorphosed felsic dike that intrudes Penobscot Formation on the southern end of the island (Rand and Gerber, 1976). This dike, dated as it is to the Permian Period, is significantly younger than the Penobscot Formation, which was last metamorphosed in the late Silurian (West and others, 1995).

Bedrock Geology

One of the folds described by Stewart and Tucker (1998) can be seen nicely in the outcrop on Sears Island (Figure 9). The axis of the fold is nearly vertical. The hinge line of the fold trends 35° east of north, making it approximately parallel with the Sennebec Pond Fault, and plunges to the northeast at an angle of 45° . This fold shows that the layers were ductile at the time of deformation, which means that they were buried deep in the ground and were therefore hot and plastic. The orientation parallel to the regional fault shows that the stresses were compressional in that direction, that is, the rocks were being pushed together as the Penobscot Formation slid into and on top of the rocks that are now farther northwest.

Figure 9. A tight fold in the foliation of the Penobscot Formation. The view is looking almost directly up the hinge line of the fold. Any resemblance to a pony is purely coincidental.



Maine Geological Survey

Photo by Ryan P. Gordon

Glacial Geology

Turn around now and walk back up the beach the way you have come. On the way, observe areas of the steep bank to your left that have been exposed by erosion (Figure 10), and return eventually to the apple tree and the start of the Homestead Trail (Figure 5). The material at these locations, just beyond the edge of the beach, is a mix of sediment sizes from clay and silt to sand, gravel, and cobbles. This sediment is called till, a material that was deposited directly by glacial ice without much sorting by meltwater. The till varies in depth across Sears Island, from shallow areas (0-10 feet deep) on the south end of the island ([Thompson, 2014](#); Rand and Gerber, 1976) to till that is greater than 78 feet deep on the western shore (Maine Department of Transportation, 1983).

The time period when glacial ice shaped the State of Maine is called the Pleistocene Epoch (between about 2.6 million years ago and 12,000 years ago). The most recent glaciation started about 35,000 years ago, covered the entire state with ice—including the top of Mount Katahdin—and depressed the land by over 750 feet with its weight ([Thompson, 2015](#)). This ice sheet began to recede around 21,000 years ago, with the edge of the ice at the present-day Maine coast around 16,000 years ago. By 12,000 years ago, the ice was gone and the ocean that replaced it had also receded from most of Maine.



Photo by Ryan P. Gordon

Figure 10. Sandy till exposed by slope erosion on the bank just above the beach. Note the wide variety of grain sizes, from clay and silt up to small boulders.

Glacial Geology

As the last ice sheet slid over Sears Island, moving from north-northwest to south-southeast, the melting ice at its base released till and plastered it on top of the bedrock. The moving ice shaped this till into forms that we can see in the shaded relief map and surficial geologic map (Thompson, 2014; Figure 11) and in person on the ground. Fluted till ridges are ridges that are elongated in the direction of ice flow, and are shown in Figure 11 as black lines bisected with arrows that indicate the flow direction. Moraines are ridges that are perpendicular to the ice flow, and are indicated with red lines in the surficial map. Moraines were created at the southern edge of the glacier as it retreated across the landscape; where the glacier paused for a season, it deposited a pile of sediment in one location. Each moraine therefore marks a successive position of the retreating ice front, getting younger towards the north.

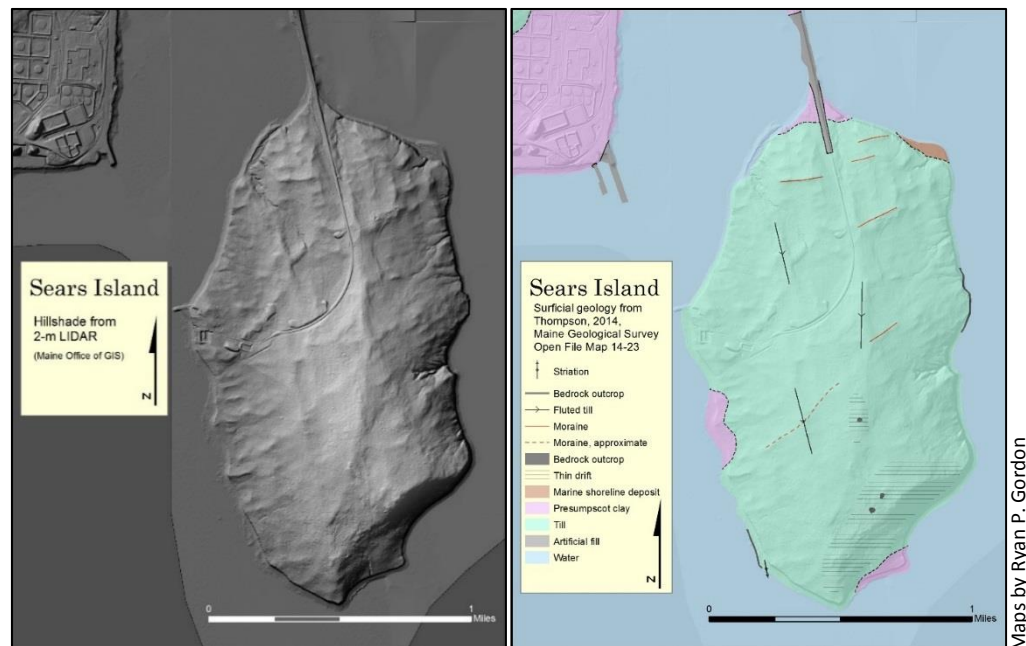


Figure 11. The same shaded relief map from Figure 3 (left), next to a detail from the map Surficial Geology of the Searsport Quadrangle, by Woodrow Thompson (2014; right). This map was made without the benefit of the 2-m LIDAR shaded relief, because mapping was completed before the elevation data were available. Glacial features seen in the maps are described in the text.

Maps by Ryan P. Gordon

Glacial Geology

As you walk down the Homestead Trail, you might be able to make out the long fluted till ridges that the trail sits between, or maybe even a couple of the moraines that the trail passes over, although it is not easy to discern these gentle landforms covered with trees and plants. It is interesting to note that the surficial geologic map ([Thompson, 2014](#)) was prepared based on field observations in the woods of Sears Island, without the benefit of the shaded relief data that we have today. You will be able to see with more ease the stone walls left over from agriculture on the island (Figure 12). Most of these stones are not Penobscot Formation, but granite. The granite stones here and on the beach (see Figure 4) were likely transported by the glacier from places to the north, possibly the Lucerne or Mount Waldo plutons.



Photo by Ryan P. Gordon

Figure 12. The remains of a stone wall along the Homestead Trail. Most of these boulders are granite, unlike the underlying bedrock.

Glacial Geology

As you walk, also note the streambeds that you pass on the trail. Are they flowing with water or dry? During visits that the author made in both May and September, there was no water in any streams (Figure 13). Because the till soil is so shallow, and the area of the island so small, there is not a lot of saturated sediment to hold water and slowly release it to streams when it is not raining. These streams probably flow during wet periods and in the spring of the year, but not during dry periods during the growing season, when water demand by plants is highest.

Figure 13. A dry streambed, seen in late summer from the Homestead Trail. While there are several wetlands and intermittent streams on Sears Island, useable surface water is rare during the growing season, and probably completely unavailable during many dry periods.



Photo by Ryan P. Gordon

Maine Geological Survey

Human History and Development

The Homestead Trail ends in a clearing, where two cellar holes and a dug well remain from a 19th Century agricultural settlement. The human history of Sears Island begins with the few records of native American people, who called the island Wassumkeag, or bright sands. A few artifacts record their use of the island for hunting and fishing. European fishermen may have begun visiting during the 16th Century, and settlers claimed ownership to land in the region in the 17th Century. The eventual owners of Sears Island used the land for fishing, farming, timber, and summer homes until it was purchased by the Bangor Investment Company in 1905, after which the farm buildings began to deteriorate ([Friends of Sears Island, 2017](#); Eastman, 1976).

The two cellar holes can be seen in the shaded relief maps, directly on top of one of the larger moraine ridges on the island (Figures 3 and 11), although the moraine may not be obvious on the ground. The settlers might have dug their well and cellars on the crest of the moraine because the material was looser and easier to dig, or because it was the only place where the material was deep enough without hitting bedrock, or maybe simply because it was a nice spot for a home.

Human History and Development

When first entering the clearing, the dug well is just on the left (Figure 14). The well is about 4 feet square, and maybe no more than 10 feet deep today, although it may have been deeper in the past. It is covered with stone slabs, but please be careful not to fall in through the cracks! Do you remember the streambeds you saw on the way in, that are often dry? This well, which was dug by hand and lined with stones, was a more reliable way for the farmers who lived here to get water (see [Locke, 2011](#) for more information on dug wells in Maine). The groundwater that fills this well originated as rain or snow that soaked into the ground and is stored in the small pore spaces in the sediment. Because till has very few open pore spaces, it is not very good at storing or transmitting water; however, the large surface area of the well sides and bottom would allow even a very small inflow to supply the homesteaders, as long as the ground around the well remained saturated. In May of 2017, this well had water at the bottom, but in September it too was dry, because the water table had dropped below the bottom of the well. It may be that the well was deeper in the past, or perhaps the well was never an entirely reliable source of water on this small island.



Figure 14. Stone slabs covering the old dug well. Be very careful around this well, especially with children.

Human History and Development

The cellar hole and a set of stone stairs lie just beyond the well (Figure 15). While the stairs have been reinforced with concrete, the walls around the cellar are made of a variety of stone without mortar, mostly granite but with other metasedimentary rocks also represented (Figure 16). Some of the stone appears to be irregularly shaped field stone, which would have been transported to Sears Island by the glacier, and gathered by the settlers from the surface of the ground. Many of the larger blocks show evidence of having been quarried. Granite has been quarried in Maine for house foundations from the early days of European settlement. It became a very large and important industry along the coast of Maine during the 19th Century ([Johnston, 2003](#)). Notable quarries were located in many nearby Penobscot Bay communities, including Thomaston, Vinalhaven, Stonington, Searsport, Swanville, and Prospect ([Austin and Hussey, 1958](#)). Any of these places, or other smaller quarries, could have been the source for these foundation stones.

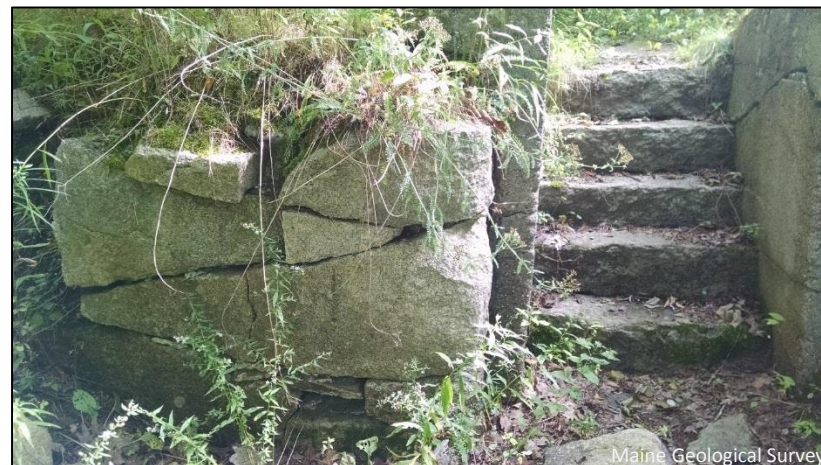


Figure 15. The homestead cellar hole, with stairs.



Figure 16. The wall of the cellar hole opposite the stairs. The light grey boulders are granite, while the less numerous, smaller dark rocks are metasedimentary.

Human History and Development

If you look at the edges of many of the large blocks, you will see the marks of the quarryman's tools. Look carefully at the bottom edge of the long, horizontal block in Figure 16, and you might be able to see regularly spaced, shallow indentations there. Looking closely at this and another stone (Figure 17) shows that these indentations are trapezoidal in shape and wider towards the outside edge of the rock. This particular shape indicates that an old method called the “flat wedge” technique was used to quarry and shape these stones ([Gauge and Gauge, 2017](#)). This method of quarrying used a flat “cape chisel” to chip narrow and shallow holes, several inches apart in a line across the rock. A series of flat wedges were then inserted into the holes and tapped in turn until the rock cracked. The flat wedge technique was in use in New England from around 1800 until the 1870s ([Gauge and Gauge, 2017](#)), so the house foundation was probably constructed sometime during that period.

Figure 17. A close up view of trapezoidal indentations along the split edge of one of the foundation stones. The indentations are each one half of a hole made with a “cape chisel” as part of the “flat wedge technique”, the method used to quarry and shape this rock.



Photo by Ryan P. Gordon

Maine Geological Survey

Human History and Development

When you return to the causeway at the end of your visit, signs of modern human development are apparent in several directions. The wide, paved causeway itself was constructed in the 1980s to provide access to a seaport that was proposed on the western side of Sears Island but was never built. Other industrial development plans that have been proposed and abandoned throughout the years include an aluminum smelter, nuclear power plant, and natural gas terminal.

From the causeway looking west, Searsport's contemporary deep water seaport on Mack Point is clearly visible (Figure 18). In the 19th Century, Searsport was a major port and shipbuilding center and a home to many ship captains, boasting that it supplied over one tenth of all the merchant marine's deep water captains at the time (Rowe, 1948). Mainland Searsport has also been the southern terminus of the Bangor & Aroostook Railroad since 1905. In the 20th Century, it developed into a significant industrial port, with important roles in the chemical, wood products, and agricultural industries. Maine's second largest port today, it still traffics in potatoes, oil, lumber, paper, chemicals, and other cargo.



Photo by Ryan P. Gordon

Figure 18. The contemporary deep water port on Mack Point, Searsport, as seen from the Sears Island causeway, looking west.

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