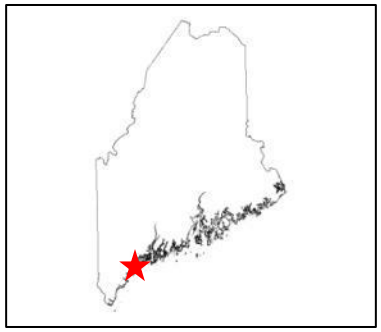
Maine Geologic Facts and Localities

July, 1997

Portland Head Light, Cape Elizabeth, Maine



43° 37‘ 22.94“ N, 70° 12‘ 29.46“ W

Text by
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Introduction

Portland Head Light, commissioned by George Washington and in operation since January, 1791, marks the southern side of the entrance to Portland Harbor. It is the quintessential Maine lighthouse, combining in a single view Maine's ocean, islands, rocky coast, colonial history, and maritime heritage.

Photo by Henry Berry

Bedrock Geology

The bedrock that is exposed to view at Portland Head belongs to the Cushing Formation. This formation, named for Cushing Island, underlies an area that stretches northeasterly across Casco Bay from the Delano Park area of the Cape Elizabeth shore through Cushing Island, Peaks Island, most of Long Island, part of Chebeague Island, the Goose Islands, and Birch Island to the Brunswick shore just west of Harpswell Neck. The Cushing Formation is more resistant to weathering than the neighboring rock formations, which is why it forms such prominent rocky headlands and islands.

A close look at the rocks at Portland Head reveals clues to its long geologic history. For safety reasons, access to the rock cliffs below the chain link fence is strictly prohibited. You can see many of these features easily from behind the fence or from the trails leading to the beach north of the lighthouse. Seen best on a clean surface, the rock is a light gray gneiss composed mainly of the minerals quartz and feldspar in very small, almost microscopic grains. Elsewhere, the Cushing Formation contains larger rock fragments in addition to the minute mineral fragments. Such fragments are typical of deposits produced by a series of explosive volcanic eruptions.

Certain minerals from the Cushing Formation, carefully collected, processed, selected and analyzed in a US Geological Survey laboratory, have been dated at approximately 471 million years old (±3 million), which is in the Ordovician Period. This means that the volcanic eruptions that produced the Cushing Formation occurred before the Himalayas or Alps had formed, before the Atlantic Ocean existed, before the dinosaurs lived, and before the first land plants had evolved. The volcanos that must have existed near here at that ancient time have long since been eroded; all that is left is a layer of volcanic debris preserved in the rocks.

Cushing Formation

At a later time, probably in the Devonian or Carboniferous periods, all the rocks of southern Maine were heated, compressed, and twisted causing the rocks to be stretched and deformed like putty. Figure 1 shows an older vein of quartz that was folded into a contorted shape.

Figure 1. An older vein of quartz in the Cushing Formation that was folded into a contorted shape, probably during the Devonian or Carboniferous period.

Lineation and Fractures in the Cushing Formation

This deformation also produced the strong "lineation," or alignment of minerals, that characterizes the Cushing Formation at Portland Head. The lineation is not horizontal, but is tilted down toward the southwest at an angle of several degrees, parallel to the yellow arrow in Figure 2.

Figure 2. Strong "lineation," or alignment of minerals parallel to the yellow arrow.

Lineation and Fractures in the Cushing Formation

Another prominent feature is that the rock is broken along a series of straight, parallel fractures oriented approximately east-west and vertical (Figure 3). While the spacing between fractures varies, their orientations are remarkably constant. Such fracture patterns form in response to regional stress when rocks are at depth in the earth, but are still relatively cool so that they snap under the stress. These cracks happen to be nearly at right angles to the older lineation, so that frost or wave action breaks the rock into jagged, angular blocks.

Figure 3. The lineation angle shown in Figure 2 is what gives the rock an overall sense of jutting out to the northeast into the sea, best viewed from the north. Notice also that the rock is broken along a series of straight, parallel fractures.

Lineation and Fractures in the Cushing Formation

Some fractures are filled by younger quartz veins. The veins form when quartz is deposited in open fractures by hot fluids circulating deep underground. Figure 4 is a view looking down on one of the veins. Notice how the vein fills a fracture that cut across the older rock structure. This vein must be much younger than the one in Figure 1.

Figure 4. View looking down on one of the younger quartz veins.

Basalt Dike

Beyond the end of the fence below the foghorn, there is a deep, steep-sided cleft in the rock (Figure 5). You can see the cleft from across the cove or look down into it at the fence by the foghorn.

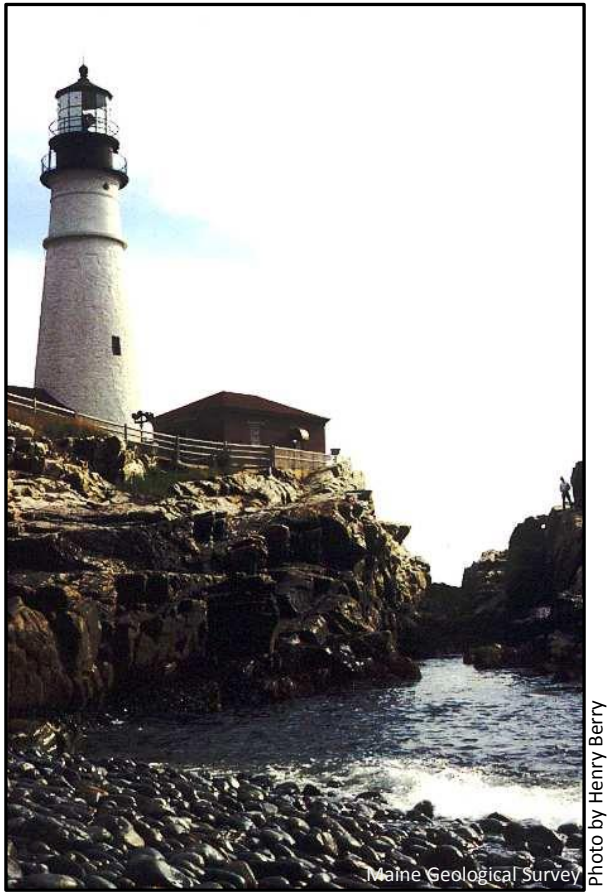

Figure 5. View looking through the cleft.

Basalt Dike

At low tide, a different type of rock is barely visible in the bottom of the cleft (Figure 6). It is a dark colored rock called diabase or basalt. It formed when molten rock (magma) intruded along a vertical fracture and solidified underground forming a thin sheet of rock called a dike. The dike rock is more fractured and therefore weaker than the Cushing Formation, so through the centuries the cleft has been eroded down almost to low tide level.

Figure 6. Diabase or basalt rock (below the red arrow).

Basalt Dike

Such dikes of black, basaltic rock are common along the Maine coast. Some are better preserved in the cliffs just on the other side of the lighthouse, toward the gift shop. Some of the larger basaltic dikes in New England have been dated at about 200 million years old, indicating that they were intruded during the Mesozoic Era at the time when Africa and Europe were splitting away from North America to begin opening the modern Atlantic Ocean.

Click here for more about Maine's bedrock geology.