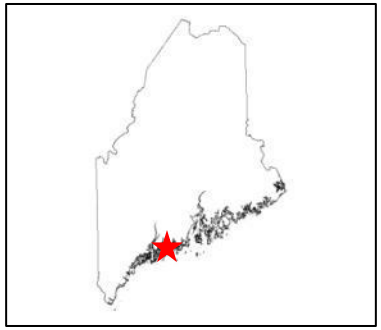
Geologic Site of the Month

July, 2002

Scenic Ledges at Pemaquid Point Lighthouse



43 50‘ 11.62“ N, 69 30‘ 23.57“ W

Text by
Henry Berry IV

Introduction

At the south end of Route 130, just 20 minutes but worlds away from the bustle of Route 1 in Damariscotta, is one of the most visited and photographed scenic spots on the Maine coast.

Photo by Henry Berry

Introduction

Pemaquid Point Lighthouse itself, built in 1827, is not particularly unusual. Rather, it is the scene below the light, where ragged rock ledges plunge into the sea that makes this such an impressive, engaging, peaceful, and spectacular place. The public is welcomed by the town of Bristol, which maintains the area around the lighthouse as a park.

Figure 1. Pemaquid Point lighthouse and ledges.

Bedrock Geology

Here, rock hundreds of millions of years old is washed clean by the sea, making it a good place to study geologic details that help geologists understand how the bedrock formed. Two major types of rocks, metamorphic and igneous, make up the ledges. Each of these is represented by several varieties.

Figure 2. Looking north along Pemaquid Point ledges.

Metamorphic Rocks

Metamorphic rocks make up the bulk of the bedrock. The thin stripes or bands on the rock surface are actually the edges of layers. Layers of different color are made up of different combinations of minerals, although the individual mineral grains are quite small (about 1/32 inch), so they may be hard to pick out with the naked eye. The medium gray layers are composed of quartz, feldspar, and black mica (biotite) grains. Layers with a greater proportion of biotite are darker colored, even black. Still other layers have a greenish color because they contain the mineral diopside in addition to the pale gray or white quartz and feldspar. Taken as a whole, metamorphic rock with this sort of layered structure is called a gneiss (pronounced "nice").

The layers were originally deep sea sediments of muddy sand and silt (the gray and black layers) or limy sand and silt (the green layers). They have been changed by heat and pressure into the metamorphic rocks we now see. This process of change (called metamorphism) occurred in the Devonian Period of geologic time, between 360 and 415 million years ago. At that time these rocks were at depth in a geologically active mountain system. The deposition of the original sediments occurred before then (in the Silurian Period), about 430 to 440 million years ago. These particular layered rocks are assigned to the Bucksport Formation, which extends (largely beneath the surface) northeastward to Bucksport and beyond.

Igneous Rocks

The white or light colored rocks that cut across the metamorphic rocks are igneous rocks. All igneous rocks form by solidification of molten rock. Some igneous rocks are volcanic, if the molten rock erupts to the surface before solidifying. The rocks here, however, formed deep underground when the molten rock was forced into fractures that cut across the metamorphic rocks.

Figure 3. Igneous rocks cutting across metamorphic rocks.

Igneous Rocks

Figure 4. Igneous rocks (white) cutting across metamorphic rocks (gray).

Igneous Rocks

The slow cooling underground produced igneous rocks with medium-sized mineral grains (granite, Figure 5) or very large mineral grains (pegmatite, Figure 6). These rocks are commonly accompanied by veins of quartz. No rocks from here have been analyzed for their age, but similar igneous rocks from this area are Devonian in age, about the same time as the metamorphism.

Figure 5. Close-up of granite with medium-sized white grains of the mineral feldspar.

Igneous Rocks

Figure 6. Close-up of pegmatite with a very large grain of feldspar, about 6 inches across.

Distortion and Deformation of Rock into Folds

During the metamorphic process, when the rocks were hot, the intense pressure within the earth's crust folded the rocks as if they were made of putty. The thin layers of the metamorphic rocks make the folds easy to see (Figure 7). In most of the rock below the lighthouse, the layers are nearly vertical, whereas they were originally deposited as horizontal layers.

Figure 7. Folded metamorphic rocks.

Distortion and Deformation of Rock into Folds

Figure 8. Folded metamorphic rocks.

Distortion and Deformation of Rock into Folds

Figure 9. Folded metamorphic rocks.

Distortion and Deformation of Rock into Folds

Figure 10. Folded thin igneous vein.

Distortion and Deformation of Rock into Folds

Figure 11. Large pegmatite distorted against metamorphic rock.

Influence of Bedrock Structure on Erosion

The current bedrock surface is being continually modified by erosion, primarily by the ocean but also by rain, snow, ice, and heat. The "rugged" shape of the resulting coastline results from the way different rocks are eroded.

Figure 12. Metamorphic rock weathered to craggy surface.

Influence of Bedrock Structure on Erosion

The more subtle action of rain and ice exploit the different layers of the metamorphic rock, leaving a very rough surface with deep cracks. The igneous rocks, on the other hand, are more uniform and weather to a smoother surface. When wave action pounds the shore, the thin layers of metamorphic rock are more easily broken into small pieces. By contrast, the igneous rock forms larger intact blocks that can only be moved by the largest storm.

Figure 13. Igneous rock (pegmatite) in large block more resistant to erosion (flat surfaces good for sitting).

Influence of Bedrock Structure on Erosion

In fact, the lighthouse itself is built on the most prominent part of the point, which is on a small ridge of pegmatite.

Figure 14. The small ridge of pegmatite running right under the lighthouse.

References and Additional Information

Hussey, A. M., II, and Marvinney, R. G., 2002, Bedrock geology of the Bath 1:100,000 quadrangle, Maine: Maine Geological Survey, Geologic Map 02-152.

Hussey, A. M., II, and Berry, H. N., IV, 2002, Bedrock geology of the Bath 1:100,000 map sheet, coastal Maine: Maine Geological Survey, Bulletin 42, 50 p.

Pemaquid Point Lighthouse