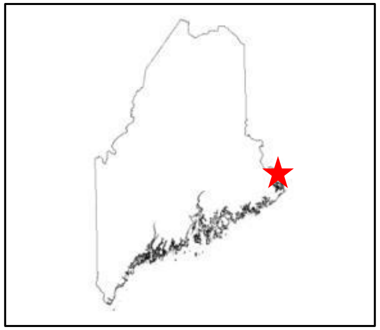
Geologic Site of the Month

October, 2003

Red Beach Granite



45 11‘ 20.27“ N, 67 16‘ 42.97“ W

Text by
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Introduction

The town of Red Beach, Maine, south of Calais on Route 1, is named for the striking natural brick-red color of its stones. The body of underlying red bedrock, named the Red Beach Granite, is several miles across. Two sites on the shore of the St. Croix River offer convenient public access to the granite.

Figure 1. Saint Croix Island International Historic Site

Saint Croix Island

The first French settlement in North America was on St. Croix Island in 1604. This historical site is commemorated on the mainland with displays on both sides of the border. At the U.S. facility on Route 1 in Red Beach, eight miles south of Calais, the National Park Service has made significant improvements (Figure 2) recently as part of the 400th anniversary celebration in 2004.

Photo by Henry N. Berry IV

Figure 2. One of the new displays at the Saint Croix Island International Historic Site.

Red Beach Granite

Below the new displays, along the shore beside the boat launch, there is a bedrock outcrop and many blocks and stones of Red Beach Granite (Figure 3). Some of these blocks were left from quarrying operations in the late 1800's and early 1900's when Maine granite was used for buildings and monuments up and down the eastern seaboard. Among the buildings which incorporate Red Beach Granite is the American Museum of Natural History in New York.

Photo by Henry N. Berry IV

Figure 3. Various sized pieces of Red Beach Granite line the shore at Red Beach. Saint Croix Island is at right edge of photo; New Brunswick in the distance.

Red Beach Granite

Some of the blocks remaining here have clean surfaces where the texture of the granite (Figure 4) can be seen. Close examination shows that, as for all true granites, three predominant minerals make up the rock. Quartz is light gray and translucent. One type of feldspar (plagioclase) is milky white. The other type of feldspar (alkali feldspar) is orangey-red. It is the red feldspar that gives the rock its distinctive color. In addition there are very tiny flecks of black mica, found mostly with quartz, that comprise a few percent of the rock.

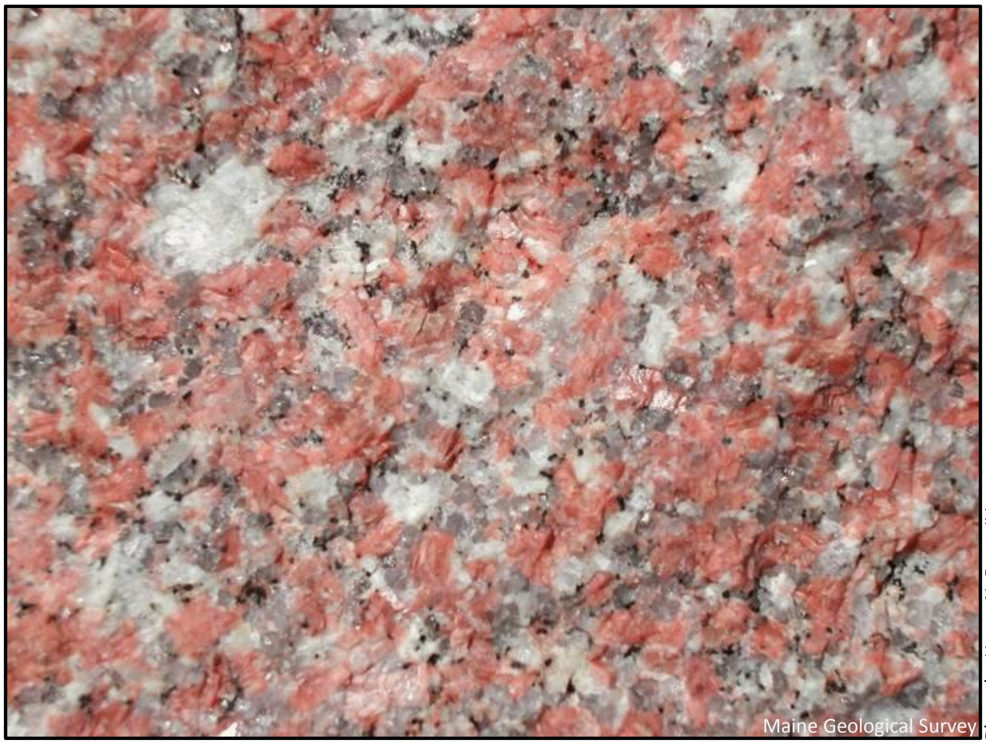

Photo by Henry N. Berry IV

Figure 4. Close-up view of Red Beach Granite at Site 1. Width of view approximately 2 inches.

Red Beach Granite

Granite is an igneous rock that forms by slow cooling and solidification from molten rock (magma). The magma is produced by melting at depth and intrudes into the overlying rocks without breaking the surface. As it solidifies underground, the various mineral grains grow from the melt to produce the interlocking mosaic of grains we see in the rock today.

Since granite must form underground, the fact that we see it at the surface today means that through geologic time a significant amount of overlying rock has been removed by erosion.

Rest Area and Boat Launch, Robbinston

About 3½ miles south of Site 1 there is a scenic roadside rest area and boat launch in Robbinston. Visitors may walk to the shore to see stony red beaches (Figure 5) and bedrock outcrops of Red Beach Granite.

Photos by Henry N. Berry IV

Figure 5. Red beach along the St. Croix River at Site 2 (Left). Boat launch is just to the left. Outcrop of the Red Beach Granite (Right).

Red Beach Granite

A close look (Figure 6) shows that the rock here is slightly different from the rock at Site 1. It is still made up of the same three essential minerals: quartz, white feldspar, and red feldspar, but the individual grains are much smaller than in the rock at Site 1. Furthermore, the tiny black minerals here are needle-shaped hornblende rather than flakes of black mica as at Site 1. On the basis of such details, the Red Beach Granite has been subdivided into six different bodies that formed by successive magma intrusions over a short span of time (Abbott, 1986).

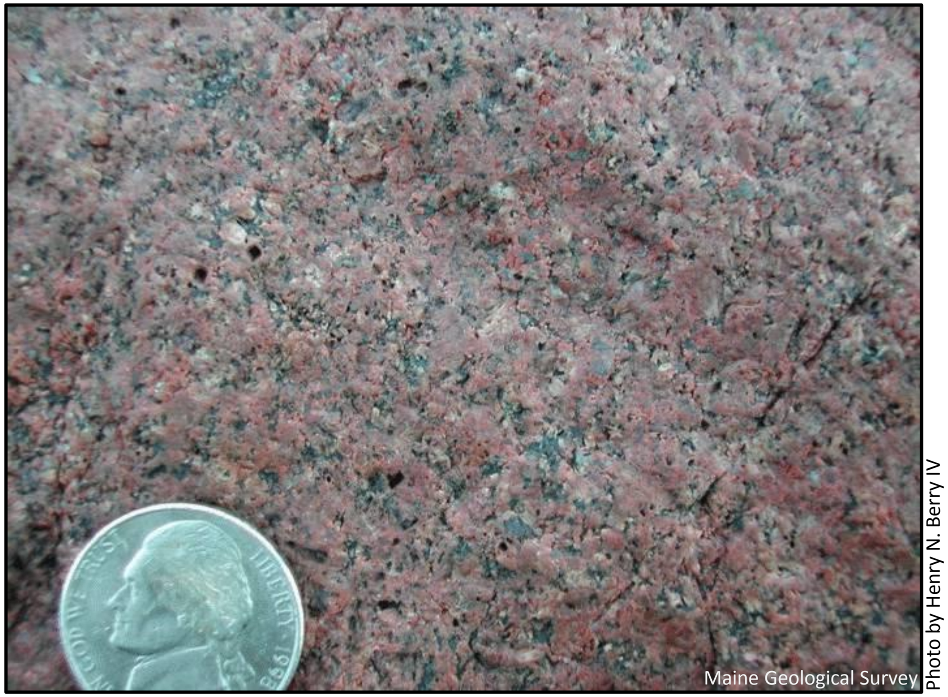

Figure 6. Close-up view of Red Beach Granite at Site 2. Note two miarolitic cavities above the nickel, and one cavity above and to the right of the nickel. These formed around gas bubbles in the crystallizing magma.

Red Beach Granite

The reason that the rock here has a finer grain size than the rock at Site 1 is that here the magma solidified more rapidly. This means that the enclosing rock must have been cooler, and was probably closer to the earth's surface when it formed. The tiny holes in the rock at Site 2 (called miarolitic cavities) are where gas bubbles exsolved from the magma as it was solidifying. Only at relatively low pressures, as the magma rises near the earth's surface, can gas bubbles be released, in much the same way that carbonation is released by taking the cap off a soda bottle.

Red Dikes

Thin, red dikes (Figure 7) cut through the granite.

Photo by Henry N. Berry IV

Figure 7. A thin dike of very fine-grained, bright red rock cuts through the outcrop from upper left to lower right. (Canada in the background.)

Red Dikes

These dikes are even finer-grained than the granite (Figure 8), with grains too small to see without magnification. Their microscopic grain size is similar to that of volcanic rocks and requires very rapid cooling. Such dikes are thought to represent the remnant portion of magma remaining after the granite had mostly solidified. This last bit of magma was injected into a thin crack and cooled instantaneously to a very fine-grained rock.

Photo by Henry N. Berry IV

Figure 8. Close-up of the fine-grained red dike. Individual mineral grains are too small to see without magnification.

Red Dikes

Thin zones of broken rock (Figure 9) (called breccia) are old fault zones that probably formed as the granite was cooling. These zones do not accommodate much sideways movement, and do not extend very far through the rock.

Figure 9. Broken rock fragments in a minor breccia zone. All the fragments are the same as the surrounding granite.

Importance of the Red Beach Granite

The Red Beach Granite holds a special place in the geology of eastern Maine because of its relationships to surrounding rocks. It intrudes into deformed sedimentary and volcanic rocks of the Eastport Formation, so it must be younger than the Eastport Formation. The Red Beach Granite is overlain, in turn, by sandstone and conglomerate of the Perry Formation (Figure 10), which contains cobbles that were eroded from the Red Beach Granite. This relationship demonstrates that the granite must have intruded, cooled, been uplifted, and eroded before the Perry Formation was deposited.

Photo by Henry N. Berry IV

Figure 10. Outcrop of Perry Formation conglomerate. Rounded cobbles are embedded in a sandstone matrix.

Importance of the Red Beach Granite

The sequence of events including eruption of volcanic rocks, deformation of the earth's crust, and intrusion of Red Beach Granite is a part of the formative process of the Appalachians called the Acadian orogeny. The subsequent, relatively quiet time of erosion and accumulation of the Perry Formation marks the end of this mountain-building episode. Therefore, the Red Beach Granite dates the climax of the Acadian orogeny in eastern Maine.

Fossils indicate that the Eastport Formation formed near the beginning of the Devonian Period and the Perry Formation formed near the end of the Devonian Period. So the Middle Devonian age implied for the Red Beach Granite is generally taken as the age of the Acadian orogeny in eastern Maine. Recent calibrations measuring the decay of natural radioactive elements (Tucker and others, 1998) date the Devonian time period to span 362 to 418 million years ago.

Importance of the Red Beach Granite

The rocks at Site 2, especially the outcrops near the boat launch, have grooves and scratches (Figure 11) on their top surfaces that were caused by movement of glacier ice during the last Ice Age, about 14,000 years ago. Stones that were frozen in the base of the continental ice sheet were dragged across the bedrock, causing the surface marks. The alignment of these marks is parallel to the direction the glacier was moving, in this case an east-southeasterly direction with a compass bearing of about 120°.

Photo by Henry N. Berry IV

Figure 11. The upper surface of this outcrop at Site 2 (near the boat launch) has scratches and grooves (parallel to the stick). This surface is virtually unchanged since that time, although the landscape has changed around it.

References and Additional Information

Abbott, R. N., Jr., 1986, Preliminary report on the bedrock geology of the Red Beach, Robbinston, and Devils Head 7.5-minute quadrangles, Maine: Maine Geological Survey, Open-File No. 86-73, map scale 1:24,000, 36 p. report.

Tucker, R. D., Bradley, D. C., Ver Straeten, C. A., Harris, A. G., Ebert, J. R., and McCutcheon, S. R., 1998, New U-Pb zircon ages and the duration and division of Devonian time: Earth and Planetary Science Letters, v. 158, p. 175-186.