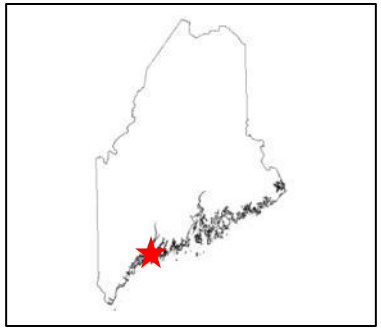
Maine Geologic Facts and Localities

November, 2000

Burnt Island's Glacial Erratics of the Lincoln Sill



44° 31‘ 52.28“ N, 67° 39‘ 42.98“ W

Text by
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Introduction

The south shore of Burnt Island in Boothbay Harbor, Maine is a location that many people visit by boat simply to see the lighthouse and scenic views of the coast. It is possible to visit the island, which is managed by the Maine Department of Marine Resources. A walk on the rocky shore below the lighthouse brings hikers by some very large dark boulders that are unlike any other rocks on the shore.

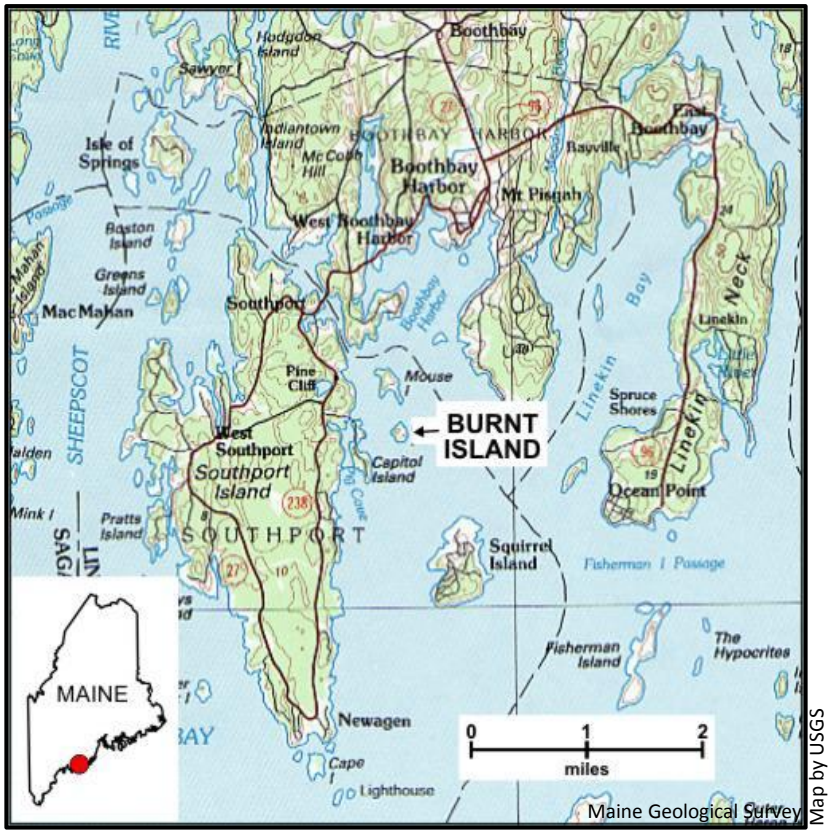

Figure 1. Location of Burnt Island, Boothbay Harbor, Maine.

What is the origin of the dark boulders?

Some people have wondered if these boulders are meteorites since they appear round and dark and seem out of place. If these boulders had been meteorites, they would have created and be within a bedrock crater - one probably much larger than Burnt Island - when they impacted the earth. Most known Maine meteorites are much smaller.

A better explanation is that the boulders were brought to their current resting place by glacial ice and left as ice melted at the end of the last ice age, perhaps 15,000 years ago. Such boulders are called glacial erratics since they appear to be erratically placed over the land surface. Two compelling facts indicate that the boulders are erratics: 1) their shape is relatively rounded and 2) their rock type is unlike other rocks on the island. This line of reasoning suggests the boulders were carried to Burnt Island by ice.

What is the origin of the dark boulders?

A sample of a dark boulder was provided to the Maine Geological Survey by Elaine P. Jones of the Maine Department of Marine Resources. It shows the crystalline texture of the rock.

Figure 2. A sample of a dark boulder. Note the crystalline texture (scale in inches)

What are the dark minerals?

A close inspection reveals that the boulders contain dark gray crystals up to 2 inches long with sharp edges that reflect the sun's rays (Figure 3). These large crystals are minerals in the feldspar family, namely the alkali feldspars orthoclase and microcline. Alkali feldspars are usually light (white or pink) not dark, as in this rock. In earlier work Perkins (1922) misidentified the microcline as labradorite, a plagioclase feldspar that is commonly blue-gray in color. The crystals have sharp edges.

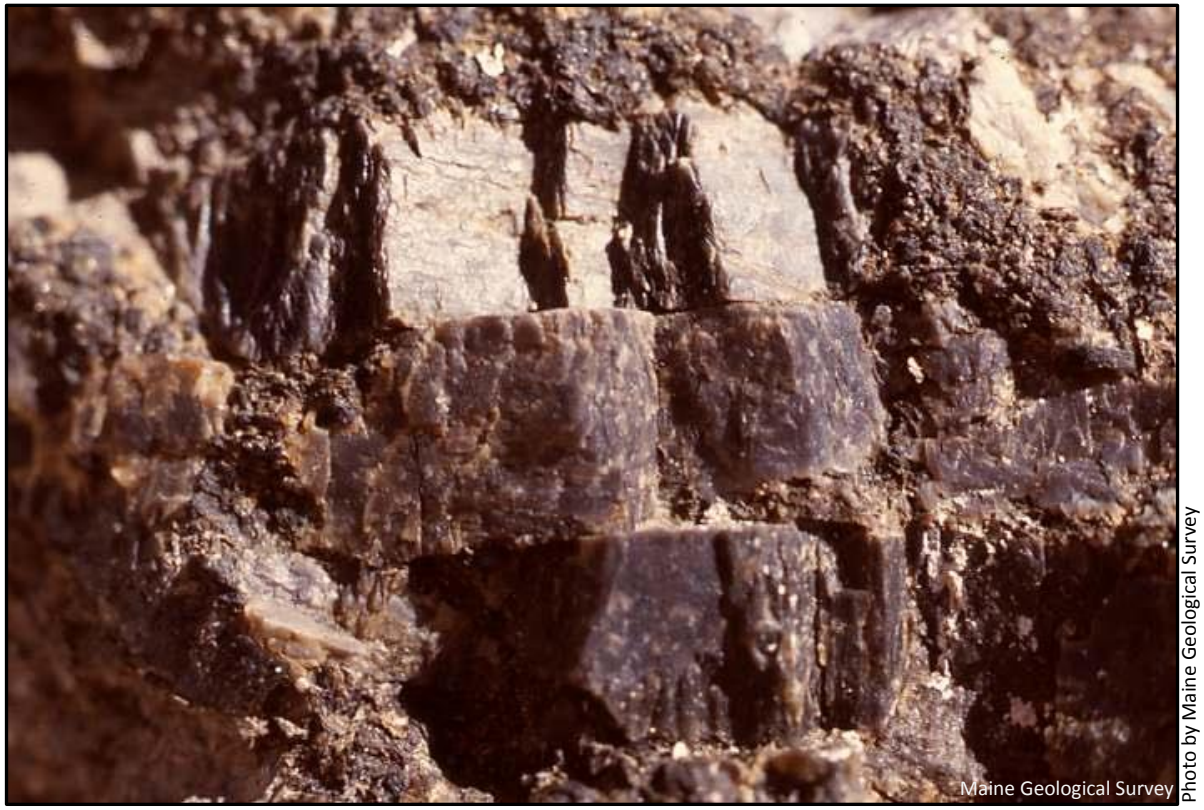

Photo by Maine Geological Survey

Figure 3. Dark gray orthoclase and microcline crystals.

What are the dark minerals?

Many of them show signs of twinning, in which two halves of the crystal are mis-aligned, but joined in the middle. The twins can be recognized by the way light reflects from only one of the twins at a time (Figure 4). This rock is composed of several other minerals, including dark pyroxenes (augite and clinopyroxene) and amphiboles (hornblende and actinolite) (King and Foord, 1994; West et al., 2000).

Figure 4. Light reflecting off one half of a crystal twin.

What is the rock type?

A rock such as this with uniform texture, well-formed crystals, and especially twinned feldspar crystals is an igneous rock. Igneous rocks, one of the three major classes of rock types, form by solidification of molten rock. The many varieties of igneous rocks are classified according to the minerals that compose them.

Early geologists gave particular names to distinctive rocks as they were discovered. The rock of the Lincoln Sill has been called a "shonkinite," a dark-colored rock composed chiefly of alkali feldspar and augite. This rock name, introduced by Weed and Pirsson in 1895, is derived from Shonkin, the Indian name for the Highwood Mountains of Montana. The name shonkinite was applied to the Lincoln Sill by Pankiwskyj (1976). It is the only shonkinite in Maine.

The modern classification of igneous rocks is more systematic, assigning names on the basis of percentages of the minerals quartz, alkali feldspar, and plagioclase feldspar. By this system, the Lincoln Sill rock, which lacks quartz and contains little plagioclase, would be called an alkali feldspar syenite. A rock with more quartz and plagioclase would be granite.

Granite is common. It forms from melting of rock at moderate depths in the earth's crust. Shonkinite, on the other hand, is rare, and probably originates by melting much deeper in the lower crust or in the earth's mantle.

Where are the erratics from?

The boulders on Burnt Island have been broken loose from the bedrock and carried by glacier ice to where they now rest. Since this kind of rock is not part of the bedrock of Burnt Island, it must have been carried for some distance.

Bedrock maps show where various rock types are found in bedrock. Figure 5 shows a bedrock map of the Lincoln Sill. It occurs in a long, thin strip from Boothbay Harbor over 40 miles inland, beyond Washington. It was first mapped by Joseph Trefethen (1937) who named it the Lincoln Sill because it extends all the way across Lincoln County. The boulders on Burnt Island must have come from somewhere indicated in red on the map.

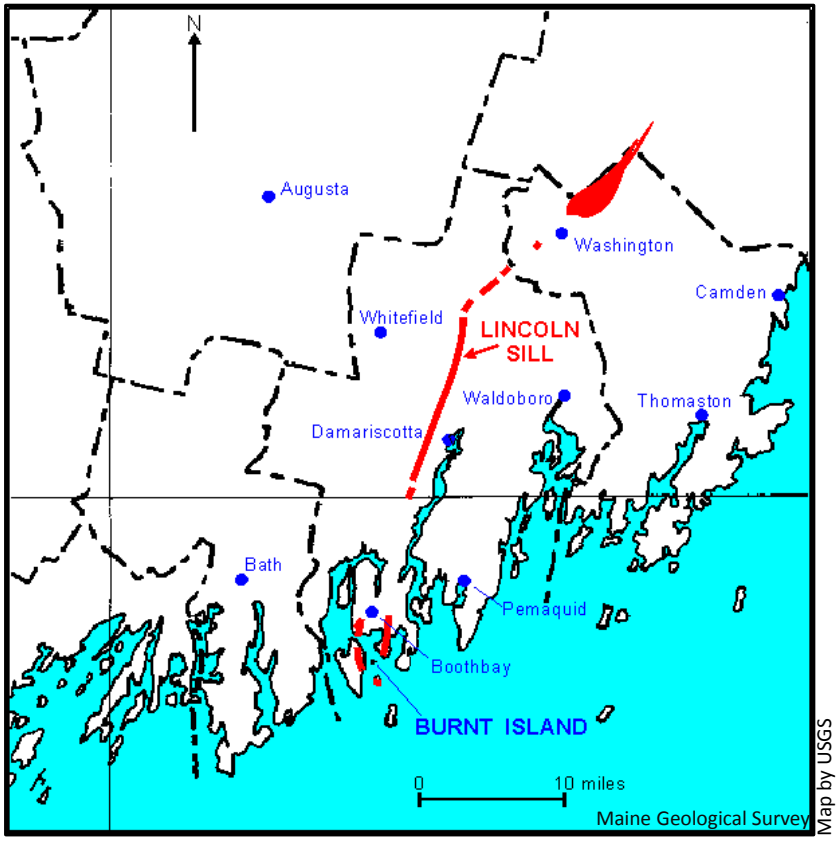

Figure 5. Map of the Lincoln Sill (red).

Where are the erratics from?

Figure 6 shows a bedrock map of the Boothbay Harbor area, with the Lincoln Sill highlighted in red (from Hussey and Pankiwskyj, 1975). Notice that the sill is part of the bedrock around Burnt Island to the west, east, and south (on Squirrel Island). Any of these places could have been the source of the Burnt Island boulders.

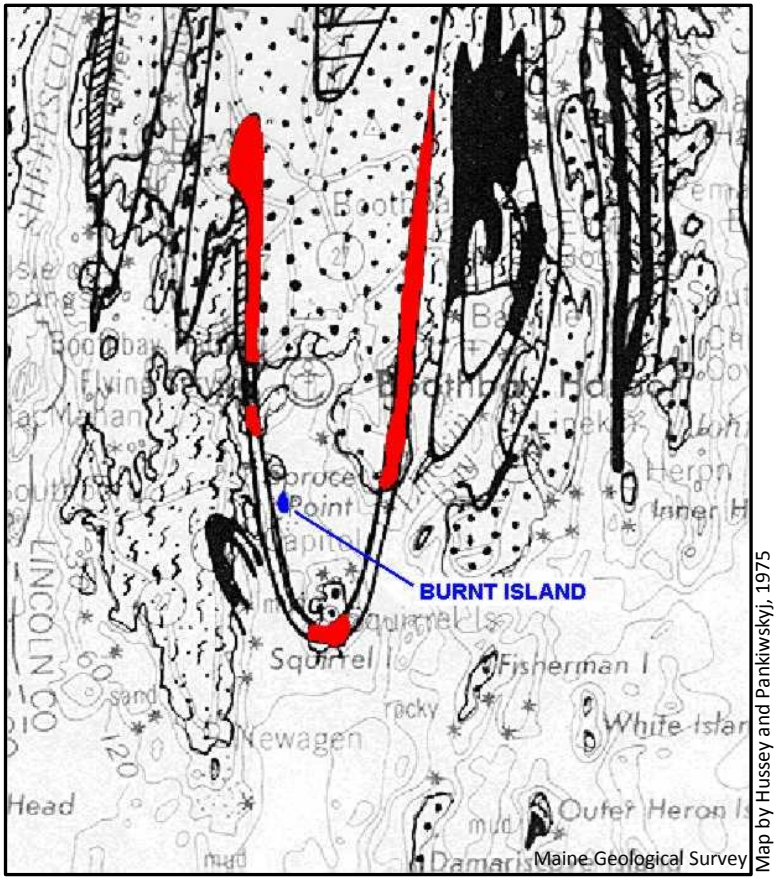

Figure 6. Bedrock map of the Boothbay Harbor area, with the Lincoln Sill highlighted in red.

Where are the erratics from?

The Surficial Geologic Map of Maine (Thompson and Borns, 1985; Figure 7) shows by small black arrows that scratches made by the glacier are oriented about 15 degrees east of south, indicating this to be the direction the ice moved. Therefore, the Burnt Island boulders must have come from the north-northwest, from the area of West Boothbay Harbor. Apparently, these boulders were not carried very far -- maybe a mile or two. By contrast, boulders of the Lincoln Sill can be found scattered along the coast from Boothbay to Camden, some of which must have been carried 10-20 miles.

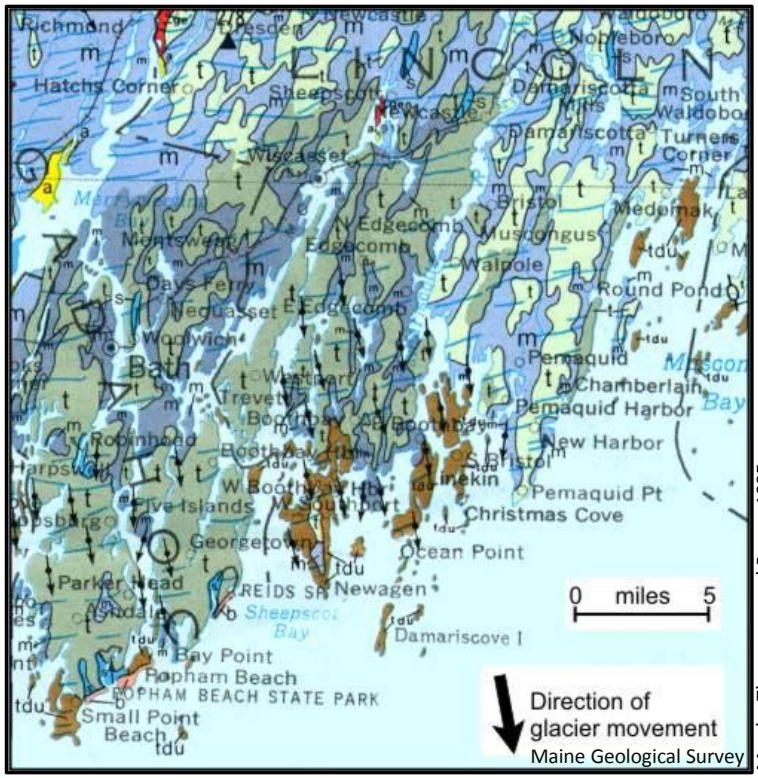

Figure 7. The Surficial Geologic Map of Maine with the direction of glacial movement.

How old are the boulders?

Rock of the Lincoln Sill crystallized from a molten magma 418 ±1 million years ago in the Early Devonian Period. Its age was determined by Robert D. Tucker (Washington University in St. Louis) using high-precision laboratory techniques to measure trace amounts of uranium and lead in grains of zircon separated from the rock. It was affected by heating some time after crystallization, probably during the interval from 400-385 million years ago, and some of the minerals that are hard to see without magnification were produced. These tiny minerals, called groundmass, occupy the spaces between the larger crystals.

Figure 8. Tiny groundmass minerals between the larger grains.

Why is this rock important?

The Lincoln Sill has importance to the structure, timing, and origin of the bedrock geology in mid-coast Maine. In contrast to the great antiquity of the rock itself, the boulders were dislodged, transported, and deposited by glacier ice quite recently -- about 14,000 years ago. The relationship of the sill to other rock types, including the igneous granites (former magma chambers) in the region is still being studied to learn more about the plate tectonic origin of Maine's bedrock.

From the standpoint of glacial geology, it is such a distinctive rock that it can be recognized in loose boulders. By comparing the original bedrock source to where the boulders rest, glacial geologists can estimate the direction and distance that materials were carried by the glacier.

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