

FIRE AND ICE
Acadia's Geologic Story



The coast of Maine was shaped by diverse geological forces. Acadia National Park, located on Mount Desert Island, Schoodic Peninsula and surrounding islands, is a great place to study the landforms created by different geologic processes. The island's bedrock, the solid rock ledge under the soil, was created by movements in the Earth's crust, volcanoes, and other geologic activities. The surface of the region has been molded by glacial ice, running water, waves, and wind.



The oldest exposed rocks on the island began as sediment deposited in an ancient sea. Over time these sediments began to build, increasing pressure on the layers below and transforming them into solid stone. Movements in the Earth's crust heated, squeezed, and buried the layered sedimentary rock. The resulting changes of metamorphism, such as folding and recrystallization, created a newly formed rock called Ellsworth Schist.



Metamorphic rocks have undergone changes induced by high temperatures, intense pressure, and/or chemical interactions. The metamorphic Ellsworth Schist is easily identified by its dark grayish-green wavy layers of chlorite separated by layers of lighter quartz or feldspar. These complex folds indicate the rock was deformed by forces deep within the Earth.



The second oldest rock exposed on the island is named after an area in which it is commonly found—Bar Harbor, Maine. The Bar Harbor Formation is composed of sedimentary rock such as sandstone and siltstone. Its banded appearance alludes to its origin as layers of sediment in an ancient sea. These sediments were deposited on top of each other for thousands of years, creating distinct layers.



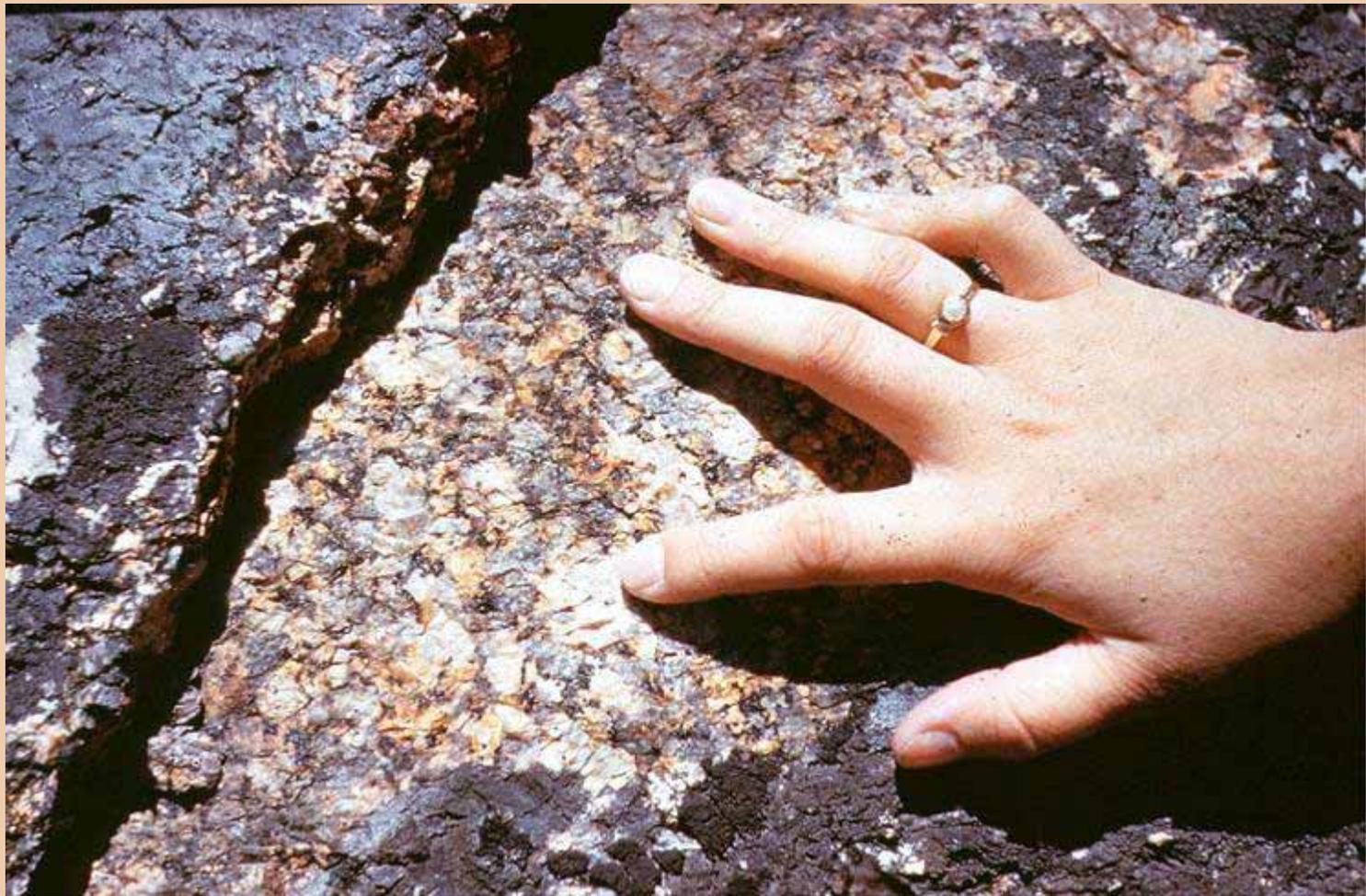
Slowly over time, the layers of sediment, also known as beds, were subjected to great pressure and compressed into solid rock. Without exposure to intense heat, this rock failed to undergo metamorphism and remained a sedimentary rock.



As you walk along the Shore Path near Bar Harbor's town pier, it is easy to see the layering found in the Bar Harbor Formation. The lack of folding indicates that these rocks were exposed to different forces than the Ellsworth Schist. This formation is also found in many locations along the Park Loop Road and Acadia's coastline.



The most common and abundant rock on Mount Desert Island is granite. Granite forms differently than both the metamorphic Ellsworth Schist and the sedimentary rock of the Bar Harbor Formation. Granite is an igneous rock that forms when rock material is exposed to intense heat, melts, and the resulting molten material cools. Molten rock found beneath the Earth's surface is called magma. The magma rose towards the Earth's surface, but did not have enough energy to break through. It cooled and crystallized beneath the Earth's surface, forming large plugs of granite.



As the granitic material cooled, mineral crystals grew. Due to the insulating properties of the Earth, the deeper a magma settles, the longer it takes to cool and solidify. This cooling rate plays a major role in crystal development. The slower the cooling process, the more time crystals have to develop. Subsequently, larger crystals are created. Granite with large, quarter-sized crystals formed very deep within the Earth. Granite with small, sugar-sized crystals formed much closer to the Earth's surface and cooled more quickly.



There are several different types of granite on the island and each varies in coloration, crystal size, and mineral content. If you look closely at a piece of Cadillac Mountain Granite, you will see black hornblende crystals, pink feldspar crystals, and clear- or white-colored quartz. Igneous rocks that crystallize underneath the Earth's surface are called *intrusive* and often intrude into older rocks. Igneous rocks that crystallize outside the Earth's surface, like those created by volcanoes, are called *extrusive* and are characterized by a much smaller crystal size.



As the magma plug pushed its way through the crust, it heated and fractured the older overlying rock. This area of contact is known as the shatter zone. In this zone, chunks and shards of rock mixed with the igneous rock, creating a chocolate chip cookie-like appearance. Pieces of the Bar Harbor Formation and Ellsworth Schist make up some of the “inclusions” or shards of rock encapsulated by the granite.



Dark bands of igneous rock can often be found cutting through the granite ledges of our area. When an igneous intrusion cuts across a pre-existing rock it is called a dike.



Many of the dikes in Acadia are composed of the igneous rock diabase. These rocks started out as magma, squeezed through cracks in the pre-existing bedrock, and cooled just below the Earth's surface. The diabase is younger than the bedrock it intrudes.

These dikes are sometimes referred to as basaltic dikes in reference to basalt, a common extrusive igneous rock. Diabase is an intrusive form of basalt that cools near the surface. These dikes can be as thin as a pencil or as wide as a car.



Quartz veins can be found throughout the island. Veins are created when minerals fill small cracks. They are produced when chemicals found in watery solutions combine to form a solid material. In contrast, a dike is crystallized from magma (gradations exist between the two).



Extrusive igneous rock exists in our area as well. Although it began as magma, the molten material exited the Earth's crust through a volcano. As the volcano spewed out hot, molten material, the ash welded together, fell into a shallow sea, and cooled quickly, creating the Cranberry Island Series. The material shares the same age and chemical make-up as the granite in our area. This formation is called a series because it contains several rock types: volcanic tuffs, felsites, and intermixed volcanic and sedimentary rocks. If you look closely at a sample, you will often see angular fragments mixed in with the bluish-gray ash.



Many forces have shaped the surface of our region. Wind, water, waves, and glacial ice have all sculpted Mount Desert Island and continue their impact to this day.



Fast-running water has cut straight stream beds across the land.



Slower-moving streams weave a meandering pattern as they follow the path of least resistance.



Ocean waves erode blocks of granite and sedimentary rock from the surrounding cliffs. The continual cutting at the underside of the cliffs creates interesting formations and plays a role in forming their rugged appearance.



Sea caves may form in areas with weaker rock and exposure to intense wave action.



Sea stacks are created as fingers of rocks are carved from the shoreline. Different degrees of exposure and varying rock strength are major factors behind their formation.



Relentless wave action, combined with the processes of freezing and thawing, causes rocks to fall into the Gulf of Maine. The continual movement induced by waves and tides grinds these jagged rocks into rounded cobbles.



In areas where the sea is calmer, cobblestones are dropped out of the churning waves, creating cobblestone beaches. These beaches form in partly protected coves where the waves strike the land with moderate energy. In these areas, the waves are not strong enough to continue carrying the cobbles but have enough energy to carry away a lighter load of sand and pebbles.



Sandy beaches form as sand is deposited in deeper coves protected from the energy of the sea. The processes of erosion and deposition continually alter the landscape of the beach.



Acadia National Park has rare sandy beaches that are easily accessible. Sand Beach, with its unique composition of sand, is a prime example.



Forty to seventy percent of the sand found at Sand Beach is composed of shell matter. Shell beaches are not rare in southern areas like Florida or the Bahamas, but are scarcer in cold northern bodies of water like the Gulf of Maine. Cold water holds a greater amount of gases, and some of these gases aid in dissolving the calcium carbonate composing sea shells. Although it is unusual to find shell beaches in Maine, the currents and the abundance of sea life can combine to form such unique sites.



Glaciers have played a significant role in shaping Acadia's landscape. The last glacial period for this area began about 25,000 – 30,000 years ago, when the Laurentide Ice Sheet advanced from Canada into Maine. As the glacier traveled south, it carved our valleys, mountains, and coastlines. The ice sheet was 1–2 miles thick and extended over 300 miles out to sea.



Due to the southeasterly direction of the glacier's travels, the northern slopes of many mountains were ground down (abrasion) while steep grades formed on the southern slopes as large boulders were removed (plucking).



Roche moutonnee, French for sheep rock or fleecy rock, is a geologic term used to describe the shape of many of our glacially carved mountains. The mountain's gradual northern slopes and steeper southern slopes create the appearance of a sheep grazing with its head down.



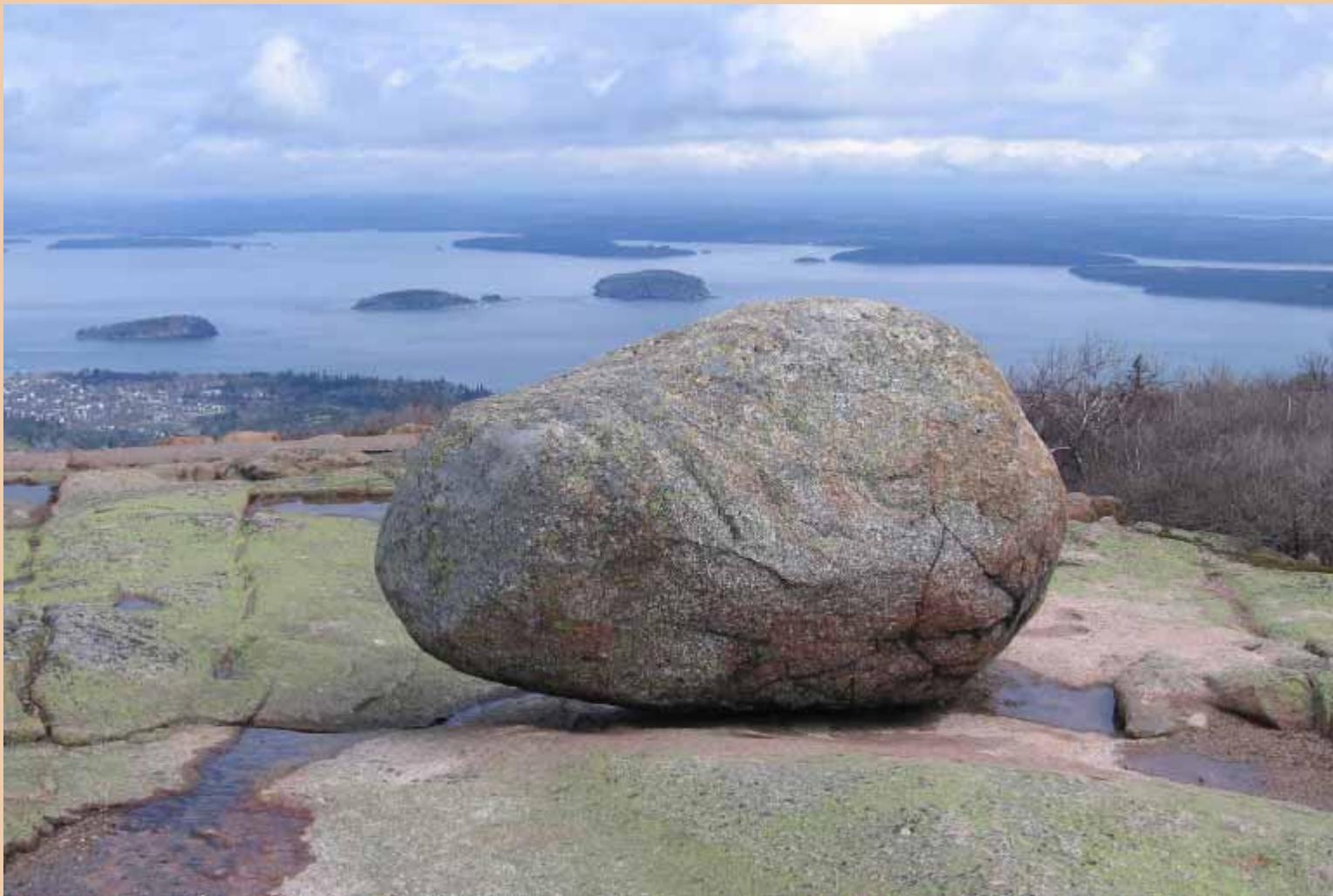
As the glaciers reached their maximum size about 20,000 years ago, they scoured the topsoil and bedrock with their load of debris. In areas where the glaciers were carrying large amounts of clay and silt, the glaciers acted like sandpaper and polished the bedrock beneath it. Today these areas of glacial polish can be found near the Tarn and Great Head. The glaciers also dragged stones imbedded in their ice, leaving narrow straight scratches along the bedrock called striations.



Larger fist-sized to bowling ball-sized rocks caught in the ice were often pinned between the glacier and the bedrock. As pressure increased, the rocks pivoted and shifted until they were free to travel with the glacier again. The shifting rocks wore away large crescent-shaped fractures in the ledges. These fractures provide evidence of the glacier's travels.



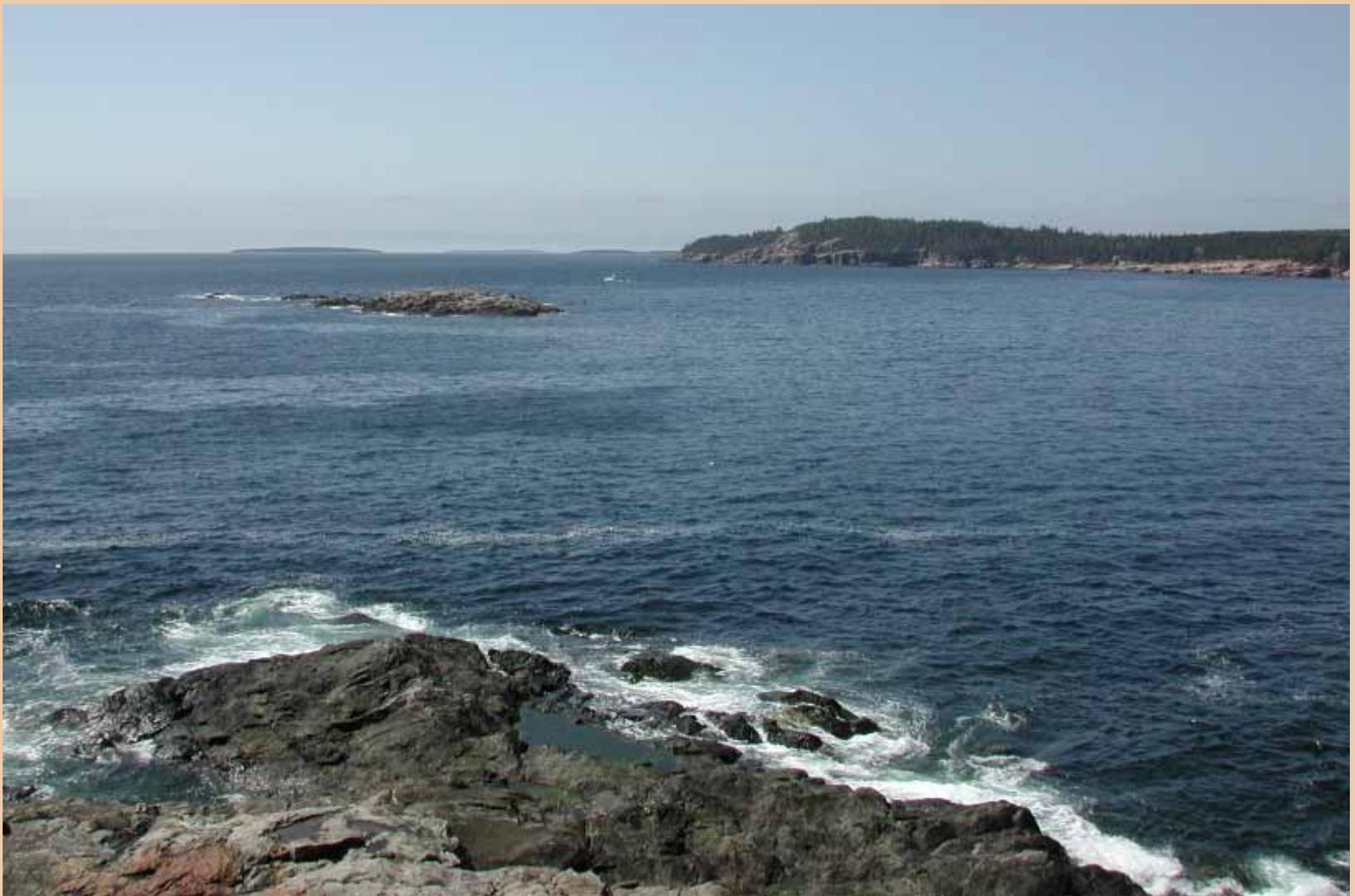
As the climate warmed and the glaciers began to melt, large amounts of rock and sediment were deposited by the glacier. Sometimes these rocks piled up at the end of a melting glacier and formed a ridge of boulders, rocks, pebbles, and clay called moraines. These moraines were large enough to block the mouth of U-shaped valleys, creating large lakes. At the southern edge of Jordan Pond, you can see the boulders and sediment that created the moraine, damming the lake.



Glacial erratics are rocks moved by glaciers that now rest on bedrock composed of a different material. Bubble Rock on South Bubble Mountain, Balance Rock on the Bar Harbor Shore Path, and the above piece of white Lucerne granite are classic examples of glacial erratics. The rock pictured here was picked up nearly 30 miles north of the island before being dropped off. Notice the rounded shape resulting from tumbling in glacial ice.



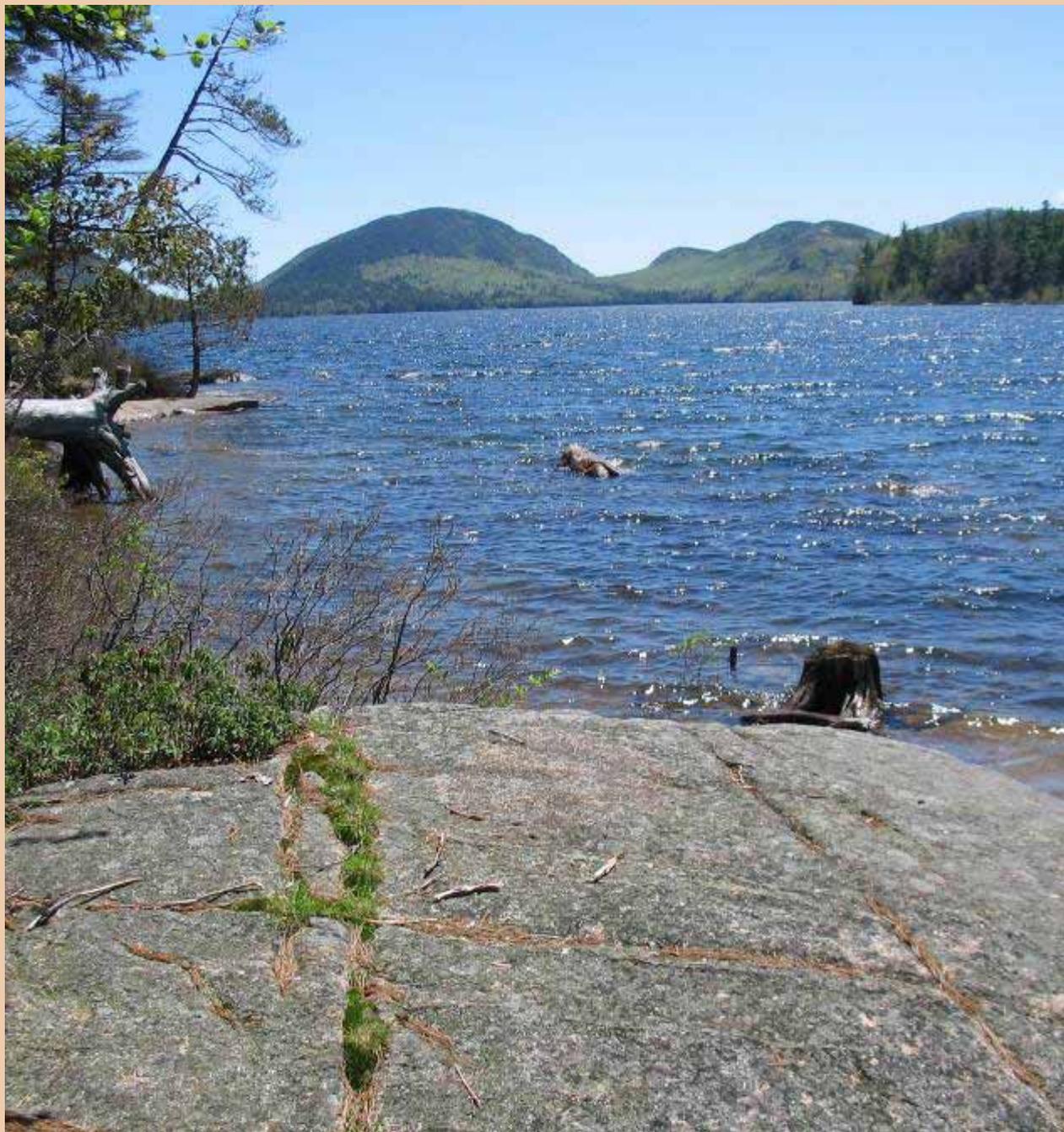
As the glacier receded, large flows of ice occasionally broke off and were covered by sediment. The buried ice was well insulated by the debris and melted very slowly, leaving a depression in the land. Kettle lakes like Half Moon, Witch Hole, and Aunt Betty's Pond were often created.



During the glacial period, the Earth's crust depressed under the immense mass of ice. When the glaciers began to melt, the Earth's crust didn't immediately bounce back to its original position. The depressed area, combined with increased water from glacial melt, led to a rise in the sea level.



Today's mountaintops were once surrounded by sea water and resembled the Porcupine Islands of Frenchman's Bay.



Everywhere you look in Acadia, you can find evidence of the area's geologic story.



As you hike Acadia's mountains, you travel old shorelines now hundreds of feet above current sea level and walk on mountain summits that were once islands exposed to the open sea.



Sea caves with cobbles and even beaches lie quietly amongst the trees awaiting discovery. These unexpected gems further relate the story of Maine's geologic history.



All of these wonderful geologic features are preserved and protected within the boundaries of the park.



Acadia is a wonderful place to explore, discover, and learn about the many forces that formed and shaped our landscape.



As you visit Acadia National Park, read and enjoy the geologic story written in the surrounding landscape.

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