

Geologic Site of the Month
December, 2002 and May, 2003

***Glacial and Postglacial Geology Highlights
in the White Mountain National Forest, Western Maine***



44 18' 37.24" N, 70 49' 24.26" W

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Introduction

The part of the White Mountain National Forest (WMNF) in western Maine contains scenic high mountains (including the Caribou-Speckled Wilderness), hiking trails, and campgrounds. A variety of interesting geological features can be seen along the Forest roads and trails. This field guide is intended as a resource for persons who are visiting the Forest and would like information about the glacial and postglacial geology of the region. The selection of sites included here is based on geologic mapping by the author, and more sites may be added to this website as they are discovered in the future.

The WMNF in Maine is an irregular patchwork of Federal lands mingled with tracts of private property. Boundaries may change from time to time, but the Forest lands included in this field trip are shown on the Speckled Mountain and East Stoneham 1:24,000 topographic quadrangle maps. Most of the sites described here are within the Forest and open to the public. A few additional sites in the nearby Crooked River and Pleasant River valleys are also mentioned to round out the geological story. Please keep in mind that although the latter places may be visible from roads, they are private property.

The roadless Caribou-Speckled Wilderness limits east-west travel in the region, so this field guide is divided into three parts based on vehicle access. Part 1 describes the Crooked River valley and the area around Crocker Pond campground, near the eastern limit of the Forest lands. Part 2 includes some of the mountains in the central Caribou-Speckled Wilderness and the Great Brook valley to the south. Part 3 covers the Evans Notch area along Route 113. Each of these areas can be included in a day trip, in some cases with more or less hiking over rugged terrain. However, a visit to all of the mountain tops in Part 2 would usually involve a couple of days and hikes from more than one trail head.



Significance

The Maine portion of the WMNF is a scenic wilderness in which the effects of the Ice Age and recent stream processes can be seen. Roads, trails, picnic areas, and campgrounds provide opportunities for outdoor recreation while visiting sites that illustrate the impact of glacial ice on the foothills of the White Mountains.

The most recent glacial episode in this region was the invasion of the Laurentide Ice Sheet, which spread southward from Canada about 25,000 years ago and covered all of New England. The resulting features in the steep terrain of the National Forest differ in some respects from lower areas of southwestern Maine.



Significance

The flanks and summits of the higher mountains usually have just a thin, patchy cover of glacial sediments, and there are extensive bedrock outcrops scraped bare by glacial erosion (Figure 1). The effects of this erosion are plainly evident on a large scale, and striations and grooves may be seen where the ledge surfaces are not too weathered.



Figure 1. View southwest across Evans Brook valley from ledges near the summit of Caribou Mountain. Evans Notch appears in the upper left.



Significance

Deposition of glacial till and water-laid sand and gravel was concentrated on the lower slopes and valley bottoms. The washed sediments include gravelly ridges (eskers) formed where water rushed through subglacial tunnels, outwash deposited in south-sloping valleys where meltwater drained freely away from the ice, and glacial lake sediments trapped where north-draining valleys were dammed by the retreating margin of the ice sheet.

After the ice sheet melted away, steep mountain brooks eroded some of the glacial sediments and redeposited them as bouldery alluvial fans where these high-energy brooks emptied into the more gently-sloping valley bottoms of larger streams. In some cases, the postglacial alluvial sediments have been subsequently dissected by stream erosion, leaving remnants of those earlier deposits as stream terraces rising above the modern flood plains. Route 113 (Evans Notch road) offers ready access to outstanding examples of these fans and terraces.



Logistics

Permission: No special permission is required to visit the White Mountain National Forest (WMNF). General information is available on the [WMNF website](#). You can also visit or call the local Evans Notch headquarters in Bethel: 18 Mayville Rd., Bethel, ME 04217-4400. Phone: (207) 824-2134. Certain trail heads and other popular places in the WMNF require daily or seasonal Forest parking passes to be displayed on your vehicle. Information about this program is posted on the above website. If you stop at a site where the pass is required, there is usually a provision right at the site to pay the \$3.00 (per vehicle) daily parking fee. Leaders of group field trips should call the above office in advance to determine whether other regulations may be in effect.

Location: Western Oxford County, between north-south Routes 5 and 113. DeLorme's Maine Atlas provides detailed maps showing access from other parts of the state. The area discussed here includes portions of the East Stoneham and Speckled Mountain 1:24,000-scale topographic quadrangle maps. The Maine Geological Survey's surficial geologic maps and reports for these quadrangles provide further information on glacial and postglacial geology of the area (Thompson, 2002, 2003 a,b,c).

Access: Road access is limited to State highways 5 and 113, and secondary town and National Forest roads. WMNF roads are often gravel, and vehicle access in remote areas may be restricted by gates. Some of these roads, including Route 113, are steep and narrow in places, and the road through Evans Notch is closed and gated during the winter. The road network is generally suitable for personal vehicles and vans, but not for buses. Caution is advised during mud season and logging operations. Parking is usually available at trail heads, campgrounds, and roadside turnouts.

Group size: Small (individuals or small groups with suitable vehicles as indicated above).



Geologic History

The field trip area was deeply eroded during the Ice Age. It is not certain how many glaciations occurred here during the Pleistocene "Ice Age," but the most recent continental glacier - the Laurentide Ice Sheet - scraped across it between about 25,000 and 13,000 years ago. Glacial action eroded the bedrock surface and pried off large blocks of rock from the "downstream" flanks of mountains, leaving high cliffs on their southern and eastern sides. Many examples can be seen in this area, including the southeast flanks of Royce and Haystack Mountains, the dramatic cliff on the south face of Red Rock Mountain, and Albany and Square Dock Mountains to the east (Figure 2).



Figure 2. Coarse glacial outwash gravel in Crooked River valley, and glacially plucked cliff on south face of Square Dock Mountain, as seen from Route 5.

Geologic History

Rock debris was incorporated into the bottom of the glacier, pulverized, and dragged across the surface of the underlying bedrock. In some places this abrasion produced smooth surfaces on the bedrock ledges (Figure 3). Occasionally we can also find parallel scratches (striations) and broader grooves produced as individual rocks and sand grains scraped across the ledge surface. These are best seen where ledges are freshly exposed, or on veins of quartz and coarse granite (pegmatite) that have resisted postglacial weathering.



Figure 3. Glacially smoothed granite ledge on Forest Road 319, east of Farwell Mountain. Striations on the rock surface indicate ice flow toward the south-southeast.

Geologic History

In many cases the striations on glacially smoothed surfaces can be detected only by careful scrutiny under favorable lighting and rubbing across them with a pencil (Figure 4).

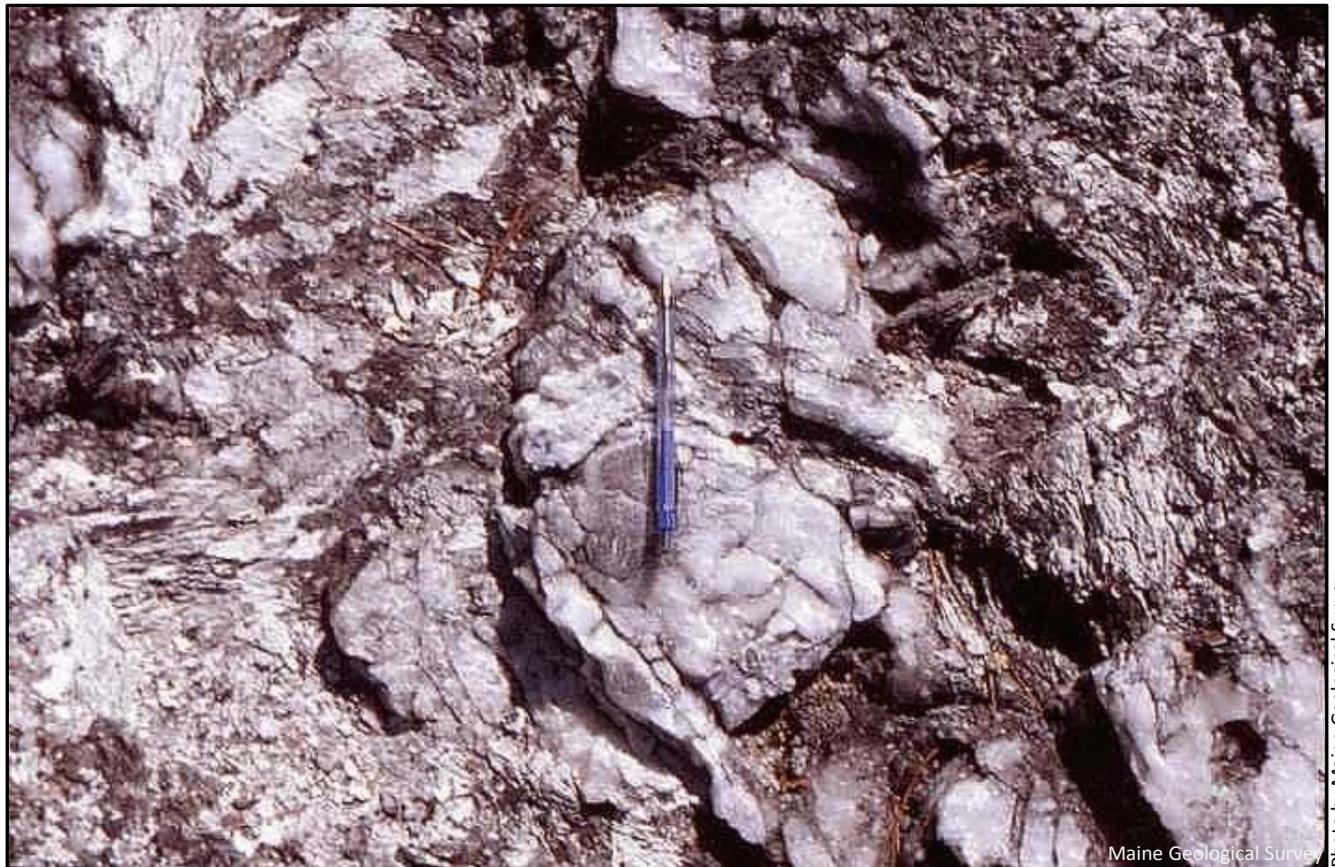


Figure 4. Glacial striations (center) trending south-southeast (parallel to pen) on quartz pod near top of Blueberry Mountain in Stow. The striations are faint and were made visible by rubbing across them with a pencil.



Geologic History

Climatic warming eventually caused the glacier to melt. The ice sheet became thinner, and its margin retreated northward from this part of Maine about 13,000 years ago. Some of the rock debris that remained in the ice was simply dropped onto the ground, leaving a sandy, bouldery deposit of glacial till across the region (Figure 5). Till mantles the lower slopes of the mountains, but is generally thinner or absent at high elevations.



Figure 5. Glacial till southeast of Bad Mountain.

Geologic History

Meltwater streams poured out of the ice and washed a lot of the glacial sediment down the valleys. These deposits include much of the sand and gravel in the Crooked River, Crocker Pond, and Pleasant River valleys in the East Stoneham quadrangle, and the Great Brook basin in the Speckled Mountain quadrangle to the west. Some of the water-transported glacial sediments on the south side of the mountains were swept farther downstream into the Saco River valley, while ice-dammed glacial lakes trapped sediments in the north-sloping Pleasant River valley.

As the landscape was exposed by melting and retreat of glacial ice, the freshly uncovered and barren mountainsides were vulnerable to erosion until they were stabilized by forest growth. It was probably during this late-glacial time that landslides and floods swept large volumes of sediment down into the valley bottoms, building alluvial fans and other flood deposits.



Part 1: Crooked River Valley and Crocker Pond Campground Area

A convenient starting point for this trip is the junction of Routes 5 and 35 in Lynchville (Albany Township), where you'll note the famous signpost showing distances to Maine towns with foreign names such as Peru, Paris, and Denmark.

Driving north on Route 5, the road follows the surface of sand and gravel outwash deposited by glacial meltwater in the Crooked River valley. Economically important gravel pits have been worked here for many years. Fresh excavations in these pits help geologists to reconstruct the environment in which the deposits were formed. For example, the very coarse gravel in Figure 2 could only have been carried by a powerful fast-moving stream; some of the boulders in this pit are 3 feet in diameter!



Part 1: Crooked River Valley and Crocker Pond Campground Area

Just across the valley to the east, a higher sand terrace records a former glacial lake that may have been trapped between the hillside and ice that still remained in the valley center (Figure 6).



Figure 6. Glacial-lake sand and huge boulder on east side of Crooked River valley.



Part 1: Crooked River Valley and Crocker Pond Campground Area

The lake sediments were laid down in relatively tranquil waters, and are finer grained and much better stratified than the boulder gravel in Figure 2. Many pits in the Crooked River valley in Albany have revealed excellent sedimentary structures indicating southward flow of glacial meltwater (Figure 7).



Photo by Maine Geological Survey

Maine Geological Survey

Figure 7. Sand, gravel, and silt deposited by glacial meltwater stream in Crooked River valley, near Albany waste transfer station on east side of Route 5. The small-scale inclined strata indicate stream flow from left to right.



Part 1: Crooked River Valley and Crocker Pond Campground Area

Some of the sand and gravel accumulations in this part of the valley are mapped as ice-contact deposits because they show examples of slumped and faulted strata, as well as topographic depressions (kettles), resulting from deposition over and around glacial ice masses that later melted (Figure 8).



Figure 8. Exposure in gravel pit, Crooked River valley, showing deformed vertical gravel beds (center) truncating gravelly sand unit at left. Disturbance probably resulted from slumping adjacent to melting glacial ice.

Part 1: Crooked River Valley and Crocker Pond Campground Area

Starting about 0.2 mile north of the Lynchville intersection, you will be on a low narrow ridge for the next 0.5 mile. This feature is probably an esker formed by a glacial stream in a tunnel within the ice. Continuing north on Route 5 for the next few miles, the Crooked River valley has gravelly deposits of both outwash and ice-contact sediments, with the latter commonly being higher on the valley side and the road following the lower flat surface of the adjacent and slightly younger outwash.



Part 1: Crooked River Valley and Crocker Pond Campground Area

Go north on Route 5 to Patte Brook Rd. on the left, and follow this road west to the National Forest and Crocker Pond Campground (Figure 9).

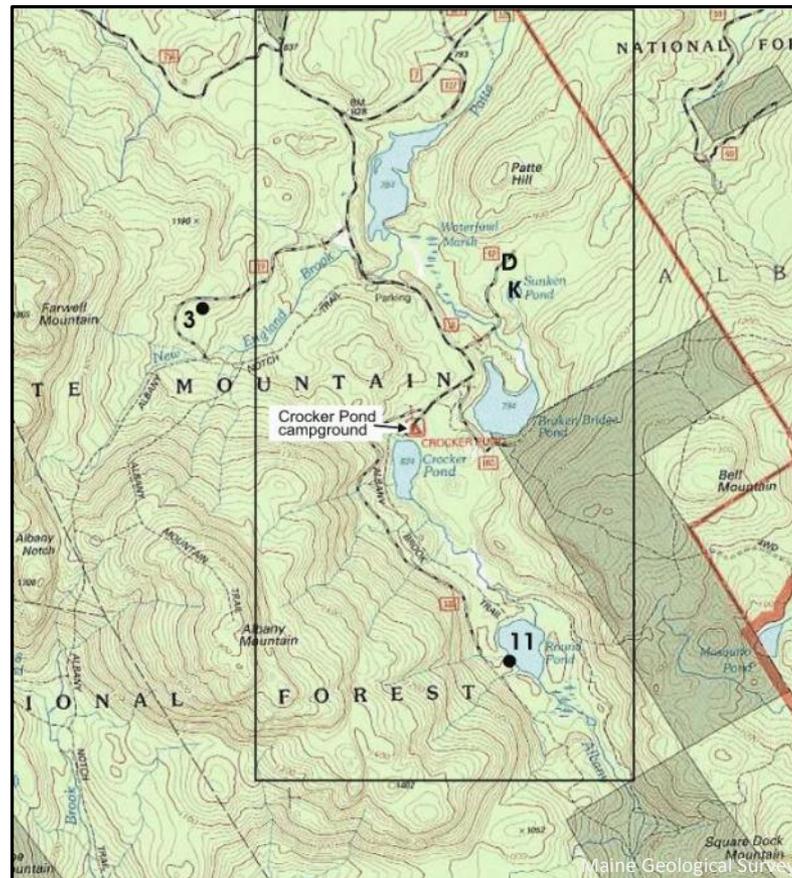


Figure 9. Part of the East Stoneham quadrangle with Crocker Pond Campground and other geographic locations. The area of Figure 10 is outlined. The "3" and "11" are sites for Figures 3 and 11. K=Sunken Pond kettle, D=glacial lake delta.



Part 1: Crooked River Valley and Crocker Pond Campground Area

The campground is a beautiful location in an uncrowded corner of the Forest, and one which has outstanding glacial landforms (Figure 10).

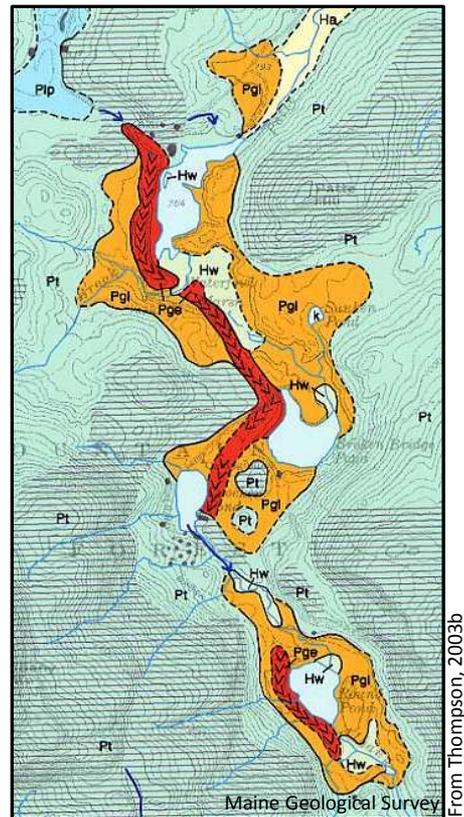


Figure 10. Part of the surficial geologic map of the East Stoneham quadrangle, showing glacial deposits in the vicinity of Crocker Pond campground, White Mountain National Forest, Albany, Maine. Glacial materials are identified as follows: green (Pt) = till; red (Pge) = esker; orange (Pgi) = other ice-contact sand and gravel; blue (Plp) = glacial Lake Pleasant deposits. Blue arrows show glacial meltwater drainage routes; gray line pattern marks areas of much bedrock exposure.



Part 1: Crooked River Valley and Crocker Pond Campground Area

Glacial action scoured out a valley that trends generally south-southeast, parallel to ice flow, and now hosts Crocker Pond and other water bodies (Figure 11). The glacier also pried off a lot of rock from the flanks of mountains, leaving high cliffs on their southern and eastern sides. Good examples can be seen on nearby hills such as Farwell and Albany Mountains.

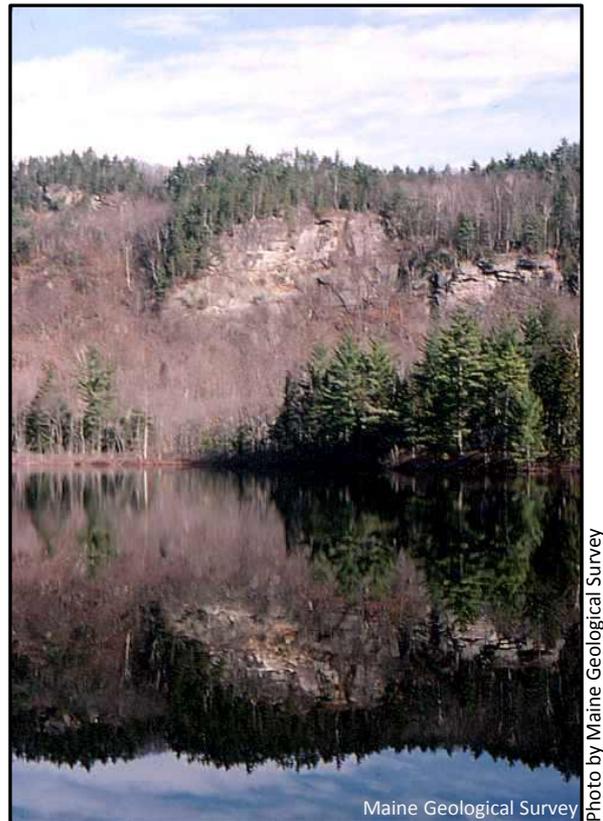


Figure 11. Glacially sculpted bedrock cliff on east side of Round Pond in the White Mountain National Forest.

Part 1: Crooked River Valley and Crocker Pond Campground Area

The sand and gravel in the Crocker Pond area formed in an ice-contact environment. The campground road follows the west side of a long narrow ridge (Figure 10), which marks the former path of a subglacial tunnel. Meltwater rushed southward through the tunnel and filled it with gravel. When the ice disappeared this deposit was left behind as a ridge called an "esker." Maine is famous for its eskers that can be traced for many miles. The one in the Crocker Pond valley is part of a discontinuous esker system that extends south at least to the Saco River valley.

South of Round Pound, the powerful glacial drainage passed through a narrow bedrock gorge along Albany Brook and carved deep potholes. During the 1800's the gorge was a tourist attraction called Albany Basin, but it is now on private property and closed to the public. Just north of where Albany Brook joins the Crooked River, the esker reappears in curious fashion as two parallel ridges. Part of this complex area of eskers and kettles may be examined along Albany Basin road, which branches off from the west side of Route 5 (about one mile from the start of the trip in Lynchville).



Part 1: Crooked River Valley and Crocker Pond Campground Area

Returning to the Crocker Pond area, a Forest road just north of Broken Bridge Pond leads northeast to a sand and gravel terrace. This is probably a delta that was built into an ice-bounded glacial lake next to the esker. Just off this road to the east is Sunken Pond, located in a glacial kettle where a remnant ice mass once existed. The pond is filling in with organic material and has a lot of spongy peat around its margins. The road ends in a large clearing where you can easily see the boundary between the flat delta top and the boulder-strewn till on Patte Hill to the north. Geologists use these contrasts in topography and ground materials to help map the contacts between different types of glacial deposits. The delta top has an elevation of about 850 feet, which approximates the former water level. The lake probably drained southward across ledges and older glacial deposits that dammed the valley in the Crocker Pond area.

If you leave the Crocker Pond campground road and go left (north) on the main road, you immediately pass through a small gap with a bedrock floor. Some of the ledges along the road have a smooth, waterworn appearance. This was the outlet channel for two stages of glacial meltwater drainage: first the subglacial tunnel along which the nearby esker formed, and then it was the outlet for glacial Lake Pleasant. The lake existed for a short time when the north-sloping Pleasant River valley was dammed by the receding glacier margin. Lake Pleasant filled the valley to the level of this gap and drained through here to the Patte Brook valley. Continuing north along the road, you drive over the fine sandy sediments that washed into the lake from the melting glacier. The lake deposits are thick and bury any remnants of the esker that may be present in the Pleasant River valley.



Part 1: Crooked River Valley and Crocker Pond Campground Area

After the demise of the glacial ice sheet, today's familiar streams and lakes came into existence. Brooks and rivers continue to modify the landscape as they erode sediments in some places and deposit them in others, particularly during floods. The West Branch of the Pleasant River has cut down to bedrock at several locations, and even formed small gorges and potholes (Figure 12). The Pleasant River extensively reworked the old glacial lake sands and formed a broad alluvial plain that you will pass over if you continue down this scenic valley to West Bethel.



Photo by Maine Geological Survey

Figure 12. Small pothole in basalt vein cutting white granite; formed by postglacial stream erosion in bed of West Branch Pleasant River, Mason township.



Part 2: Great Brook Valley and central Caribou-Speckled Wilderness

Great Brook Valley. The sand and gravel in the Great Brook valley in Stoneham may have a glacial origin, but most of the coarse water-laid sediments in the area were left by streams in postglacial time. It is likely that just after the glacier melted away, steep brooks vigorously eroded the freshly deposited, and often unstable, sediments on the mountainsides before a vegetation cover was established. Occasional severe floods throughout postglacial time would have caused additional slope erosion. The brooks dropped much of their coarsest load and built alluvial fans where they emptied into larger valleys with gentler gradients. Many of these fan gravels are very bouldery.



Part 2: Great Brook Valley and central Caribou-Speckled Wilderness

Several interesting geologic and cultural features can be seen along the National Forest road and trail leading up the Great Brook valley in Stoneham. Park off the road, just before the locked gate where the road crosses the brook, and walk downstream along the granite ledges. Small potholes are evident where the brook has cut into the ledges (Figure 13).



Photo by Maine Geological Survey

Figure 13. Potholes in bed of Great Brook, Stoneham.

Part 2: Great Brook Valley and central Caribou-Speckled Wilderness

In this same area, the brook falls over several steps resulting from the fracture patterns in the granite (Figure 14).



Photo by Maine Geological Survey

Maine Geological Survey

Figure 14. Waterfall and pool along Great Brook. This part of the brook flows across a nearly horizontal joint surface on the granite ledge. Note vertical joint cutting the ledge in foreground.



Part 2: Great Brook Valley and central Caribou-Speckled Wilderness

Continuing north on foot, the Great Brook trail follows an old woods road, passing at least one other nice waterfall. A short distance past the end of the improved road, the trail rises onto a coarse bouldery alluvial fan on the lower south slope of Butters Mountain. Watch closely on the left for the foundation hole of the old Butters family farm, in which a huge tree has grown. A slate tombstone on the mound in front of the cellar hole has a weathered inscription commemorating two of the Butters children. While the inscription is not fully legible, it appears they died within two days of each other in December, 1849. Many cellar holes and stone walls in this part of Maine record the efforts of farmers who cleared the land in the 1800's, but much of that farmland was abandoned and reverted to forest.



Part 2: Great Brook Valley and central Caribou-Speckled Wilderness

Miles Notch and Red Rock trails. Miles Notch can be reached by moderately long walks from either the north or south. The notch is very narrow, and large boulders have fallen into it from the cliff on the west side. Just south from the highest part of the trail through the notch, a ledge on the east side of the trail has a smooth polished surface. Some of the white quartz in this outcrop is polished to a brilliant mirror luster! The surface has small shallow indentations that are more like the products of fluvial erosion than the features produced by glacial abrasion. No definite glacial striations were found here. The site most likely indicates scouring by sediment-laden glacial meltwater rushing southward through the notch.

To the north of Miles Notch, the Red Rock trail leads off to the west and passes over several peaks before reaching the top of Speckled Mountain. A high cliff on the eastern spur of Red Rock Mountain can be seen by walking a few feet south of the trail (watch your step here!). This rusty-colored bedrock precipice can be seen from miles away on Route 5 and may have inspired the name of the mountain. The granite ledges on top of Red Rock Mountain show a general smoothing by glacial erosion, but they are too weathered to preserve striations. Spalling of the rock surface due to forest fires may have accelerated the weathering process.

Three very small remnants of striated ledge surface were found on the eastern part of Red Rock Mountain. They indicate glacial flow to the south-southwest, in contrast to striations recording south-southeast flow on nearby Butters Mountain. One of the Red Rock sites also has a southeast-trending set of striations which is probably older than the SSW set. Striations on the south spur of Speckled Mountain and other places in southwestern Maine likewise record a late shift in glacial ice flow from southeast to south or southwest.



Part 3: Evans Notch and the Evans Brook Valley (Route 113)

Evans Brook. Evans Brook starts in Evans Notch and flows north to its junction with the Wild River near Hastings Campground. As Route 113 ascends this valley, it crosses both modern flood-plain deposits next to the river and higher alluvial fans and terraces. A coalescing network of gravelly fans has developed along the upper part of Evans Brook and at the mouths of its tributaries. The lower ends of Caribou and Mud Brook trails are mostly located on these fan deposits. The Caribou trail actually starts on the toe of the Mud Brook fan and then goes north across a short stretch of bouldery till before crossing the fan on the lower part of Morrison Brook.

When the leaves are off the trees, an alluvial terrace is visible in the woods east of Route 113 in this same part of the Evans Brook valley. The terrace stands about 20 feet higher than the modern brook and slopes northward with a similar gradient. Gravel and sand comprising the terrace were deposited by Evans Brook during some earlier part of postglacial time, perhaps soon after glacial retreat as discussed above.



Part 3: Evans Notch and the Evans Brook Valley (Route 113)

Erosion has been dominant in more recent centuries, and the brook has dissected the terrace as it cut down to its present level. A small exposure of the alluvial deposits in the terrace was noted south of Morrison Brook on the east side of Rte. 113 (Figure 15).



Figure 15. Sand and gravel in postglacial alluvial terrace, Evans Brook valley.

Part 3: Evans Notch and the Evans Brook Valley (Route 113)

Evans Notch area. The uppermost mile of Evans Brook cuts through a hummocky area of sand and gravel deposited from melting glacial ice. The internal structure of these ice-contact deposits is not exposed, but they may have formed in a small glacial lake ponded between the ice margin to the north and Evans Notch to the south. Alternatively, some of these sediments may have been laid down as a subglacial tunnel deposit (esker) while ice still covered the area (Thompson, 2002). In any case, there was a great outpouring of glacial meltwater through the notch. The upper end of the Cold River valley (just south of Evans Notch) is hundreds of feet deep. This deep chasm is aligned obliquely to the regional flow of glacial ice, and though some of it probably was carved directly by the ice, the torrential meltwater flow caused further erosion.

Meltwater drainage through the notch could have occurred in three stages: first beneath the ice, when meltwater was under pressure; then as streams issued from the ice when the glacier margin stood right in the notch; and finally when the ice margin had retreated farther north and a glacial lake drained through the notch. The lake overflow would have had very little erosive power, so the most effective downcutting was caused by sediment-laden streams pouring directly out of the glacier.

There is a channel carved by glacial meltwater on the floor of Evans Notch, but it is partly obscured by a bouldery alluvial fan on the divide between Cold River and Evans Brook. This small fan underlies the parking lot for the East Royce Trail on the northwest side of Route 113. It was deposited where a small unnamed brook descends from the mountainside. The shape of the fan suggests that the brook may have shifted its course over time, alternating between draining north into Evans Brook and south into Cold River.



References and Additional Information

- Thompson, W. B., 2002, Surficial geologic map of the Speckled Mountain quadrangle, Maine: Maine Geological Survey, Open-File No. 02-144.
- Thompson, W. B., 2003a, Surficial geology of the Speckled Mountain 7.5-minute quadrangle, Oxford County, Maine: Maine Geological Survey, Open-File Report 03-5, 9 p.
- Thompson, W. B., 2003b, Surficial geologic map of the East Stoneham quadrangle, Maine: Maine Geological Survey, Open-File No. 03-2.
- Thompson, W. B., 2003c, Surficial geology of the East Stoneham 7.5-minute quadrangle, Oxford County, Maine: Maine Geological Survey, Open-File Report 03-4, 11 p.

