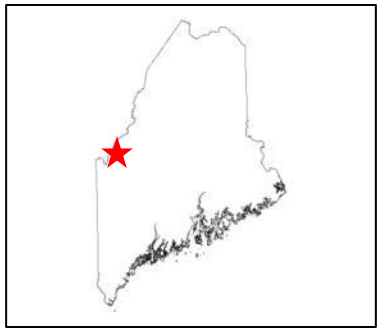
Geologic Site of the Month

September, 2015

The Geology of Sarampus Falls



45° 18′ 07“N, 70° 36′12"W

By
John Haley
Gray-New Gloucester High School, Gray, ME

Introduction

Sarampus Falls is set about 13 miles south of the Canadian Border on Route 27 between Stratton and Coburn Gore. There is a small rest area with picnic tables and restroom facilities along the North Branch of the Dead River. In addition to the falls, there are views of nearby mountains and a multifaceted window into the geology of the region.

Photos by Henry Berry

Figure 1. Views of the Sarampus Falls Rest Area.

Introduction

While Sarampus Falls provides the name and most notable feature of the site, its active work on the landscape is just the most recent part of the complex geologic story that is told by features of this site. The sandy material that covers rock outcrop north of the site, as well as the polished surface of the bedrock, tell the story of an icier time in the region's history around 11,500 years ago. The bedrock itself tells a tale of a more distant past, 480 million years ago, when sediment settled in an ancient seaway before it was intruded with molten magma deep in the Earth. Each of these components of the area's history can be seen from the rest area and are labeled in Figure 2.

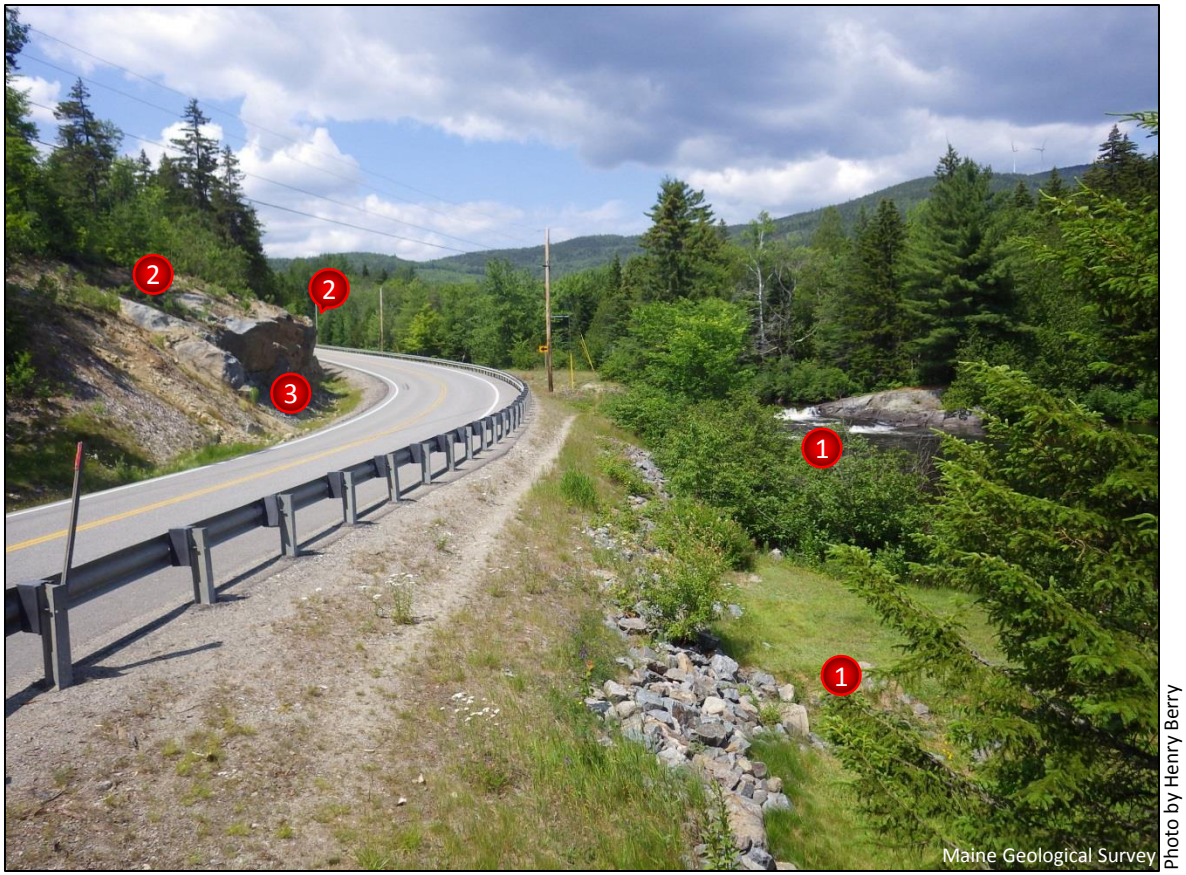


Photo by Henry Berry

Figure 2. The view from the northern end of the rest area. This image includes evidence of 1) modern, 2) glacial, and 3) tectonic processes.

Photos by Henry Berry

Photos by John Haley

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Figure 3. Flows near Sarampus Falls.

Observing Modern Stream Flow

Sarampus Falls creates an interesting opportunity to view a variety of water flow environments. The Falls themselves are a high energy flow environment. Sediment carried by the stream has abraded the bedrock beneath, creating a smoothed surface. In the energetic environment below the falls all but the largest cobbles have been carried downstream. Visible eddies move sediment in a circular motion.

Photos by Henry Berry

Figure 4. A deposit of cobbles in the river left behind by the quick moving stream at a time of high flow.

Observing Modern Stream Flow

In lower energy environments like the one downstream smaller sediments, in this case smaller cobbles than the ones upstream, remain. As the stream's energy gets lower and lower even finer-grained sediments will remain. Look for areas where the underlying material is made of smaller and larger sediments due to changing amounts of flow. Many of the cobbles that have been tumbled downstream are rounded as a result of their transport. To the left of the stream there is a flat grassy area. As the river flows it cuts through sediment and carries it downstream. As the river moves back and forth in its bed it occasionally leaves flat terraces that were once the bottom of the stream.

Figure 5. Looking downstream from Sarampus Falls.

Photos by Henry Berry

Figure 6. Flat terrace below the road was created by the modern stream.

An Icy Stream in Glacial Times

The large bedrock outcrop along Route 27 holds an older story of flow. On the upper surface and at the northern end surficial sediment was removed, during road construction revealing the smooth natural outcrop surface.

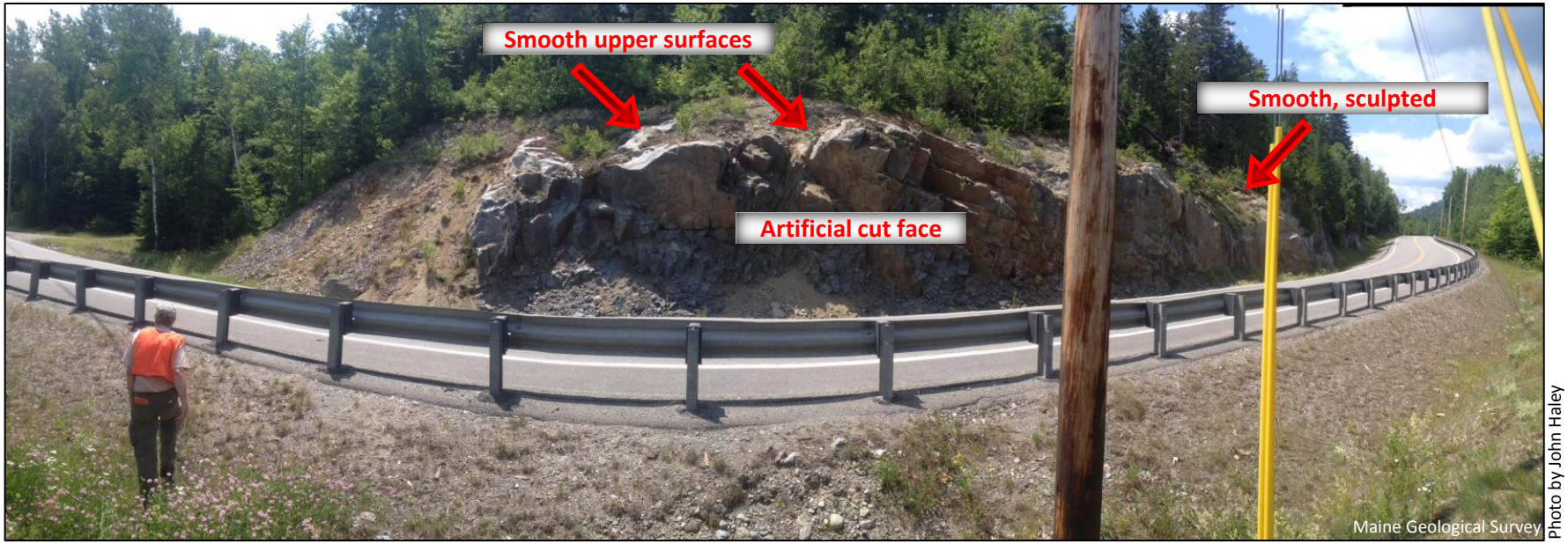


Photo by John Haley

Figure 7. View of the roadcut across Route 27. Smooth natural surfaces are visible on top of the outcrop and at the north end to the right of the telephone pole in this photo. The vertical rock face was created by blasting for the road. Note: This is a dangerous curve; please stay behind the guardrail and do not cross the road.

An Icy Stream in Glacial Times

The smooth surface is interpreted as being smoothed by a river that traveled through this area around 11,500 years ago, when the glacier was receding from the area (Borns et al., 2004). As glaciers begin to melt they create large volumes of water. As water flows it creates high energy flow environments, powerful enough to abrade the bedrock beneath. Eddies in this glacial river may have caused sediment to move in circular motions leaving behind rounded erosion features called potholes.

Figure 8. A portion of the roadcut showing a smoothed surface.

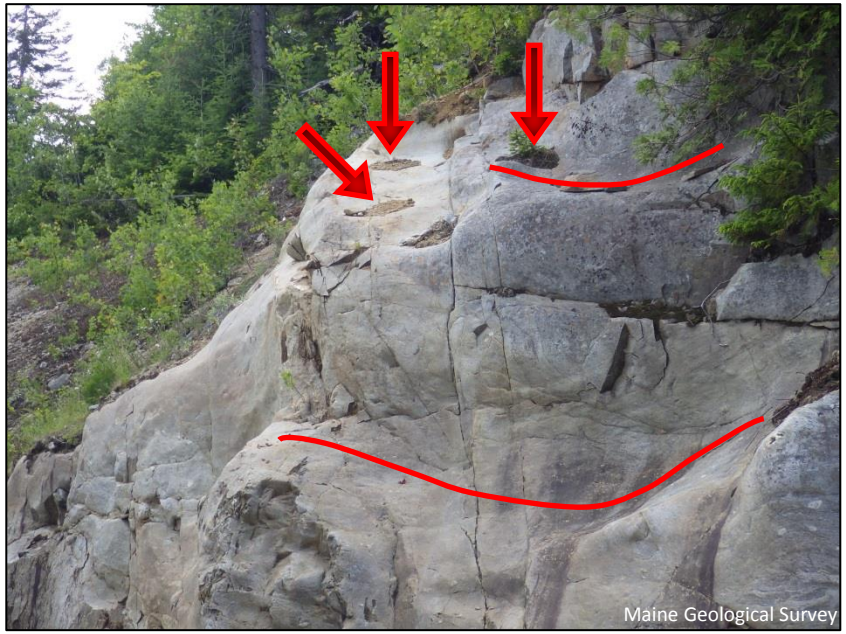


Figure 9. Smoothly curved surfaces (red lines) are typical of scour in high-velocity streams. Circular holes (arrows) are potholes that form in turbulent flow.

Photos by Henry Berry

An Icy Stream in Glacial Times

The glacial streams, much like the modern stream, would have eroded the surface of the bedrock, but it could have deposited material as well. The material overlying the bedrock exposure is a mixture of sand, gravel and cobbles. Notably, finer-grained sediments, like clay, are missing from this mixture. This suggests that this was a high enough energy environment to carry clays away from the site. Also, the cobbles are visibly rounded. This may have occurred as the cobbles were tumbled by the flow of the stream. A gravelly sediment deposited by glacial meltwater is called outwash.

Photo by Henry Berry

Figure 10. A deposit of glacial outwash rests on top of the bedrock.

An Icy Stream in Glacial Times

Surficial geologic maps of the area reveal sedimentary deposits that demonstrate that this area was host to a network of glacial meltwater flows. Rivers beneath and in front of the melting ice may have flowed into what some have called Glacial Lake Bigelow, a natural lake centered around present day, man-made Flagstaff Lake but at about 10 feet higher elevation (Leavitt and Perkins, 1935; Borns and Calkin 1977).

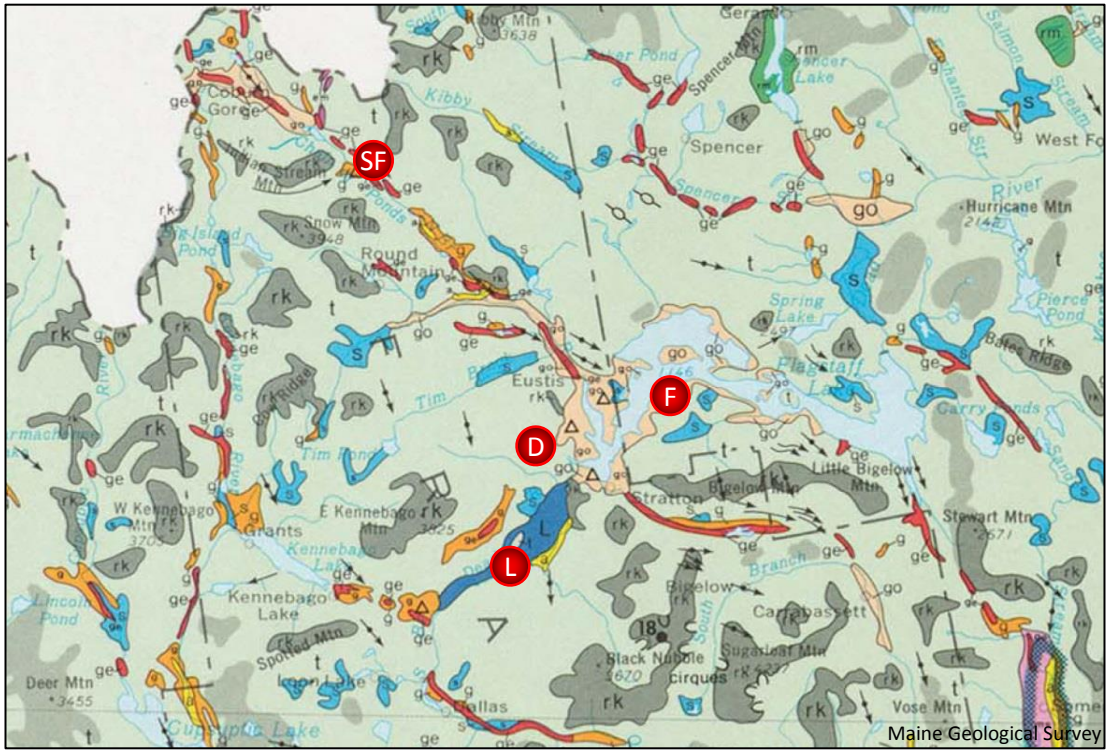


Image from Surficial Geologic Map of Maine, 1985

Figure 11. Surficial geologic map of the area. SF is Sarampus Falls. Red indicates ridges of sand and gravel thought to have been deposited by subglacial rivers. Orange is other gravel deposits including outwash. Notice Flagstaff Lake (F) and the lake bottom deposits indicated in blue (L). These areas would have been contained within Glacial Lake Bigelow. Pink represents a delta (D) where the glacial river system flowed into the glacial lake. (From Thompson and Borns, 1985).

An Ancient Seaway and Intruded Molten Rock

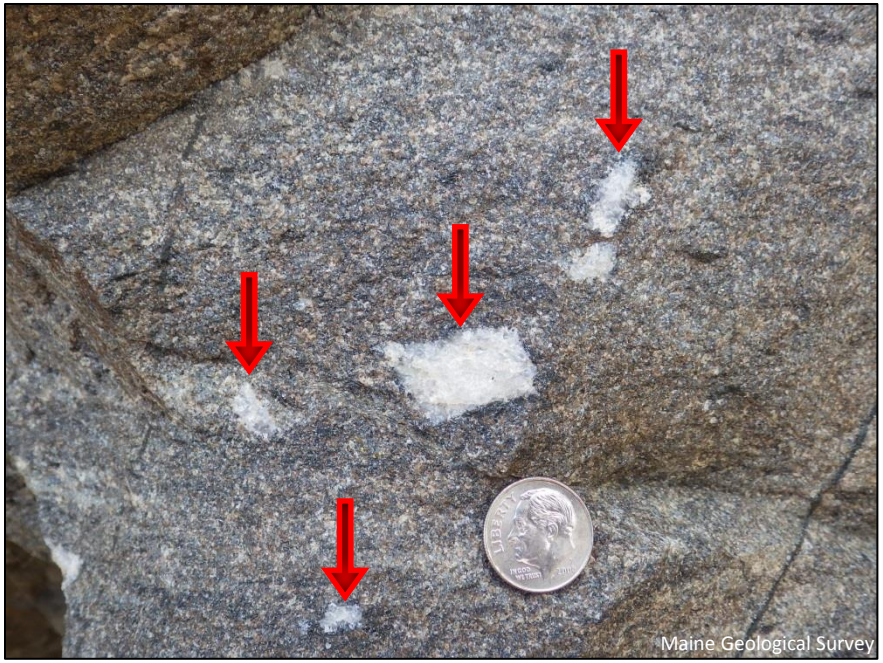
Features of the rock structure show that the rock has flowed. The flow seen here, however, was not a flow of water, but of hot rock.

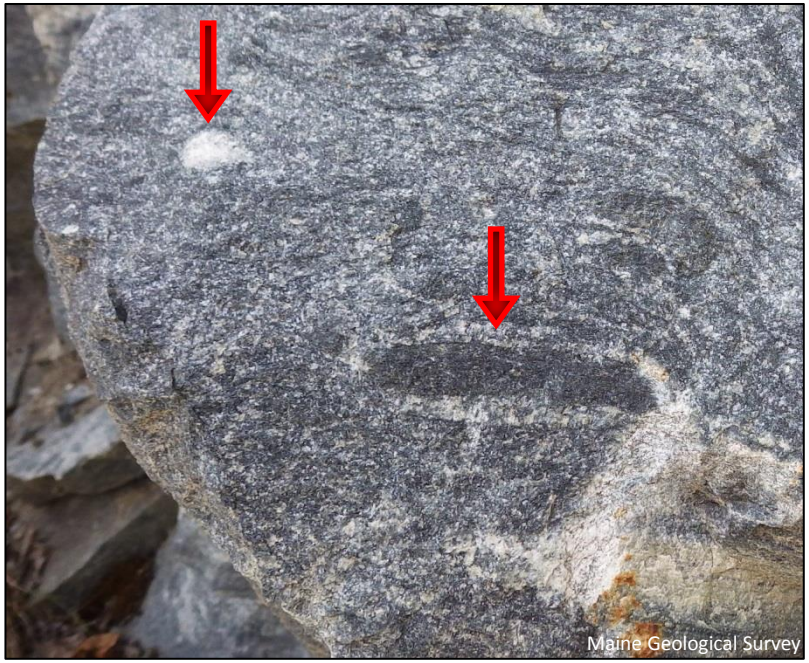
Photo by Henry Berry

Figure 12. Bedrock at Sarampus Falls showing metamorphosed material deformed by flow.

An Ancient Seaway and Intruded Molten Rock

The bedrock at Sarampus Falls belongs to a large region called the Chain Lakes Massif. Included fragments in the rock tell us about the early origins of this rock. What are now metamorphic rocks of the massif may have formed initially as sediment deposited 480 million years ago in a seaway that separated ancestral North America to the west and an arc of islands that now make up rocks now found a few miles to the east (Gerbi, et al., 2006)





Photos by Henry Berry

Figure 13. Bedrock at Sarampus Falls showing included fragments.

An Ancient Seaway and Intruded Molten Rock

Amidst the fragments and streaks are portions of the rock that are light colored, which are interpreted as formerly melted rock. What is the origin of this melt? Evidence suggests that the material comes primarily from within the original sedimentary rock. Around 470 million years ago, heat from within the Earth may have cooked the Chain Lakes rocks in place. Minerals with a lower melting point became flowing magma that we now see as formerly melted rock. Other material retained its structure, but transformed into new minerals. The entirety of the mass, metamorphosed rock and (igneous) magma, flowed together causing the variety of patterns seen in Figures 12 through 17.

Photos by Henry Berry

Figure 14. Bedrock at Sarampus Falls with lighter colored melt rock highlighted.

An Ancient Seaway and Intruded Molten Rock

There are many examples of materials in the bedrock that have retained some of their structure but have been metamorphosed, deformed or repositioned by flow.

Photo by Henry Berry

Figure 15. Bedrock at Sarampus Falls with curved streaks and rounded, rotated fragments.

An Ancient Seaway and Intruded Molten Rock

New minerals which are stable at high temperature, grew during metamorphism.

Photo by Henry Berry

Figure 16. Bedrock at Sarampus Falls with metamorphosed mineral grains.

An Ancient Seaway and Intruded Molten Rock

Features formed during earlier stages of the bedrock history continued to be deformed as the metamorphic process progressed.

Photo by Henry Berry

Figure 17. Bedrock at Sarampus Falls with white layered fragments cut off on left side, thinned and curved toward the right.

Flow at Sarampus Falls Rest Area

Flow in the materials surrounding Sarampus Falls Rest Area began 480 million years ago. Sediments from an ancient continent and a nearby island arc were deposited in a prehistoric seaway. As a result of tectonic shifting around 470 million years ago some of this material was melted in place, producing magma, causing a flow of not water, but rock. The patterns of this movement are preserved in the bedrock here at Sarampus Falls.

More than 12,000 years ago flow left its mark again. As a glacier that shaped much of Maine's landscape receded, large volumes of water powered through the area. This scoured the bedrock and buried it in sand, gravel and cobbles, still seen at the site.

Now, modern flow patterns are shaping the landscape leaving behind more smoothed rock surfaces, rounded cobbles and river terraces. A visit to Sarampus Falls provides a window to each of these times when flow shaped northwestern Maine's landscape.

References and Additional Information

Borns, Harold W., Jr., and Calkin, Parker E., 1977, Quaternary glaciation, west-central Maine: Geological Society of America, Bulletin, v. 88, no. 12, p. 1773-1784.

Borns, H. W., Jr., Doner, L. A., Dorion, C. C., Jacobson, G. L. Jr., Kaplan M. R., Kreutz, K. J., Lowell, T. V., Thompson, W. B., and Weddle, T. K., 2004, The deglaciation of Maine, U.S.A.: in Ehlers, J., and Gibbard, P. L. (editors), Quaternary glaciations - extent and chronology, Part II: Elsevier, p. 89-109.

Gerbi, Christopher, 2006, The Boundary Mountains of Maine: Diatexite and the Taconian arc: in Gibson, David, Daly, Julia, and Reusch, Douglas (editors), Guidebook for field trips in western Maine: New England Intercollegiate Geological Conference, University of Maine at Farmington, p. 1-12.

Gerbi, C. C., Johnson, S. E., Aleinikoff, J. N., Bédard, J. H., Dunning, G. R., and Fanning, C. M., 2006, Early Paleozoic development of the Maine-Quebec Boundary Mountains region: Canadian Journal of Earth Sciences, v. 43, no. 3, p. 367-389.

Trzcienski, W. E., Jr., and Rodgers, John, 1991, Alternate hypotheses for the Chain Lakes Massif, Maine and Quebec (abstract): Geological Society of America, 1991 annual meeting, Abstracts with Programs, v. 23, no. 5, p. 138.