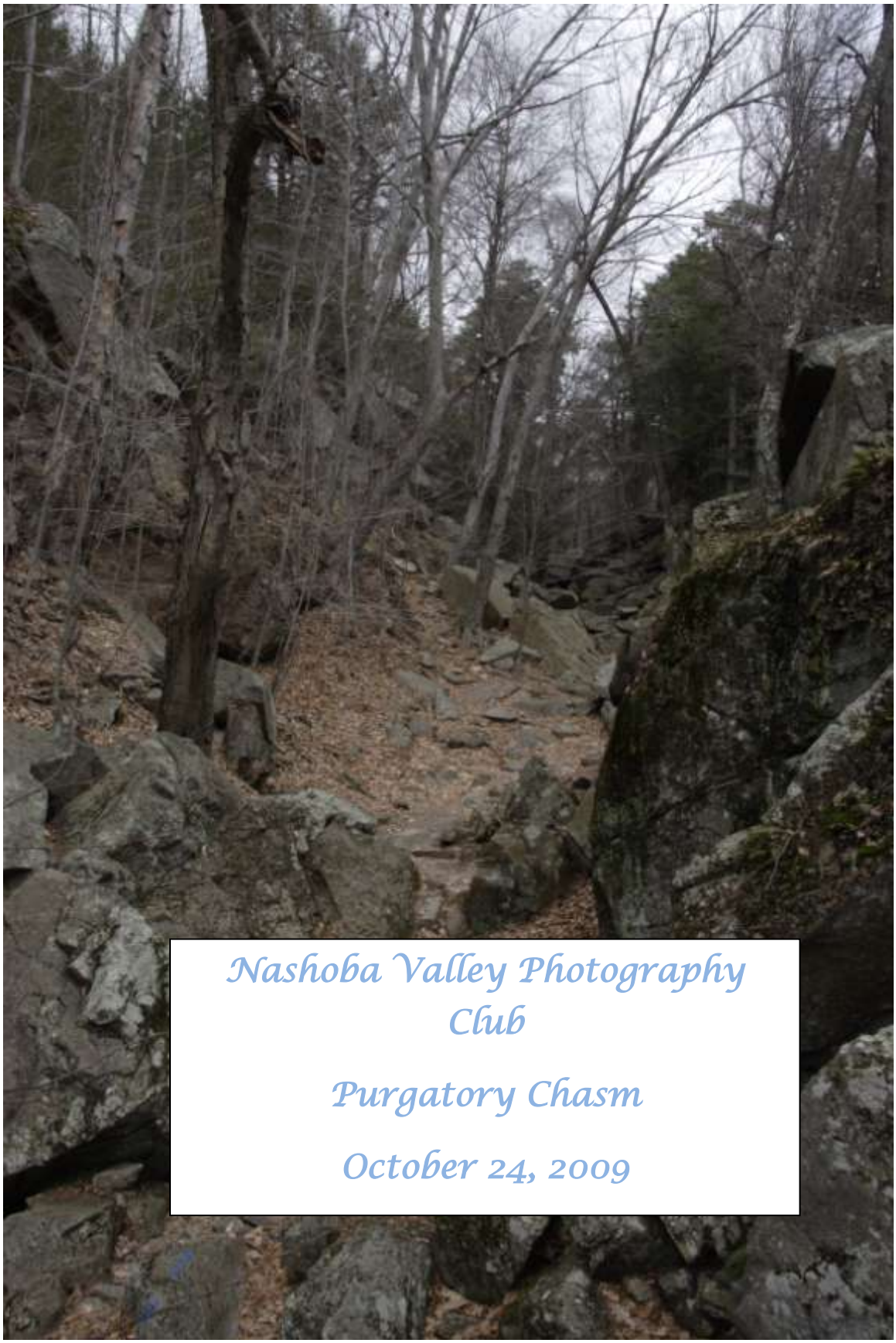


Nashoba Valley Photography Club

Purgatory Chasm

October 24, 2009

Purgatory Chasm Photography Trip

Nashoba Valley Photography Club

October 24, 2009 Meet at Westford Library at 7 am

Note: these notes were taken from different web sites and are provided for interest and background for our trip.

Welcome to Purgatory Chasm State Reservation

"This is the most stupendous place, and fills the mind of the beholder with the most exhalted ideas of the infinite power of the great Creator of all things..."
Peter Whitney, Worcester County: America's First Frontier, 1793

The Corn Crib, Fat Man's Misery, The Coffin, The Pulpit, Lover's Leap, His Majesty's Cave...the names given to the rock forms in the Chasm attest to a long fascination with its formidable landscape.

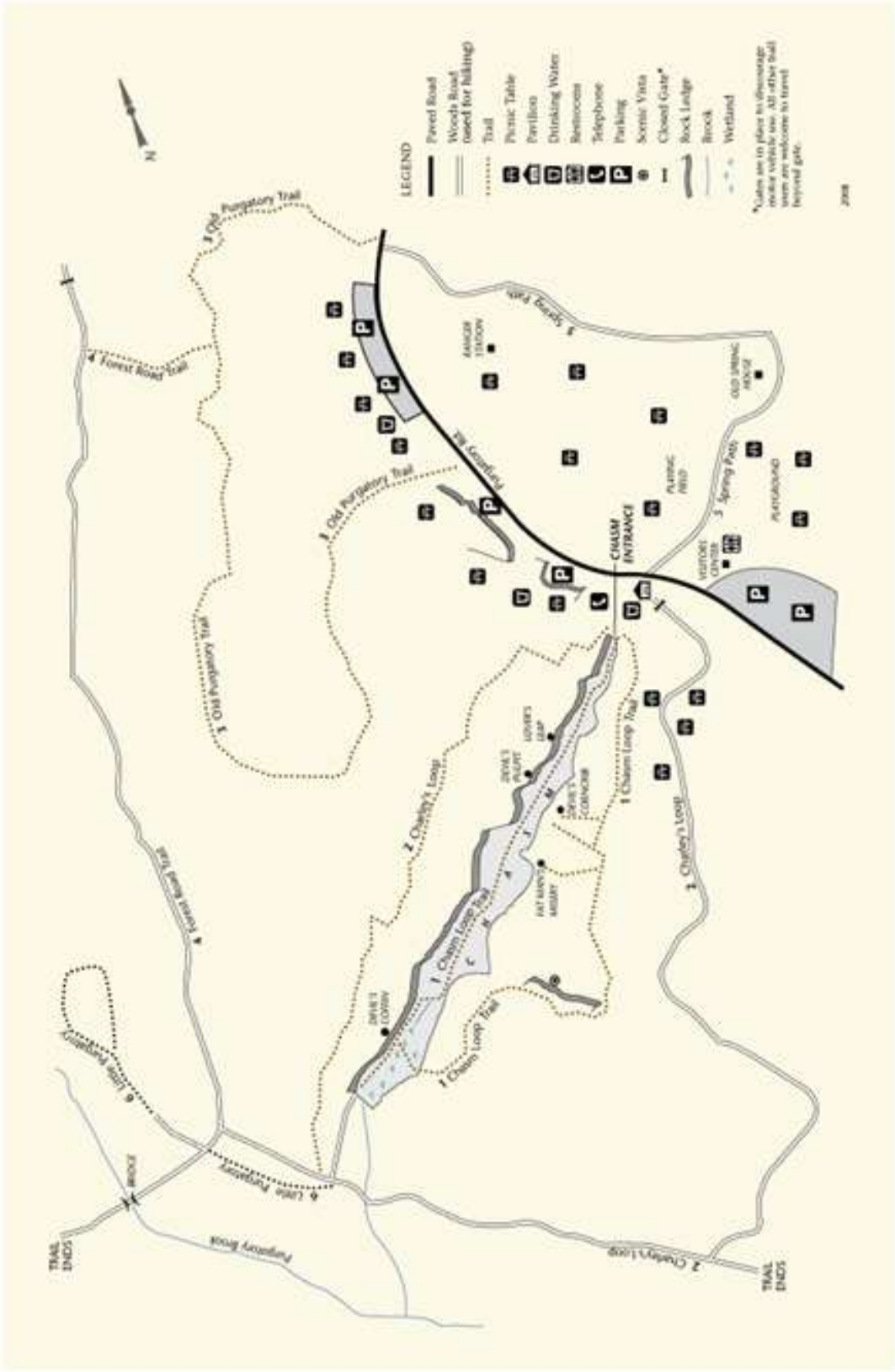
Our tour

Purgatory Chasm is a state park with some interesting rock formations and wooded walks which should provide creative photo opportunities. The park is about 1 hour from Westford in Sutton Ma (south of Worcester). We will depart at 7 am to get good morning light. There are several trails at the park and 3-4 hours should be adequate. There are facilities for lunch if people want to bring their own lunches. The yellow trail (Charlie's loop) is not steep or rocky but some hiking is required. The blue trail (Chasm loop) is more challenging but not serious hiking. Both trails are about 1 mile long. The trails can be walked in either walking shoes or hiking boots. Restrooms are available at the main visitor's center.

From discussions with the ranger, the fall color should be close to peak when we go there in October. These are typical scenes that we might see

Getting to Purgatory Chasm

Purgatory Chasm Trail Map



Notes for fall photography

The fall foliage is expected to be exceptional this year due to the rain we had in June and July and the warm August and September. Based on foliage maps, we will be going to Purgatory Chasm at the peak foliage season. Here are some tips for fall photographing that I have picked up from magazines and other reading

- Use a tripod for razor sharp images even if you have image stabilized lenses
- Use a polarizing filter to create a deep blue sky and take some of the glare off the leaves and bring out the colors
- Take your time to compose your photographs. Think about what it is that is capturing your interest in each scene.
- Use your f stop to create the depth of field that you want for each image. The tripod will allow you to take fast or slow images to match the f stop.
- Underexpose your photographs by ½ to 1 stop for best saturation of the fall colors. Your light meter is calibrated for blues and greens and not the reds and yellows of fall
- Use a low ISO for the best detail of the leaves
- Be creative - think big and think small
- A flash is often useful as a fill flash. I set mine for -2/3 f stop to provide a good fill for shadows
- Consider bracketing your shots and processing with High Dynamic Range software but don't be a slave to HDR
- This is the time of year that many mushrooms come out on the forest floor. Look down as well as up. These mushrooms take a variety of shapes and often have beautiful soft colors
- The chasm and the individual rocks in it offer endless opportunities for photographs – both close up and wide angle

Things to bring

- Clothes for the weather – it may be cool
- Shoes for walking in the woods
- Camera
- Tripod
- Polarizing Filter
- Flash attachment
- Spare battery and memory cards
- Water or other drinks if you want them
- Snacks if you want them

History of Purgatory Chasm

According to legend, Hobomoko (the Native American devil) carried a woman to Purgatory Chasm after she had murdered a "white man". When the woman began to fight, Hobomoko hit her head against a boulder and attacked her with a tomahawk. The bowl-like depressions show where her head hit the boulder, the ax-marks where the tomahawk struck, and the footprints in the vein of stone where he carried his victim's body to the edge of the fissure.

Purgatory Chasm State Reservation was established under an act written by Mr. Herbert L. Ray in 1919. This act created the Purgatory commission which consisted of three members, all of whom were residents of Worcester County. Mr. Ray was a member of this commission, and also served as the Superintendent of the reservation until he passed away in 1941.

Geology

(The following text is taken directly from the welcome bulletin board at Purgatory Chasm.)

For many years, the origin of the Chasm was attributed to wave action or the trauma of earthquakes. Most geologists today, however, agree that the chasm was formed when large volumes of glacial ice melted and were suddenly released. Purgatory Chasm was an escape route for ice fed torrents from Ramshorn Pond, Singletary Pond and Casey Brook on the western part of Sutton. The force of the sudden release broke away large blocks of granite and deposited gravel terraces further to the south in Whitinsville. The Chasm is about one-fourth mile in length, with sheer rock walls rising as high as seventy feet in some places. The ice-worn rocks surrounding the Chasm have long been favorite destinations for picnics and explorations. As early as 1793, historian Peter Whitney wrote that many visitors came to the Chasm to experiment with dropping pebbles, to marvel at the icicles still visible in May or June and to climb the boulders and explore the small caverns. "After all," write Whitney, "no description given of this place, by another, will enable persons to form just and adequate conceptions of it."

Geology History

Note: I included this because of the radically different theories about how the Chasm came to be. Bob

The first state geologist of Massachusetts, Dr. Edward Hitchcock (1793-1864) of Amherst, described Purgatory in his Geology of Massachusetts published in 1841.

“It is a fissure in gneiss (rock type), nearly half a mile long, in most parts partially filled by the masses of rock that have been detached from the walls. The sides are often perpendicular, and sometimes 70 feet high; being separated from each about 50 feet.

This is an immense chasm: and I confess myself at a loss to explain its origin. It is natural to suppose that its sides have been in some manner separated from one another. But I can conceive of no mode in which this could have been accomplished, but by a force acting beneath: and this would so elevate the strata that they would dip on both side from the fissure. But I could discover no such dip. The inclination along the fissure correspond with that which is common in the region around; about 25° NE. In the vicinity of the fissure, however, the rocks are often exceedingly broken into fragments; and this circumstance indicates some early subterranean convulsion or the agency of troubled waters: And I am rather inclined to refer these fragments as well as the fissure, to the long continued action of the waves of the sea, when the spot was so situated as to form a shore of moderate elevation. The case of a purgatory in Newport, RI which I shall describe, will illustrate the mode in which the waves might produced such effects.

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Problems:

Dr. Hitchcock professes that he is perplexed by the Chasm, and at this point the science of geology was just beginning. The existence of ice ages and the resulting ice sheets had not even been proposed for North America. Thus, it is no surprise that Dr. Hitchcock had no ready explanation, as he readily admitted. There are no marine deposits in the vicinity of the chasm, nor does the lower part of the chasm indicate the smoothing that waves generate.

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A View to the end of the Chasm

Professor W.O. Crosby (1850-1926) of MIT and his son Irving B. Crosby (1891-1959) described the mode of chasm formation in the Bulletin 36 of the Geologic Society of America as an exceptionally normal example of a keystone fault.

" At no point do the walls of the chasm show the slightest trace of water action and the floor, instead of being bare and smooth, or covered only with rounded and waterworn boulders and pebbles, is piled with huge angular blocks of gneiss. The same fact, as well as the situation of the chasm on a hill and not in a valley, are fatal to the notion that it is the channel of some ancient river. Glaciation also is entirely out the question for the chasm is transverse (ne-sw)to the direction of glacial movement (nw-se), its wall are entirely unglaciated and it is devoid of (glacial) drift.
The only explanation commending itself to my mind is that referring the chasm to a local subsidence. In short, I conceive that during some disturbances of this portion of the earth's crust, such as a violent earthquake, the wedge shaped mass of rock included between the two master joints converging downwards has dropped, to a depth of 100 feet, more or less, thus giving rise to the chasm.

It is a common but evident error to refer all such geological events to some remote period and I have seen nothing inconsistent with the view that Purgatory, in Sutton, is geologically speaking of very recent origin, being perhaps only a few centuries old.

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Problems:

Professor Crosby correctly notes the lack of water action as an erosive agent, precluding water as the principal agent of erosion in the chasm. He also correctly noted that the chasm does represent a fault plane. This theory proposed prior to our understanding of rock mechanics and earthquakes, could not have foreseen that a Keystone Fault, in which the bottom of the chasm just drops, does not occur at this scale or in this type of rock. This would require a downward shift of the entire earth's crust beneath the chasm. His notion that glaciers could not have eroded the chasm because no glacial drift exists and the chasm is oriented incorrectly are both incorrect. There is considerable glacial drift around the Chasm. Glaciers do not generally erode by flowing through a narrow valley gouging the rock out, but by plucking rocks out. This means the glacier need not flow parallel to the chasm orientation.

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Spring emerges at the end of the Chasm

In 1951 Professor R.J. Lougee a geologist at Clark University reexamined Purgatory Chasm. His widely quoted theory has been accepted by many for several decades, though it also is unrealistic.

"Aerial photographs show that Purgatory Chasm is part of an ice-marginal channel cut through a ridge of bedrock in an area of strongly jointed granite surrounded by regions of schist and gneiss. Other glacial streams nearby cut in till and schist, have none of the spectacular qualities of this gorge. If Purgatory is a water-quarried chasm, it contained a falls descending initially from 550 feet in elevation at the ice polished saddle in the granite ridge to 475 feet at the base--a descent of 75 feet in a horizontal distance of 400 feet. The crest of the falls was eroded headward through the granite to a final elevation of 530 feet, at the point where visitors enter the chasm. The water fall theory assumes that when the last ice border had melted back to a position abutting on the north side of the 550 foot saddle in the granite ridge, and the ice cap still covered all regions to the north,

an ice marginal lake in Casey Brook Valley was released suddenly forming a torrent that flowed along the ice edge to a point where the water could discharge into Purgatory Brook Valley through the Chasm. From map and ground study it can be shown that several northward sloping tributary valleys on the west side of the Blackstone Valley, including the basins of present day Ramshorn Pond, Singletary Pond and Casey Brook in the western part of Sutton, were dammed by the front of the retiring ice sheet so that ice border lakes were formed at various levels up to 650 feet. From this elevation downward almost to the Blackstone River the Blackstone watershed is scarred on its west side by glacial channels so located on hillsides and spurs of the valley wall as to indicated southeastward release of the lakes as the ice margin melted back toward the northeast. Pounding action of the boulders that were rolled over the falls broke out joint blocks, and all but the largest blocks were washed away at the same time rock expansion (pooping rock) in the process of this sudden quarrying may have assisted in further disrupting the granite. The floor of the chasm is now completely hidden by great blocks that may represent accumulations due to post glacial weathering of the walls, for immense masses threaten even now to fall into the chasm. However, the channel of Purgatory Brook contains potholes that testify to volumes of be load discharged through the chasm and by other ice-fed torrents in the valley of this small brook, and that are now preserved in gravel terraces further south in Whitinsville.

Rounded Rock in Little Purgatory

The entire work of rifting the Purgatory chasm must necessarily have been completed before the ice border melted away from the present upper end of the chasm; in fact the magnitude of the excavation argues for a large volume of water working incredibly fast. The flume in Franconia Notch, NH was perhaps formed in a similar manner.

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Problems:

The Lougee theory ignores the accurate observation of Professor Crosby that there is no evidence of water erosion in the chasm or on its walls. You cannot have water erosion without the smoothing results it has on the walls of any rock it flows against. More importantly how do transfer the water from the Casey Brook Valley to the head of the chasm. Standing at the entrance to the chasm you are on a ridge. How can water flow down a ridge? Each valley and low point must be plugged with ice. Thus, the entire area north and east of the chasm that is at a lower elevation than the chasm entrance, must be filled with ice.

This includes the valley across the road where the playground and picnic area are, the parking lot by the visitor center along Route 146, the saddle at the west entrance to the Reservation where the pond is, and the entire Blackstone Valley from Sibley and Clark Reservoir south to Purgatory. To reach the chasm from Casey Brook Valley this river would have dropped 100 feet. To erode the chasm it must be a large dynamic erosive stream that would have been unable to pass over the area north of the chasm without leaving a very distinct path. Since in dropping 75 feet it eroded the chasm according to Dr. Lougee. If we sketch in the areas that would have to have been with ice to allow the river to reach the chasm, we have a completely unrealistic picture. A lake trapped on the highest ground in southern Worcester County surrounded by low areas all filled by ice. Than a glacial river would along the border between the valleys filled with ice and the clear uplands. This substantial river manages to leave no trace from Casey Brook to Purgatory Chasm. Having worked on more than 200 different glaciers, many with lakes on them, the tendency for subglacial drainage is ubiquitous as it would have been here. There is no mechanism to trap the water on a valley wall, this does not happen on glaciers of similar size today in Alaska or Greenland.

The only evidence of water erosion are the potholes upstream along Purgatory Brook of the chasm exit, thus, they could not have resulted from water flowing through the chasm. The potholes instead result from drainage down the Purgatory Brook Valley from the Little Purgatory Brook. The natural drainage path for any glacial runoff from the north is into the Purgatory Brook Valley at the pond marking the western edge of the reservation. The area immediately down valley of this pond but upvalley of the chasm exit is known as Little Purgatory and is the site of the potholes indicating limited fluvial erosion. Potholes are also slow developing features, several famous potholes in the Alps have been observed to develop over a period of decades. Certainly a period well beyond that of an outburst flood is necessary.

The Lougee theory also ignores the eskers that lead from Sutton toward the Blackstone Valley indicating that drainage was in fact occurring toward and in the valley. The sand and gravel deposits along the Cold Spring Brook are from glacial streams draining toward the Blackstone Valley.

It must be emphasized that none of the above theories were completely acceptable to the authors. It is much easier to identify problems with specific reconstructions of geologic events than it is to put together a comprehensive theory. Lougee, Hitchcock and Crossby did not have the chance to visit currently glaciated areas. It must be emphasized that trying to determine a formation that is of glacial origin without having actually visited currently glaciated terrain is difficult.

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Theory proposed by Dr. Mauri S. Pelto, professor of geology at Nichols College.

Exactly what happened to form the chasm cannot be pieced together. However, common sense and general observations within the chasm will lead to the general mode of formation. First at the entrance there is some glacially polished rock. This rock could not have been glacially polished and then withstood

the glacial torrent of Professor Lougee. One of the first boulders you step on entering the chasm is grooved. The grooves form by motion along a fault plane. With the rocks on opposite sides of the fault grinding against one another. The sides of the chasm exhibit a series of northward dipping joint surfaces. These joints do not match up across the chasm indicating displacement of the two chasm walls. This occurs only along fault planes. Thus, the chasm is a fault plane. The tectonic forces in the area that could generate such faulting have been silent for 200 million years. Thus, the fault caused a weakness in the rock, but not an open fissure. This crack in the rock across which there was displacement, was then taken advantage of by ice and water to form the chasm.

The initial section of the chasm is filled with boulders that fell in from the walls after formation burying any evidence as to its mode of formation. Near the end of the chasm rockfall is rare and the walls of the chasm show no polishing from water, nor are the gravels in the bottom of the chasm rounded. This is particularly evident near the Coffin. Beyond the end of the chasm Purgatory Brook Valley is littered with large boulders from 1 to 3 m^3.

These boulders could not be moved by anything short of a massive flood, but even in this case they should be rounded and would not be randomly scattered across the valley bottom and somewhat up the next valley wall. Thin sections taken from these boulders indicate that they came from the chasm. This is the chasm filling shifted south. What extracted and then carried the boulders out of the chasm?

Glaciers typically erode rock not by grinding, but by plucking. The base of the glacier is a wet region. Much of the water is generated from the pressure of ice moving into hard rock protuberances at the base, causing pressure melting. This water then trickles along the rock into cracks and downslope of rock obstacles to refreeze where pressure is reduced. As it refreezes it often fills joints and crack in the rock and freezes to the base of the glacier. The rocks are thus frozen to the bottom of the glacier and carried away. However, like grit on sandpaper these rocks are then easily knocked off when they in turn come into contact with bedrock as the glacier grinds onward. I have had the chance to observe the base of many glaciers, there are substantial areas at the base of each glacier that are loaded with rocks scraping along the rock surface. You can also observe the melting and refreezing around boulders that the glacier is plucking from the rock outcrops.

In the chasm we can observe that there is no source of water for a stream, there is no water erosion evidence in the chasm only in the Purgatory Brook Valley. The boulders taken from the chasm are large, unrounded and widely scattered in the valley immediately beyond the chasm. All of these points argue for the plucking action of a glacier moving over a preexisting crack in the rock caused by faulting. This is a typical mechanism of glacier erosion. Professor Crosby did not think the glacier could flow through the chasm because of its orientation. He was correct. The glacier-icesheet really is far to large to flow through the chasm. However, water dripping from the base of the glacier and refreezing in the chasm allowed rock material to be incorporated into the base of the glacier and carried out of the chasm. This material now litters the Purgatory Brook Valley.