Geomorphology and Glacial History of Sunlight Basin, Park County, Wyoming

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Introduction

Sunlight Basin is located a few kilometers to the east of Yellowstone National Park. The main part of the basin is eleven kilometers long from east to west and between one and two kilometers wide from north to south. The mouth of Sunlight Basin faces the Clarks Fork Canyon, and Sunlight Creek drains into Clarks Fork of the Yellowstone river. Several small valleys are located on the north and south edges of the basin. My field area covered the main basin and several of the adjacent valleys.

Three groups of rocks crop out in the Sunlight Basin area (Pierce and Nelson ,1971; Pierce, Nelson and Proska ,1982). Cambrian sandstone, limestone and shale form the bedrock at the eastern edge of the basin. Heart Mountain fault blocks containing Paleozoic carbonates and shales form some of the cliffs surrounding the basin. Cenozoic Absaroka volcanic rocks compose many of the hills surrounding the basin. Though no granite crops out within the basin, Precambrian granitic boulders can be found there. These boulders were transported into the basin during the Pleistocene when Sunlight Basin underwent one or more periods of glaciation.

The glacial history of Sunlight Basin was first investigated by Parsons (1937), who cited evidence for two periods of glaciation and the presence of a large lake in Sunlight Basin during the first glaciation. He believed that a glacier at the mouth of the basin blocked the drainage of the basin, causing the formation of the lake. He based his interpretation of two periods of glaciation on the morphology of the moraines found within the basin and the presence of differing rock lithologies in the separate moraine systems. I investigated the geomorphology of Sunlight Basin to find evidence for a glacial lake and to gain a better understanding of the timing and extent of glaciation within the basin.

Methods

In the field, I located and described the geomorphic features. I also recorded the location of each feature on a topographic map and noted the elevation of the feature in my field book. For tills, I noted the grain size of the matrix and the lithologies of clasts. I made maps by transferring data from my field map and verifying locations of features with air photos. I used the position of moraines and the elevation of erratics to determine the maximum elevation of the lake and to determine glacial limits.

Geomorphic Features

The geomorphic features in Sunlight Basin can be divided into glacial and postglacial features (Figure 1). Glacial features include lateral, terminal and recessional moraines, kettles, and possible outwash plains. Postglacial features include flood plains, a sinkhole, gullies, dunes, alluvial fans, meandering and braided streams and stream terraces. There is a limestone gorge in the basin and one in Elk Creek valley.

The glacial features can be divided into two groups on the basis of the lithologies of cobbles associated with moraines. Glacial deposits located at the east end near the mouth of the basin, in Elk Creek valley, in Dead Indian Creek valley, along Painter Gulch and along Trail Creek all contain cobbles of Precambrian granite or Flathead Sandstone. Features found at the western end of the basin near the convergence of Sunlight and Little Sunlight Creeks do not contain Precambrian granite or Flathead Sandstone cobbles. Parsons (1937) also noted that some moraines in Sunlight Basin contained granitic rocks and Flathead Sandstones whereas the moraines at the west end of the basin did not. He used this as evidence for two distinct glaciations.

Clarks Fork Glacier

Moraines containing granite or sandstone cobbles were probably deposited by the Clarks Fork glacier. Precambrian granites and gneisses are not exposed anywhere within the Sunlight Basin drainage area and Flathead Sandstone is only exposed along the far eastern floor of the Basin. Flathead and granite cobbles were probably brought by ice moving into the basin from the Clarks Fork canyon area.

The terminal moraine of the Clarks Fork Glacier is located near the junction of Teepee Gulch and the main part of the basin. To the east of the terminal moraine is a series of recessional moraines. Lateral moraines along the sides of the Basin indicate that the maximum elevation of the glacier was about 7375 feet near the mouth of the basin.

Both Elk Creek and Dead Indian Creek valleys contain evidence that the glacier moved into these side valleys from Sunlight Basin. Both side valleys contain moraines with granite and sandstone erratics. The two valleys also contain fine-grained sediments. The sediments were probably deposited in lakes formed when the ice moving up valley from Sunlight Basin blocked drainage of Elk Creek and Dead Indian Creek.

Ice from the Clarks Fork glacier also moved over divides between the Clarks Fork valley and Painter Gulch, and between Clarks Fork and Trail Creek. Both of these valleys drain into Sunlight Basin. Parsons (1937) first proposed the movement of ice over divides, and my data support this interpretation. The moraines in these valleys contain granitic and sandstone cobbles. The valleys drain into Sunlight Basin west of the terminal moraine located in the main basin, indicating that ice did not move into the two valleys from the Sunlight Basin. Trail Creek valley contains a well-defined terminal moraine, whereas Painter Gulch does not.

Sunlight Glacier

Two well-defined moraines from the Sunlight Glacier are located near the junction of the Sunlight and Little Sunlight Creeks. These moraines contain no granitic or sandstone clasts. This indicates that the ice that formed the moraine was not from the Clarks Fork glacier, but rather flowed downvalley along the present course of Sunlight Creek.

Timing of the Two Glaciers

Parsons (1937) used the morphology of the Sunlight and Clarks Fork moraines to determine the relative age of the features. There is not a well-defined terminal moraine in Painter Gulch. In contrast, the Sunlight glacier moraines have well-defined crests. Parsons believed that the subdued topography of the Clarks Fork moraine indicated that the moraine had been more weathered than the Sunlight moraines. From this he concluded that the Sunlight glaciation happened much later than the Clarks Fork glaciation.

Parsons (1937) also proposed the presence of a glacier-dammed lake filling Sunlight Basin during the Clarks Fork glaciation. His proposal is supported by evidence for a glacial lake in the basin (see next section). Moraines formed at the contact between glaciers and lakes commonly have a very different morphology than moraines formed by glaciers not in contact with water (Sudgen and John, 1976). I suggest that the lack of a well-defined moraine in Trail Creek valley, and the presence of a small terminal moraine crest in the basin from the Clarks Fork glacier may indicate that the ice in these two areas might have terminated at the edge of a glacial lake.

Glacial Lake Sunlight

Parsons (1937) proposed the presence of a glacial lake in Sunlight Basin formed by the damming of the basin with ice from the Clarks Fork glacier. Ballard (1976) supported this interpretation on the basis of deposits related to catastrophic flooding associated with the draining of the basin. Parsons believed that the contrast of the flat basin floor to the steep basin sides indicated the presence of thick lake deposits. Though no shoreline features are present in the basin, there seems to be evidence for the former presence of Glacial Lake Sunlight.

Determining the former level of Sunlight Lake is important because this information might help determine which glaciers flowed into the lake. I found granite erratics at an elevation of 7250 feet on the southern edge of Sunlight Basin south of the Trail Creek-Sunlight Basin Divide. There is no evidence that glaciers ever flowed to this area, and it is highly unlikely that they did, considering the elevation and position of the terminal moraines of the glaciers in the basin. One explanation for the presence of these erratics is ice rafting: icebergs calved from a glacier and floated to the edge of the lake in the southwest part of Sunlight Basin. Rocks trapped in the ice would then be deposited at the level of the lake, putting the maximum level of the lake at 7250 feet. This is possible, considering that the Clarks Fork glacier enters Sunlight Basin at an elevation of 7300 feet, which means that it could have dammed the basin to this level. One difficulty with this interpretation is that there are no shoreline features at this, or any level within the basin suggesting that if the lake were at 7250 feet, it was not there for very long, though long enough for the rafting of many icebergs across the lake.

Another piece of evidence for the lake level not remaining at 7250 feet for long, is the fact that the terminal moraine in Trail Creek valley is considerably lower than 7250 feet. Either the lake must not have been present, or it was at a much lower elevation during much of the time that this moraine was being formed. Ballard (1976) proposed that Lake Sunlight drained several times in catastrophic events, as is evident by flood deposits located along the Clarks Fork River. Though he did not believe that the lake was as deep as 7250 feet, this periodic draining may explain the absence of shoreline features.

After the retreat of the Clarks Fork glacier, the terminal moraine could have dammed the basin causing the formation of a lake at an elevation of 6800 feet. Such a shallow lake would not have extended to the terminal areas of the Painter Gulch and Trail Creek lobes. With a lower lake level, a well-defined terminal moraine could have been deposited by the Trail Creek lobe. The Sunlight glacier moraines could also have been deposited after the retreat of the lake. The terminus of the Painter Gulch lobe would also have been above 6800 feet at the base. The Painter Gulch ice lobe might have retreated prior to the formation of the lake at the 6800-foot level, thus preventing the formation of a terminal moraine in the Painter Gulch area.

Given the fact that there are no shoreline features, and that the lake probably was at a level of 7250 feet at one time, the lake level probably fluctuated during its whole existence, possibly due to periodic catastrophic drainage and the subsequent refilling of the lake. Lake sediments would have been deposited in Glacial Lake Sunlight. So far, no lake sediments have been found exposed in the basin. If a better understanding of the glacial history of the basin is the be obtained, then more evidence of the depth and the longevity of the lake is needed.

References

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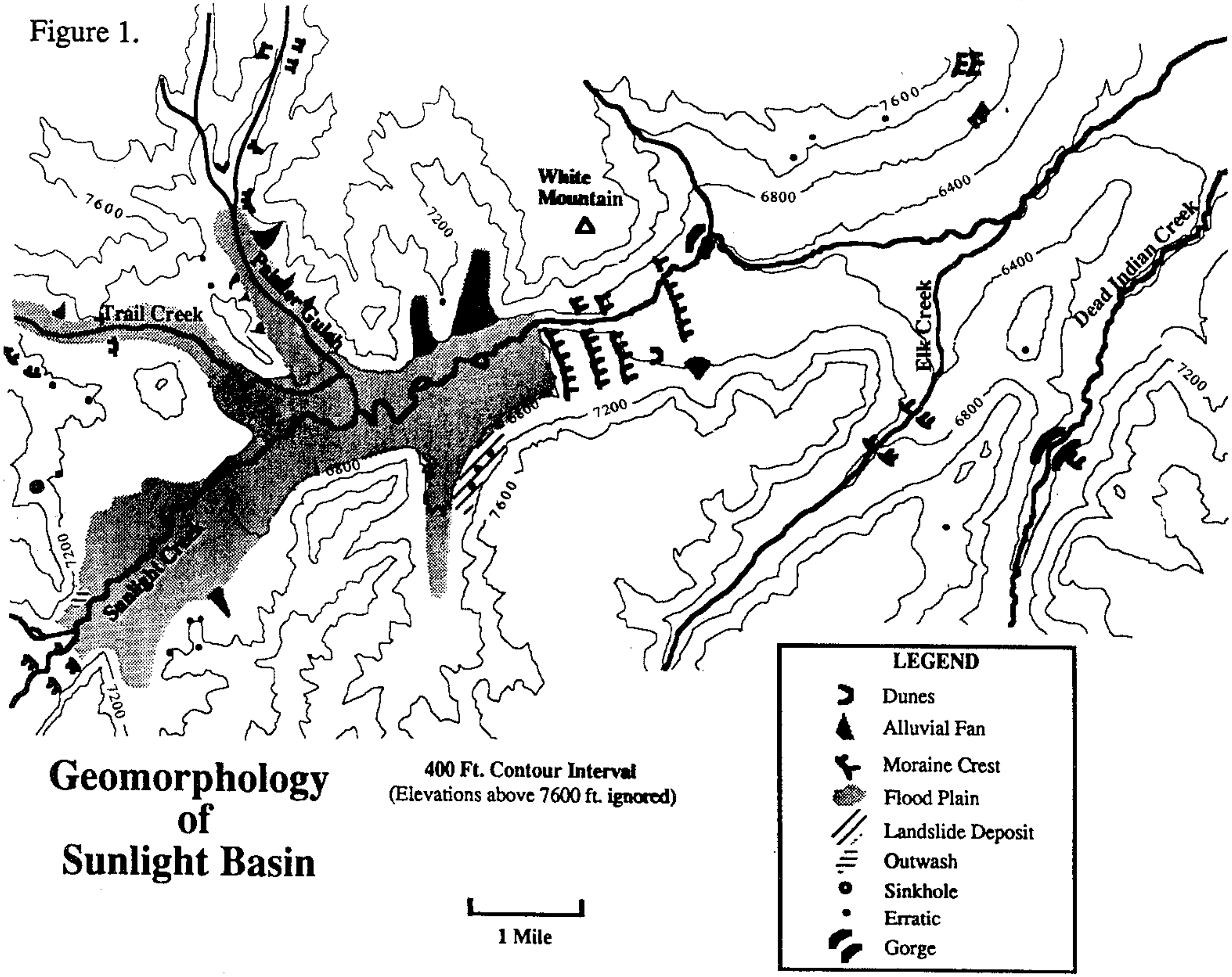
Figure 1.



White Mountain
Trail Creek
Painter Gulch
Sunlight Creek
Elk Creek
Dead Indian Creek
7600
7200
6800
6400
Geomorphology of Sunlight Basin
400 Ft. Contour Interval
(Elevations above 7600 ft. ignored)
1 Mile
LEGEND
Dunes
Alluvial Fan
Moraine Crest
Flood Plain
Landslide Deposit
Outwash
Sinkhole
Erratic
Gorge