**The Holocene History of the Sunlight Basin**
**Park County, Wyoming**

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## INTRODUCTION

Parsons first described the history of the Sunlight Valley in 1937. His research concluded that during the Pleistocene, the Sunlight Valley experienced glaciation from the north, east and west. Glaciers moved both up and down valley. The 12 $km^2$ area between the moraines of these two glaciers is referred to by Parsons as the Sunlight Basin. The majority of this study was conducted in the Sunlight Basin. The purpose of this study was to interpret the history of the valley since the glaciers retreated based on the present morphology and processes occurring in the valley.

The Sunlight Valley is located in Park County, Wyoming. The valley is east of Yellowstone Park, in the northern Absoraka Mountains, and includes portions of the Shoshone National Forest. The Beartooth Mountains lie to the south of the valley. The Sunlight Creek follows an approximately 39 km long course through the valley from it's headwaters at Sunlight Peak. The creek flows in a northeasterly direction and joins the Clark's Fork River just south of the Beartooth Plateau.

The underlying stratigraphy of the valley is essentially horizontal. Pre-Cambrian granite is overlain in places by blocks of the Heart Mountain fault. These blocks are composed of Paleozoic limestones, shales and silts. The Absaroka volcanics comprise most of the present day topographic highs. An important component of the regional stratigraphy is the outcrop of Pre-Cambrian granite on top of Beartooth Butte. (USGS Map of Beartooth Quadrangle 1971).

## METHODS

Stratigraphic sections were measured in three locations where the creek has eroded into its banks and nearly 6 m of mostly fluvially deposited sediments have been exposed. A core of the basin floor was taken. Carbon samples were collected from both the creek bank sections and the core sediments. Samples of the sediments comprising the alluvial fans were also collected. Profiles of the valleys adjacent to the basin area were made using a Geodetic GTS-2B Total Station Total Station.

The data collected with the total station was combined with information taken from topographic maps to make profiles of the alluvial fans. Profiles of the alluvial fans were constructed in KaleidaGraph™. Stratigraphic sections of the bank cuts and the coring site were composed. Radiocarbon dates were performed by Geochron Laboratories, Cambridge, MA. A longitudinal profile of Sunlight Creek was made from topographic maps. Air photos of the valley were studied.

## RESULTS

The stratigraphic columns combined with the carbon dates provide exact ages for the sediments in the valley (Figure 1). Carbon sample 1 was a wood chunk taken from a peat deposited layered both top and bottom by fine silts. The age of carbon sample 1 is 5,745 $\pm$90 years. Carbon sample 2 from the base of the main bank cut has an age of 7,920 $\pm$ 280 years.

The profiles of the alluvial fans yielded a plano-concave-upward geometry for all six fans. In addition all of the fans approximate a second order polynomial curve within 97% accuracy. The profile of the creek indicates that neither the up-valley moraine nor the limestone canyon are acting as nick point for the present stream.

Results of the air photos reveal numerous meander scars formed by the creek in the basin section of the valley as well as incision of the creek in the moraine. The morphology of the creek in the Sunlight Basin also has interesting braided to meandering transition characteristics.

## DISCUSSION

It is unusual that there is little evidence in the Sunlight valley for a glacial lake. No outcrops of glacial lake sediments have yet been uncovered in the valley. The expected deltas built into glacial lakes are also absent. Coring of the basin floor reveals no laminated clays. There is a ring of glacial erratics in the basin at 2210 m, but their presence is not irrefutable evidence for a glacial lake. Thus while in the field, a quest for evidence of the glacial lake was sought.

The data from the stratigraphic columns can be interpreted in the context of the timing of the glacial events in the Rocky Mountains. Richmond (1965) places the end of the Pinedale glaciation at 8,000 years B.P. based on soils formed on glacial till in the Wind River Mountain range of Wyoming. This data is easily correlatable to the Sunlight Valley because the Wind River range lies south of the Absaroka range. Porter, Pierce and Hamilton place the end of the Pinedale glaciation to be 9000 years B.P. Thus the wood chunk from an apparent flood deposit at the base of the main bank cut probably represents some of the first vegetation to form after the retreat of the glaciers. Therefore the lake sediments can be inferred to be relatively close to the surface of the present river in this area.

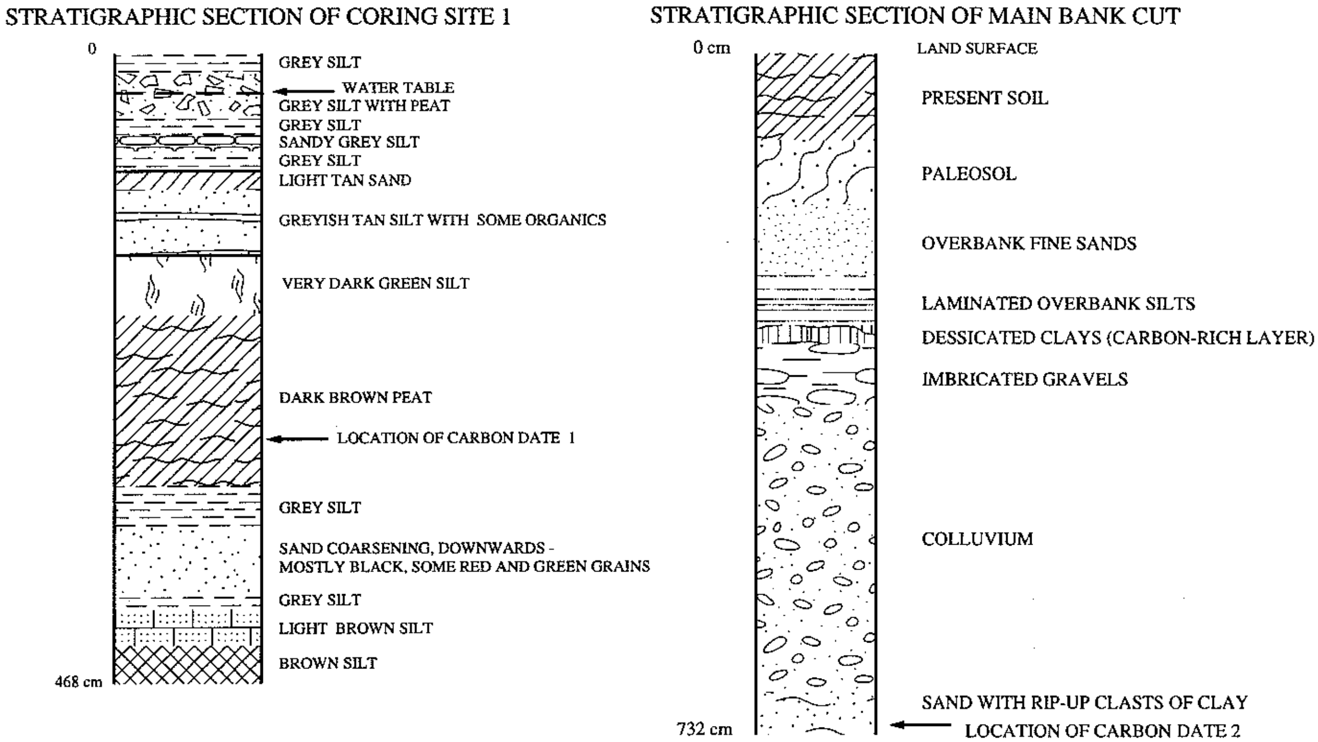

Figure 1 Stratigraphic sections of basin sediments. Note location of carbon dates.

It is important to the history of the valley to establish the timing of glacial events in the valley. Parsons (1939) refers to the two periods of glaciation in the valley simply as early and late periods of glaciation. The last two periods of glaciations in the Rocky Mountains are referred to as the Bull Lake and Pinedale. Obsidian-hydration and potassium-argon dating has indicated that the Bull Lake period ended 140,000 - 150,000 years B.P. (Pierce 1979). Pierce et al (1979) have established the period from 45,000 - 9,000 years B.P. for the Pinedale glaciation, with maximum extent of the ice at 20,000 years B.P. based on radiocarbon dates. Parsons said that the moraine located approximately 9.3 km up-valley from the Clark's Fork River came up-valley from the Beartooth Plateau because of the presence of the pre-Cambrian granite boulders in the moraine which outcrops only on the plateau. The up-valley movement of the ice-sheet is associated with the Pinedale glaciation. Thus if Parsons' early glaciation is Pinedale, then his later glaciation would have to be perhaps a very late stage of the Pinedale glaciation, or as suggested by glacial history study of the Sunlight valley by Erb (1995 personal communication), concurrent up and down valley glacier movement.

The profiles of the alluvial fans were made because through field observations Fan 1 appeared to have an unusual morphology. I hypothesized that if the glacial lake had been damned by the up-valley moraine, perhaps the observed break in slope could have been a delta built into the lake. Thus the transects of the fans were made. The profiles of the fans are in accordance with alluvial fan models. The Trollheim alluvial fan model provides for a plano-concave-upward geometry of alluvial fans. This geometry is formed by distally decreasing slope values (Blair and McPherson 1992). All six of the fan profiles display a concave upward geometry (Figure 4). The formation of these fans provides some interesting observations relative to the basin history. The current source area for the fans seems small relative to the size of the present day fans. This is especially true in the morphologies of Fans 1 and 5 (Figure 5). The absence of glacial erratics from the Beartooth Plateau on the surface of the fans combined with the current watershed/current fan size discrepancy is evidence for the formation of these fans from glacial melt water. Parsons has interpreted ice from the Beartooth Plateau breaching the divide and coming down Trail and Painter Creeks. This observation is especially true in the morphologies of Fans 1 and 5 (Figure 5). The absence of glacial erratics from the Beartooth Plateau on the surface of the fans combined with the present watershed/present fan size discrepancy is evidence for the formation of these fans from glacial melt water. Parsons has interpreted ice from the Beartooth Plateau breaching the divide and coming down Trail and Painter Creeks. This observation is important in developing the history of the basin because it has been shown that alluvial fans in close proximity to glaciers or glaciated areas often form during or shortly after the beginning of glacial recession. Thus "fans in or near glaciated regions become time-dependent phenomena" (Ritter and Ten Brink 1986).

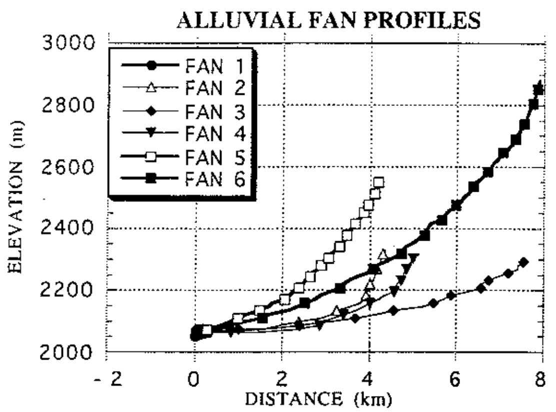


Figure 2. Profile of all six fans

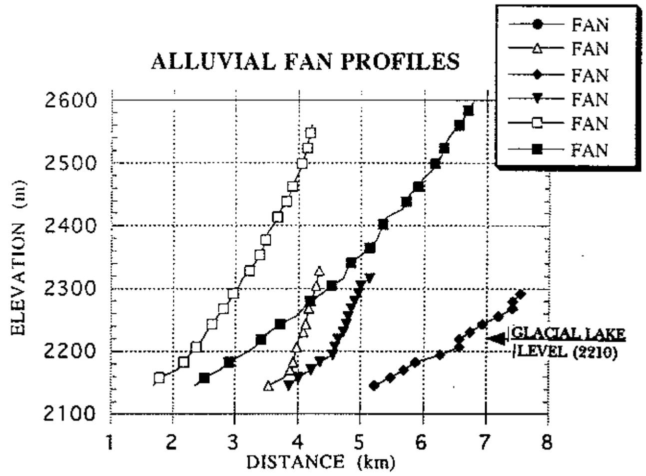


Figure 3. Profile of 5 fans at level of glacial lake

The profile of the current creek is that of a graded stream. A graded stream is defined as a stream that has reached an equilibrium state. Equilibrium is controlled by slope, discharge, load and channel characteristics. The slope of a graded stream is a concave upward curve. "Irregularities along a profile, then, should be suspected as clues to additional constraints of structure, lithology, or recent deformation of the profile by tectonic or mass movements" (Easterbrook 1993). The current profile indicates that the neither the up-valley moraine nor the limestone canyon are acting as nick points for the stream.

The air photos revealed that the stream has braided to meandering characteristics as it flows across the basin. The photos also reveal numerous meander scars and incision of meanders by the river in the up-valley moraine. These are important observations for the history of the valley. Schumm (1960) did many experiments regarding braided versus meandering morphology. He found that the ease with which the banks and floor of the river channel can be eroded under the hydraulic shear conditions of the stream permits the stream to develop a channel form consistent with the erodability of the bank forming material. Thus cohesive bank material has meandering channel form while less cohesive bank material has a braided channel form. This can be seen in the air photo observations. As the creek flows across the relatively less cohesive fluvially deposited sediments of the basin it has both braided and meandering characteristics while it strictly meanders where it enters the cohesive sediments of the moraine.

## CONCLUSIONS

A study of the current processes and morphology in the valley is an excellent indicator of the history of the basin in the Holocene. The history of the basin can be interpreted as follows (Figure 4).

During the Wisconsin period, ice moved south off of the Beartooth Plateau and moved down the Clark's Fork Valley. Encountering Dead Indian Hill and Bald Mountain directly in it's southwest path, the ice split into two lobes and traveled east and west. However, only a small portion of the glacier could move through a large canyon that was present just east of the confluence of Russell, Sunlight and Dead Indian Creeks with the Clark's Fork River. Thus, the majority of the glacier traveled up Sunlight Creek with Russell and Dead Indian Creek receiving portions of the up-valley glacier as well. The glacier left its terminal moraine approximately 9.3 km up valley from the Clark's Fork River. The glacier left this moraine almost flush with White Mountain, filling the entire width of the valley. An ice-damned glacial lake was formed in front of the glacier. The level of this lake was approximately 2210 m (Erb N. personal communication 1995). Sedimentation into the lake commenced immediately. The level of the lake was quite variable, as there is very little evidence of shore lines or deltas built into the lake. A second period of glaciation also contributed to this lake. It saw a glacier coming down valley from the Sunlight Peak and halting approximately 17.4 km from the Clark's Fork River. This leaves the area of the glacial lake bottom to be almost 12 $km^2$. The current alluvial fans also started


Plate 2. (Sault and Thomas)