

# GLACIATION OF CACHE PEAK AND MOUNT INDEPENDENCE, CASSIA COUNTY, IDAHO

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## INTRODUCTION

With a summit 3151 m (10339 ft) above sea level, Cache Peak is the highest point in both the Albion Mountains and in southern Idaho. Northwest along a ridge from Cache Peak's summit is Mount Independence, 3033 m (9950 ft). Together, Cache Peak and Mount Independence form a cirque approximately 1.5 km long and 0.8 km wide on the north side of Cache Peak and the east and south side of Mount Independence. This cirque contains the Independence Lakes, five tarn lakes that fluctuate seasonally. In addition to the main cirque, Cache Peak possesses a cirque (960 m wide by 570 m long) on its east face and two smaller cirques (350 m wide by 350 m long and 300 m wide by 360 m long) on the west face. A small rock glacier, informally referred to here as the Independence Rock Glacier, is present in the smaller cirque on the west face, and was studied in detail. This study analyzes a variety of data collected on or around lateral and terminal moraines in order to map the last 140 Ka of glacial activity on Cache Peak (Figure 1).

## GEOLOGIC SETTING

### The Albion Mountains

Covering northern Utah and southern Idaho, the Albion Mountains are a 36 mile long, northeast-trending range (Anderson, 1931). Physiographically, the Albion Mountains are considered part of the Basin and Range Province, which extends from Canada to northern Mexico, approximately 3000 km, and has a maximum width of about 1000 km

(Coney, 1987). Four metamorphic core complexes constitute the Albion Mountains: Moulton, City of Rocks, Independence Lakes, and Big Bertha. As Cache Peak was formed from the Independence Lakes metamorphic core complex, we are primarily interested in this its structure. Cache Peak is comprised mainly of the Green Creek Complex (Armstrong, 1968). On Cache Peak, the Green Creek Complex is a porphyroblastic biotite-quartz-plagioclase-microcline gneiss (Armstrong, 1968). The Green Creek Complex formed in the Precambrian and was buried in the Cambrian (Armstrong, 1968). During the Paleozoic and Mesozoic, the section was buried even deeper until erosion in the Jurassic began to wear the overlying sediment away (Armstrong, 1968). Finally, rapid, post-Oligocene uplift exposed the complex fully (Armstrong, 1968).

### Glacial History of Region

The morphology of the Cache Peak's glacial landforms demonstrates that the region has experienced more than one recent glaciation (Anderson, 1931). The most recent glaciation the region experienced is likely the Pinedale Glaciation, which correlates with most of the Wisconsin glacial advance (Pierce et al., 1976). Multiple researchers have developed a glacial chronology for the Pinedale period. Using  $^{10}\text{Be}$  dating in the Wind River Range, Wyoming, Gosse et al. (1995) estimate the Pinedale glacial maximum occurred approximately 22.4-21 Ka years ago, and lasted 5900 years.

Whereas evidence of an earlier glaciation is present on the peak, it is more difficult to accurately gauge the age. Despite this, the earlier glaciation likely corresponds to the Bull Lake glaciation, correlating with the late Illinoian glacial period (Pierce et al., 1976). Bull Lake glaciation reached a maximum roughly 140 Ka (Pierce et al., 1976).

## **METHODS**

Locations where moraines were tested were recorded in a Trimble GeoExplorer. This data was then transferred into a digital raster graphic of a 7.5-minute USGS map of the study region

On each set of suspect moraines, several techniques were employed to estimate the age of the landform. First, surface boulder frequency was utilized. A boulder was taken to begin at 25cm (~10in). In this technique, 25 m<sup>2</sup> is squared off on a moraine. After this, the relative quantities of quartzite and granite boulders are recorded. Older moraines will have a lower frequency of granite boulders to quartzite boulders as the weak granite weathers at a faster rate than the more resistant quartzite.

Using a ruler, depths of weathering pits on granite boulders were measured to estimate age. Here, one expects the older moraines to contain granite boulders with deeper weathering pits relative to recent moraines.

The third technique used for moraine age estimates is a sonic-based procedure intended to provide a sense of the percent of fresh clasts present. This technique involves striking the boulders in the area with a rock hammer and determining the resulting sonic frequency. A high pitched “ring” indicates the outer layer of the boulder has not weathered significantly, while a lower pitched “thud” indicates the outer layer of the boulder has experienced significant weathering. Thus, a “ring” indicates a younger boulder and a “thud” indicates an older boulder.

The angles formed by moraine slopes were recorded to provide further information on ages. Older moraines have been exposed

longer and should have gentler slopes relative to younger moraines.

Degree of soil maturity was also used to estimate moraine ages. Older soils will have experienced a greater buildup of loess, indicating more time has elapsed since the formation of the moraine.

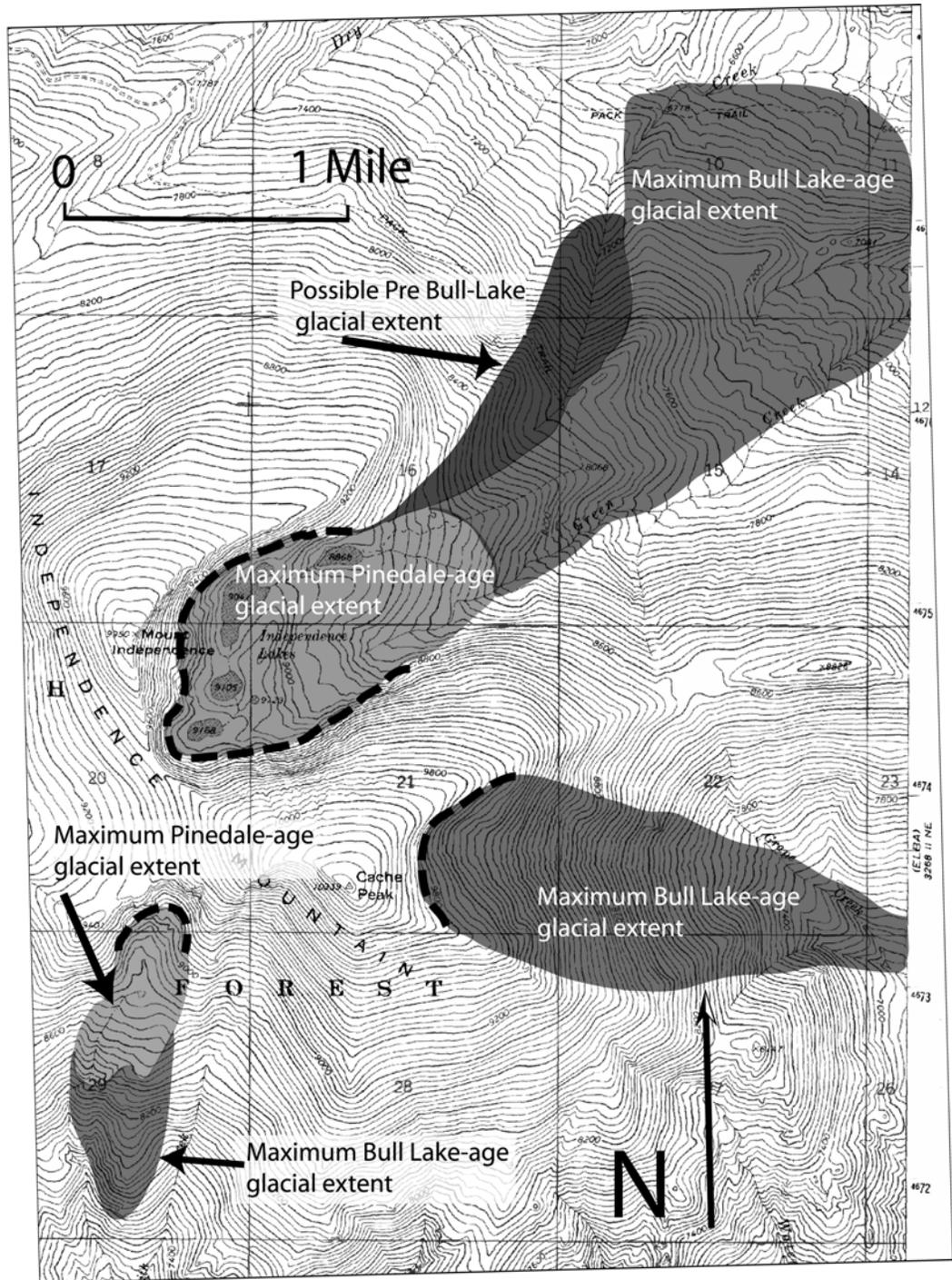
## **RESULTS**

### **Pinedale Glacial Extent**

Pinedale-age glaciation evidence, manifested as relatively shallow weathering pits on boulders, high boulder frequencies, younger soil and steeper moraine slopes, is not as extensive as evidence of previous glaciations on Cache Peak (Figure 1, lightest shading). On the large cirque on the north side of Cache Peak, evidence for Pinedale glaciation disappeared around 1800 m from the cirque headwall. Additionally, evidence on south side ends roughly 1060 m from the cirque headwall. No evidence for Pinedale-age glaciation was uncovered in the east cirque; only moraines with deeper weathering pits, low surface boulder frequencies, and mature soils containing large quantities of loess.

### **Bull Lake Glacial Extent**

Evidence for Bull Lake-age glaciation is more spatially expansive relative to Pinedale-age glaciation (Figure 1, medium shading). Deeper weathering pits, lower boulder frequencies, mature soil, and gentler moraine slopes are indicative of Bull Lake glaciation. Bull Lake-age moraines are present up to 4800 m from the cirque headwall on the north face of Cache Peak. On the south face, evidence for Bull Lake-age glaciation ends around 1600 m from the cirque headwall. Furthermore, there is a large bedrock tower approximately 500 meters from the point Bull Lake evidence ends. This tower would have been demolished by any advancing glacier, and thus provides a maximum limit of Bull Lake-age glaciation. Finally, on the east side of Cache Peak, Bull Lake-age evidence is found up to 3000 m from the cirque headwall.



**Figure 1: Map displaying the maximum glacial extent of the Pinedale-age, Bull Lake-age, and possible pre-Bull Lake-age glacial extent.**

### **Pre-Bull Lake Glaciation?**

There is preliminary evidence for pre-Bull Lake glacial extent of Cache Peak. This suggestion is based on evidence uncovered west of the Bull Lake limit on the north side of Cache Peak (Figure 1, darkest shading). Here,

there is a lateral moraine with deeply weathered granite boulders. This moraine yielded boulders with much deeper weathering pits than nearby Bull Lake-age moraines (Table 1). It is not possible to definitively state here whether this landform is a result of a

**Table 1: Summary of Relative Moraine Age Data**

Age of Glaciation	Mean Weathering Pit Depth (cm)	Total Boulder Ratio (granite/ quartz)	Mean surface boulder count per 25 m <sup>2</sup> per moraine	Mean Slope Angles (Inner/Outer)	Mean Ring/Thud Ratio	Soil Components
Pinedale	1.9	57/9	30	17°/23°	N/a	Low loess levels
Bull Lake	2.9	60/88	20	19°/16°	3/5	Higher loess levels
Pre-Bull Lake	5.9	N/a	N/a	N/a	N/a	N/a

pre-Illinoian glacial advance, the features present are consistent with a stage of glaciation prior to the Illinoian. However, the features could also have resulted from an initial surge of Bull Lake glaciation, and the other Bull Lake features examined are a result of late Bull Lake glaciation.

### Rock Glacier

A relict rock glacier, informally called Independence Rock Glacier, is present on the south-facing side of Cache Peak. Based on medium-sized trees growing on the feature, the Independence Rock Glacier has not been active for at least 100 years. As Hamilton and Whalley (1995) point out, classification of rock glaciers is fraught with disparities. Despite this, Hamilton and Whalley (1995) propose the term 'rock glacier' be applied to landforms existing on valley floors composed of angular rock debris generally possessing steep front and lateral slopes with lengths greater than widths. Morphologically, this describes the Independence Rock Glacier well. Rock debris in the feature was quite angular, and the largest boulder present was roughly 33 m<sup>3</sup>. Slopes measured on the Independence Rock Glacier were around 32°; steep, but less than the angle of repose for the constituent sediment. At the top, Independence Rock Glacier gradually grades into a talus. The maximum length of Independence Rock Glacier is approximately 260 m, while the maximum width is approximately 80 m.

### CONCLUSION

At the minimum, Cache Peak has experienced two separate glaciations: the Pinedale advance around 22 Ka (Gosse et al., 1995) and the Bull Lake glaciation around 140 Ka (Pierce et al., 1976). Bull Lake-age glaciation was much more expansive than Pinedale-age glaciation; evidence of Bull Lake-age glaciation extends up to 3 km further than evidence of Pinedale-age glaciation on the north side of Cache Peak. Cache Peak may have been glaciated prior to 140 Ka, as is evidenced by severe weathering on a lateral moraine out of the direct path of the Bull Lake glacial advance. Finally, to fully comprehend the glacial history of Cache Peak, it would be useful to perform cosmogenic dating of boulders on Pinedale and Bull Lake-age moraines.

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