DESCRIPTION OF AN ACTIVE ALPINE GLACIER, LOST RIVER RANGE, IDAHO

by
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ABSTRACT

An active alpine glacier at an elevation of about 10,400 feet is located approximately one kilometer northwest of Borah Peak in the Lost River Range of Idaho. Length of the glacier is nearly 400 meters and maximum width is nearly 300 meters. Seismic depth sounding indicates a maximum ice thickness of at least 64 meters. Crevasses in the upper portion of the glacier are generally open and continous whereas those in the lower portions are generally filled with rock fall and avalanche debris.

During field work in August 1975, a maximum firn depth of 2.5 meters was measured. Permafrost was found in surrounding surficial deposits within 77 centimeters of the ground surface. Periglacial processes are active in the area and periglacial landforms such as stony earth circles and stone stripes exist in proximity to the glacier.

Existence of this glacier is attributed to the following factors: 1) general location and morphology of the Pleistocene glacial cirque; 2) the shading effect of a high, precipitous arete; and, 3) snow accumulation from sheet avalanches off the cirque headwall and from a large avalanche chute.

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INTRODUCTION

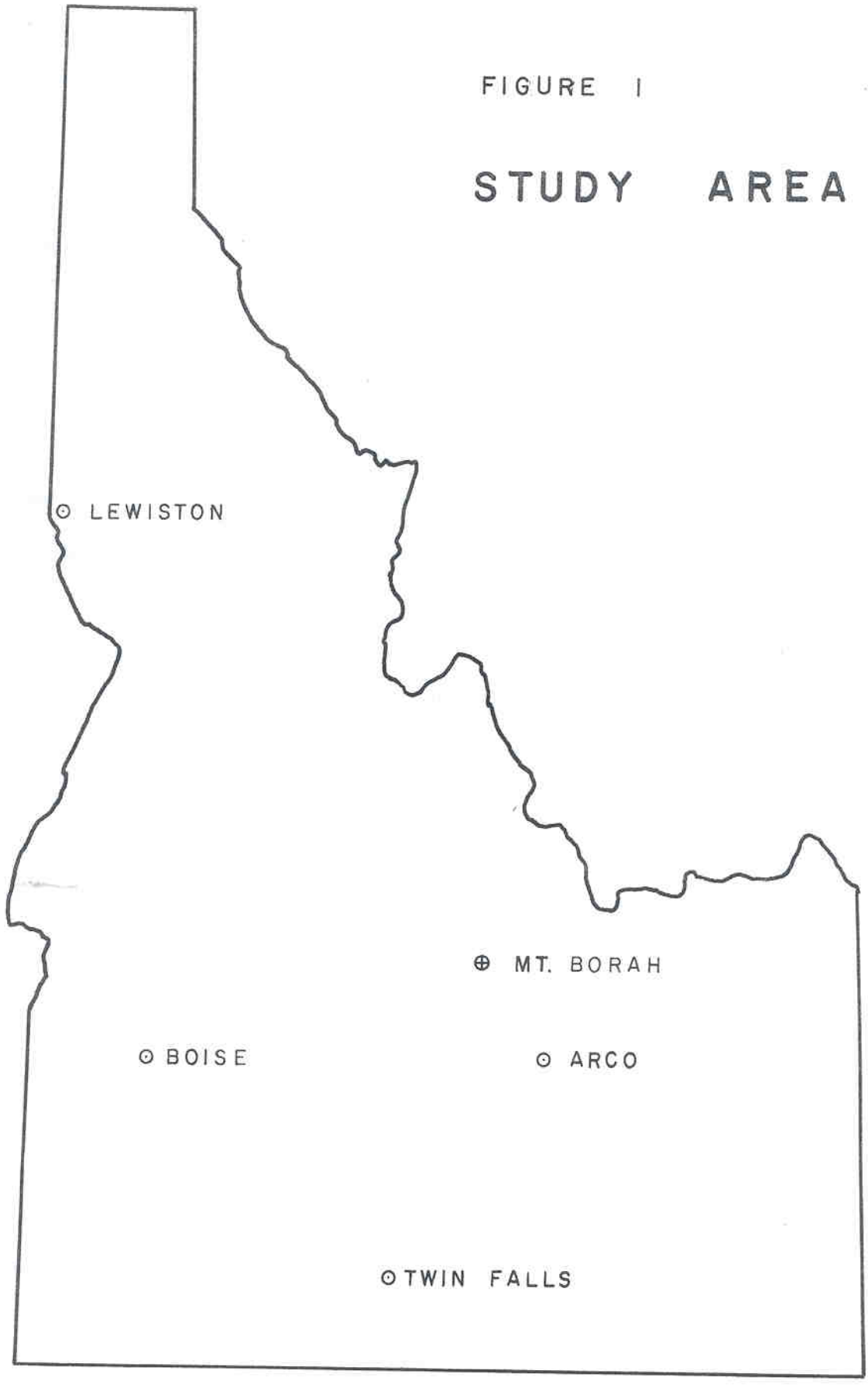
It has often been said that nowhere in Idaho is there a real, live glacier (Rhodenbaugh 1961, p. 94). While working on a field project for a Geomorphology class in October of 1974, an active alpine glacier was discovered on the flank of Idaho's highest peak, Mount Borah. Borah Peak towers with five other 12,000 foot peaks of the Lost River Range in Custer County, (see Figure 1.). The glacier, situated at an elevation of 10,400 feet (3170 meters), is located at approximately 44 09'N latitude and 113 47'W longitude. Access to the area is by hiking from Highway 93A. Length of the hike is approximately 6 miles with a net gain in elevation of 3,000 feet.

Geologic Setting

The Lost River Range is located in the Northern Rocky Mountain physiographic province (Rhodenbaugh 1961, p. 35). Dominant rock type in the area is Paleozoic limestone with interbedded layers of dolostone (Ross 1962). The rock is highly folded and faulted as a result of tectonic events assumed to have occurred from the Mesozoic era on (Alt and Hyndman 1972, p. 181). The Lost River Range is the western-most of three fault block ranges in eastern central Idaho. The area was extensively glaciated in Pleistocene time leaving cirques, glacial troughs and aretes throughout the ranges. Active glaciation in the Lost River Range is restricted to this small alpine glacier located in the Rock Creek drainage. An active rock glacier located at the

FIGURE 1

STUDY AREA



head of Mahogony Creek, 2.5 kilometers north of Borah Peak, is being studied by Boise State University geology student Sonny Hornbaker.

Geomorphology of Lower Rock Creek Valley

Located at the mouth of Rock Creek is a large alluvial fan which forms the northernmost end of a bajada approximately 27 kilometers in length. The alluvial fan has been dissected by Rock Creek. For a distance of 5 kilometers upstream from the fan, Rock Creek flows through a steep sided canyon which is V-shaped in cross profile (see Figure 2).

The central portion of the Rock Creek drainage is a glacial trough herein interpreted to be of Pleistocene age (see Figure 3). The trough is approximately 1.2 kilometers in width and 2.4 kilometers in length. This formerly glaciated portion of the canyon rises from an elevation of 8,800 feet (2,683 meters) to 9,400 feet (2,866 meters). The bottom of the trough is largely covered with talus and avalanche debris which has weathered from the sides of the canyon during Holocene time. The uppermost portion of the trough has a thick accumulation of debris derived from a high trogschluss and from the hanging cirque above. This massive amount of debris is dissected by gulleys which probably resulted from erosion by glacial meltwater during the Pleistocene.

Geomorphology of Upper Rock Creek Valley

Separating lower Rock Creek from the complex hanging cirque is a trogschluss 250 meters in height (see Figure 4). A large bedrock ridge extending from the top of the trogschluss, nearly to Borah Peak separates the cirque into the two components. The eastern portion is small and is not so well developed as the western component. The western portion, in which the

glacier lies, is approximately 0.8 kilometers in length and 0.6 kilometers in width (see Figure 5). The cirque headwall has a maximum height of 600 meters. Numerous permanent snowfields occupy many of the couloirs and ledges. These snowfields are visible from Willow Creek Summit on Highway 93 Alternate.

A large amount of surficial material not associated with the active glacier, lies on the cirque floor. Much of this debris was deposited by Pleistocene glaciers. A terminal moraine 230 meters in length and 90 meters in width lies on the threshold of the cirque (see Figure 5). It has been breached on the western margin, probably either by a "bulldozing" effect of a previous glacial advance or by stream erosion. The moraine has a small amount of soil and vegetal cover. Other surficial materials include former crevasse fillings now deposited on bedrock 60 meters upslope from the cirque threshold. The bearing of these numerous features is roughly perpendicular to the axis of the valley. Ground moraine deposits exist throughout the cirque. Located on the floor of the cirque is a 5 centimeter accumulation of clay type sediment covering approximately 200 square meters. The sediment lies in a slight depression so it is likely that it was deposited by a small body of water.

Periglacial landforms such as stony earth circles and stone stripes exist approximately 650 meters from the glacier. The stone nets are of the small polygonal type characteristic of mid-latitude alpine areas (Embleton and King 1968, p. 504). Size of the rock debris in the polygons ranges up to 30 centimeters. Maximum diameters of the features range from 1 meter to 2.5 meters. The polygons are located on top of an unprotected ridge; it seems likely that this location would have more annual freeze-thaw cycles

than surrounding areas and would therefore, favor development of patterned ground. Another major factor contributing to their development is thought to be due to the topographically flat area in which they exist. Because of the lack of effectiveness of erosional processes, soil and regolith buildup is favored, promoting the growth of patterned ground. Permafrost exists in the area; it will be discussed later in the paper.

GLACIER MORPHOLOGY

The debris covered glacier lies in the southwest corner of the large cirque discussed previously. It is located directly at the base of the high precipitous arete which extends northwest from Borah Peak (see Figure 5).

The glacier was mapped in detail during field work in August of 1975 by plain table and alidade methods. Three triangulation points were used and 120 rod points were surveyed.

General Description

Overall length, including the terminal moraine is 550 meters (refer to map). Length of the ice is 400 meters. Width varies along the length with the widest portion, 250 meters, being across the headwall. Width at the 1975 firn line is 170 meters but this increases to 200 meters at the toe of the glacial ice.

The moraines are typical of most alpine glacial moraines in that they extend around the entire lobate portion of the ice (see Figure 5). Maximum height at the center portion of the terminus is 80 meters but moraine height decreases to a few meters at the upper parts of the lateral portions. Width of the terminal moraine is approximately 45 meters at its widest portion and

the front or north slope is 45 degrees. The terminal moraine is bisected by a gulley cutting through it parallel to the valley axis (see Figure 6). The gulley is located along the same axis as a large longitudinal crevasse to be discussed later. Possible orgin of the gulley could either be due to glacial movement or to meltwater. The latter is more likely. At the base of the terminus, directly below the gulley, is an accumulation of debris which has built up in a cone shape. The rock in the cone has obviously been transported by water from the gulley above (see Figure 6). The transportation probably occurs during high discharge events associated with spring melting of the snowpack.

Seismic Depth Determinations

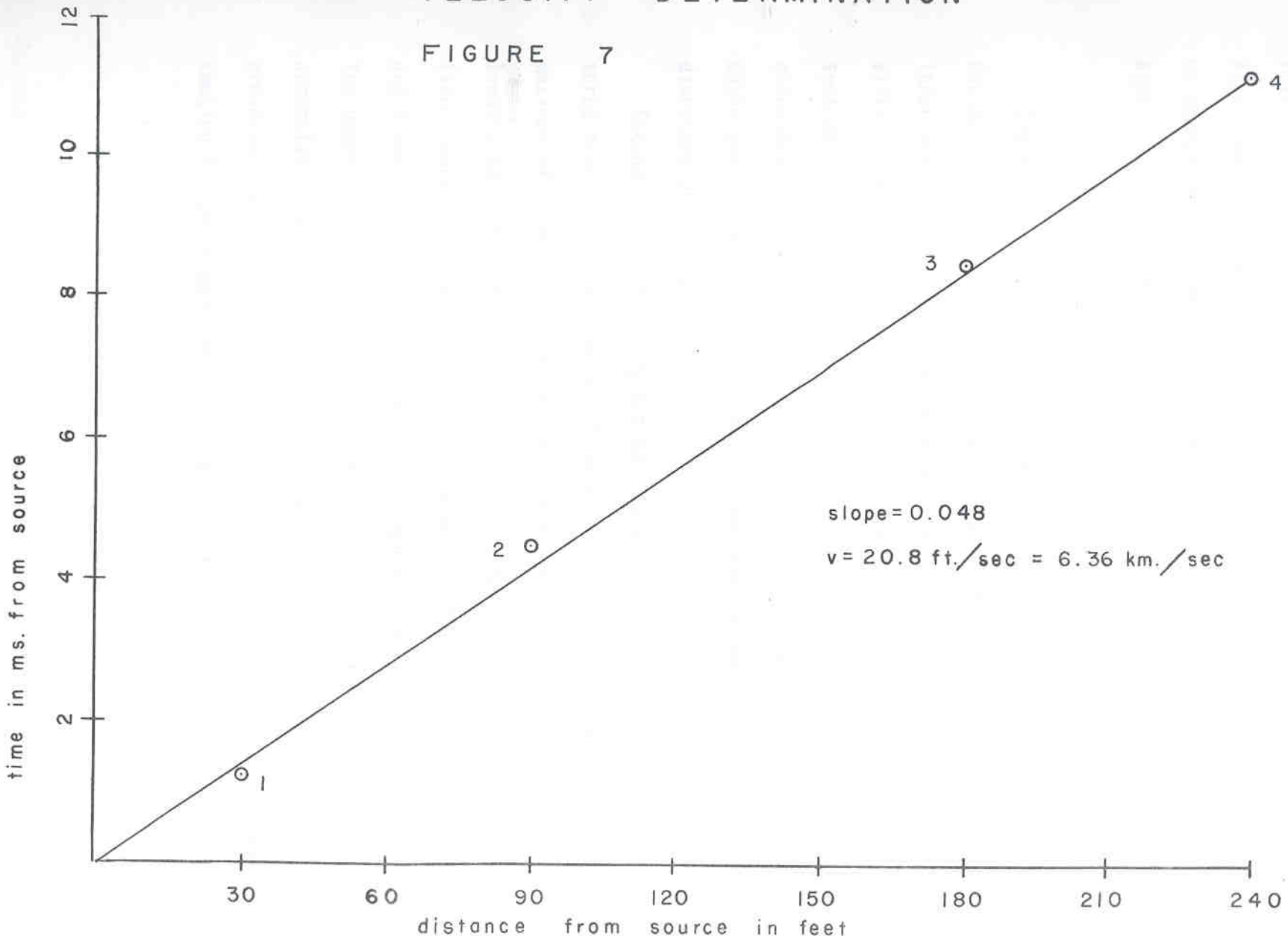
Standard spread shooting was used to determine the velocity of energy traveling through the ice medium. Energy travel recorded at four locations indicates a velocity of 6.36 kilometers per second (see Figure 7).

Depth measurements were accurately determined at 16 points in the lower portion of the glacier. Standard spread shooting was not successful because of fractures in the ice so a single point reflection technique was used. The energy source was a ten pound sledge hammer and the energy travel time was recorded with a Nimbus brand engineering seismograph.

Greatest ice thickness, 64 meters, was located in the central portion of the glacier directly below the 1975 firn line (see map). Other depths ranged from 64 meters to a minimum of 18 meters near the

VELOCITY DETERMINATION

FIGURE 7



toe of the glacier. These depths indicate that the cirque floor is a small closed basin in the bedrock directly below the average annual firn line. The depression has a U-shape valley extending northward or downvalley from this basin (see Figure 8). This bedrock basin is approximately 150 meters long, 70 meters wide and 25 meters deep.

Crevasse Patterns

Crevasses are exposed over much of the surface of the glacier. One main longitudinal crevasse was traced from the firn line to the inner margin of the terminal moraine (see Figure 9). It is largely filled with rock debris, however, much of the ice is visible and many sections are open to depths of 3 meters. The axis of this crevasse coincides with both the long axis of the sub-glacial cirque floor basin and the gulley cutting through the terminal moraine, both discussed previously.

Extending from the longitudinal crevasse at right angles are three transverse crevasses which vary in length from 40 meters to a maximum of 75 meters. The uppermost one, which is 75 meters in length, has a moulin located approximately halfway along its length (see Figure 10). The moulin is 1.5 meters in diameter at the surface and funnels rapidly into an opening of approximately 15 centimers. The upper sector of this crevasse extends far into the zone of accumulation and can be visibly traced nearly to the bergschrund crevasse. Width of the opening along this crevasse varies; its lower section is open a maximum of 0.5 meters but most of the upper section

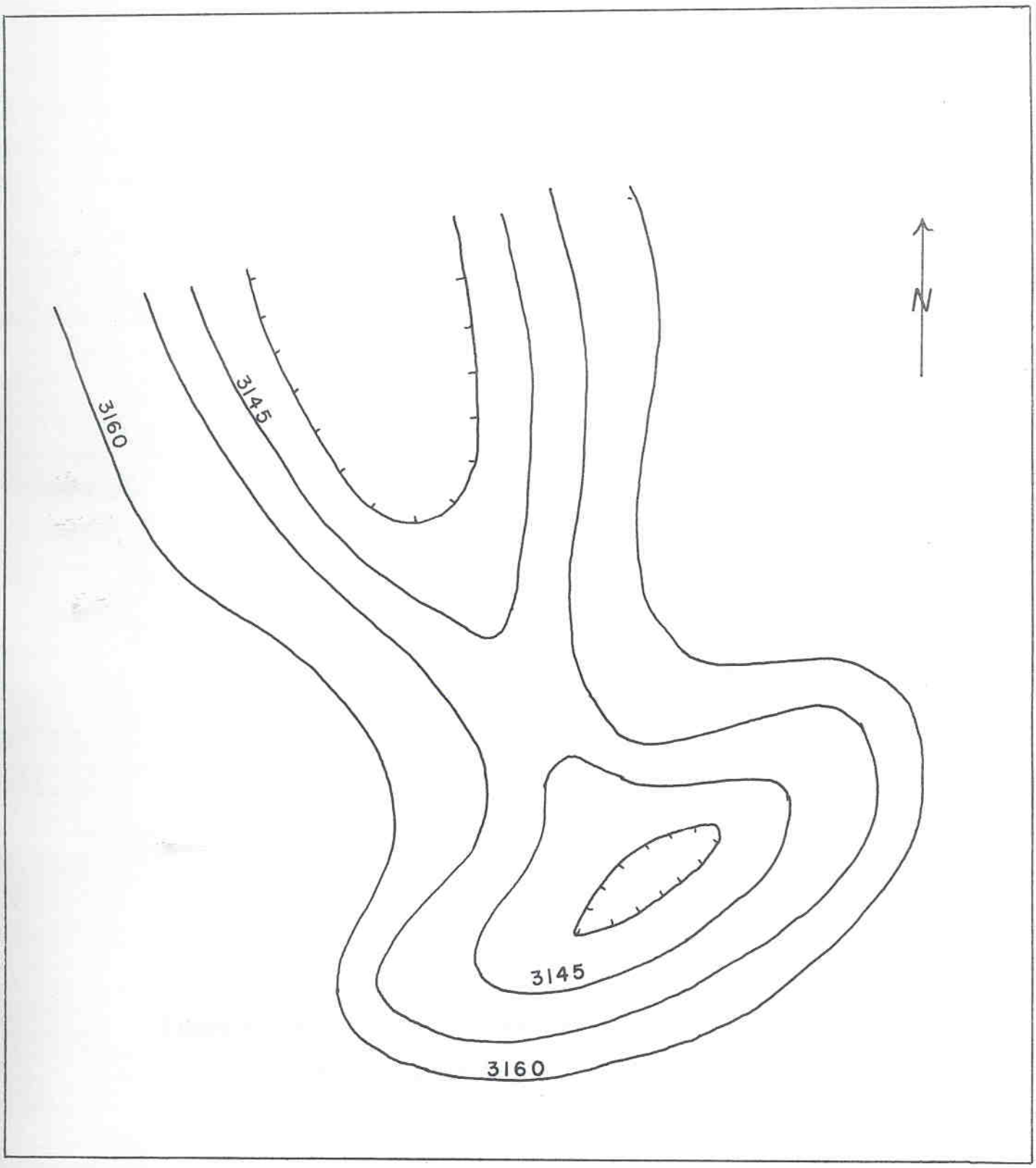


FIGURE 8

Contour map of cirque floor beneath deepest portion of glacier

SCALE

60 meters

Contour interval 7.5 meters

is open only 20 centimeters or less. This crevasse was open in October of 1974 but it was closed along most of its length by August of 1975. The other two transverse crevasses are almost filled with rock debris, however, ice is visible at many locations.

Two crevasses oriented obliquely to the glaciers long axis, extend from the main longitudinal crevasse, one on each side. Both crevasses parallel the sides of the glacier very close to the margin of the ice at their upper end and then curve to intersect the longitudinal crevasse near the terminus (see map). These crevasses are also mostly filled with rock debris. The oblique crevasse on the eastern side of the glacier paralles the lateral moraine. This was used as criteria for the assumed extent of the ice on this side. The oblique crevasse on the western side is not so long or so well defined due to a greater accumulation of rock debris on the glacier surface.

On the surface of the glacier, directly above the north rim of the depression in the sub-glacial floor, numerous cracks as well as two transverse crevasses are present. These crevasses probably exist due to tensional forces which occur in the brittle upper ice layer as the plastic lower layer flows over this small rise of approximately 25 meters.

The bergschrund crevasse is a very impressive sight (see Figure 11). It extends the full width of the glacier's headwall, approximately 250 meters. It varies in width from a few centimeters to as much as 5 meters. Depth of this crevasse was determined to be at least 40 meters but lack of proper equipment hindered further exploration. It appears to be approximately 60 meters in depth. It is generally narrow at the surface and opens into many large rooms within its deep interior. Some of the rooms are as large

as 12 meters in width, 15 meters high and 45 meters in length. False floors are numerous; some holes in the floor reach to depths of 15 meters. Icicles 0.5 to 0.75 meters in diameter and 5 meters in length are numerous. Many have been rotated due to the motion of the glacier and now hang at various angles. The cirque haedwall is visible in many places along this bergschrund crevasse.

GLACIER MASS BALANCE

Area Climate

The Lost River Range has been classified as a semi-arid area with great extremes in temperture (Rhodenbaugh 1961, p. 35). After a study of all available climatologic data, which is unfortunately rather sparse, it is my conslusion that this semi-arid climate exists only at the lower elevations (see Figure 12). United States Weather Service summaries show that over a 16 year period, the town of Challis, elevation 5,280 feet, received an average amount of 7.62 inches of precipitation yearly (for locations, see Figure 13). Mackey, elevation 5,890 feet, for a 22 year period 10.0 inches annually. Salmon, elevation 3,970 feet, over a 29 year period received only 9.39 inches annually. In contrast to these figures, two higher elevation weather station reports were reviewed. The Wet Creek Summit station, located approximately 25 kilometers southeast of the glacier, received 23.8 inches of precipitation annually over a 9 year period. This weather station is situated at an elevation of 7,600 feet, 1,700 feet above nearby Mackey. The Leatherman Pass station, located only 6 kilometers southeast of the glacier, at an elevation of 9,800 feet, received 35.1 inches annually over the same 9 year period. Precipitation measurements at Leatherman Pass in 1975 indicate a 20 percent increase over 1967.

CUMULATIVE PRECIPITATION TOTALS

LOCATION	YEARS REPRESENTED	DURATION in years	ELEVATION in feet	PRECIPITATION in inches
'CHALLIS	1914 - 1930	16	5280	7.62
"SALMON	1940-1969	29	3970	9.39
'MACKAY	1908—1930	22	5897	10.0
"WET CREEK	1967-1975	9	7600	23.80
"LEATHERMAN PASS	1967-1975	9	9800	35.10

FIGURE 12

' From: United STates Dept. of Agriculture, Weather Bureau. Climatic Summary of the U.S. sec. 6, southern Idaho

" From: United States Dept. of Commerce, National Oceanic and Atmospheric Administration, Climatologic Summary

LOCATION MAP OF WEATHER STATIONS

FIGURE 13

CHALLIS 60 KM

⊙ GLACIER

⊙ LEATHERMAN PASS

⊙ WET CREEK

⊙ MACKAY

SCALE

0 4 8 kilometers

In light of these records of annual precipitation, it is my interpretation that the lower portions of the Lost River Range, as well as adjacent valleys, can properly be classified as semi-arid. However, most of the range (those portions above 6,500-7,500 feet elevation) receive too much precipitation to be called semi-arid. Sparseness and small size of vegetation at these higher elevations is attributed to poor soils and low temperatures, not to a semi-arid climate as earlier workers have stated.

Climatic Survey of Upper Rock Creek

Permafrost

The existence of permafrost in close proximity to the glacier indicates that a low mean annual temperature is present in the Rock Creek cirque. During field work in August of 1975, permafrost was located in the north slope of the terminal moraine at a depth of 77 centimeters. The existence of the permafrost is due to two main factors. The first and more important of these is obviously the low mean annual temperature. The second reason is that the high, precipitous arete to the south protects the cirque from insolation.

Glacial Top Loading

Snow accumulation occurs in three ways. The least significant of these with respect to volume, is by direct precipitation from periodic winter storms. Of more importance is the deposition of large snow drifts by nearly continual strong winds. It was noted by J. G. McCall (1972, p. 207) that wind blown snow played an important role in the accumulation of firn on a small cirque glacier, Vesl-Skautbreen, in Jotunheimen, Norway. Avalanche loading is the most important means of snow accumulation on the glacier.

Sheet avalanches are the primary type, however, there is one large avalanche chute which extends the full height of the 600 meter headwall (see Figure 5). Much debris from the highly fractured headwall is carried down with the numerous avalanches.

As mentioned before, the 600 meter arete has a considerable shading effect on the immediate area. The cirque faces due north which also contributes to the protection of the accumulating snow from solar radiation. The glacier's headwall received no sunlight during field work from August 21 to August 30, 1975. Observations in October revealed the entire glacier to be shaded all day. It is apparent from these observations that the glacier is never entirely in the sun and that it is only partially in the sun for a short part of each summer.

Firn Depth Survey

Firn depth surveys in October of 1974 and late August of 1975 revealed a mass balance in the zone of accumulation for that 10 month period. These observations showed that the annual firn line was located about 30 meters further down slope in 1975; elevation of the firn line was approximately 3,286 meters in October 1974 and 3,276 meters in August 1975. Firn accumulation of 2 meters or less was present over the lower half of the glacier's zone of accumulation. The upper half of the zone of accumulation and the sector below the large avalanche chute had a maximum firn accumulation of 8 meters.

CONCLUSIONS

The glacier located at the north flank of Mount Borah is Idaho's only known glacier. Studies in October 1974 and August 1975 indicate that the glacier experienced a positive mass balance for that 10 month period. Crevasse patterns changed considerably over the same 10 month period which indicates that the glacier is active, however, flow rates have not been determined. It is hoped that the students and or faculty at Boise State University will continue survailence in order to establish long term mass balance data and flow rates.

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