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ROCPS/39MA-P22

GLACIER SURVEY

ROCKY MOUNTAIN NATIONAL PARK

1939

H. R. Gregg
Park Naturalist

E. E. MATTHES COLLECTION

*Was not received in time
to be incorporated in the
1940 report of the
Committee on Glaciers*

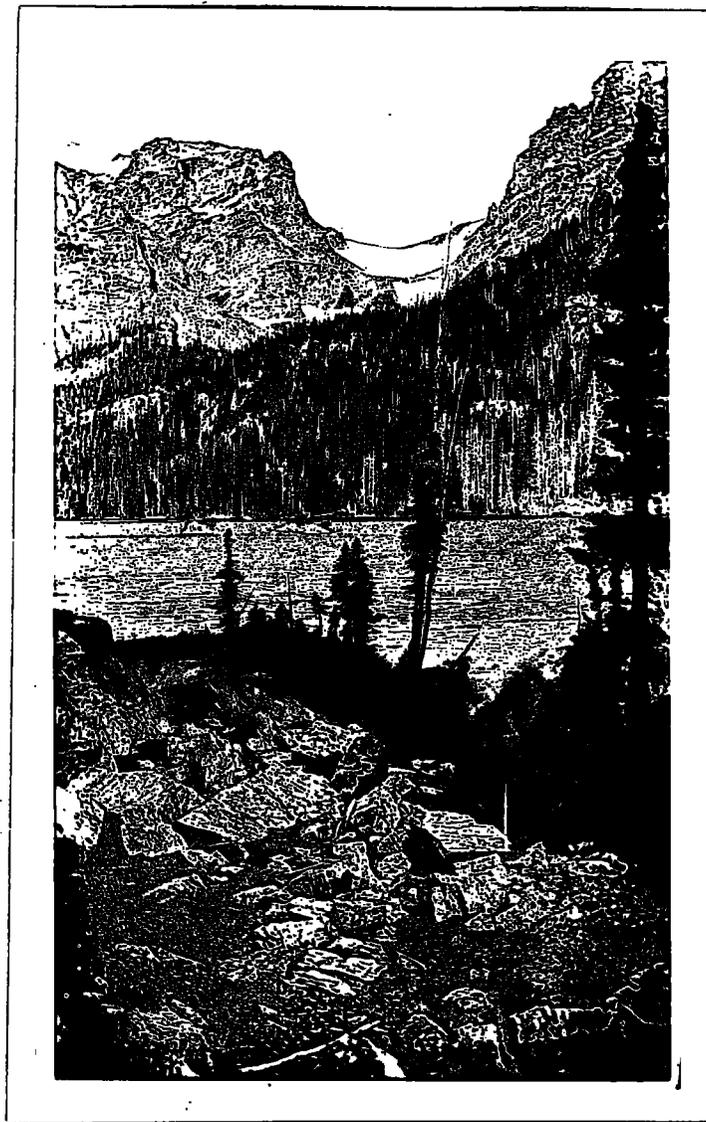
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GLACIER SURVEY
ROCKY MT. NATIONAL PARK

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H.R. Gregg
Park Naturalist

39MA-P01



ANDREWS GLACIER FROM LOCH VALE
August, 1909
Photograph, Courtesy Roy G. Coffin

1939 GLACIER STUDIES
ROCKY MOUNTAIN NATIONAL PARK

Initiated in 1932, annual glacier surveys have been made in Rocky Mountain National Park through the year 1939, with the exception of the glacier year 1935-36, when personnel was not available to conduct the studies. The 1937 survey was reported as comparative for the two-year period from 1935-37.

Andrews and Tyndall Glaciers lend themselves to a single-day trip for measurement, and represent the two types of small ice bodies present in the park: Andrews is a miniature valley glacier, while Tyndall now is little more than a steep icebank, perhaps classifiable as a "cliff" glacier.

Method of Measurement

Measurements made are not precise from a mathematical standpoint, being made without benefit of instrumentation, but are consistent in that the same method is employed each year, yielding comparable results. Tape-line measurements along ground slope are made from fixed points directly in front of the glacier terminus, with measurement figures recording the distance from the fixed point to the nearest "ice". In years of greater snowfall, persistent snow overlay on the glacier snout makes accurate determination of the actual ice front impossible, in which case the measurement reflects the advance of the solid overlay toward the fixed station.

1. Andrews Glacier

At Andrews Glacier, two measurements are now made, the second line of measurement having been established in 1938.

The original line of measurement is along the southwest corner of the glacier lake from a rock at the edge of the water, marked in large white cross as Station X'. This station is 44' 7" from a large fixed boulder which has a conspicuous white cross marked X", as a reference point for location and determination of stability of Station X'. When the lake is full, the near line from Station X' to nearest ice will extend across the surface of the water. In 1937, low level of the lake made it possible to measure along bare ground, but in 1938 and 1939, higher water filled the depression within the normal lakeshore, so that the tape-line was stretched across the water's surface.

The second line of measurement established in 1938 extends from a large boulder which apparently shows no signs of instability, although the solid ice is against it and "flows" past it to form the northern edge of the ice front of the glacier. Directly east of a fixed point on the face of this Boulder, Station "1", in line with the center of the outlet of the glacier lake, it is possible to extend a tapeline along the down-sloping surface of the ice to an easily determined "snout", so that a figure uninfluenced by persistent snow overlay may be obtained. Of course, should marked advance, accompanied by powerful thrust of the ice front occur, movement of the rock on which Station X' is located might result, affecting the accuracy of the figures for comparison.

However, results obtained in 1939, by comparison with 1938 measurement at this point, convince the writer that this figure is a better index to the true condition of the ice volume than the figures obtained at the south edge of the glacier where less melting of snow takes place, and exaggerated limits of advance and recession have been recorded during the years over which the glacier studies have extended, because of snow overlay.

2. Tyndall Glacier

As in 1938, the triangle of stations on the frontal moraine ridge remained stable, after having shown some shifting between 1935 and 1937, for which corrections were made in the 1937 survey report. Two lines of measurement were followed in 1939, along the same lines used in 1938, when a distinct lobe extended forward of the main body of the glacier on the northeast corner. One line was from Station X', the fixed point for measurement, northwesterly to the nearest "ice", the other in a direct line westward to the nearest clear ice on the direct front of the main body of the glacier. Since past figures have been based on nearest ice from station X', without any indication of direction of the line of measurement, the comparison with past-years' figures is made by use of the nearest ice-figure for 1939. A second comparison on the direct-west line is also included as a more stable figure for the main body of the glacier, since the lobe to the northeast of the glacier may be largely compacted "slide" off of the ice surface. Of course, in view of stagnant ice underlying the rock-strewn basin between the frontal moraine and the visible ice front, no figure is strictly accurate as an indicator of position of the actual terminus of the glacier.

1939 Glacier Survey Party

Park personnel of the survey consisted of Park Ranger Ernest K. Field and Park Naturalist Raymond Gregg, who made the actual measurements. Accompanying on the trip was a group of 14 hikers who were invited by public announcement to accompany the glacier survey party. The following were in the group: Misses Enda Mills and Helen Clatworthy of Estes Park, Colo.; Messrs. Alex Ham, Allen Cook, and Willard Schlotter, of St. Louis, Mo.; Mrs. David O. White, of Columbus, Ohio; Mr. Phailmetzger, and daughter Helen, of Neward, New Jersey; Mr. and Mrs. John Rowell and Mr. Walter Selburg, of Bloomington, Ill.; Mr. George Drew, of Boulder, Colo.; Miss Jan Smith; and Mr. Robert Peterson, of Cheyenne, Wyoming.

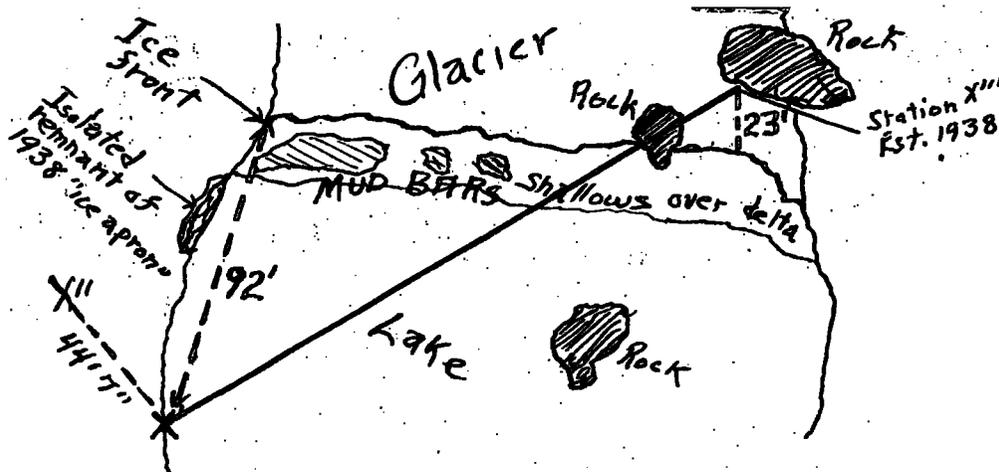
Weather

The trip was made on September 13, 1939, which opened clear, with cloudiness increasing both from the east and from the west, so that skies were almost completely overcast by 11:00 am. Showers, interspersed with intervals in which skies broke sufficiently to allow occasional spreads of sunshine, occurred from 1 p.m. until about 4:30 p.m. One of the most spectacular rainbows observed by the writer since coming to this park was observed over Tyndall Gorge at about 1:30 p.m., and was photographed in color from a point directly above Tyndall Glacier.

The Measurements

1. Andrews Glacier

A study of 1938 photographs made on the scene in 1939, verified the evident shrinkage in Andrews Glacier from the 1938 advance, which, on the basis of measurement along the south edge, was the most forward position assumed since measurements were begun in 1932. The entire south edge of the glacier showed shrinkage from the lateral "moraine", slide, or nevation ridge, as may be the proper term. Lateral collection areas likewise were less extensive on both sides of the glacier. The "aprons" along the sides of the lake, and continuous with the glacier body at its front, had shrunk considerably from the 1938 condition. Again, the delta in front of the ice at the west end of the lake was in evidence, although higher water level, and more advanced position of ice front made it less extensive than was the case in 1937. This delta was completely covered by ice and water in 1938, when the glacier front extended into the lake.



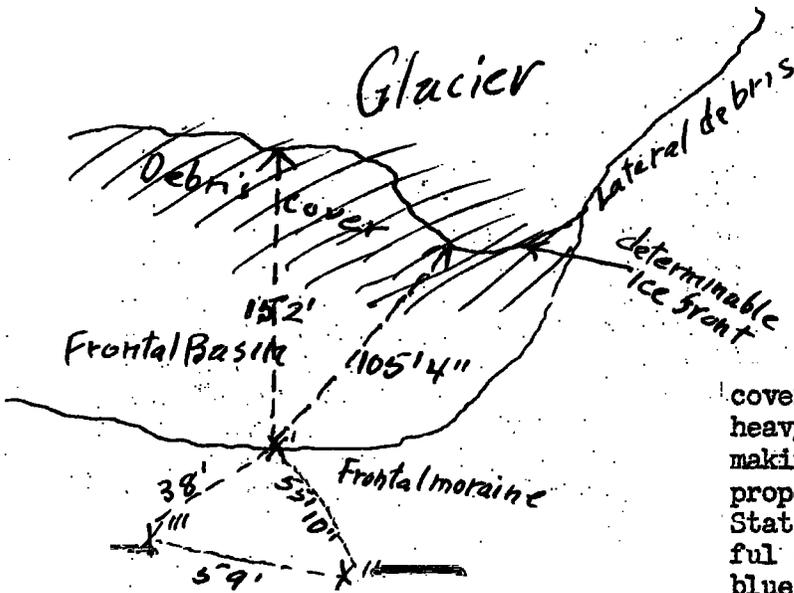
ANDREWS GLACIER

Measurements and comparison with previous measurements are as follows:

| <u>Station XI to Ice</u> | | <u>Station X''' to Ice Front</u> | |
|--------------------------|---------|---|---------|
| 1939 | 92' | 1939 | 23' |
| 1938 | 32' 3" | 1938 | 48' 11" |
| 1937 | 96' 10" | | |
| 1935 | 66' | | |
| 1934 | 139' | | |
| 1933 | 58' 10" | | |
| 1932 | 48' 7" | | |
| | | Apparent recession, 1938-1939 on north front 25' 11" | |

Apparent recession, 1938 to 1939
on south front: 58' 9"
Cumulative recession since 1932: 43' 5"

Average apparent recession, 1938 to 1939: 42' 10"
(average of X'-Ice and X'''-Ice Front figures)



TYNDALL GLACIER

2. Tyndall Glacier

The lobe at the north-east corner of the glacier front was visibly more distant from Station X', the point of measurement than in 1938, probably due to dissipation of overlay more than to any other factor. Over much of the area which was

covered by this "lobe" in 1938, a heavy cover of debris was strewn, making it difficult to determine a proper point for measurement from Station X' to nearest ice. By careful selection, the nearest clear blue ice which seemed to continue unbroken among the debris to the mass of the glacier was chosen, and was found to be 105' 4" distant.

Measurement along a direct line westward, used as the closest ice in 1937, and re-measured for comparison in 1938, showed a distance of 152' in 1939, as compared with 105' in 1938, and 201' 11" in 1937. The point measured was the clear and continuous front, more evident from overlain stagnant ice at this sector than along the north edge of the glacier front, where closest-ice measure figure was recorded as outlined above.

Interesting sidelights were recorded during the measurements at the front of Tyndall Glacier. An old ear-flap cap, a shoe, and bits of canvas, as well as bones which probably those of a pack-animal, were found wedged between solid ice and heavy boulders near the north edge of the ice some fifty to seventy-five feet west of the north edge of the ice front. These probably are bits of the pack lost by the prospector, Chitwood, whose remains are buried near the head of the glacier. Chitwood perished on the Continental Divide above the glacier in the autumn of 1920, probably on about October 12 or 13, during a blizzard. His two horses, tailed together, fell over the cliff, and the pack of one of the animals was strewn down over the face of the glacier along the north edge. Fragments of this pack and its contents have been found along the glacier periodically for the past 19 years.

Water melting out and running off in surface streams along the central and northern part of the glacier form a distinct stream that wanders around through the rough rock debris in the frontal basin, finally turning back westward and southward to flow into a melted basin under the front of the ice near the south edge of the main body of the glacier. In a sense, the water runs away from the glacier, turns, and comes back to run under it, later to drain off and disappear as percolating water beneath the large frontal moraine. At the point where this water flows under the ice edge (illustrated) there is the best ablation front seen by the writer on any of the small glaciers in this park.

Several ice tables were found along the north edge of the glacier, where the sun falls upon the ice for a longer period of the day than at the south side, against the abrupt walls.

The bergschrund at the head of the glacier, which did not open noticeably in 1938, was about identical with its 1937 condition, as shown in the accompanying illustrations.

Measurements and comparisons with previous figures for Tyndall Glacier are as follows:

| <u>Station X' to Nearest Ice</u> | | <u>Station X' To West</u> | |
|--|----------|---|----------|
| 1939 | 105' 4" | 1939 | 152' |
| 1938 | 62' 4" | 1938 | 105' |
| 1937 | 201' 11" | 1937 | 201' 11" |
| 1935 | 38' 6" | | |
| 1934 | 72' 5" | | |
| 1933 | 63' 4" | | |
| 1932 | 30' 3" | | |
| | | Apparent recession on line to west of Station X', 1938 to 1939: 47' | |
| | | Cumulative recession, 1937-38: (apparent advance of 49' 11"). | |
| Apparent recession on line from Station X' to nearest ice, 1938 to 1939: 43' | | | |
| Cumulative recession, 1932-1939: 75' 1" | | | |

Average recession, 1938 to 1939: 45'

An error in use of an uncorrected figure from 1937 in the 1938 report makes the 1938 glacier report in error on the figure of apparent advance recorded for that year. It was stated in that report that advance for 1938-1937 was 134' 5". A correction of 5' 2" in 1937, to compensate for shifting of Station X' was not taken into account through error in using a measurement of 196' 9" from X' to nearest ice in 1937 instead of 201' 11", the correct figure after allowing for the advance of the boulder on which Station X' is located. Thus, the proper apparent advance figure is 139' 7", and previous report should be corrected. The 1939 recession figure is based upon the correct measured distance from X' to nearest ice in 1938, and needs no correction.

Temperature and Precipitation

On the next page, a table of figures showing mean temperature, depth and water content of snow, and total precipitation are presented. These figures are given for the two Cooperative Observer stations at Estes Park and Grand Lake, and an average figure is computed. Drift from prevailing westerly winds no doubt contributes greatly to glacier accumulation, and thus west-slope figures bear as much, or more, upon glacier recession or advance as east-slope figures. Comparisons of average figures from 1935 to 1939 is included below the compiled table for 1938 to 1939.

TEMPERATURE AND PRECIPITATION

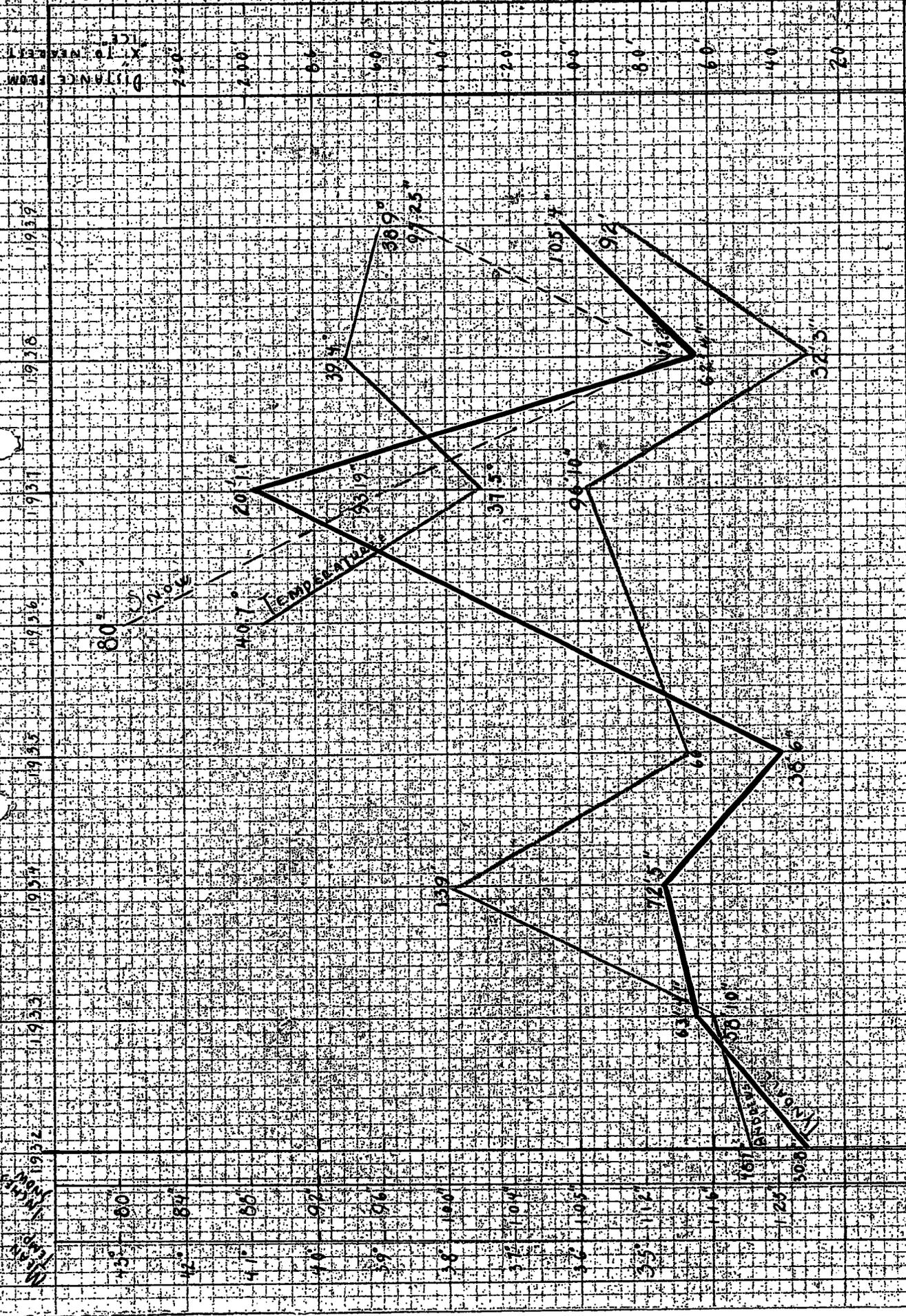
| MONTH | STATION OR AVERAGE | MEAN TEMPERATURE | SNOW | | TOTAL PRECIPITATION |
|-----------------------------|-----------------------|---------------------|---------|-------------|------------------------|
| | | | DEPTH | IN. PRECIP. | |
| October 1938 | G.L. | 40.6 | 0" | .12 | .12 |
| | E.P. | 46.3 | 3" | .19 | .57 |
| | Av. | 43.4 | 1½" | .15 | .29 |
| November | G.L. | 29.0 | 15" | 1.20 | 1.20 |
| | E.P. | 29.0 | 9½" | .77 | .77 |
| | Av. | 24.5 | 12¼" | .98 | .38 |
| December | G.L. | 17.0 | 44" | 2.69 | 2.69 |
| | E.P. | 27.5 | 20 3/4" | 2.40 | 2.40 |
| | Av. | 22.3 | 32½" | 2.54 | 2.54 |
| January 1939 | G.L. | 15.8 | 25½" | 1.83 | 1.83 |
| | E.P. | 25.4 | 8½" | .39 | .39 |
| | Av. | 20.6 | 17" | 1.11 | 1.11 |
| February | G.L. | 16.8 | 19" | 1.27 | 1.27 |
| | E.P. | 18.4 | 7 3/4" | .80 | .80 |
| | Av. | 17.6 | 13½" | 1.03 | 1.03 |
| March | G.L. | 26.1 | 15" | 1.11 | 1.39 |
| | E.P. | 31.2 | 12½" | .87 | .87 |
| | Av. | 28.6 | 12 3/4" | .99 | 1.13 |
| April | G.L. | 38.1 | 4" | .47 | .68 |
| | E.P. | 39.7 | 11" | .89 | .89 |
| | Av. | 38.9 | 7½" | .68 | .78 |
| May | G.L. | 45.0 | 1" | .20 | 1.22 |
| | E.P. | 49.3 | 0" | .00 | 1.25 |
| | Av. | 47.1 | ½" | .10 | 1.53 |
| June | G.L. | 48.5 | | | .84 |
| | E.P. | 59.7 | | | 1.18 |
| | Av. | 54.1 | | | .76 |
| July | G.L. | 57.2 | | | 1.48 |
| | E.P. | 63.0 | | | .56 |
| | Av. | 60.1 | | | .92 |
| August | G.L. | 53.1 | | | 1.16 |
| | E.P. | 60.5 | | | 1.68 |
| | Av. | 56.8 | | | 1.42 |
| September | G.L. | 51.3 | | | .83 |
| | E.P. | 56.4 | | | .44 |
| | Av. | 53.9 | | | .63 |
| For Glacier Year 1938-39 | G.L. | 35.7 | 121½" | 8.89 | 14.21 |
| | (E.P.) | 42.2 | 73" | 6.31 | 12.00 |
| | (Av.) | 38.9 | 97¼" | 7.60 | 13.10 |
| For Glacier year 1937-8 | Av. | 39.4 | 115.20" | 11.56 | 21.86 |
| For Glacier year 1936-7 | Av. | 37.5 | 93.19" | 6.65 | 17.22 |
| For Glacier year 1935-6 | Av. | 40.7 | 80.00" | 7.11 | 18.16 |

ANALYSIS OF GLACIER CHART

Four lines are plotted on this chart. The red line represents the trend to advance or recession by Andrews Glacier; the ink-line represents similar tendencies in Tyndall Glacier. The green line plots the annual mean temperature, representing an average figure of the readings at the Estes Park and Grand Lake weather stations; the Blue line represents the annual total depth of snowfall as averaged from Grand Lake and Estes Park.

Trends indicated

1. Although the quantitative advance or recession varies as between the two glaciers from year to year, over the period from 1932 to 1939 both glaciers have been found to have shown the same tendency in any given year; that is, both have either advanced or receded.
2. There does not appear to be any tendency to conformance between the average temperature and advance or recession of the glaciers. No doubt, wind, rain precipitation, humidity, number of cloudy days during the summer, and other factors are so influential as to make the mere matter of varying temperatures of minor importance in producing effects upon the glaciers.
3. The glaciers are immediately responsive to larger or smaller snowfall. This is to be expected in glaciers of such small size, especially where snow overlay persisting through a glacier year affects the frontal measurement, as it does in both Andrews and Tyndall glaciers. The downward trend of the snow line between 1936 and 1937, an opposite trend to that indicated on the plotted lines for the glaciers is not a contradiction. The 1937 reading represents a condition after an elapsed period of two years, since measurements were not made in 1936. The very dry year 1935-36 probably produced a recession condition even more marked than that recorded in 1936-37 (measured in 1937), so that the year 1936-37, when the snowfall is shown by the graph trend to be larger than that for 1936-36 (indicated under 1936 on the graph), probably was one of advance as compared with 1935-36, although the two-year trend is plotted as an even line because no measurements were made in the autumn of 1936.



DISTANCE FROM
X TO NEAREST
ICE

1932 1933 1934 1935 1936 1937 1938 1939

80°

140.7°

20.1°

39.1°

38.9°

97.25°

37.5°

96.1°

10.5°

91.2°

35.6°

113.9°

72.3°

63.8°

56.1°

161°

125°

30.0°

11.1°

35.112°

11.6°

10.4°

10.5°

10.6°

10.7°

10.8°

10.9°

11.0°

11.1°

11.2°

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11.7°

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12.0°

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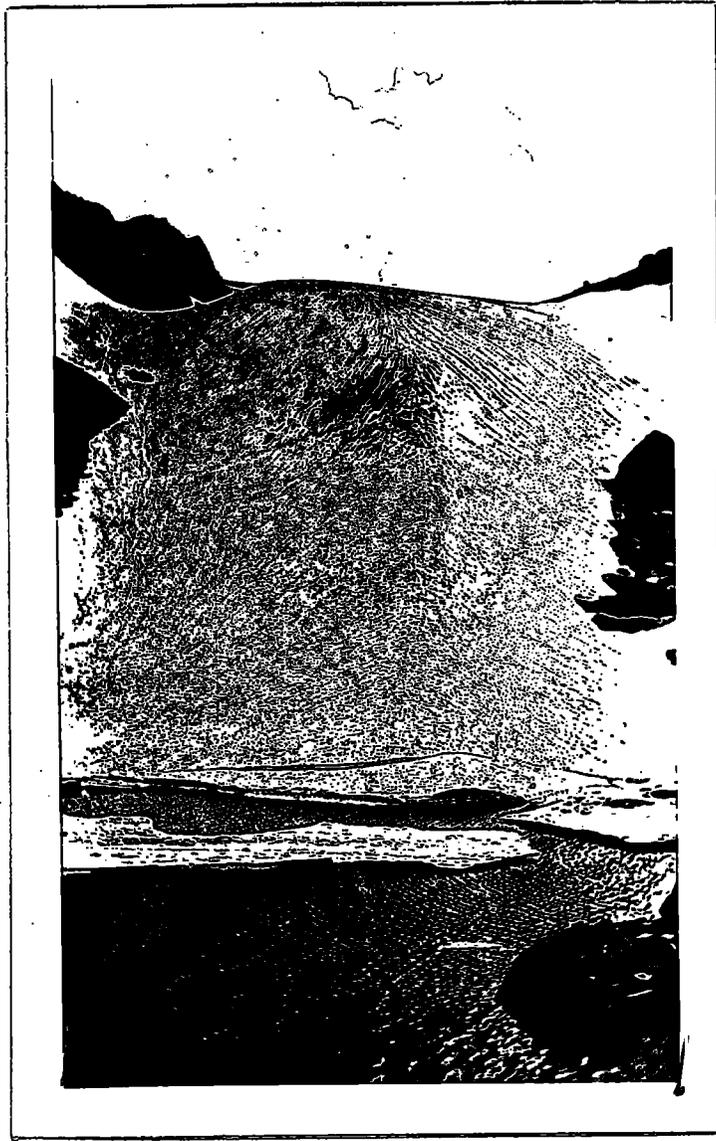
34.6°

34.7°

34.8°

34.9°

35.0°



ANDREWS GLACIER

Photograph made in August, 1909, showing vastly larger size of this icefield thirty years ago. Compare with photograph in regular plates in this report. Photograph by courtesy of Prof. Roy G. Coffin, geology department, Colorado State College, who made the picture in 1909.

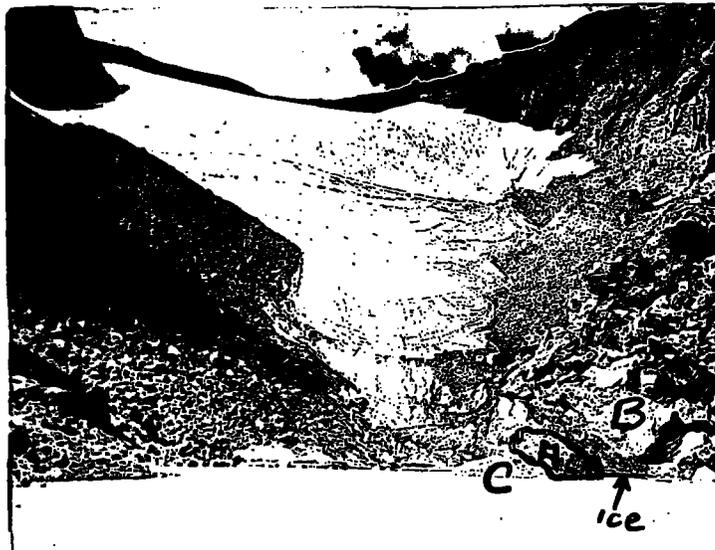


ANDREWS GLACIER

Looking west across lake at foot of glacier,
showing comparative appearance in 1938 and 1939.

Above: 1938 Below: 1939

Identified points assist visualization of the
alteration of the position of the glacier front.





LOOKING SOUTH ACROSS THE FRONT OF ANDREWS

Above: 1938 photograph, showing advance along the center and south edge of the ice front. Note that point D, a large rock, is almost completely surrounded and imbedded in the ice.

Below: 1939 photograph, showing melting. Small isolated fragment of "apron" remains at water's edge just below point B. Note that D is exposed.





ANDREWS GLACIER

Looking north from Station X' to north edge of ice front. Above, 1938; below, 1939.

Dotted-line overlay in 1939 photograph indicates extent of shrinkage. Measurement showed this recession to be 25' 11".

Location of Station X'' is indicated on 1938 photograph above, with line of measurement.



ANDREWS GLACIER



Left: View of south edge of Andrews Glacier in 1938. Note position of the "ice apron" along the south margin of the lake in front of the glacier. Identified points are repeated in the 1939 photograph, to give a comparative idea of shrinkage along the south side and front of the glacier.

Below: Comparable view, made in 1939. Dotted-line overlay indicates 1938 position of ice edge.





LOOKING DOWN ANDREWS GLACIER

Above: 1938 Below: 1939

Little difference in position of the north edge of the ice is evident, although it appears from comparison of identifiable accretion lines in the ice that the 1939 snow cover extends lower than that in 1938. Dissipation of the glacier front is clearly shown by comparison of the two photographs.

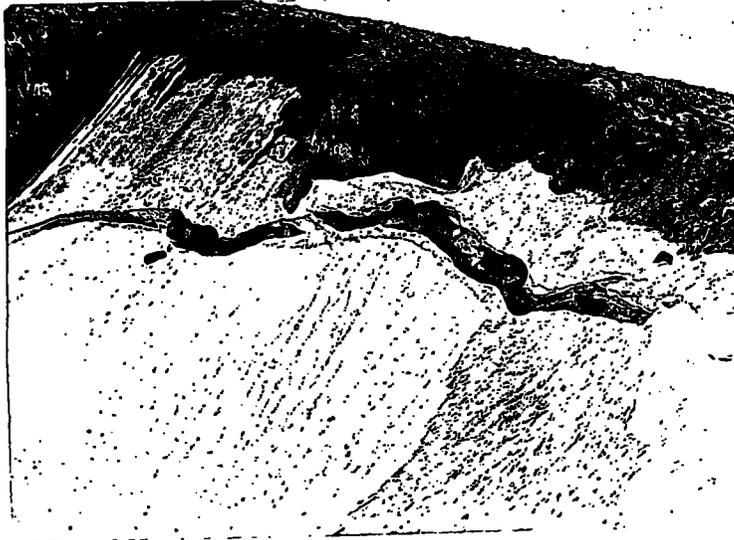




HEAD OF TYNDALL GLACIER

Above: In 1938, the bergschrund did not open.

Below: The bergschrund was opened with a maximum gape of some 15 feet in 1939. Comparison of the line of contact of the glacier with the headwall shows noticeable, but not great meltage in 1939, as compared with 1938.





LOOKING DOWN TYNDALL GLACIER

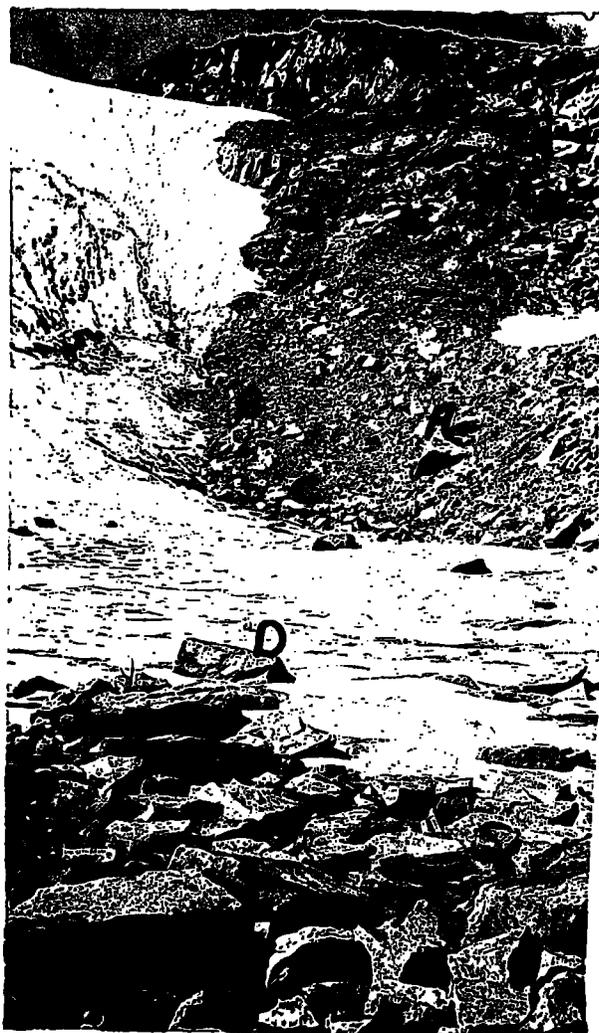
Above, 1938, below, 1939.

Photographs made from same point on headwall above glacier. In upper photo, notice the extended "lobe" at center, which was measured front in 1938. Lower photo shows meltage of this forward portion, with resultant heavy debris cover over the same area. Greater surface stream activity is evident below.



RIGHT:

North edge of Tyndall Glacier showing "tongue" extending forward toward Station X' in 1938. Identifiable rocks are indicated with capital letters. Same rocks are identified on the 1939 photograph below.



LEFT:

North edge of Tyndall Glacier in 1939. Note shrinkage by melting of the "tongue" so pronounced in 1938, as indicated by comparison of rocks A, B, C, and D. Compare the upper right edge of the ice, and less noticeable shrinkage is evident, where snow overlay played a minor part in the apparent condition of the glacier.





ABOVE:

South edge of Tyndall Glacier in 1938, showing "the funnel" and condition of the glacier front (lower left corner).



LEFT:

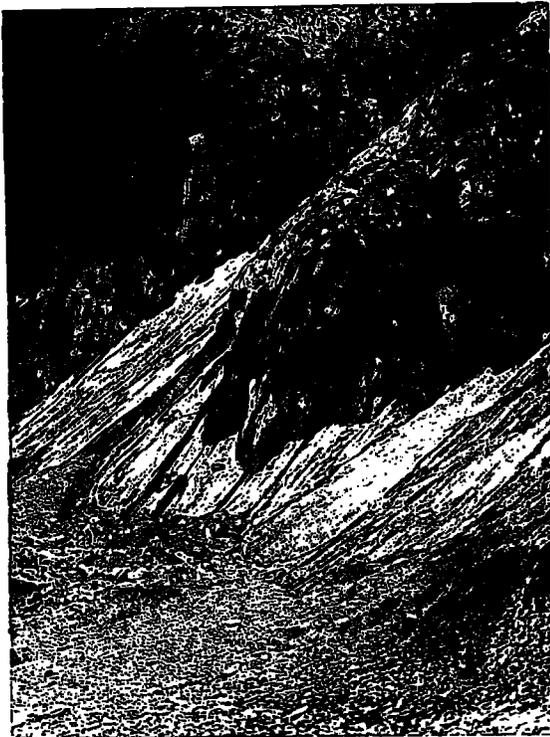
Two views, forming vertical panorama, showing condition of Tyndall Glacier from same position as in the photograph above. General wasting along the glacier edge is evident, and disappearance of the extended front "lobe" (lower left of lower photo) is visible.



South "Wing", Tyndall Glacier

Above: 1938 photograph.

Left: 1939 photograph.



Principal difference noted on this well-shaded icebank to the south, separated from the main body of the glacier, is in the melting of the overlay, and increase of slide and ablation debris along the bottom edge of the ice.

ICE TABLE

At the foot of Tyndall Glacier, 1939. With heavy snow overlay in 1938, such phenomena were not noted, although they were frequent in 1939, when much exposed surface debris made conditions ideal for their formation.



"SNOUT"

Abrupt front of Tyndall Glacier along the south edge of the main body of the glacier. Distinct blue glacier ice was exposed with under-melting creating a frontal cavity similar to "ice caves" at the terminus of large glaciers.



Surface Stream

Falling over the "snout" of Tyndall Glacier shown in the middle photograph. A stream flowing from the north edge of the glacier front made a semi-circle through the debris in front of the glacier, and flowed under this ice front, later percolating from the pool under the shadow of the ice front visible in this photograph.

