ROCPS/41MA-P02

UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE
ROCKY MOUNTAIN NATIONAL PARK
ESTES PARK, COLO.

October 10, 1941

Rec'd Oct. 20, 1941

Dr. Francois E. Matthes,
Committee On Glaciers,
U.S. Geologic Survey,
Washington, D. D.

Dear Dr. Matthes:

Enclosed is a copy of the 1941 glacier report for Rocky Mountain National Park.

You will note that due to conditions described in the report, Tyndall Glacier was not measured this year.

We believe that the photographs, together with data included in this report will give a good picture of changes in Andrews Glacier since 1940.

We shall appreciate receiving the Committee's summaries when they are issued.

Yours very truly,

David H. Canfield
Superintendent

By Russell D. Andrews
Acting

ROCPS/41MA-P01

10-23
(May 1929)

8/72 ✓

UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

Dr Matthes

ROCKY MOUNTAIN NATIONAL PARK

FILE NO.

F. E. MATTHES COLLECTION

ROCPS/41MA-P15

1941

GLACIER SURVEY

ROCKY MOUNTAIN NATIONAL PARK

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ARNO B. CAMMERER,
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ROCPS/41/MR-P03

1941 GLACIER STUDIES
ROCKY MOUNTAIN NATIONAL PARK

The annual measurements of glaciers has been made on Andrews and Tyndall glaciers since 1932, excepting 1936 when personnel was not available to conduct the studies. In 1941, the study was undertaken, and only in part successfully. On the date of September 13, selected for the measurement expedition, weather became so adverse that only Andrews Glacier was measured, and the results of photography were quite unsatisfactory, due to the overcast skies and prevailing storm. Tyndall Glacier could not be seen, let alone photographed, when we reached it. Subsequent to that date, repeated storms so engulfed the front of Tyndall Glacier in new snows that lie deeply over it that measurement at a later date was not feasible. Hence, the 1941 study includes only Andrews Glacier.

Date

September 13

Weather

Party started at 7:30 a.m. At that time, skies were clear except for low cloudiness. High clouds rolled up from the west by mid-morning. By 11:30 a.m., skies were completely overcast. Snow and sleet, with fine rain were falling before measurements were concluded at Andrews Glacier. Throughout the rest of the day snow continued to fall, and heavy clouds lay completely over elevations above 11,000 feet. It was impossible to see Tyndall Glacier from its headwall or from the rim of the gorge on Flattop Mountain. The party dropped below the storm clouds just above 11,000 feet on Flattop Mountain about mid-afternoon, but skies were overcast by high clouds through the whole park region.

Party

The party consisted of Park Naturalist Raymond Gregg, Ranger-Naturalist Paul N. Nesbit, Bob Hutchison, of Denison, Texas, E. B. Scurr, of Omaha, Nebraska, and Dr. E. B. Settle, of Rockport, Mo.

ANDREWS GLACIER

As first observed from the east end of the lakelet at the foot of Andrews Glacier, the ice did not appear to be greatly different in volume, and probably only a minimum of shrinkage took place in the actual body of the ice itself, due to the heavy late springsnows that covered it deeply through most of the summer. The comparative photographs minimize even more the differences in actual peripheral relation to the canyon sides because of overlying new snow from a storm of September 8.

However, at the ice front, it was evident that continued retreat of the ice front had taken place during the glacier year 1940-41.

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SKETCH OF ANDREWS GLACIER
Rocks identified by letters correspond to Plate I

Measurement from X'

The continuous tie-up with measurement data since 1932 is provided by measurement from Station X', on the south edge of the lake, although the oblique angle from this station to the present ice front is flat enough to introduce an error of several feet in actual forward or backward position of the front from a point directly ahead of the ice but horizontally even with Station X'. However, yearly measurements introduce about the same error due to angle of measurement, and as distance increases the angle changes less in percentage of error produced. Thus, measurement is comparative, if not of detailed accuracy.

In 1940, tapeline measurement along water surface and ground-slope across the mud delta to the ice front was 179'. In 1941, it was 212' 5". The large "apron" on the south shore produced by the marked advance of 1938 had completely disappeared, except for a snowbank from the September 8 storm that lay over the same territory between Station X' and the mud delta.

Measurement from X'''

This station, on a huge, stable boulder at the south edge of the glacier was established in 1938, when it was possible to measure from X''' forward (eastward) to the ice front which then extended out on the north edge beyond the boulder on which the station was located. In 1939, the ice still held its front 23' in front of Station X'''. In 1940, it had receded to a point 16' 9" back (west) of this station. In 1941, it was 54' 3" behind Station X''', a new peak of recession.

With recession, the edges of the "snout" have thinned rapidly, to the extent that Station X''' measurements now must be made at an oblique angle (this was true in both 1940 and 1941). As long as the recession continues, requiring measurement westward from Station X''', it will be difficult to obtain a straight east-west line measurement. However, the error involved is small. The sketch probably exaggerates somewhat the departure from direct-line measurement. However, the presence of intervening boulders of considerable size make measurement in two to three reaches necessary, with some loss of ground-slope accuracy from Station X''' to the snout. In fact, Station X''' is some ten feet up on the boulder from the present surface of the mud floor, and is even higher than the level of the ice front at present.

In the sketch, and in the photographs showing the snout, the recession of the ice front is quite evident when viewed in relation to the rock immediately west of Rock "A" of Plate I and the sketch above. This rock is identified as Rock "D" in Plates IIIA and VI, which show the recession with reference to it most advantageously.

The mud delta in front of the glacier showed considerable increment over the status in 1940. Since 1938, this mud deposit has increased in its approach toward the large rock in the lake. Except for the advance of 1939, there has been no push of the glacier to remove it and its growth is noticeable in comparative photographs. Eventually, it may make possible shallow wading to the rock in the lake, in which case a station established there would give a very accurate annual figure as long as the glacier remains westward of the position of this rock. This point of advance was reached and exceeded during the first two decades of this century, as determined by early photographs. If it is reached again, a station on the rock should be established, with auxilliary measurement from a sight-line between two established points in north-south line across the lake either way from this rock. Thus, if the rock were submerged by the glacier, a line for measurement forward to the ice front could be determined.

If good weather prevails at the time of the 1942 measurements, it is hoped to establish those auxilliary stations on the walls of the canyon at either side of the lake in line with the rock in the lake. With this established basis, a direct compass line west from the south point to a man standing directly south of the most advanced point of ice would give an accurate forward-backward line figure of relative position from year to year. It will be necessary to find absolutely stable points to make this measurement feasible and accurate.

An interesting feature in 1941 was the presence of an ice cone on the north edge of the glacier near the front. This is indicated by arrow in PLATE III B, and is shown closeup in Plate V. Ablation debris also was more abundant on the front than in 1940.

Following precedent of 1940, determined recession from X''' is used here as the report figure. Thus, 1940-41 recession is here reported to be 57' 6".

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Table of Comparative Measurements

Station X' to Nearest Ice			Station X''' to Nearest Ice		
1941	212'	5"	1941	-54'	5"
1940	179'	(est. from 179' measure)	1940	-16'	9"
1939	92'		1939	23'	
1938	32'	3"	1938	48'	11"
1937	96'	10"	1937	No Station Used	
1936	66'				
1934	139'		Apparent Recession, 1940-41:		
1933	68'	10"	37' 6"		
1932	48'	7"			

Apparent Recession, 1940-41:
33' 5"

With the disappearance of the thin "apron" edge along the south front, measured from X', there is now a fairly consistent recession figure for the glacier in the two measurements. Undoubtedly, the smaller figure for the X' measurement is due to more rapid dissipation of the north edge of the glacier as determined from Station XIII, and the difference in recession of south and north edge as reflected in the measurements is real. In view of the shorter distance involved, with less error percent inherent in it, Station X''' figures were used in the reported recession figure.

Meteorological Table

In determining influence of precipitation and temperature, figures for standard observer stations at Estes Park and Grand Lake are used, and an average drawn. It is probable, in view of prevailing westerly winds which accumulate drift for the building of the glaciers, that the Grand Lake figures influence glacier-advance or glacier-recession more than figures at Estes Park. On the other hand, major snowstorms are normally produced from easterly to northeasterly air currents, so that the Estes Park figure may bear more influence on actual volume of falling precipitation. At any rate, from figures compiled to date, no definite trends are traceable that make even, coinciding curves for temperature-precipitation factors and glacial advance or recession. However, the data should be compiled annually, in the hope that a long-range set of figures may reveal some consistent results in time.

TEMPERATURE AND PRECIPITATION

MONTH	STATION OR AVERAGE	MEAN TEMPERATURE	SNOW Depth	In. Precip.	TOTAL PRECIPITATION
Oct. 1940	G.L. Grand Lake	41.0	3/4"	.09	.69
	E.P. Estes Park	46.4			.52
	Av.	43.7			
Nov. 1940	G.L.	22.9	7 "	.75	.75
	E.P.	31.4	7 1/8 "	.69	..69
	Av.	27.1			

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	Station	Mean Temp.	Depth of snow	Precip. inches	Total precip.
Dec. 1940	G.L. (Grand Lake)	21.2	13 "	1.00	.68
	E.P. (Estes Park)	31.0	9 ½"	.47	.47
	Av.	26.1			
Jan. 1941	G.L.	16.5	11 "	.80	.80
	E.P.	23.0	11 ½"	.64	.64
	Ave	22.1			
Feb. 1941	G.L.	20.0	24 "	1.40	1.40
	E.P.	30.5	1 ½"	.17	.17
	Av.	28.6			
Mar. 1941	G.L.	29.0	16 ½"	1.69	1.65
	E.P.	28.2	24 "	2.03	2.03
	Av.	27.0			
Apr. 1941	G.L.	31.6	23 "	2.80	4.48
	E.P.	36.7	12 3/8"	1.09	2.91
	Av.	34.2			
May 1941	G.L.	45.2			.75
	E.P.	48.9			.68
	Av.	47.0			
June 1941	G.L.	46.6			2.20
	E.P.	53.2			3.48
	Av.	50.0			
July 1941	G.L.	54.8			1.10
	E.P.	61.1			2.68
	Av.	57.9			
Aug. 1941	G.L.	54.8			2.70
	E.P.	64.5			2.04
	Av.	59.6			
Sept. 1941	G.L.	44.2	2 "	1.29	1.75
	E.P.	50.9	3 "	.72	1.71
	Av.	47.6			
For Glacier-Year, 1940-41	G.L.	33.9	97 ½"	9.89	19.41
	E. P.	42.3	71 ⅝"	5.81	17.85
	Av.	39.0	84 7/16"	7.85	18.63

Comparative Data

1939-40	G.L.	37.2	80 "	2.17	19.81
	E.P.	43.3	65 ½"	4.49	16.49
	Av.	40.2	72 1/8"	3.33	17.84
1938-39	Av.	38.9	97 ½"	7.80	18.10
1937-38	Av.	39.4	116.20"	11.56	21.88
1936-37	Av.	37.5	93.19"	6.85	17.29
1935-36*	Av.	40.7	80.00"	7.11	19.16

* Figure computed on Estes Park report only for 1935-36, prior to installation of Grand Lake weather station.

It is interesting to note that a substantial part of the April and most of the May precipitation through the years studied has fallen as rain rather than snow. In most instances, only slightly lower temperature conditions could have added considerably, often as much as 20% to the potential increment of the glaciers.

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PLATE I

ANDREWS GLACIER

Looking west across lakelet at foot of the glacier showing comparative appearance in 1940 and 1941.

Above: 1941 Below: 1940

Identified points and points indicated by arrows assist visualizing alteration of the position of the peripheries of the ice. The ice was still in a position behind Rock A in the photograph, as it was in 1940. Measurement from X''' was done toward the ice on an oblique angle.

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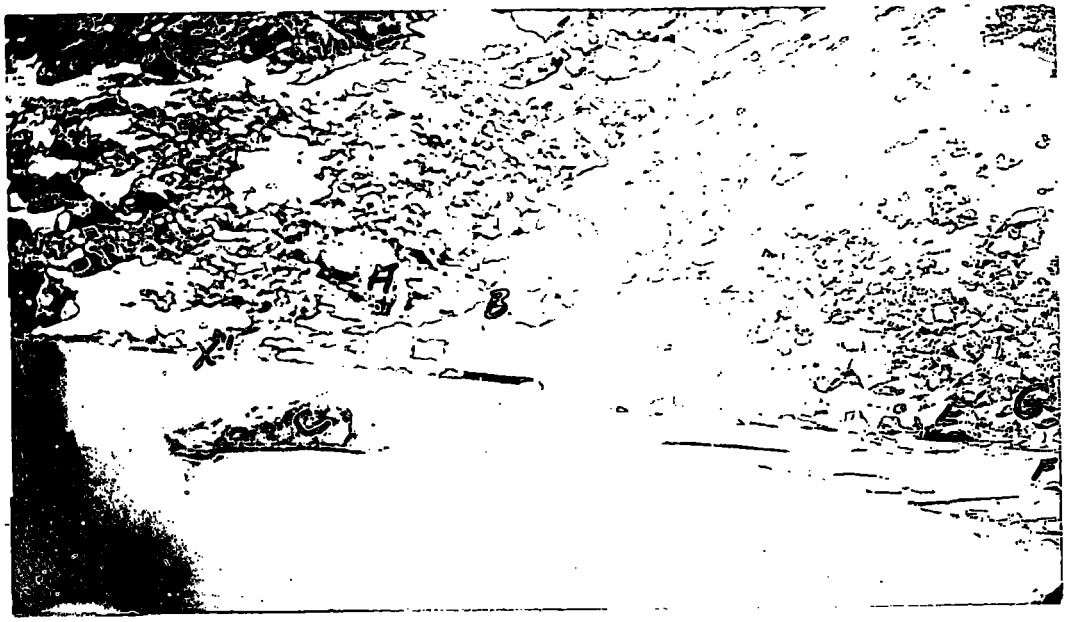
PLATE II A



LOOKING SOUTH ACROSS FRONT OF ANDREWS GLACIER
Above: 1941 Below: 1940

Comparable points are identified. The extreme front of the ice in 1940 is visible in the lower photograph. This point is just in the field of the upper photograph, but the ice was considerably behind this point.

Note that the mud delta built up considerably in 1941, as the ice moved back and dumped its silt and flour burden on the old delta.

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PLATE II B

ANDREWS GLACIER

Looking south across snout of glacier.

Above: 1941 Below: 1940

Points are identified, overlapping with Plate II A. By referring the edge of the ice to the right of Rock "D" to identified or identifiable points, it is possible to see shrinkage along the south edge of the ice. Although the 1941 photo was made farther to the left, the ice front is not visible to the left of Rock "D", as was the case in 1940.

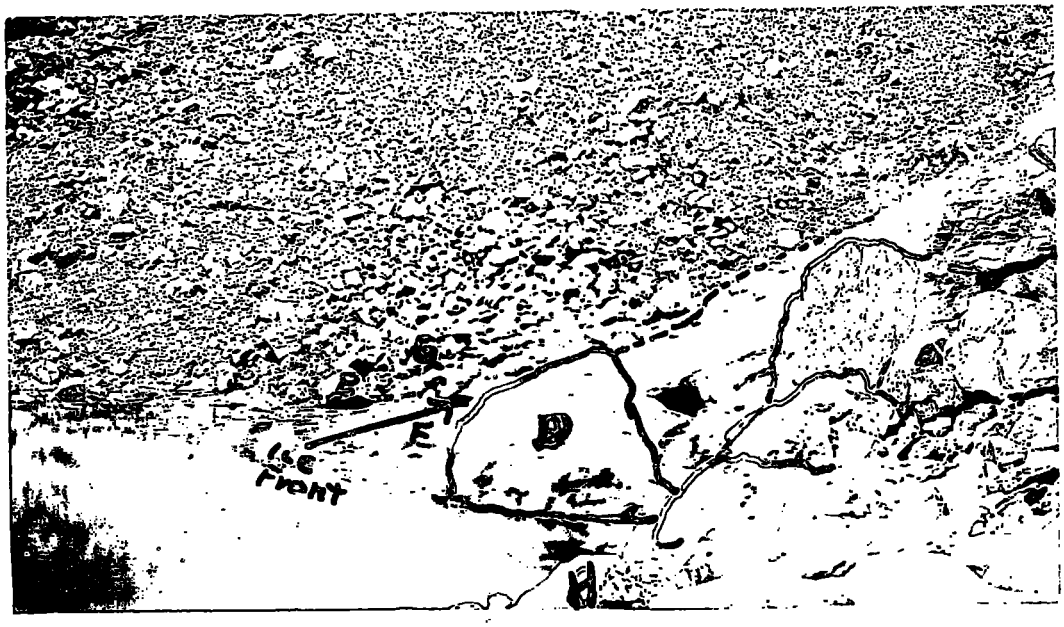

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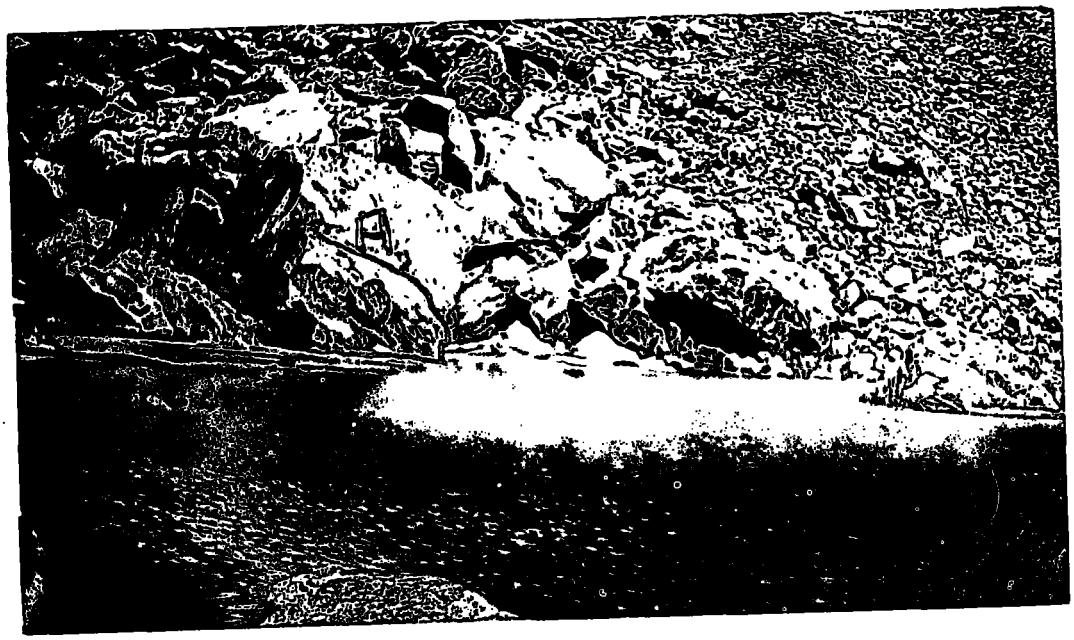
PLATE III A



ANDREWS GLACIER

Looking north from Station X' to north edge of ice.

Above: 1941 Below: 1940

Similar points are identified. Relation of ice front to Rock C is indicated in each case by arrow at left edge of photograph.

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PLATE III B

ANDREWS GLACIER

Views of the ice front, looking northerly.

Above: 1941 Below: 1940

By comparision of relation of ice front to Rock "A", one gets an impression of shrinkage from 1940 to 1941.

Ice Cone shown closeup in Plate V is indicated by arrow in 1941 photograph, above.