

GLACIERS AND GLACIATION

IN GLACIER NATIONAL PARK



ADMINISTRATION

Glacier National Park is administered by the National Park Service, U.S. Department of the Interior. A Superintendent, whose address is West Glacier, MT 59936, is in immediate charge.

This leaflet is published by Glacier Natural History Association, a non-profit organization, cooperating with the National Park Service in the interpretive program of Glacier National Park. The association offers at a nominal cost publications to develop a broad public understanding of the geology, plant and animal life, history, Indians, and related subjects.

WHAT ARE GLACIERS?

Glaciers are slow-moving, thick masses of ice. Snowfields are thinner, almost motionless masses of permanent snow. Most of the white patches seen in Glacier in late July and August are snowfields. The two main types of glaciers are CONTINENTAL GLACIERS large masses of very thick ice covering all or portions of continents; and ALPINE GLACIERS that flow down mountain valleys.

GLACIATION is the effect glaciers have on the land. Glaciers are powerful land shaping forces and their special effects on land features are both distinctive and spectacular.

THEIR SIGNIFICANCE

In the late 1800's Hans Cloos, a famous German geologist, wrote that "because of glaciers that still exist we know that it is possible for water to crystallize and form large cohesive masses which flow through valleys, overrun plains, climb mountains, and permanently alter the face of the earth."

Cloos' thought is important because if it were not for existing glaciers would we understand the formation of such spectacular scenery as found in Glacier National Park and other places throughout the earth? Could we imagine that the almost sheer mountain peaks, joined by narrow vertical-walled ridges, and paralleled by deep flat-bottomed valleys had been formed by moving ice?

Large alpine glaciers still do exist in Alaska and Switzerland. Continental glaciers cover Greenland and the South Pole. But the glaciation existing today is not on the scale that existed during the Pleistocene period of geologic history.

TERMS AND PROCESSES

FIRN. Small granules of ice formed by the compaction of feathery snowflakes and by the thawing and refreezing of their edges. It is the stage between snowflakes and ice.

GLACIAL MOTION. Ice appears hard and brittle, but with the weight of overlying snow and firn, the deepest snow becomes plastic and fluid allowing the glacier to flow downhill. This motion is not visible to the eye but can be shown by rows of stakes driven into the glacier in straight lines. The glacier moves the stakes as it moves. The movement is greatest near the center where the ice is the thickest and where there is the least contact with the valley sides. Speeds of 50 meters per day have been measured in Alaskan glaciers.



CREVASSE. A large and deep crack in the glacier ice formed as ice flows over the ledges on the valley floor.

TILL. Loose soil and rocks of all sizes dumped by the melting ice of a glacier. These rocks, when carried by the glacier, help to wear away valley sides and bottoms.

MORAINE. A ridge of glacial till dumped along a glacier's edges (lateral moraine) and front (terminal moraine) and sometime in its center (medial moraine).

STRIATIONS. The hairline scratches to large gouges formed on a flat rock surface by the scraping of rocks carried by the glacier.

POLISH. The shiny surface of a rock formed by glacial ice rubbing against the rock.

ALPINE FEATURES

The most distinctive feature in Glacier are the large U-shaped valleys scooped out by glaciers. Other distinctive features include CIRQUES, the giant amphitheatres laying at the head of glacial valleys where glaciers first form. From there the glacial valley usually drops straight into a BASIN that descends gradually to become a valley.

Sheer-walled mountain peaks, some of them known as HORNS like the Swiss Matterhorn, are the most prominent park feature. These were formed by glaciers cutting away on three or four sides of pre-glacial mountains. Thin-walled ARETES, such as the Garden Wall, are another prominent feature formed when two glaciers flowing in parallel valleys erode mountain ridges leaving a wall-like ridge as much as 2000 feet high and sometimes less than 100 feet in width at the top.

HANGING VALLEYS are still another glacial phenomena formed as the result of a main valley glacier cutting its canyon more rapidly than smaller glaciers joining from tributary valleys. Today we see streams flowing from these side valleys dropping off into space and falling hundreds of feet to join the river below. Examples of these in the park are Birdwoman and Feather Plume Falls.

GIANT'S STAIRWAYS can be the result of the sudden increased downcutting power of the main valley glacier at the point tributary glaciers join. They can also be created when the glacier moves over rock layers of varying hardness. The glacier can cut more easily into the softer rock than into harder rock. A series of such occurrences along the course of the valley produces a giant's stairway effect.

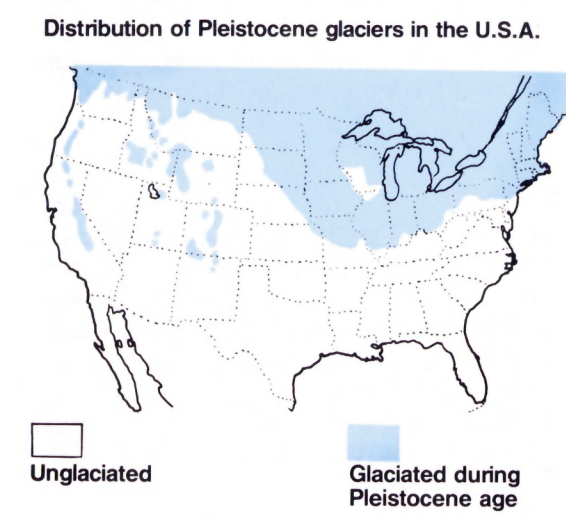
THE PLEISTOCENE - AGE OF ICE

The Pleistocene, known popularly as the "Ice Age", is a part of geologic time that began about three million years ago and ended about 10,000 years ago.

Geologists can detect changes in past climates by noting changes in rock formations and the fossils they contain. They can tell from the rock record that the world-wide climate began to change about 3 million years ago from warm and dry to increasingly colder and wetter. This coincided with longer winters and shorter summers, resulting in increasing accumulations of snow in high mountains and on the continents.

The cause of these climatic changes is not certain. One theory is a decrease in solar intensity, while another is that a shift in the earth's orbit tipped the northern hemisphere slightly away from the sun's direct rays. Still another is that an increase in volcanic activity caused more smoke and haze in the atmosphere blocking solar rays. It may have been a combination of factors, but whatever the cause, the Ice Age began with the climatic changes.

EXTENT OF PLEISTOCENE GLACIATION



Evidence of this glacial coverage includes row after row of abandoned glacial moraines, behind which lie striated rock floors strewn with glacial till and boulders. Lakes and marshes occupy gouged out depressions; outwash fans spread from gaps in moraines. In mountainous areas such as the Sierras and northern Rockies in the United States and the Alps in Europe such distinctive terrain indicates the past existence of glaciers.

UPPER McDONALD VALLEY



IN GLACIER NATIONAL PARK

The large glaciers that once moved through the valleys of the park during the Pleistocene have been gone for 10,000 years. But their effect on the terrain is evident throughout the park. The glaciated terrain is the reason for the name — Glacier National Park.



There are about 50 small glaciers that still exist in the Park. These small glaciers are commonly known as CIRQUE GLACIERS because they do not extend beyond the boundaries of cirques at the heads of valleys. The existence of glaciers such as Grinnell and Sperry give the visitor an insight into the work of glaciers. These glaciers have melted extensively since first discovered. The description of Grinnell and Sperry Glaciers which follows provides a view into the “life” of glaciers in the park.

SPERRY GLACIER



Sperry Glacier is located 9 miles south of Grinnell Glacier on the west side of the Continental Divide. The glacier is reached by a steeply climbing trail 10 miles long which begins at Lake McDonald Lodge. Persons wishing to visit the glacier should plan to stay overnight at the Sperry Chalet or campground, hiking the four miles to the glacier early the second day.

The glacier is named in honor of Dr. Lyman B. Sperry of Oberlin College. He and his party succeeded in scaling the steep glacial wall at the head of Avalanche Basin to view the glacier in 1895. However, he did not actually reach the glacier until a later trip in 1897.

AREA. Sperry has been melting at a steady but decreasing rate.

Year	Acres	Average Annual Loss (acres)
1901	800	
1938	390	11
1946	330	8
1950	305	6
1960	287	2
1973	279	.6

The glacier is presently about .6 mile long and 1 mile wide.

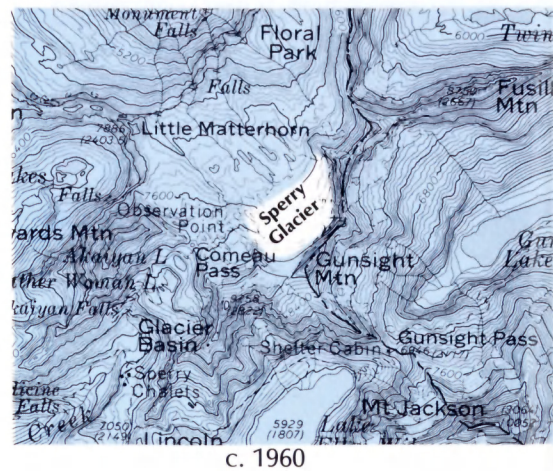
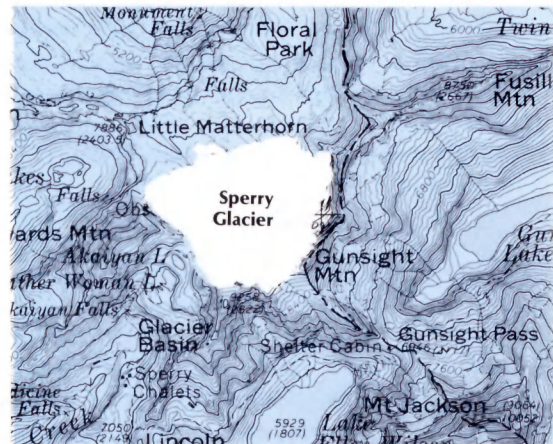
At one point of measurement on the glacier the ice decreased 150 feet in thickness from 1913 to 1944, an average of about five feet per year.

RECESSION. The rate of recession of the ice front is as follows:

Period	Recession	Average Annual Loss (feet)
1938-45	351	50
1945-50	177	35
1950-56	85	14
1956-61	196	39
1961-69	185	23

Total recession of the glacier since first measured is 994 feet.

FORWARD MOVEMENT. One aspect that distinguishes a glacier from a stagnant ice field is forward movement of the glacier. As long as a glacier has forward movement, it is an active glacier. This is true even though the rate of melting of the front of the glacier may exceed the rate of forward movement. From 1949 to 1969, for example, the rate of forward movement of Sperry Glacier at a given location was 14 feet annually. The rate of recession of the glacial front for the same period was 28 feet annually. Thus while Sperry Glacier was moving forward, it was still retreating 14 feet a year. When movement exceeds recession, if and when it does, the glacier will begin to regain lost territory and move down into the valley again.



GRINNELL GLACIER



Grinnell Glacier is located on the east slope of the Continental Divide, at the head of Grinnell Valley, a tributary to the Many Glacier Valley. It is reached by a 5-mile trail beginning at the Many Glacier Hotel. The trail parallels the shores of Swiftcurrent and Josephine Lakes. From the head of Josephine Lake the trail climbs 1500 feet to the glacier.

As far as records show, Grinnell Glacier was first visited by George B. Grinnell, Lt. Beacom, U.S. Army, and James W. Schultz in 1887. Mr. Grinnell was then editor of Forest & Stream, a well-known outdoor magazine of that period. He was among the early supporters for establishing Glacier National Park. The glacier and vicinity were first mapped by geologist Francois Matthes in 1900. Since that time the glacier has been the subject of detailed research.

Grinnell Glacier in 1900 measured 480 acres and consisted of two separate lobes connected by an icefall. Later the icefall melted leaving two separate glaciers, the lower Grinnell Glacier and the upper now known as Salamander Glacier.

AREA. The glacier has been melting at a steady but decreasing rate since 1900.

Year	Acres	Average Annual Loss (acres)
1900	480	
1937	328	4.1
1946	280	5.3
1950	272	2.0
1960	259	1.3
1966	244	2.5
1970	238	1.5
1974	243	+1.2

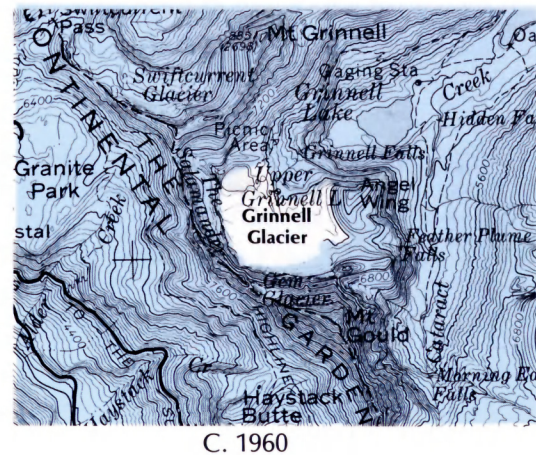
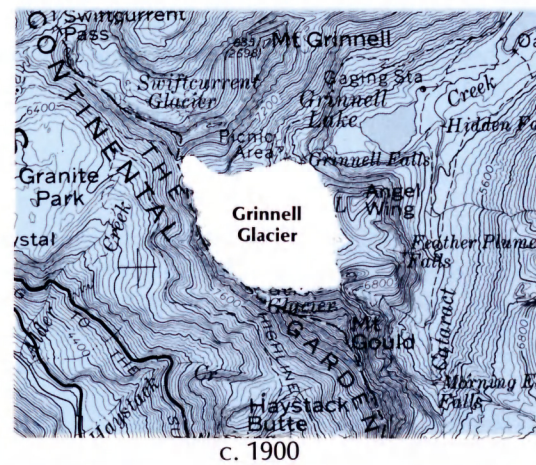
Presently the glacier is approximately .5 mile long and 1.2 miles wide.

RECESSION. Accompanying the decreased glacial area has been a recession or retreat of the glacial front and a reduction in thickness. The first known recession measurements were made by M. J. Elrod, a naturalist in the 1920's. He made these measurements by pacing from a large conspicuous rock near the trail to the front of the ice. From 1925 to 1927 the glacier receded over 60 feet. Geologic mapping of the glacier has shown the following amounts of recession.

Period	Recession	Average Annual Loss (feet)
1937-45	243	30
1945-50	61	12
1950-60	87	9
1960-68	19	2

Total recession of the glacier front for the period 1937-68 is 410 feet. Note the abrupt decrease in rate of recession beginning in the 1940's which correlates with the worldwide cooling trend at that time.

FORWARD MOVEMENT. Although Grinnell is gradually getting smaller, its forward movement in 1972 was 38 feet.



GLACIERS AND MAN

Man has a certain kinship with glaciers. His migrations were controlled by their ebb and flow. It was during the last retreat of the glaciers that man is believed to have first set foot on our continent. His early migrations down from the Bering Straits may have been through passages of retreating ice past the eastern portions of Glacier National Park.

Glaciation has determined many of the present works of man. The Great Lakes and Mississippi River system were formed by glaciers affording man a great industrial advantage. The rich soil formed on glacial deposits of the northern Midwest provide man an agricultural advantage. We also seek out recreation in mountainous areas such as the Rockies and Sierras, intricately shaped by glaciers.

Now there is evidence that man may be affecting glaciers. Scientists have noted a slight but significant cooling of the earth's temperature since the 1940's. Some feel that the cooling is due to increased dust and gases in the atmosphere caused by the great boom in industrialization in the 1940's. By shutting out some solar radiation and lowering temperatures, man may be in the process of speeding up the beginning of a new “Ice Age,” but probably not by too much. Ice ages come and go regardless of man.