Further Studies of the Dinwoody Glaciers, Wind River Mountains, Wyoming

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Glaciological studies around Gannett Peak in 1950[1] suggested that high névé fields were thickening and that the rate of glacier recession was diminishing. The author was grateful for the chance to return to the glaciers in 1952 to check their most recent variations. A structural investigation of Dinwoody Glacier was also completed at that time, and other glaciological studies were continued. Deteriorating weather in September prevented access to glaciers west of the Continental Divide, so research was confined to Dinwoody, Gooseneck, Heap Steep, and Gannett glaciers. Donald O. Emerson served as an able field partner. The field data have not been completely analyzed; the conclusions presented must therefore be regarded as tentative.

Glacier Variations

The year 1950 was exceptional for Dinwoody Glacier, for in spite of general recession the glacier ended the season with considerable excess of accumulation over ablation. The year 1952 was also exceptional, but in the opposite extreme: the balance sheet of accumulation and ablation was strongly negative. With the firn limit at nearly 12,500 feet, ablation exceeded accumulation on 57 percent of the glacier surface. Clearly discernible below the 1952 firn limit was a broad névé zone, the outcropping edge of 1951 and 1950 snow accumulation. The position of the firn limit in 1945, 1950, and 1952 is shown in the illustration. An abnormally high firn limit was observed on all glaciers studied, and the figures for Dinwoody Glacier are typical.

Current photographs of Dinwoody, Gooseneck, and Gannett glaciers show striking changes when compared with those taken in

[1] M. F. Meier, "Glaciers of the Gannett-Fremont Peak area, Wyoming," *A. A. J.*, VIII (1951), 109-113.

1940 by Delo[2] and in 1930 by Wentworth.[3] Thinning and recession have been continuous at lower elevations; most of the deterioration occurred between 1930 and 1941. Recession of Gooseneck and Gannett glaciers has been nearly constant since 1945.

High altitude snowfields, on the other hand, have thickened noticeably since 1940. The snow crown on Gannett Peak snowfields around the Sphinx, Dinwoody Glacier firn east of Pinnacle Ridge, and the upper parts of Gannett Glacier all show this effect. In spite of the bad year 1952, firn north of Gannett Peak has thickened about 50 feet since 1950.

This low-level recession and concurrent high-level thickening cannot be attributed as yet to any single cause. A rise in the altitude of maximum snowfall is one possibility, but a general increase in winter precipitation or decrease in summer temperature will also induce thickening of the névé, which might not affect recession of the terminus until a "wave" of increased thickness reaches the snout.

Glacier Structures

Glaciers exhibit many sedimentary and structural features reminiscent of the sedimentary bedding, faults, and metamorphic foliation found in deformed rocks. Rarely, however, have these features been mapped so that they could be used to gain insight into the manner of flowage of glaciers. Consequently, in 1952 the author completed a map of the surface features of Dinwoody Glacier.

Crevasses (tension joints) and isolated thrust faults are usually obvious and unambiguous. However, two prominent planar features were found which are completely different in origin, yet are almost indistinguishable. These are a sedimentary layering inherited from the firn and a foliation induced by flow. The cyclic nature of the sedimentary layers suggests that they represent annual snow accumulations. After considerable study, several criteria were found which, in most cases, made it possible to distinguish these structures in the field:

(1) Foliation surfaces are generally very planar except where

[2] D. M. Delo, "Recent Recession of Dinwoody Glaciers," (abstract), *Geol. Soc. Amer. Bull.*, 51 (1940), 1924.

[3] C. K. Wentworth and D. M. Delo, "Dinwoody Glaciers, Wind River Mountains, Wyoming," *Geol. Soc. Amer. Bull.*, 42 (1931), 605-620.

secondarily contorted, whereas annual layers are more irregular and only sub-parallel.

(2) Foliation planes may be very close together, and in some cases are separated only by small fractions of an inch. Sedimentary layers were never observed so close together.

(3) Flow foliation is made recognizable by contrasts between bubbly and clear ice, or ice of different crystal sizes. Very thin lamellae of fine-grained (sheared) ice are sometimes found. Sedimentary layers, on the other hand, usually occur as cycles of clean and dirty, banded ice. Accumulations of debris conformable with the bedding occurs locally.

(4) The trend of foliation is often roughly parallel to the direction of flow. Annual layers are roughly parallel to the firn line near that line, but farther down dip steeply up-glacier.

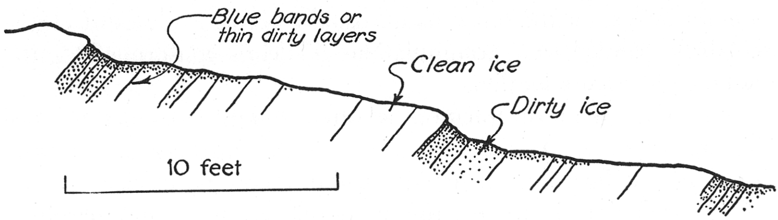
(5) Foliation is most strongly developed near the margins, terminus, and medial moraines; annual layers are indistinct in these places and most prominent in the center of ice streams.

(6) The foliation is indistinct or unrecognizable from a distance, but annual layers are most obvious when viewed from a distant point—apparently slight differences in dirt content set off the annual bands.

As can be seen from the accompanying map, the pattern of structures on the surface is clearly related to the flow of the glacier. The sedimentary bands are pushed downhill fastest in the center of ice streams, and are rotated so that they change from an initial low-angle down-glacier dip through the horizontal to a steep up-glacier dip, which flattens out somewhat at the terminus. These bands are highly contorted below the margins of the steep tributary which descends from Mount Wilson, but are perfectly regular below the much steeper Doublet Peak icefall. At the intersection of several ice streams are zones (medial moraines) where the velocity is evidently very low, for here movement of annual layers is retarded, debris is accumulated, and a foliation parallel to the shearing is strongly developed. Sedimentary layers and foliation here have a parallel trend and can be distinguished only by differences in dip. Foliation is well developed along the east margin of the glacier; here the planes dip up-glacier and overthrust sedimentary layers. Near the terminus are many isolated thrust faults where active ice overrides the stagnant terminal ice.

Other Studies

If one assumes that the glacier is approximately in equilibrium, then the spacing of annual bands is an indication of surface velocity distribution. Annual bands just below the Doublet Peak icefall, for instance, average 29 feet apart; thus one component of velocity here is 29 feet per year if the assumption is valid. The exact analysis is more complicated than this, involving consideration of ablation,



dip of layers, and slope of surface, and awaits completion of a topographic map of the glacier.

The ice caves above a small nunatak near the terminus of Gannett Glacier were revisited in 1952, in the hope that the crystalline structure of extruded ice could be further investigated. Unfortunately, all of the ice caves had closed so that no extruded ice could be obtained. The cause of this change in the caves is not known.

With the completion of mapping on Dinwoody Glacier, this becomes one of the few glaciers in the world that have been thoroughly investigated from a structural point of view. Photographs taken in 1930 and almost yearly since 1939, together with regimen calculations of 1950, provide a rich collection of data for further study of glacier variation in this area. It is hoped that future workers can continue the investigations of these small, continental high-altitude ice masses.