SURFACE-HEIGHT CHANGE 1957 TO 1978

In 1974 the U. S. Geological Survey began an intensive investigation of the stability of Columbia Glacier, a calving tidewater glacier terminating in Columbia Bay, near Valdez, Alaska (figure 1). Investigations showed that since about 1850 the glacier had experienced a number of short-lived advances along various parts of its terminus (Gilbert, 1910; Grant and Higgins, 1913; Tarr and Martin, 1914; sheet 3, note A). Since 1920 the glacier's retreats have exceeded its advances (Field, 1932, 1948, 1962). Aerial observations from 1960 to the present disclose conspicuous trimlines in the adjacent vegetation above the glacier's edges within 15 km of the terminus, demonstrating that the ice surface along the margins has been lowered in recent decades. In order to determine mass changes in detail, aerial photographs taken in 1957, and a sequence of aerial photographs taken at approximately 2-month intervals starting in July 1976, were analyzed photogrammetrically, utilizing control points established along the margins of the glacier by ground survey parties (Columbia Glacier Team, 1978; Mayo and others, 1979). One of the results of the photogrammetric analysis is a comparison of surface altitudes at different photographic dates (figures 2 to 6). The comparison has been extended upstream (figure 7) using point altitudes of the glacier surface from 1978 ground surveys (Mayo and others, 1979). The results show that with the possible exception of the head of the glacier, which was not included in the photographic study, the glacier surface has generally lost altitude from 1957 to present. This loss was most pronounced near the terminus, and losses during the last few years were large compared with the average loss from 1957 to 1974. From July 29, 1957, to July 27, 1974, the average rate of thinning over the reference data area shown on figure 5 was 0.55 ± 0.08 meter per year, whereas from July 27, 1974, to July 30, 1978, the rate of thinning had increased to 3.20 ± 0.32 meter per year over the same area.

Figure 1. Map of Columbia Glacier showing glacier margins, the Universal Transverse Mercator (UTM) coordinate grid, latitude (N), and longitude (W). The defined centerline coordinates are also shown, with units in kilometers originating at the head of the main ice stream, and with tributaries west (W), middle west (MW), east (E), and northeast (NE).

Figures 2 through 5. Contour maps obtained from aerial photogrammetric analyses, showing changes in surface height. The shaded parts represent areas where data points were obtained. Surface altitudes were picked on a grid spacing of about 500 m, and the contour maps showing surface rise or drop were made using these altitudes. Standard error on all maps is ±5 m for a single point measurement. Because of the random nature of this error, average height changes over larger areas of the glacier have smaller associated errors. Centerline profile, glacier margins, UTM coordinates, and latitude and longitude ticks (see also figure 1) are shown.

Figure 6. Comparison of surface height changes from 1957 to recent years. The values plotted were taken along the centerlines in figures 2 through 5.

Figure 7. Surface-height change extending further up the main stream and three tributaries, using the aerial photographs from July 29, 1957, and ground surveys from 1978. From 52 to 66 km on the central profile, data was obtained from figure 5. The remaining points were obtained using ground surveys from August 24, 1978 to September 6, 1978 (Mayo and others, 1979).

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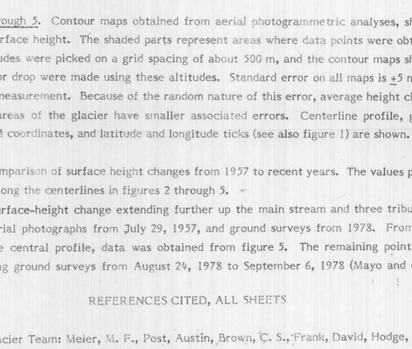


LOCATION MAP

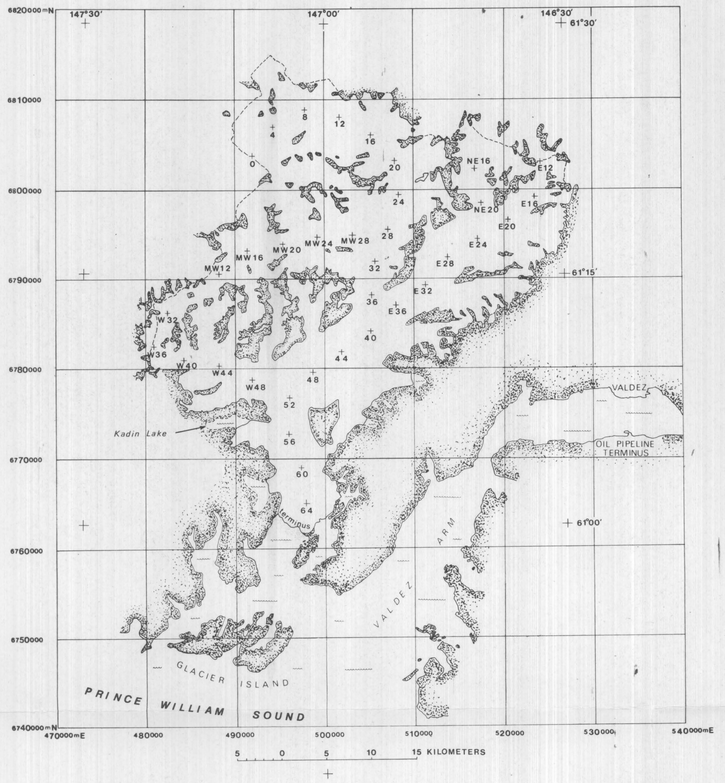
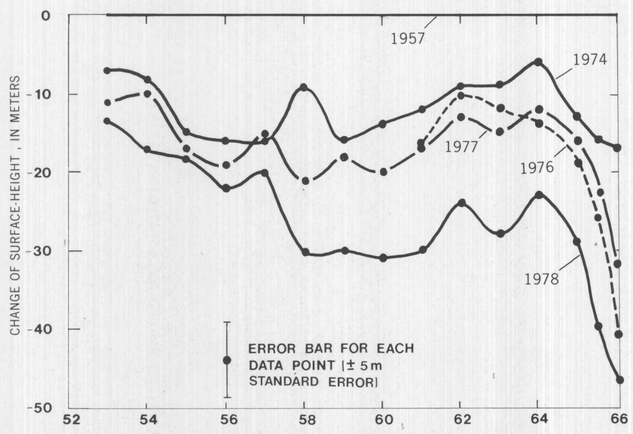
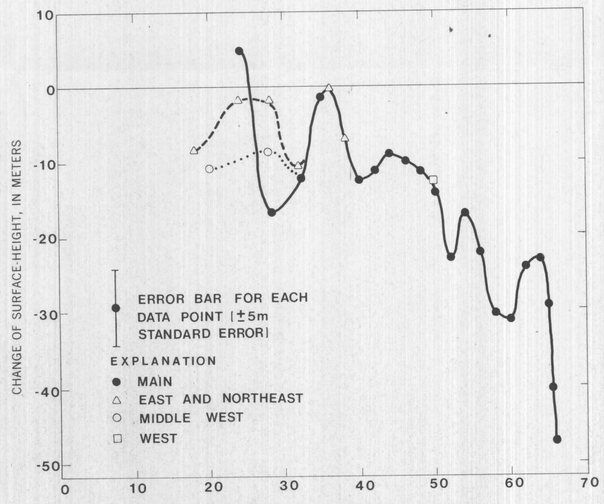


Figure 1



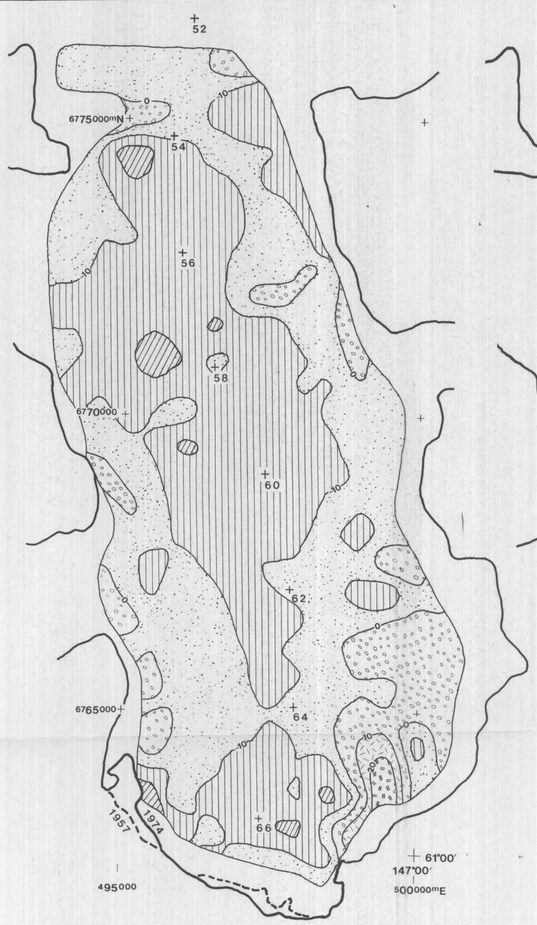
COLUMBIA GLACIER SURFACE-HEIGHT CHANGE FROM 1957

Figure 6



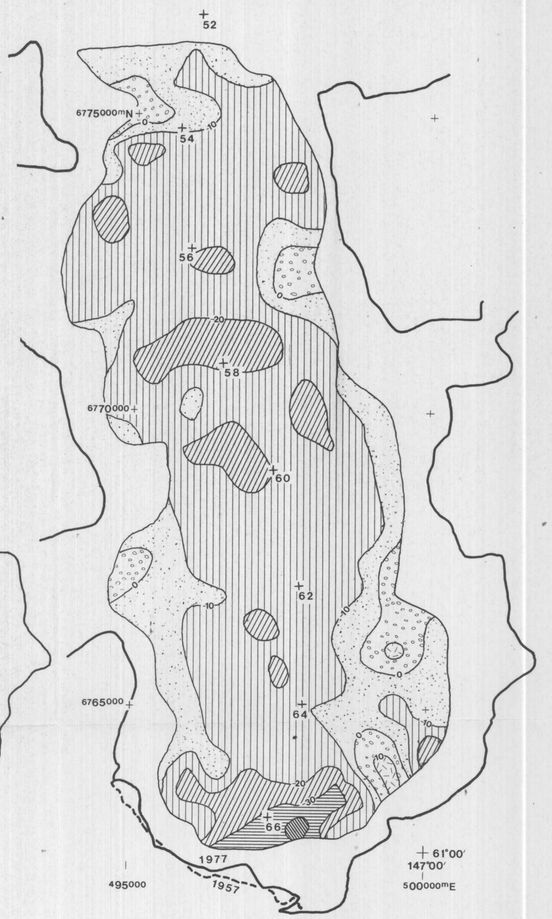
SURFACE-HEIGHT CHANGE, 1957 TO 1978

Figure 7



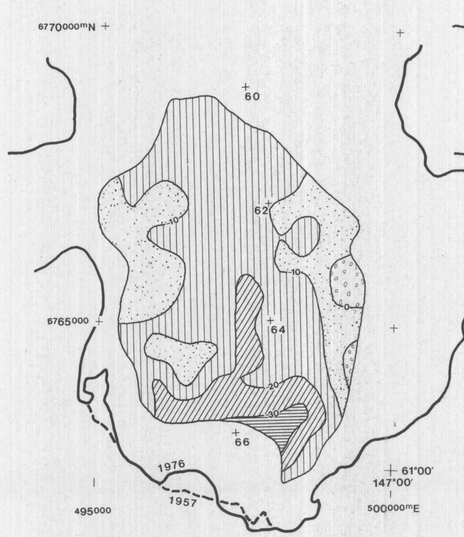
JULY 29, 1957 TO JULY 24, 1974

Figure 2



JULY 29, 1957 TO JULY 7, 1977

Figure 4



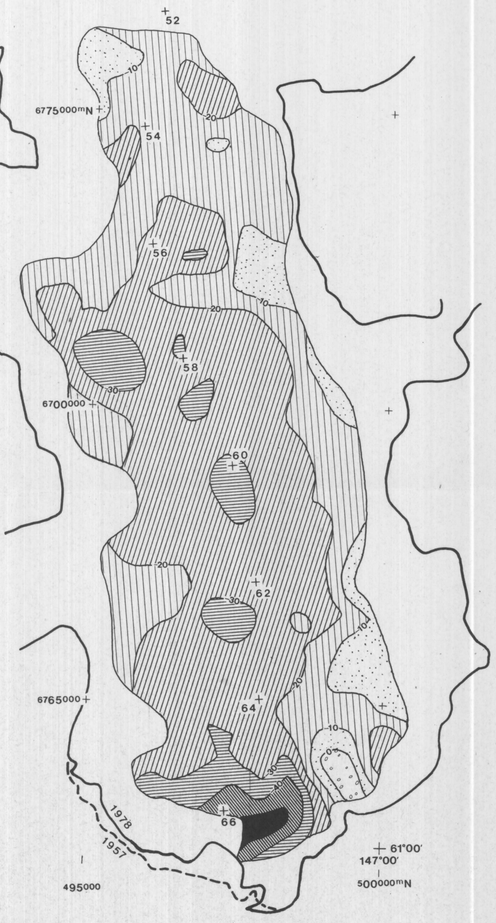
JULY 29, 1957 TO JULY 24, 1976

Figure 3

1 0 1 2 3 4 5 KILOMETERS

EXPLANATION

- 20 TO 30 m RISE
- 10 TO 20 m RISE
- 0 TO 10 m RISE
- 0 TO 10 m DROP
- 10 TO 20 m DROP
- 20 TO 30 m DROP
- 30 TO 40 m DROP
- 40 TO 50 m DROP
- 50 TO 60 m DROP



JULY 29, 1957 TO JULY 30, 1978

Figure 5

COLUMBIA GLACIER, ALASKA: RECENT ICE LOSS AND ITS RELATIONSHIP TO SEASONAL TERMINAL EMBAYMENTS, THINNING, AND GLACIER FLOW

by

William G. Sikonia and Austin Post

1979