

UNITED STATES  
DEPARTMENT OF THE INTERIOR  
GEOLOGICAL SURVEY

KNIK GLACIER, ALASKA  
MAY 1979 MONUMENT AND GLACIER SURVEY

by

D. C. Trabant and L. R. Mayo

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UNITED STATES DEPARTMENT OF THE INTERIOR

CECIL D. ANDRUS, Secretary

GEOLOGICAL SURVEY

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ABSTRACT

From 1915, or earlier, to 1966, with the exception of 1963, Knik Glacier annually formed and released Lake George, the largest glacier-dammed lake in Alaska. Eleven geodetically controlled survey stations were defined in the basin, and 22 glacier surface altitudes were measured. This is the first effort in a continuing program whose goal is predicting the future behavior of Knik Glacier and Lake George.

## INTRODUCTION

Knik Glacier, in the Chugach Mountains northeast of Anchorage, presently calves into the Knik River along a gorge whose west bank is the east-facing flank of Mount Palmer (fig. 1). From 1915, or earlier, to 1962 (Stone, 1963) and from 1964 to 1966, Knik Glacier annually closed the gorge, damming the Knik River between Lower Lake George and the wide, braided reach of the river northwest of the glacier. Each year that the lake formed behind the glacier-ice dam, the dam failed during the summer, releasing the impounded water and causing severe flooding in the Knik River valley (Post and Mayo, 1971). At the present time the river flows in a gorge less than 100 m (meters) wide. A minor advance of the glacier would be sufficient to re-form Lake George.

A cooperative State-Federal project operated by the U.S. Geological Survey is attempting to determine by what mechanism Knik Glacier could advance and what data are necessary to predict the glacier's behavior. We estimate that a 5-year period of observation may be required before a reliable prediction of Knik Glacier changes can be made.

The first step in this study is to survey the longitudinal profile and terminus position. This baseline information is required for measuring annual changes in the glacier.

This report contains the coordinate systems used to calculate the results of the May 1979 survey of station monuments and glacier surface points in the Knik Glacier basin.

## COORDINATE SYSTEMS

The basic coordinate system used is the Universal Transverse Mercator (UTM) projection. The UTM Zone 6 surface ranges from about 1,800 to 2,200 m below sea level in the Knik Glacier area. A local, sea-level-scale metric coordinate system, which facilitates calculations in the project area, was defined relative to the UTM system by the following approximations:



$$x = \frac{X_{UTM} - 400,000}{0.999724 + \frac{(-2.105 \cdot 10^{-9})(X_{UTM} - 400,000)}{2}} \quad (1)$$

$$y = \frac{Y_{UTM} - 6,780,000}{0.999724 + \frac{(-2.105 \cdot 10^{-9})(X_{UTM} - 400,000)}{2}} \quad (2)$$

where  $x$  and  $y$  are the local system coordinates of a point;  $X_{UTM}$  and  $Y_{UTM}$  are the UTM Easting and Northing of that point; 400,000 and 6,780,000 are the UTM coordinates of the local system origin point; 0.999724 is the sea level-to-UTM scale factor at the local system origin; and  $-2.105 \cdot 10^{-9}$  is the average scale factor gradient per meter in the Knik Glacier area (fig. 2).

Given the local system coordinates of a point, the UTM coordinates can be calculated by using the reverse approximation and assuming  $x = X_{UTM} - 400,000$ .

$$X_{UTM} = x \cdot 0.999724 + \frac{x(-2.105 \cdot 10^{-9})}{2} + 400,000 \quad (3)$$

$$Y_{UTM} = y \cdot 0.999724 + \frac{x(-2.105 \cdot 10^{-9})}{2} + 6,780,000 \quad (4)$$

Altitude above mean sea level,  $Z$ , is the same in both UTM and local coordinate systems.

A third coordinate system, the curvilinear longitudinal profile system, is useful for data analysis, for modeling purposes, and for quick reference to specific locations along the glacier. The longitudinal profile originates at the head of the glacier at a peak near Mount Marcus Baker and progresses downstream at 1-km (kilometer) intervals, at UTM scale, along the centerline of the main ice stream and its major tributaries (plate 1). The longitudinal profile is designated as  $x'$ , increasing down glacier; transverse profiles,  $y'$ , are defined approximately perpendicular to  $x'$  in a right-handed sense (table 1).

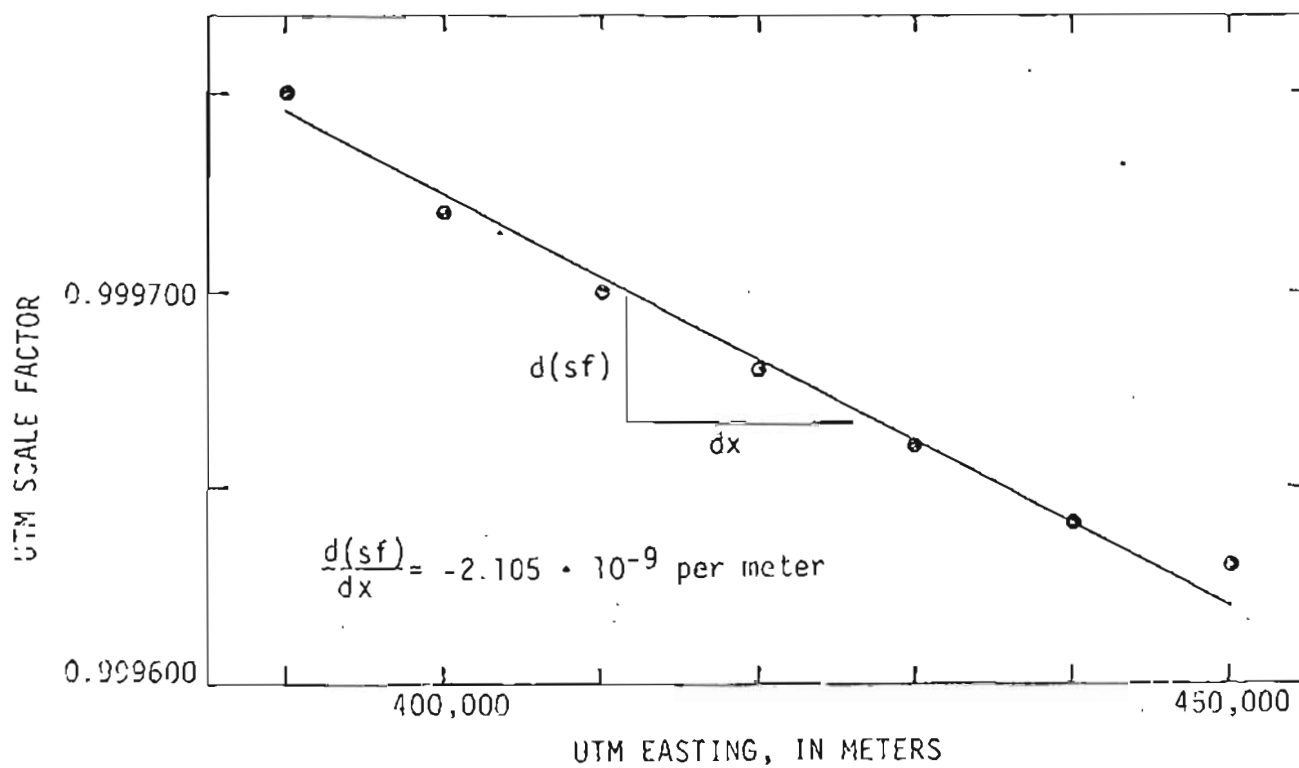


Figure 2.--UTM scale factor gradient in the Knik Glacier area. Scale factors from Dept. of Army and Air Force Technical Manual (1951);  $d(sf)$  is the change in scale factor and  $dx$  is the change in the UTM easting.



## SURVEY STATION MONUMENTS .

Seven newly monumented triangulation stations were established in the Knik Glacier basin on May 17-18, 1979. Each station is marked with a 44.5-mm (millimeter)-diameter aluminum rod cemented into a 50-mm-diameter hole drilled approximately 0.6 m deep into rock. The station name and year of installation (1979) are stamped into the top of each monument. The monuments protrude approximately 0.8 m above the bedrock. They serve as backsight reference marks as well as instrument locations. The gasoline-powered rock drill would not run at the 2,700-m altitude of station "Start"; therefore, that monument is supported by a mixture of snow, rocks, and cement that is expected to remain permanently frozen.

Two U.S. Army Corps of Engineers stations, standard bronze discs set in rock (MOM 1941 and JULIA), were reoccupied and resurveyed. In addition, two ground intersection points, "Upper Peak" and "Lower Peak", were surveyed to provide backsight references from the upper Knik Glacier.

## MONUMENT CONTROL SURVEY

The geodetic positions of U.S. Coast and Geodetic Survey triangulation stations BODE 2 1964 and WEISEN 1964 near Palmer (northwest of the study area) had been determined after the Alaska Good Friday Earthquake of 1964 (table 2). These two stations are the origin of the May 18-20, 1979, control survey (fig. 3). The altitude of BODE 2 1964 is the reference altitude. The geodetic latitude and longitude of WEISEN 1964 and BODE 2 1964 were converted to UTM coordinates by W. G. Sikonia, USGS, Tacoma, using a USGS computer routine. Equivalent positions in the local system were then calculated by using equations (1) and (2) of this report.

The control survey (fig. 3) consists of measured horizontal angles between stations (table 3), electronically measured slope distances between instruments over stations (table 4), and simultaneously measured vertical angles between theodolite axes over stations (table 4). The slope distances were reduced to sea level, and Earth curvature-atmospheric refraction coefficients between stations were calculated by a procedure devised by Mayo and others (1979). Minimum adjustments (tables 3 and 5) were made. The largest angular adjustment was  $0.0027^{\circ}$

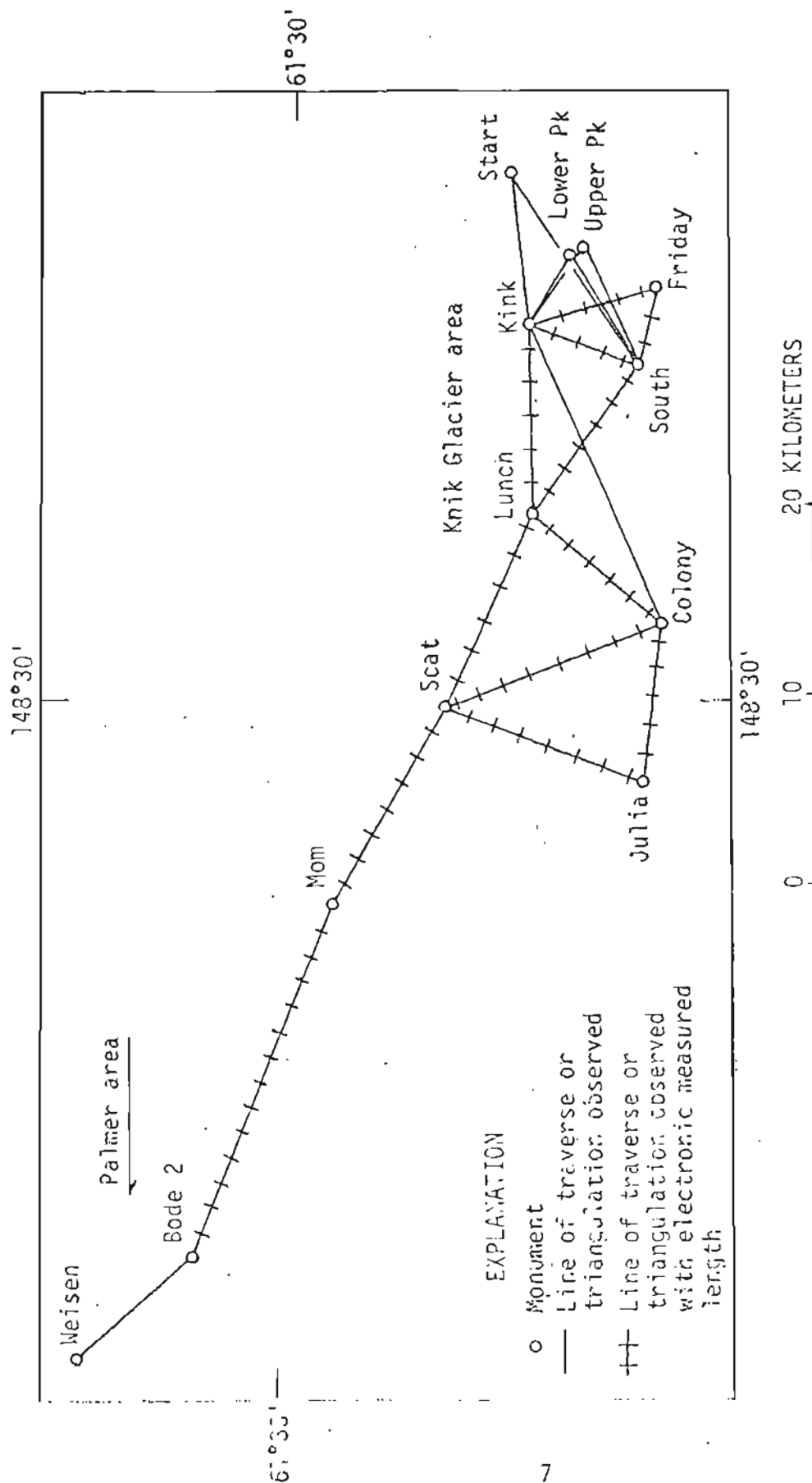


Figure 3.--Traverse, triangulation, intersection, and trilateration survey diagram, Palmer to Knik Glacier, May 18-19, 1979.

(grad\*), and the average adjustment was 0.0006<sup>9</sup>. The largest adjustment of a measured distance was 0.30 m (34 parts per million); the average adjustment was 0.12 m. No adjustments were made to traverse and intersection surveys.

Local position coordinates, including altitudes (table 6), were calculated first by using the adjusted angles and distances. Then the approximate UTM coordinates of the monuments (table 6), based on the adjusted local coordinates, were calculated by using equations (3) and (4) of this report.

#### KNIK GLACIER SURVEY

- Three types of measurements of Knik Glacier were made on May 23-24, 1979, to provide baseline data for subsequent comparisons. First, the glacier surface altitude was measured at nine preselected longitudinal profile locations (plate 2 and table 7a) as the first step in determining changes in glacier mass and surface slope and in possibly detecting waves or flow instabilities. Second, the location and altitude of 10 points at the top of the glacier terminus at The Gorge were surveyed to detect changes in the calving terminus. This survey involved guiding a helicopter into preselected positions by radio from a survey station and then surveying the rotor mast while the helicopter hovered over the ice-cliff side of The Gorge. These 10 altitudes and positions were averaged for future comparisons (table 7b). Third, the "normal" glacier terminus along its north side was surveyed at three locations. Numerical results are in table 7c.

Terminus retreat of Knik Glacier since the period 1950-57 is indicated by comparison of the Anchorage, Alaska, quadrangle maps B-3, B-4, and B-5 with the May 1979 survey data. The net decrease in altitude of the surface of the glacier from the surface shown on the maps, is a measure of the decrease in the thickness of glacier ice plus the 1964 earthquake downwarping. A prediction of the future behavior of Knik Glacier cannot be made from these data alone because the data do not indicate how the glacier has changed during the most recent decade (1969-79), and the presence or absence of fast-moving waves on the surface cannot be confirmed.

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\*Grad--an angular measure unit in the centesimal system equal to 0.9 degree.

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- Post, Austin, and Mayo, L. R., 1971, Glacier dammed lakes and outburst floods in Alaska: U.S. Geological Survey Hydrologic Atlas HA-455, 3 sheets, (1972).
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Table 1.--Coordinates of curvilinear longitudinal and transverse profile points arbitrarily defined at Knik Glacier

| x' km | Local   |         | UTM      |           |
|-------|---------|---------|----------|-----------|
|       | x       | y       | X        | Y         |
| 0     | 58800.0 | 30700.0 | 458800.0 | 6810700.0 |
| 1     | 58113.6 | 30003.6 | 458092.9 | 6809992.9 |
| 2     | 57406.2 | 29296.2 | 457385.8 | 6809285.8 |
| 3     | 56756.6 | 28535.6 | 456736.4 | 6808525.4 |
| 4     | 55947.3 | 27947.5 | 455927.4 | 6807937.6 |
| 5     | 55240.0 | 27240.2 | 455220.3 | 6807230.5 |
| 6     | 54430.7 | 26652.2 | 454411.3 | 6806642.7 |
| 7     | 53621.4 | 26064.2 | 453602.3 | 6806054.9 |
| 8     | 52730.1 | 25610.0 | 452711.3 | 6805600.9 |
| 9     | 51805.8 | 25227.2 | 451787.4 | 6805218.2 |
| 10    | 50854.4 | 24918.1 | 450836.3 | 6804909.2 |
| 11    | 49881.7 | 24684.6 | 449863.9 | 6804675.8 |
| 12    | 48884.4 | 24606.1 | 448867.0 | 6804597.3 |
| 13    | 47896.4 | 24762.5 | 447879.3 | 6804753.7 |
| 14    | 46972.1 | 25145.4 | 446955.4 | 6805136.4 |
| 15    | 46080.8 | 25599.5 | 446064.4 | 6805590.4 |
| 16    | 45227.9 | 26122.2 | 445211.8 | 6806112.9 |
| 17    | 44336.6 | 26576.4 | 444320.8 | 6806566.9 |
| 18    | 43339.3 | 26654.9 | 443323.9 | 6806645.4 |
| 19    | 42387.9 | 26345.8 | 442372.8 | 6806336.4 |
| 20    | 41627.2 | 25696.1 | 441612.4 | 6805687.0 |
| 21    | 40919.9 | 24988.8 | 440905.3 | 6804979.9 |
| 22    | 40159.2 | 24329.2 | 440144.9 | 6804330.5 |
| 23    | 39235.0 | 23956.3 | 439221.0 | 6803947.8 |
| 24    | 38246.9 | 24112.8 | 438233.3 | 6804104.2 |
| 25    | 37355.6 | 24566.9 | 437342.3 | 6804558.2 |
| 26    | 36502.7 | 25029.6 | 436439.7 | 6805080.7 |
| 27    | 35578.5 | 25472.5 | 435565.8 | 6805463.4 |
| 28    | 34605.7 | 25706.0 | 434593.4 | 6805696.8 |

Table 1.--Coordinates of curvilinear longitudinal and transverse profile points arbitrarily defined at Knik Glacier--Continued

| x' km | Local   |         | UTM      |           |
|-------|---------|---------|----------|-----------|
|       | x       | y       | X        | Y         |
| 29    | 33608.5 | 25627.4 | 433596.5 | 6805618.3 |
| 30    | 32684.2 | 25244.6 | 432672.6 | 6805235.6 |
| 31    | 31874.9 | 24656.6 | 431863.6 | 6804647.8 |
| 32    | 31065.7 | 24068.6 | 431054.6 | 6804050.0 |
| 33    | 30174.3 | 23614.4 | 430163.6 | 6803606.0 |
| 34    | 29177.1 | 23535.9 | 429166.7 | 6803527.5 |
| 35    | 28225.6 | 23845.0 | 428215.6 | 6803836.5 |
| 36    | 27274.2 | 24154.1 | 427264.5 | 6804145.5 |
| 37    | 26322.8 | 24463.2 | 426313.4 | 6804454.5 |
| 38    | 25398.5 | 24846.0 | 425389.5 | 6804837.2 |
| 39    | 24447.1 | 25155.2 | 424438.4 | 6805146.2 |
| 40    | 23474.4 | 25388.6 | 423466.0 | 6805379.6 |
| 41    | 22522.9 | 25697.7 | 422514.9 | 6805688.6 |
| 42    | 21571.5 | 26006.9 | 421563.8 | 6805997.6 |
| 43    | 20620.0 | 26316.0 | 420612.7 | 6806306.6 |
| 44    | 19668.6 | 26625.1 | 419661.6 | 6806615.6 |
| 45    | 18777.3 | 27079.2 | 418770.6 | 6807069.6 |
| 46    | 17924.4 | 27601.9 | 417918.0 | 6807592.1 |
| 47    | 17217.0 | 28309.3 | 417210.9 | 6808299.2 |
| 48    | 16629.0 | 29118.6 | 416623.1 | 6809108.2 |
| 49    | 16041.0 | 29927.9 | 416035.3 | 6809917.2 |
| 50    | 15453.0 | 30737.1 | 415447.5 | 6810726.2 |

Middle (M) longitudinal profile

|     |         |         |          |           |
|-----|---------|---------|----------|-----------|
| 12  |         |         | 448867.0 | 6804597.3 |
| M11 | 49872.5 | 24449.6 | 449854.7 | 6804440.9 |
| M10 | 50860.5 | 24293.1 | 450842.4 | 6804284.5 |
| M9  | 51857.8 | 24214.6 | 451839.3 | 6804206.0 |
| M8  | 52855.0 | 24136.1 | 452836.2 | 6804127.5 |

Table 1.--Coordinates of curvilinear longitudinal and transverse profile points arbitrarily defined at Knik Glacier--Continued

| x' km | Local   |         | UTM      |           |
|-------|---------|---------|----------|-----------|
|       | x       | y       | X        | Y         |
| M7    | 53855.4 | 24136.1 | 453836.2 | 6804127.5 |
| M6    | 54855.7 | 24136.1 | 454836.2 | 6804127.5 |
| M5.3  | 55556.0 | 24136.1 | 455536.2 | 6804127.5 |

South Main (SM) longitudinal profile

|        |         |         |          |           |
|--------|---------|---------|----------|-----------|
| 12     |         |         | 448867.0 | 6804597.3 |
| SM11   | 49737.3 | 24083.4 | 449719.6 | 6804074.8 |
| SM10   | 50590.2 | 23560.7 | 450572.2 | 6803552.3 |
| SM9    | 51399.5 | 22972.7 | 451381.2 | 6802964.5 |
| SM8    | 52208.8 | 22384.7 | 452190.2 | 6802376.7 |
| SM7    | 52969.5 | 21735.0 | 452950.6 | 6801727.3 |
| SM6    | 53492.1 | 20882.1 | 453473.1 | 6800874.7 |
| SM5    | 53725.6 | 19909.4 | 453706.5 | 6799902.3 |
| SM4    | 53804.2 | 18912.1 | 453785.0 | 6798905.4 |
| SM3    | 53725.6 | 17914.9 | 453706.5 | 6797908.5 |
| SM2.37 | 53484.4 | 17332.7 | 453465.4 | 6797326.5 |

South Branch (S) longitudinal profile

|     |         |         |          |           |
|-----|---------|---------|----------|-----------|
| 25  |         |         | 437342.3 | 6804558.2 |
| S24 | 38063.0 | 23859.6 | 438049.4 | 6803851.1 |
| S23 | 38585.6 | 23066.7 | 438571.9 | 6802998.5 |
| S22 | 38968.5 | 22082.5 | 438954.6 | 6802074.6 |
| S21 | 39351.3 | 21158.2 | 439337.3 | 6801150.7 |
| S20 | 39734.1 | 20234.0 | 439720.0 | 6800226.8 |
| S19 | 40188.3 | 19342.7 | 440174.0 | 6799335.8 |
| S18 | 40642.5 | 18451.4 | 440628.0 | 6798444.8 |
| S17 | 41096.6 | 17560.1 | 441082.0 | 6797553.8 |
| S16 | 41550.8 | 16668.7 | 441536.0 | 6796662.8 |
| S15 | 42005.0 | 15777.4 | 441990.0 | 6795771.8 |

Table 1.--Coordinates of curvilinear longitudinal and transverse profile points arbitrarily defined at Knik Glacier--Continued

| x' km | Local   |         | UTM      |           |
|-------|---------|---------|----------|-----------|
|       | x       | y       | X        | Y         |
| S14   | 42387.8 | 14853.2 | 442372.7 | 6794847.9 |
| S13   | 42696.9 | 13901.7 | 442681.7 | 6793896.8 |
| S12   | 43006.0 | 12950.3 | 442990.7 | 6792945.7 |
| S11   | 43162.5 | 11962.3 | 443147.1 | 6791958.0 |
| S10   | 43083.9 | 10965.0 | 443068.6 | 6790961.1 |
| S9    | 42629.8 | 10073.7 | 442614.6 | 6790070.1 |
| S8    | 42107.1 | 9220.8  | 442092.1 | 6789217.5 |
| S7    | 41519.1 | 8411.5  | 441504.3 | 6788408.5 |
| S6    | 40869.4 | 7650.8  | 440854.9 | 6787648.1 |
| S5    | 40162.1 | 6943.5  | 440147.8 | 6786941.0 |
| S4    | 39401.4 | 6293.8  | 439387.4 | 6786291.6 |
| S3    | 38640.8 | 5644.2  | 438627.0 | 6785642.2 |
| S2.31 | 38082.4 | 5238.5  | 438068.8 | 6785236.6 |

Gorge (G) longitudinal profile

|     |         |         |          |           |
|-----|---------|---------|----------|-----------|
| 41  |         |         | 422514.9 | 6805688.6 |
| G42 | 21522.6 | 25697.7 | 421514.9 | 6805688.6 |
| G43 | 20525.3 | 25619.2 | 420518.0 | 6805610.1 |
| G44 | 19552.6 | 25385.7 | 419545.6 | 6805376.7 |
| G45 | 18601.1 | 25076.6 | 418594.5 | 6805067.7 |
| G46 | 17649.7 | 24767.5 | 417643.4 | 6804758.7 |
| G47 | 16698.2 | 24458.4 | 416692.3 | 6804449.7 |
| G48 | 15806.9 | 24004.2 | 415801.3 | 6803995.7 |
| G49 | 14915.6 | 23550.1 | 414910.3 | 6803541.7 |



Table 1.--Coordinates of curvilinear longitudinal and transverse profile points arbitrarily defined at Knik Glacier--Continued

| y' km                  | Local   |         | UTM      |           |
|------------------------|---------|---------|----------|-----------|
|                        | x       | y       | X        | Y         |
| G48 transverse profile |         |         |          |           |
| G48                    |         |         | 415801.3 | 6803995.7 |
| G48+1                  | 15963.4 | 23016.2 | 415957.7 | 6803008.0 |
| G48+2                  | 15963.4 | 22015.8 | 415957.7 | 6802008.0 |
| G48+3                  | 15884.9 | 21018.6 | 415879.2 | 6801011.1 |
| G48+4                  | 15728.4 | 20030.5 | 415722.8 | 6800023.4 |
| G48+5                  | 15494.9 | 19057.8 | 415489.4 | 6799051.0 |
| G48-1                  | 15573.4 | 24977.0 | 415567.9 | 6804968.1 |
| G48-2                  | 15264.3 | 25928.4 | 415258.9 | 6805919.2 |
| G48-3                  | 14955.2 | 26879.9 | 414949.9 | 6806870.3 |
| G48-4                  | 14646.1 | 27831.3 | 414640.9 | 6807821.4 |
| G48-5                  | 14192.0 | 28722.6 | 414186.9 | 6808712.4 |
| G45 transverse profile |         |         |          |           |
| G45                    | 18601.1 | 25076.6 | 418594.5 | 6805067.7 |
| G45+1                  | 18757.6 | 24088.6 | 418750.9 | 6804080.0 |
| G45+2                  | 18836.1 | 23091.3 | 418829.4 | 6803083.1 |
| G45+3                  | 18836.1 | 22091.0 | 418829.4 | 6802083.1 |
| G45+4                  | 18836.1 | 21090.6 | 418829.4 | 6801083.1 |
| G45+5                  | 18757.6 | 20093.4 | 418750.9 | 6800086.2 |
| G45+6                  | 18524.1 | 19120.6 | 418517.5 | 6799113.2 |
| G45-1                  | 18367.6 | 26049.4 | 418361.1 | 6806040.1 |
| G45-2                  | 18058.5 | 27000.8 | 418052.1 | 6806991.2 |
| G45-3                  | 17604.4 | 27892.1 | 417598.1 | 6807882.2 |

Table 2.--Coordinates of monuments used to control the May 1979 survey

| Station     | Geodetic        |                  | UTM zone 6<br>(m) |             | Local sea level<br>(m) |          | Altitude<br>(m)<br>Z |
|-------------|-----------------|------------------|-------------------|-------------|------------------------|----------|----------------------|
|             | Latitude        | Longitude        | Easting           | Northing    | X                      | Y        |                      |
| WEISEN 1964 | 61°35'59.35488" | 149°09'19.63717" | 385635.358        | 6831290.959 | -14368.39              | 51304.34 | --                   |
| BODE 2 1964 | 61°32'47.17195" | 149°03'01.48651" | 391020.189        | 6825166.254 | - 8982.21              | 45178.30 | 269.2                |

JAN 1977  
U.S. DEPARTMENT OF COMMERCE  
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION  
NATIONAL OCEAN SURVEY, NATIONAL GEODETIC SURVEY

## HORIZONTAL CONTROL DATA

by the  
National Ocean Survey  
NORTH AMERICAN 1927 DATUM

U.S. DEPARTMENT OF COMMERCE  
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION  
NATIONAL OCEAN SURVEY, NATIONAL GEODETIC SURVEY

### DESCRIPTION OF TRIANGULATION STATION

NAME OF STATION: WEISEN STATE: Alaska COUNTY: 3rd Judicial Division  
CHIEF OF PARTY: L. G. Burdine YEAR: 1964 DESCRIBED BY: C. M. Galt

| OBJECT                    | DISTANCE   | BEARING |      | DISTANCE | BEARING | DISTANCE | BEARING |
|---------------------------|------------|---------|------|----------|---------|----------|---------|
|                           |            | TO      | FROM |          | TO      |          | FROM    |
| BODE 2                    |            |         |      |          |         |          |         |
| 11 b Reference Mark No. 1 | 13.56      | 12.080  | 00   | 22       | 44      |          |         |
| 12 b Reference Mark No. 2 | 26.69      | 8.327   | 140  | 58       | 55      |          |         |
| 13 b Reference Mark       | (0.3 mile) | 310     | 00   | 49.2     |         |          |         |

|                                |              |
|--------------------------------|--------------|
| QUAD 611491                    | STATION 1004 |
| ALASKA                         |              |
| LATITUDE 61° 30' TO 62° 00'    |              |
| LONGITUDE 149° 00' TO 149° 30' |              |
| DIAGRAM NQ-06-04               | MAC118       |

### ADJUSTED HORIZONTAL CONTROL DATA

NAME OF STATION: WEISEN STATE: Alaska YEAR: 1964 FIRST

ADJUSTED HORIZONTAL CONTROL DATA

|                                |              |
|--------------------------------|--------------|
| QUAD 611491                    | STATION 1004 |
| ALASKA                         |              |
| LATITUDE 61° 30' TO 62° 00'    |              |
| LONGITUDE 149° 00' TO 149° 30' |              |
| DIAGRAM NQ-06-04               | MAC118       |

JAN 1977  
U.S. DEPARTMENT OF COMMERCE  
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION  
NATIONAL OCEAN SURVEY, NATIONAL GEODETIC SURVEY

## HORIZONTAL CONTROL DATA

by the  
National Ocean Survey  
NORTH AMERICAN 1927 DATUM

### ADJUSTED HORIZONTAL CONTROL DATA

NAME OF STATION: BODE 2 STATE: Alaska COUNTY: Third Judicial Division  
CHIEF OF PARTY: L.G. Burdine YEAR: 1964 DESCRIBED BY: J.E.P.

|                                |              |
|--------------------------------|--------------|
| QUAD 611491                    | STATION 1004 |
| ALASKA                         |              |
| LATITUDE 61° 30' TO 62° 00'    |              |
| LONGITUDE 149° 00' TO 149° 30' |              |
| DIAGRAM NQ-06-04               | MAC118       |

NAME OF STATION: BODE 2 STATE: Alaska YEAR: 1964 FIRST

|                                |              |
|--------------------------------|--------------|
| QUAD 611491                    | STATION 1004 |
| ALASKA                         |              |
| LATITUDE 61° 30' TO 62° 00'    |              |
| LONGITUDE 149° 00' TO 149° 30' |              |
| DIAGRAM NQ-06-04               | MAC118       |

Table 3.--Measured and adjusted horizontal angles for traverse and triangulation survey of May 1979 [Angles are grad.]

| Horizontal Angle |        |            | Standard error |                |              |
|------------------|--------|------------|----------------|----------------|--------------|
|                  |        |            | Measured       | of observation | Adjusted     |
| WEISEN           | BODE 2 | MOM        | 170.5435       | $\pm .0005$    | not adjusted |
| BODE 2           | MOM    | Scat       | 210.9420       | $\pm .0002$    | not adjusted |
| Colony           | Scat   | JULIA      | 48.7896        | $\pm .0011$    | 48.7893      |
| JULIA            | Colony | Scat       | 67.9252        | $\pm .0013$    | 67.9250      |
| Scat             | JULIA  | Colony     | 83.2867        | $\pm .0004$    | 83.2857      |
| South            | Kink   | Lunch      | 79.1413        | $\pm .0006$    | 79.1409      |
| Lunch            | South  | Kink       | 80.5250        | $\pm .0009$    | 80.5223      |
| Kink             | Lunch  | South      | 40.3368        | $\pm .0006$    | 40.3368      |
| Colony           | Lunch  | Scat       | 79.8664        | $\pm .0004$    | 79.8649      |
| Scat             | Colony | Lunch      | 69.0679        | $\pm .0002$    | 69.0675      |
| Lunch            | Scat   | Colony     | 51.0672        | $\pm .0001$    | 51.0676      |
| Friday           | Kink   | South      | 39.3509        | $\pm .0009$    | 39.3515      |
| South            | Friday | Kink       | 64.5803        | $\pm .0005$    | 64.5801      |
| Kink             | South  | Friday     | 96.0668        | $\pm .0011$    | 96.0684      |
| Kink             | Lunch  | Colony     | 145.7986       | $\pm .0005$    | 145.7990     |
| Colony           | Kink   | Lunch      | 25.8768        | $\pm .0008$    | 25.8761      |
| Lunch            | Colony | Kink       | 28.3246        | $\pm .0004$    | 28.3249      |
| Lunch            | Kink   | Start      | 193.8691       | $\pm .0007$    | not adjusted |
| Lunch            | South  | Start      | 123.5901       | $\pm .0009$    | not adjusted |
| Lunch            | Kink   | Lower Peak | 232.5139       | $\pm .0007$    | not adjusted |
| Lunch            | South  | Lower Peak | 125.5234       | $\pm .0011$    | not adjusted |
| Lunch            | Kink   | Upper Peak | 238.1883       | $\pm .0007$    | not adjusted |
| Lunch            | South  | Upper Peak | 133.0489       | $\pm .0006$    | not adjusted |

Table 4.--Measured height of instrument above monument,  $H_i$ ; vertical foresight angle,  $V_f$ ; vertical backsight angle,  $V_B$ ; and slope distance,  $D$  between stations, May 1979 control survey

| <u>FORESIGHT</u> |              |                |                           | <u>BACKSIGHT</u> |              |                |
|------------------|--------------|----------------|---------------------------|------------------|--------------|----------------|
| Station          | $H_i$<br>(m) | $V_f$<br>grads | Slope Distance<br>$D$ (m) | Station          | $H_i$<br>(m) | $V_B$<br>grads |
| BODE 2           | 1.48         | 0.3865         | 20204.22                  | MOM              | 1.52         | -0.5568        |
| MOM              | 1.52         | 0.0844         | 12075.29                  | Scat             | 0.80         | -0.1884        |
| Scat             | 0.80         | -1.9100        | 10640.63                  | JULIA            | 1.07         | 1.8362         |
| JULIA            | 1.07         | 7.3201         | 8479.81                   | Colony           | 0.53         | -7.3750        |
| Scat             | 0.80         | 3.5504         | 11748.64                  | Colony           | 0.53         | -3.6399        |
| Scat             | 0.80         | 2.9601         | 10925.59                  | Lunch            | 0.67         | -3.0505        |
| Colony           | 0.53         | -1.0965        | 8871.15                   | Lunch            | 0.67         | 1.0268         |
| Lunch            | 0.67         | 3.7032         | 9675.91                   | Kink             | 0.78         | -3.7828        |
| Colony           | 0.53         | 1.5151         | not measured              | Kink             | 0.78         | -1.6559        |
| Lunch            | 0.67         | 3.9623         | 9609.62                   | South            | 0.78         | -4.0422        |
| Kink             | 0.78         | 0.3505         | 5997.69                   | South            | 0.78         | -0.3928        |
| South            | 0.78         | 1.1673         | 4096.82                   | Friday           | 0.68         | -1.1969        |
| Kink             | 0.78         | 0.9763         | 7050.32                   | Friday           | 0.68         | -1.0357        |
| Kink             | 0.78         | 8.8701         | not measured              | Start            | not occupied |                |
| South            | 0.78         | 5.9088         | not measured              | Start            | not occupied |                |
| Kink             | 0.78         | 10.1611        | not measured              | Upper Peak       | not occupied |                |
| Kink             | 0.78         | 8.3608         | not measured              | Lower Peak       | not occupied |                |
| South            | 0.78         | 7.4439         | not measured              | Upper Peak       | not occupied |                |
| South            | 0.78         | 5.2022         | not measured              | Lower Peak       | not occupied |                |

Table 5.--Sea-level scale equivalent of measured and adjusted horizontal distances, May 1979 survey

| [Distance in meters] |          |              |
|----------------------|----------|--------------|
| Distance             | Measured | Adjusted     |
| BODE 2 - MOM         | 20202.53 | not adjusted |
| MOM - Scat           | 12074.44 | not adjusted |
| Scat - JULIA         | 10635.54 | 10635.46     |
| Scat - Colony        | 11728.48 | 11728.42     |
| Colony - JULIA       | 8422.58  | 8422.67      |
| Scat - Lunch         | 10912.21 | 10912.25     |
| Lunch - Colony       | 8871.47  | 8871.17      |
| Lunch - Kink         | 9657.30  | 9657.19      |
| Lunch - South        | 9588.73  | 9588.73      |
| Kink - South         | 5996.13  | 5996.07      |
| Kink - Friday        | 7047.68  | 7047.59      |
| South - Friday       | 4092.08  | 4091.98      |

Table 6.--Coordinates of resurveyed and new monuments in Krik Glacier area, May 1979 survey. Coordinates in meters

| Station    | UTM Zone 6 |            | Local sea-level |          | Altitude |
|------------|------------|------------|-----------------|----------|----------|
|            | Easting    | Northing   | x               | y        | Z        |
| Start      | 447917.23  | 6807883.51 | 47932.88        | 27892.62 | 2695.5   |
| Upper Peak | 443975.41  | 6804134.93 | 43989.59        | 24142.71 | 2365.2   |
| Lower Peak | 443620.85  | 6804855.56 | 43634.90        | 24863.56 | 2125.6   |
| Kink       | 439681.64  | 6807021.97 | 39694.25        | 27030.56 | 1529.4   |
| Friday     | 441753.03  | 6800288.00 | 41766.39        | 20294.49 | 1640.7   |
| South      | 437797.85  | 6801331.58 | 37809.79        | 21338.32 | 1564.5   |
| Lunch      | 430028.13  | 6806945.47 | 30037.37        | 26953.76 | 961.0    |
| Colony     | 424237.74  | 6800237.53 | 24245.05        | 20234.63 | 1109.0   |
| JULIA      | 415889.23  | 6801323.44 | 15893.88        | 21329.68 | 132.1    |
| Scat       | 419960.20  | 6811145.39 | 19966.13        | 31154.64 | 445.4    |
| MOM        | 409724.42  | 6817545.19 | 9727.20         | 37555.94 | 418.8    |

Table 7.--May 1979 Knik Glacier surface altitude surveyed May 23-24, 1979

a) Longitudinal

| <u>position</u> | <u>Altitude (m)</u> |
|-----------------|---------------------|
| M10             | 2265.1              |
| 19              | 1454.6              |
| 25              | 863.8               |
| 30              | 709.3               |
| 35              | 527.6               |
| 40              | 375.0               |
| G45             | 239.5               |
| S12             | 1619.2              |
| S18             | 1367.2              |

| <u>Measured data points</u> | <u>Mean altitude</u> | <u>Mean (x')<br/>position</u> |
|-----------------------------|----------------------|-------------------------------|
| G48 + 0.2 to G48 + 2.0      | 102.0                | 16108.8                       |

| <u>c)</u> | <u>Position</u> | <u>x</u> | <u>y</u> | <u>Altitude (m)</u> |
|-----------|-----------------|----------|----------|---------------------|
|           | NT1             | 18065.5  | 29975.0  | 78.7                |
|           | NT2             | 17826.7  | 29894.5  | 73.7                |
|           | NT3             | 17401.4  | 29581.7  | 70.1                |