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

OPEN-FILE REPORT 80-48

Prepared in cooperation with the Alaska Department of Natural Resources, Division of Geological and Geophysical Surveys.

Fairbanks, Alaska
1979

UNITED STATES DEPARTMENT OF THE INTERIOR

CECIL D. ANDRUS, Secretary

GEOLOGICAL SURVEY

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KNIK GLACIER, ALASKA
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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:

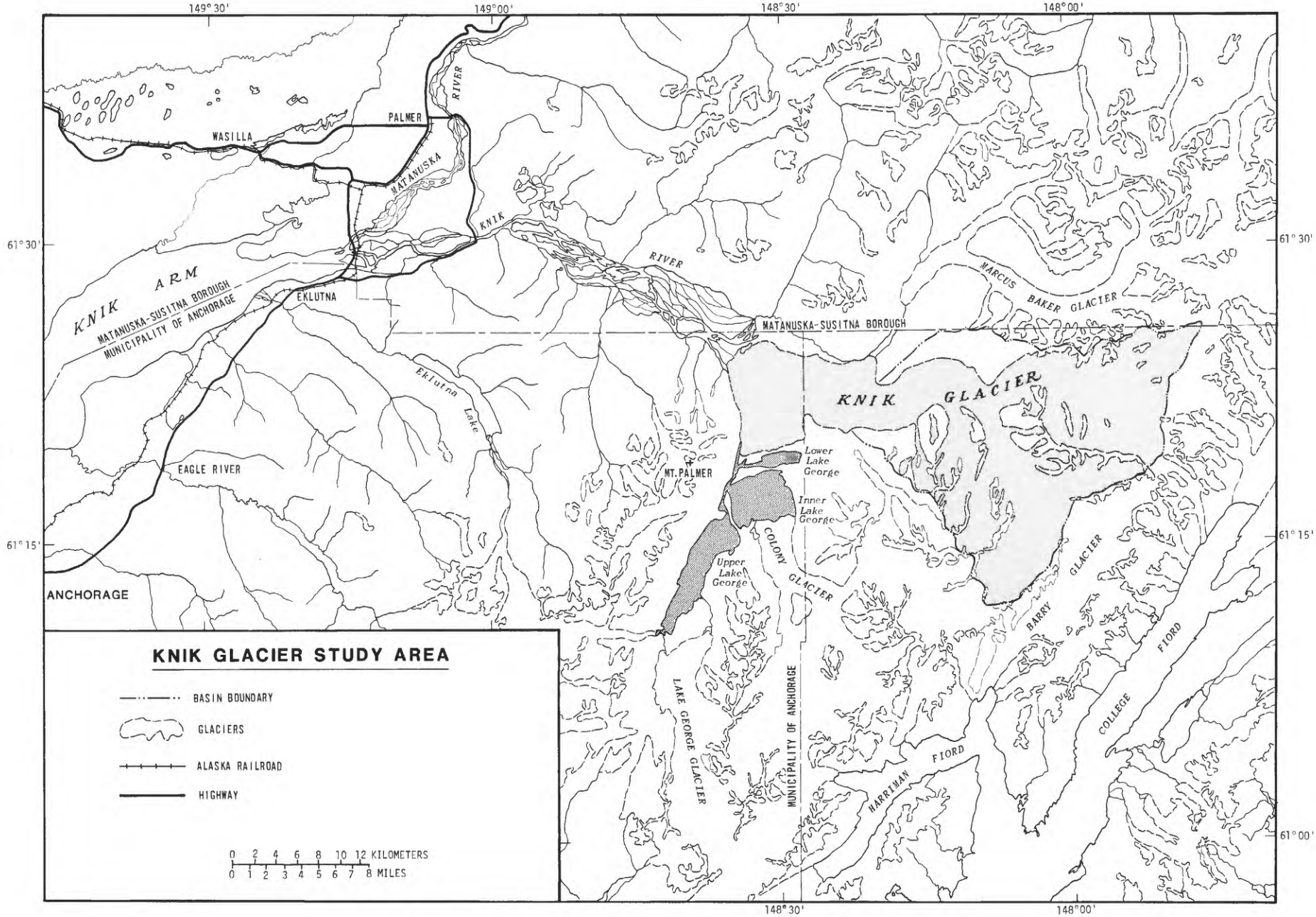

Figure 1.--Location of Knik Glacier study area.

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

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

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 $x = X_{UTM} - 400{,}000$.

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

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

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).

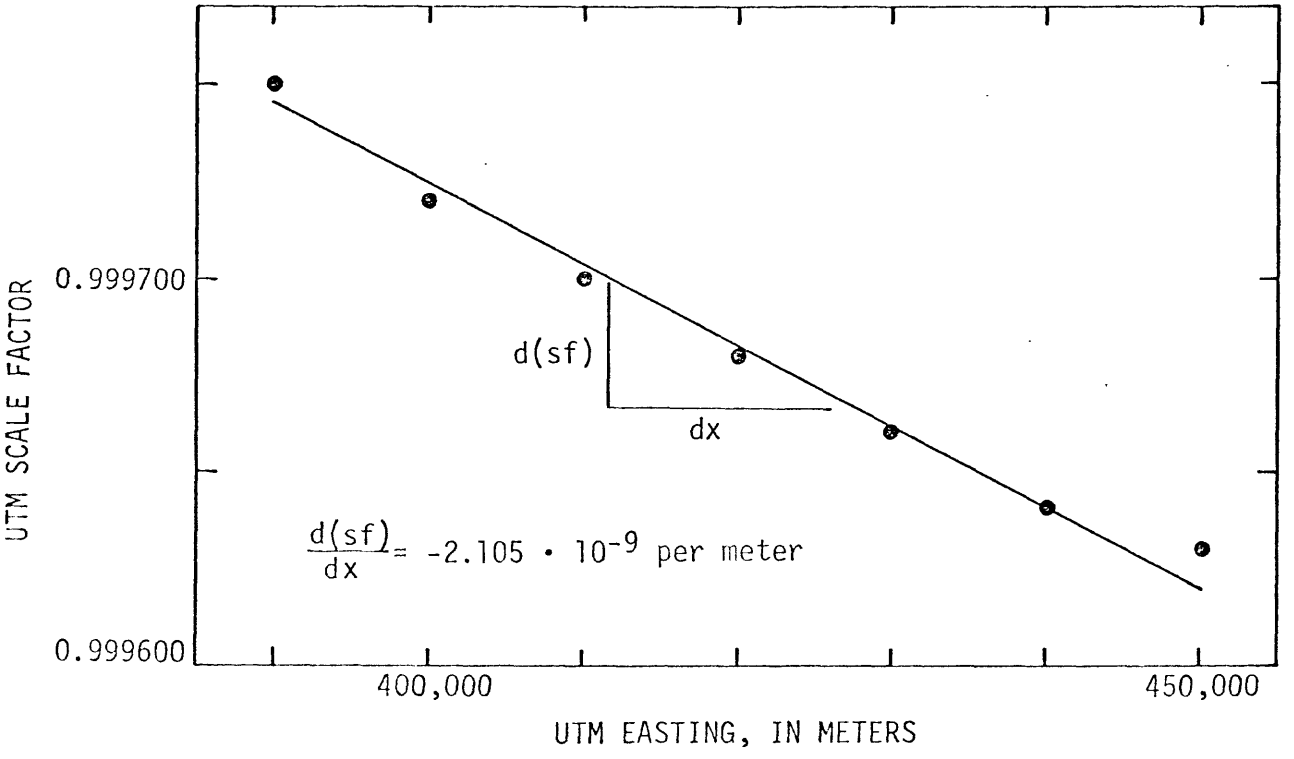

Figure 2.--UTM scale factor gradient in the Knik Glacier area. Scale factors from Dept. of Army and Air Force Technical Manual (1951); d(sf) is the change in scale factor and dx is the change in the UTM easting.

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^{g}

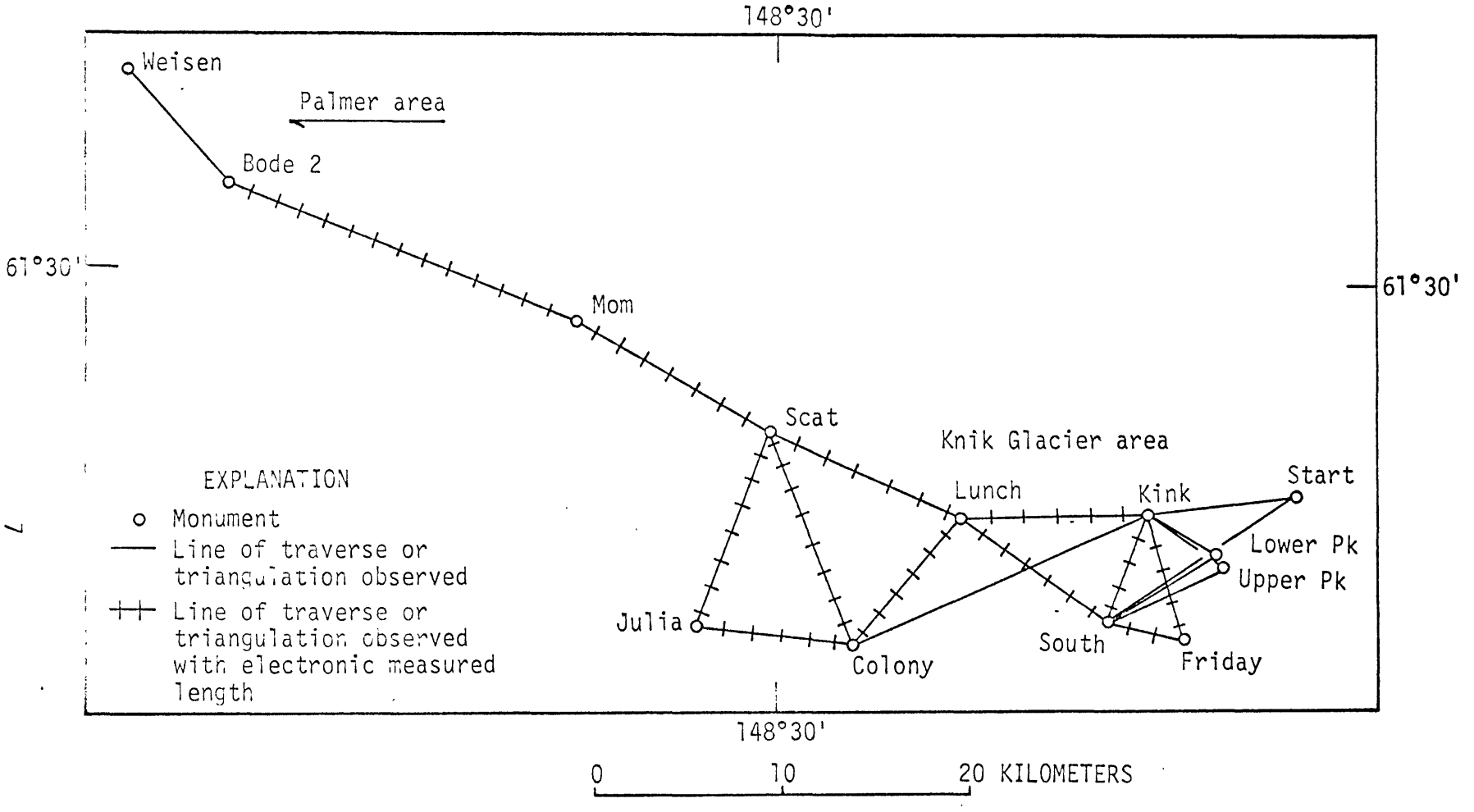

Figure 3.--Traverse, triangulation, intersection, and trilateration survey diagram, Palmer to Knik Glacier, May 18-19, 1979.

(grad*), and the average adjustment was 0.0006^g. 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.

REFERENCES

Department of the Army and the Air Force, 1951, The universal grid systems: U.S. Army Technical Manual TM 5-241 and U.S. Air Force Technical Order TO 16-1-233, p.

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

	Local		UTM	
x' km	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	24339.2	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	25089.6	436489.7	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 arbitarily defined at Knik Glacier--Continued

	Local		UTM	
x' km	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	6804060.0
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 arbitarily defined at Knik Glacier--Continued

	Local		UTM	
x' km	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	23006.7	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 arbitarily defined at Knik Glacier--Continued

	Local		UTM	
x' km	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 arbitarily defined at Knik Glacier--Continued

	Local		UTM	
y' km	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 (m)		Local sea level (m)		Altitude (m)
	Latitude	Longitude	Easting	Northing	x	y	Z
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

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NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL OCEAN SURVEY , NATIONAL GEODETIC SURVEY

HORIZONTAL CONTROL DATA

by the
National Ocean Survey
NORTH AMERICAN 1927 DATUM

QUAD 611491 STATION 1040
ALASKA
LATITUDE 61 ° 30′ TO 62 ° 00′
LONGITUDE 149 ° 00′ TO 149 ° 30′
DIAGRAM NQ-06-04 WAC118

FORM 525
10-15-691

U.S. DEPARTMENT OF COMMERCE
COAST AND 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. Call

NOTES: HEIGHT OF TELESCOPE ABOVE STATION MARK 1.83 METERS.| HEIGHT OF LIGHT ABOVE STATION MARK METERS.

	SURFACE-STATION MARK, UNDERGROUND-STATION MARK	DISTANCES AND DIRECTIONS TO AZIMUTH MARK, REFERENCE MARKS AND PROMINENT OBJECTS WHICH CAN BE SEEN FROM THE GROUND AT THE STATION					
	OBJECT	BEARING	DISTANCE FEET	DISTANCE METERS	DIRECTION		
7 a	BODE 2				00°	00′	00.0″
11 b	Reference Mark No. 1	WNW	45.54	13.880	80	22	44
11 b	Reference Mark No. 2	SW	26.69	8.137	140	58	55
16 b	Azimuth Mark	E	(0.3 mile)		310	00	49.2

ADJUSTED HORIZONTAL CONTROL DATA

NAME OF STATION WEISEN
STATE: ALASKA YEAR 1964 FIRST -ORDER
LOCALITY.
SOURCE. G-14462 FIELD SKETCH

GEODETIC LATITUDE	61 °35′59.3548″	ELEVATION:	102.0 METERS
GEODETIC LONGITUDE.	149 09 19.63717		335 FEET

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

QUAD 611491 STATION 1004
ALASKA
LATITUDE 61 ° 30′ TO 62 ° 00′
LONGITUDE 149 ° 00′ TO 149 ° 30′
DIAGRAM NQ-06-04 WAC118

FORM 525
10-15-691

U.S. DEPARTMENT OF COMMERCE
COAST AND GEODETIC SURVEY

DESCRIPTION OF TRIANGULATION STATION

NAME OF STATION: BODE 2 STATE: Alaska COUNTY: Third Judicial Division

CHIEF OF PARTY. L.G. Burdine YEAR: 1964 DESCRIBED BY: J.E.F.

NOTES: HEIGHT OF TELESCOPE ABOVE STATION MARK 1.79 METERS.| HEIGHT OF LIGHT ABOVE STATION MARK METERS.

	SURFACE-STATION MARK, UNDERGROUND-STATION MARK	DISTANCES AND DIRECTIONS TO AZIMUTH MARK, REFERENCE MARKS AND PROMINENT OBJECTS WHICH CAN BE SEEN FROM THE GROUND AT THE STATION		
	OBJECT	BEARING	DISTANCE	DIRECTION
2				

ADJUSTED HORIZONTAL CONTROL DATA

NAME OF STATION. BODE 2
STATE. ALASKA YEAR: 1964 FIRST -ORDER
LOCALITY.
SOURCE. G-14462 FIELD SKETCH:

GEODETIC LATITUDE	61 °32′47.17195	ELEVATION.	269.2 METERS
GEODETIC LONGITUDE:	149 03 01.48651		883 FEET

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

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

	FORESIGHT				BACKSIGHT	
Station	H_i (m)	V_F grads	Slope Distance D(m)	Station	H_i (m)	V_B 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 Knik Glacier area, May 1979 survey. Coordinates in meters

	UTM Zone 6		Local sea-level		Altitude
Station	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

position	Altitude (m)
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

b)

Measured data points	Mean altitude	Mean (x') position
G48 + 0.2 to G48 + 2.0	102.0	16108.8

c)

Position	x	y	Altitude (m)
NT1	18065.5	29975.0	78.7
NT2	17826.7	29894.5	73.7
NT3	17401.4	29581.7	70.1