

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

SHORT-TERM VELOCITY MEASUREMENTS AT COLUMBIA GLACIER, ALASKA:

AUGUST - SEPTEMBER 1984

By B. H. Vaughn, C. F. Raymond, L. A. Rasmussen, D. S. Miller,
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U. S. GEOLOGICAL SURVEY

OPEN-FILE REPORT 85-487

Tacoma, Washington
1985

UNITED STATES DEPARTMENT OF THE INTERIOR

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Symbols and Abbreviations

<u>Symbol</u>	<u>Name</u>	<u>Units</u>
a	Coefficient in equation of sighting line	dimensionless
b	Coefficient in equation of sighting line	dimensionless
c	Correction factor for both refraction and Earth's curvature	dimensionless
E	Subscript for survey station Easy	--
EDM	Electronic Distance Meter	--
G	Subscript for survey station New Gilbert	--
H	Distance measurement station on Heather Island	--
h	Height of instrument above ground	mm
K _θ	Quality code for estimated error in original theodolite azimuth angle reading	dimensionless
K _φ	Quality code for estimated error in original theodolite vertical angle reading	dimensionless
km	Kilometer	--
m	Meter	--
n	Number of distance values	--
p	Atmospheric pressure	mm Hg
Q	Subscript for survey station New Quickie	--
r	EDM distance adjusted for variation in atmospheric density	mm
r	Actual distance measured by EDM at (H)	mm
s	Subscript to represent either G or Q	--
T	Air temperature in degrees Celsius, and also as a subscript denoting target	°C
t	Time in decimal 1984 Julian days	days
u	Velocity component in the x-direction	m/day
UTM	Universal Transverse Mercator	--
v	Velocity component in the y direction	m/day

Symbols and Abbreviations (continued)

x	Horizontal component, positive to the east	m
y	Horizontal component, positive to the north	m
z	Vertical coordinate above mean sea level	m
ϵ	Error implied by quality codes	grads
θ	Horizontal angle measured to the right of station Easy	grads
λ	Weighting factor for combining estimates of z from two different survey sightings	dimensionless
σ	EDM instrument error	mm
ϕ	Elevation angle below local horizontal	radians

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ABSTRACT

Ice velocity data are presented for the lower reach of Columbia Glacier, Alaska. The data span a 29 day period and contains 1,072 angle sightings from two survey stations to 22 markers placed on the ice surface, and 1,621 laser measurements of the distance to one of those markers (number 11) from another station. These short-interval observations were made to investigate the dynamics of the glacier and to provide input to models for estimation of future retreat and iceberg discharge. The mean ice velocity (at marker number 11) was approximately 9 meters per day and ranged from 8 to >15 meters per day. The data set includes a well defined 2-day 50-percent velocity increase and a clear pattern of velocity fluctuations of about 5 percent with approximately diurnal and semi-diurnal periods.

INTRODUCTION

Columbia Glacier is a large, grounded, iceberg-calving glacier located in south-central Alaska about 38 km (kilometers) west of Valdez (fig. 1). It has an area of approximately 1100 km² (square kilometers) and extends 65 km along its main branch to the terminus in Columbia Bay. A short distance in front of the terminus lies a moraine shoal with a maximum depth of about 23 m (meters) below mean sea level. Much of the ice in the lower reach of the glacier lies below sea level. Although the glacier thickness is generally sufficient to overcome the buoyant effect of the water, a notable exception may have occurred briefly during the summer of 1984, when a localized region near the terminus appeared to be floating.

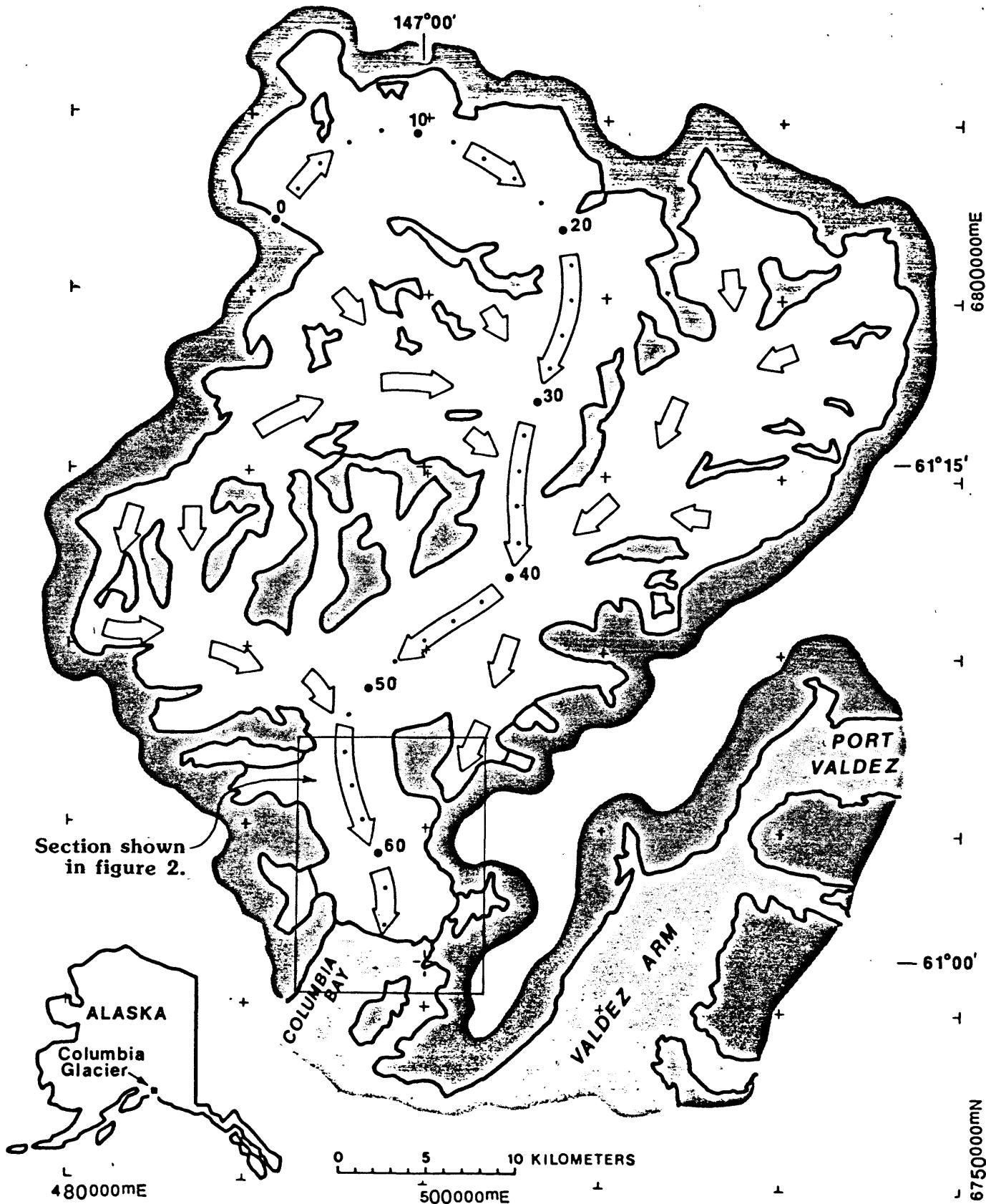


Figure 1.--Index map of Columbia Glacier, Alaska. Arrows show general direction of flow. Main ice stream is indicated by longer arrows and dots at 2-kilometer intervals along the curvilinear, longitudinal coordinate system.

In 1974 Austin Post surmised that an irreversible drastic retreat would ensue should the glacier retreat slightly behind the moraine shoal (Post, 1975). A major research program on Columbia Glacier (Meier and others, 1978) was begun in 1974. Since 1978 the terminus has retreated from the crest of the shoal into water more than 200 m deep. A few kilometers behind the terminus the water is more than 350 m deep.

During the transition from a stable state to one of retreat, knowledge of both the calving flux and the ice velocity is important to understanding the dynamics of the glacier, as well as the continued estimation of iceberg discharge. Two empirical calving relations were developed (Brown and others, 1982; Sikonia, 1982) and then used in numerical models in order to assess the future behavior of Columbia Glacier (Rasmussen and Meier, 1982; Sikonia, 1982; Bindschadler and Rasmussen, 1983). The numerical results indicated that the lower reach would begin disintegrating during the 1980's and that the calving flux would sharply increase. The model results appear to be valid, as the predicted retreat and flux increase (Meier and others, 1980) are occurring. The terminus has retreated about 2 kilometers between 1978 and 1984, and the calving flux approximately tripled between 1978 and late 1984 (Meier and others, 1985). However, the models were very sensitive to the assumed calving relation and therefore may not be applicable in future interpretations.

The terminus configuration and the rate of calving have changed since the early 1980's, which suggests that the calving relations derived empirically from data pertaining to an earlier configuration and mode may no longer be appropriate. The model results are highly sensitive to the calving relation because that relation uses the glacier terminus as a boundary condition. The empirical calving relations were hypothesized first, then calibrated from a data set that included only a few variables, that was relatively sparse in space and time, that was subjected to only preliminary data reduction techniques, and that pertained to

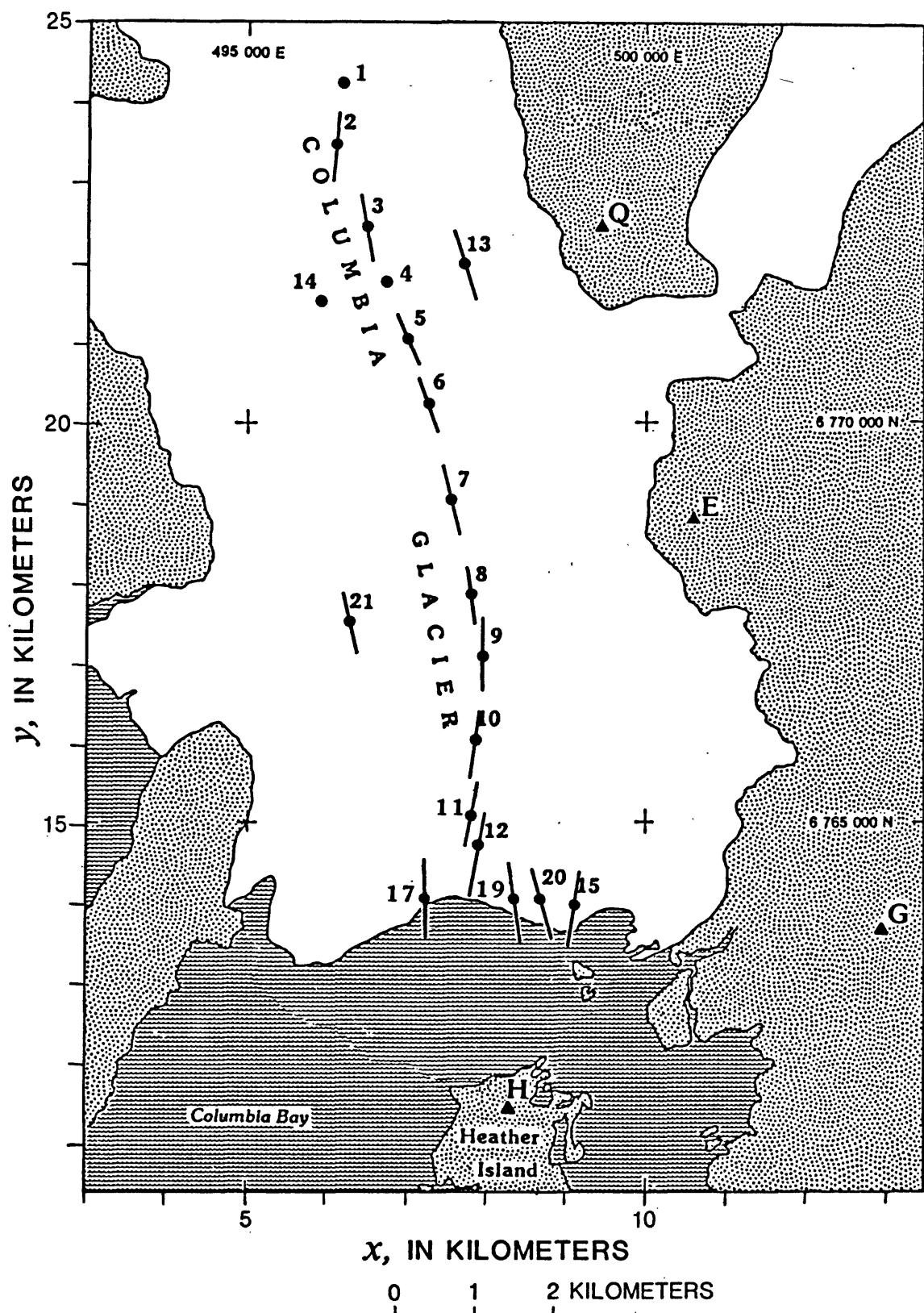


Figure 2.--Survey stations and approximate August 13, 1984 marker positions (dots). Line segments indicate mean direction of flow, and lengths have no significance. Sightings of the markers were made from New Gilbert (G) and New Quickie (Q), using Easy (E) as the azimuth reference, and the distance to marker 11 was measured from the EDM-site (H). The meteorological data used to correct the EDM results were obtained at station (M). The terminus position is that of August 15, 1985.

an earlier configuration of the glacier and mode.

Observations by Austin Post (written communication, 1984) during the summer and fall of 1983 suggested the association of high calving rates with periods of heavy rainfall although this was not true during the 1984 field experiment. Detailed studies of Variegated Glacier (Kamb and others, 1985) indicated that rapid sliding of a glacier during a surge was controlled by water at the bed as were "minisurges" propagating downglacier before and during a surge. Obviously the connection between ice flow, water at the bed, and iceberg calving needs to be investigated.

To that end, an intensive field program in August-September 1984 collected data on calving, ice velocity, terminus position, seismic activity, meltwater production and rainfall, other meteorological variables, tide stage, and runoff from marginal rivers. This data set, when used in conjunction with other data collected systematically but less frequently since about 1977, will be useful in many investigations: those mentioned in this report, others identified but not mentioned, and others that have not been identified yet. The ice-velocity data in this report include both the comprehensive listing of 1,072 survey sightings from two survey stations used to sight 22 markers placed on the ice surface and the comprehensive listing of 1,621 laser measurements of the distance to one of those markers (no. 11) from another station. This report also describes the data-reduction methods and a few preliminary results.

THE 1984 VELOCITY MEASUREMENT FIELD PROGRAM

As a part of the multidisciplinary 1984 field program, the velocity data were obtained in the following manner. Survey stations New Gilbert and New Quickie were occupied 29 and 20 days respectively, beginning August 7 (Julian day 220) during which daily or more frequent sightings of many of the 22 surface marker positions were recorded (fig. 2). The markers were 1-meter tetrahedra constructed from tubular steel covered with fluorescent orange cloth and weighted

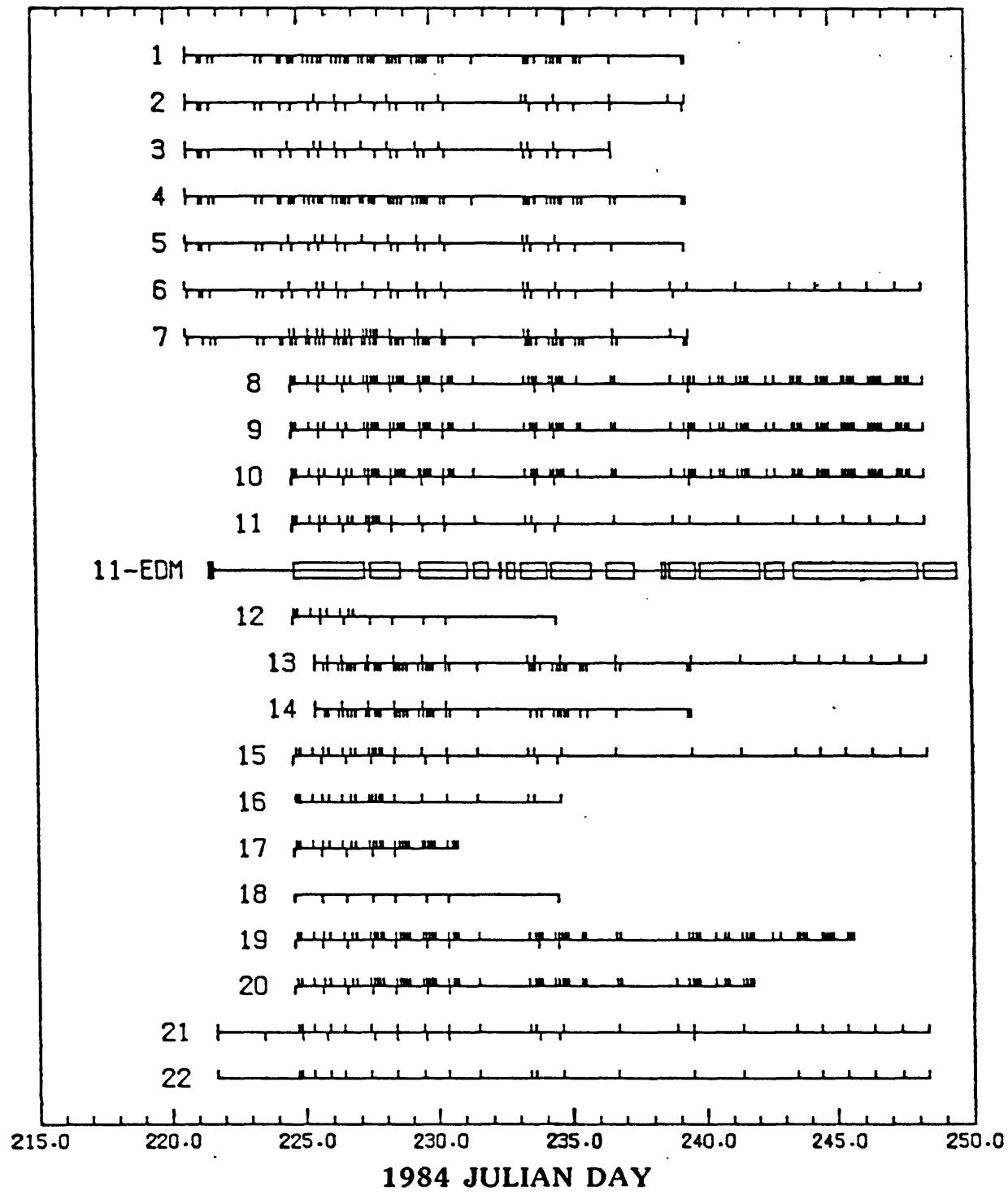


Figure 3.--Period of record of sightings (markers 1-22) and distance measurement (marker 11). For each marker, the upward-pointing tick indicates an azimuth sighting from New Gilbert (G), a downward-pointing tick, one from New Quickie (Q). For marker 11, the rectangles indicate periods during which a distance measurement was made at least every three hours.

with rocks. These were placed by helicopter atop ice pinnacles within pre-determined areas on the lower 11 km of the glacier. All markers visible from each station were surveyed once a day, and markers closer to each respective station were surveyed every 3 to 5 hours during daylight hours (fig. 3). Some breaks in the data occurred during periods of fog or heavy rain when the markers could not be seen.

On August 8 distance readings began with a recording electronic distance meter (EDM) located atop a bluff on the north end of Heather Island (fig. 2). The target was a three-prism reflector assembly fixed to two vertical stakes to minimize rotation and wind vibration. The stakes were drilled into the ice about 3.8 km from the EDM, or about 1 km upglacier from the terminus. Readings were taken at 15-minute intervals day and night. In the first several days there were a few short recording gaps during equipment failures. After this shakedown period, the major gaps were caused by fog or heavy rain.

The Hewlett-Packard 3808 EDM¹ uses a gallium arsenide lasing diode with a non-visible beam divergence of 0.0370 grads and a factory rated accuracy of 5mm (millimeter) + 1mm/km, or 9 mm at the beginning target distance of 3.8 km (Adams, 1978). The maximum rated range is 10 km but may require as many as six reflectors. These specifications are accurate during minimal heat shimmer. The details of the data reduction and atmospheric correction are discussed in subsequent sections.

The HP-3808 was operated in a remote function mode, and was triggered electronically by interval timers. Digital output of the metric distance measurements in binary coded decimal was converted by a Wild Heerbrugg interface into signals compatible with an HP-41 series calculator. The data from this interface were automatically transmitted to a HP-41cv calculator, thermal printer, and a digital cassette drive. All systems were operated on external 6 or 12 volt lead-acid

¹ The use of brand names in this report is for identification purposes only and does not imply endorsement by the U.S. Geological Survey.

batteries, which were maintained by a 132 watt array of solar cells fixed to the roof of the instrument shelter. A 3 kilowatt generator was used intermittently during extended periods of foul weather. This system represents a unique field application of data acquisition equipment normally intended for office use.

In operation, the distance reading was automatically stored in the memory of the HP-41 with a time and date, and printed out on thermal paper tape which provided a vital permanent record, immune to power fluctuations and memory loss. The EDM required re-aiming 2 or 3 times a day because the target was not moving directly toward the instrument. Small data gaps appear when this was not done regularly (fig. 3).

Suggested improvements to these instruments include illuminated cross-hairs in the telescope of the instrument for nighttime target viewing with the aid of a flashlight to illuminate the target reflector. This would allow re-aiming during the night as well as switching between multiple targets at any time of day.

DATA REDUCTION

Survey Markers

A local coordinate system with x positive to the east and y positive to the north is related to the Universal Transverse Mercator system according to

$$\begin{pmatrix} x \\ y \end{pmatrix} = \frac{1}{0.9996} \begin{pmatrix} \text{EUTM} - 490,000 \text{ m} \\ \text{NUTM} - 6,750,000 \text{ m} \end{pmatrix} \quad (1)$$

and z is the vertical coordinate, positive upward. Time is represented by the Julian day of 1984; it is 214.000 at 0000 hours local time on August 1, 1984 and increases by 1 each day thereafter.

The EDM instrument (H) was on Heather Island and Kern DKM2-AE theodolites were operated at stations New Gilbert (G) and New Quickie (Q), where azimuth angles $\hat{\theta}_G$ and $\hat{\theta}_Q$ to the markers were measured in grads to the right of station Easy (E). These stations are shown in figure 2 and their coordinates are given in

Table 1.--Survey stations.

[Coordinates x, y, z are in local coordinate system (equation 1) in meters].

Station	x	y	z
Easy (E)	10,543.3	18,808.9	461.1
New Gilbert (G)	12,923.2	13,643.6	448.4
New Quickie (Q)	9,441.6	22,464.6	701.8
EDM-site (H)	8,272.3	11,373.6	26

table 1. These letters will be used as subscripts as well as subscript T meaning Target.

The original angles $\hat{\theta}_G$ and $\hat{\theta}_Q$ are transformed to radians measured in the mathematically positive direction from the positive x-axis according to

$$\begin{pmatrix} \theta_G \\ \theta_Q \end{pmatrix} = \begin{pmatrix} 8.285744 \\ 5.005084 \end{pmatrix} - \frac{\pi}{200} \begin{pmatrix} \hat{\theta}_G \\ \hat{\theta}_Q \end{pmatrix} \quad (2)$$

in which the constants are related to the azimuths to station Easy from stations New Gilbert and New Quickie.

Neglecting the effect of Earth's curvature in determining horizontal coordinates, the equations of the two sighting lines are:

$$y = \begin{pmatrix} a_G \\ a_Q \end{pmatrix} x + \begin{pmatrix} b_G \\ b_Q \end{pmatrix} \quad (3)$$

Letting s represent either G or Q, the slope in the x,y plane is $a_s = \tan \theta_s$ and the intercept is $b_s = y_s - a_s x_s$ (fig. 4). The coordinates of their intersection are

$$\begin{pmatrix} x_T \\ y_T \end{pmatrix} = \frac{1}{a_Q - a_G} \begin{pmatrix} b_G - b_Q \\ a_Q b_G - a_G b_Q \end{pmatrix} \quad (4)$$

in which the subscript T denotes the survey target.

Taking into account the effects of both refraction and Earth's curvature, by means of the factor (Bouchard and Moffitt, 1972) $c \approx 6.8 \times 10^{-8}$ for distances in meters, the vertical coordinate of the marker is given by

$$z_T(s) = z_s + h_s + (cr_s - \tan \phi_s) r_s \quad (5)$$

in which h_s is the height of the instrument above the ground, z_s is altitude of station, ϕ_s is the elevation angle in radians as measured below the local horizontal, and $r_s = [(x_s - x_T)^2 + (y_s - y_T)^2]^{1/2}$. As the vertical coordinate can be estimated from either station independently from observations at the other station, a linear combination of the two estimates may be used for the altitude of the marker.

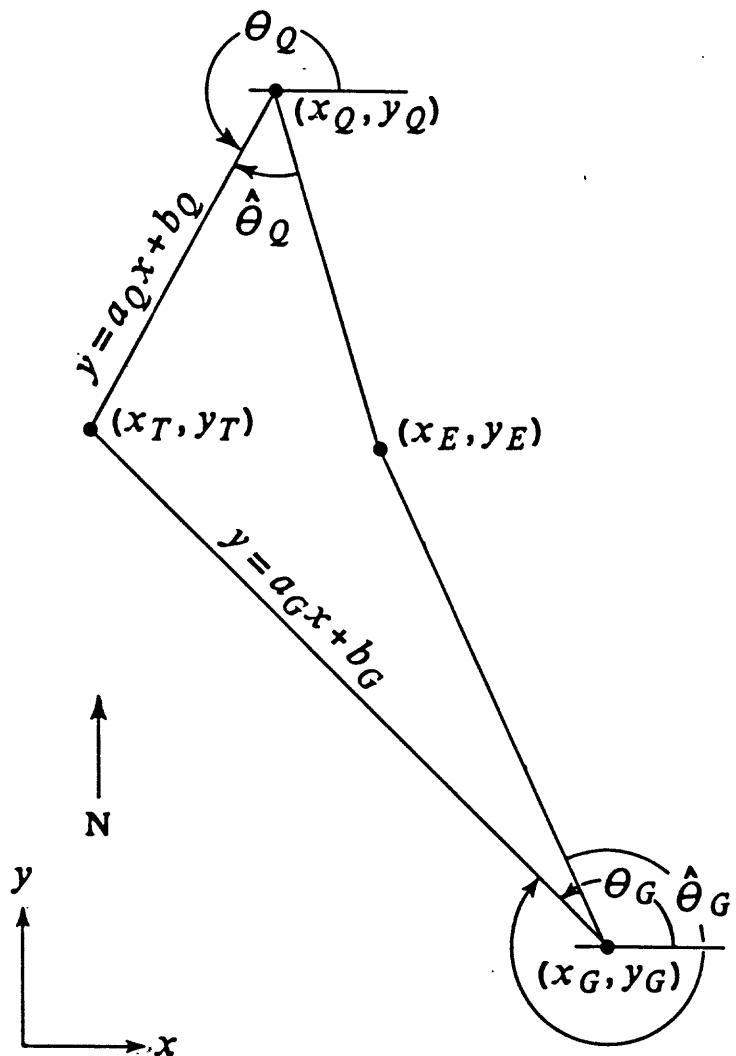


Figure 4.--Horizontal triangulation from survey stations New Gilbert (G) and New Quickie (Q), using Easy (E) as the reference.

$$z_T = \lambda z(G) + (1-\lambda)z(Q) \quad (6)$$

Determining the optimum value of λ (L. A. Rasmussen, U.S. Geological Survey, written communication, 1985) is beyond the scope of this report.

Because sightings of the moving markers were not made simultaneously from the two survey stations, time interpolation in the angle data--from one, or the other, or sometimes both stations--was used to get synchronous values for use in equations 2-6. The period of record of observation of each of the markers is shown in figure 3. Marker trajectories over this short period of record are very nearly straight lines; trajectory directions and representative marker positions are given in table 2.

Quality codes--based on comparison of forward and reverse sightings and, for the azimuth angles, on the apparent change of azimuth to the reference station Easy between the beginning and the end of a set of sightings--were assigned to each of the measured angles, indicating the probable error: 0 for 0.0030 grads, 1 for 0.0060, 2 for 0.0090, and 3 for 0.0120. Reference elevation angles to a fixed, known point were not regularly made, as a check on atmospheric refraction; therefore, this report does not include c-values for use in equation 5. The individual angles, along with the times of the sightings and the quality codes, are given in Appendix 1.

Each of two points (x_1, y_1) and (x_2, y_2) on a marker's trajectory--which is taken to be a straight line--is determined by applying equation 4 to a pair of azimuth angles, one from each of the two survey stations, generally with the use of some time interpolation to make them synchronous. The position of the marker corresponding to azimuth θ_S from survey station (x_S, y_S) is

$$\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} x_S \\ y_S \end{pmatrix} + \frac{a}{b} \begin{pmatrix} 1 \\ \tan \theta_S \end{pmatrix} \quad (7)$$

in which $a = (x_1 - x_S) \Delta y - (y_1 - y_S) \Delta x$ and $b = \Delta y - \Delta x \tan \theta_S$, with $\Delta x = x_2 - x_1$ and $\Delta y = y_2 - y_1$. Given the time rate of change $\dot{\theta}_S$ of the azimuth angle as

Table 2.--Marker positions and trajectory inclinations. The positions are for
 $t = 226.000$ (0000 hours local time on August 13, 1984), except that t
 $= 220.837$ for no. 1 and $t = 220.806$ for no. 4. [Coordinates x , y , z are
in local coordinate system (equation 1) in meters].

Marker	x	y	$\Delta\xi/\Delta\psi$
1	6147	24274	
2	6118	23497	0.085
3	6482	22464	-0.193
4	6723	21721	
5	6982	21066	-0.428
6	7244	20239	-0.375
7	7514	19044	-0.242
8	7761	17867	-0.131
9	7885	17059	0.003
10	7805	16027	0.135
11	7739	15112	0.175
12	7819	14734	0.169
13	7692	21998	-0.316
14	5922	21530	-0.450
15	9049	13962	
17	7173	14058	0.022
19	8263	14039	0.162
20	8608	14052	0.286
21	6256	17509	-0.231

well, the velocity of the marker along the trajectory is

$$\begin{pmatrix} u \\ v \end{pmatrix} = \frac{(1 + \tan^2 \theta_s) a \dot{\theta}_s}{b^2} \begin{pmatrix} \Delta x \\ \Delta y \end{pmatrix} \quad (8)$$

in which u is the component in the x -direction, and v is the component in the y -direction.

EDM Measurements

The EDM readings were recorded digitally at approximately 15-minute intervals except during periods of equipment failure or impaired visibility (fig. 3). They were adjusted for variations of atmospheric density (Adams, 1978) where the adjusted value r is given by

$$r = \left(279.42 - \frac{105.885 p}{273.2 + \bar{T}} \right) \times 10^{-6} \hat{r} \quad (9)$$

in which p is the pressure in mm of mercury, \bar{T} is the air temperature in degrees Celsius, and r is the original distance reading. The values of \hat{t} , r , and \hat{r} are given in Appendix 2. The adjustment was small ($-41 \leq r - \hat{r} \leq 1$ mm) especially compared with the average daily change in r , which was about 9 m. The p and \bar{T} data were taken at a site approximately 300 m to the northwest of the EDM instrument site at an altitude of 15 m above sea level and 1 m above the ground (Fig. 2).

Given two points (x_1, y_1) and (x_2, y_2) on the trajectory of the EDM-reflector (marker 11)--which is assumed to be a straight line--and given the distance r from the EDM-instrument at (x_H, y_H) , the point on the trajectory is given by

$$y = y_H + (mF + \sqrt{Mr^2 - F^2}) / M \quad (10)$$

$$x = my - f$$

in which $M = m^2 + 1$ and $F = f + x_H - my_H$, with $m = (x_2 - x_1) / (y_2 - y_1)$ and $f = (x_2 y_1 - x_1 y_2) / (y_2 - y_1)$. Given the time rate of change \dot{r} of the distance as well, the velocity of the reflector is given by

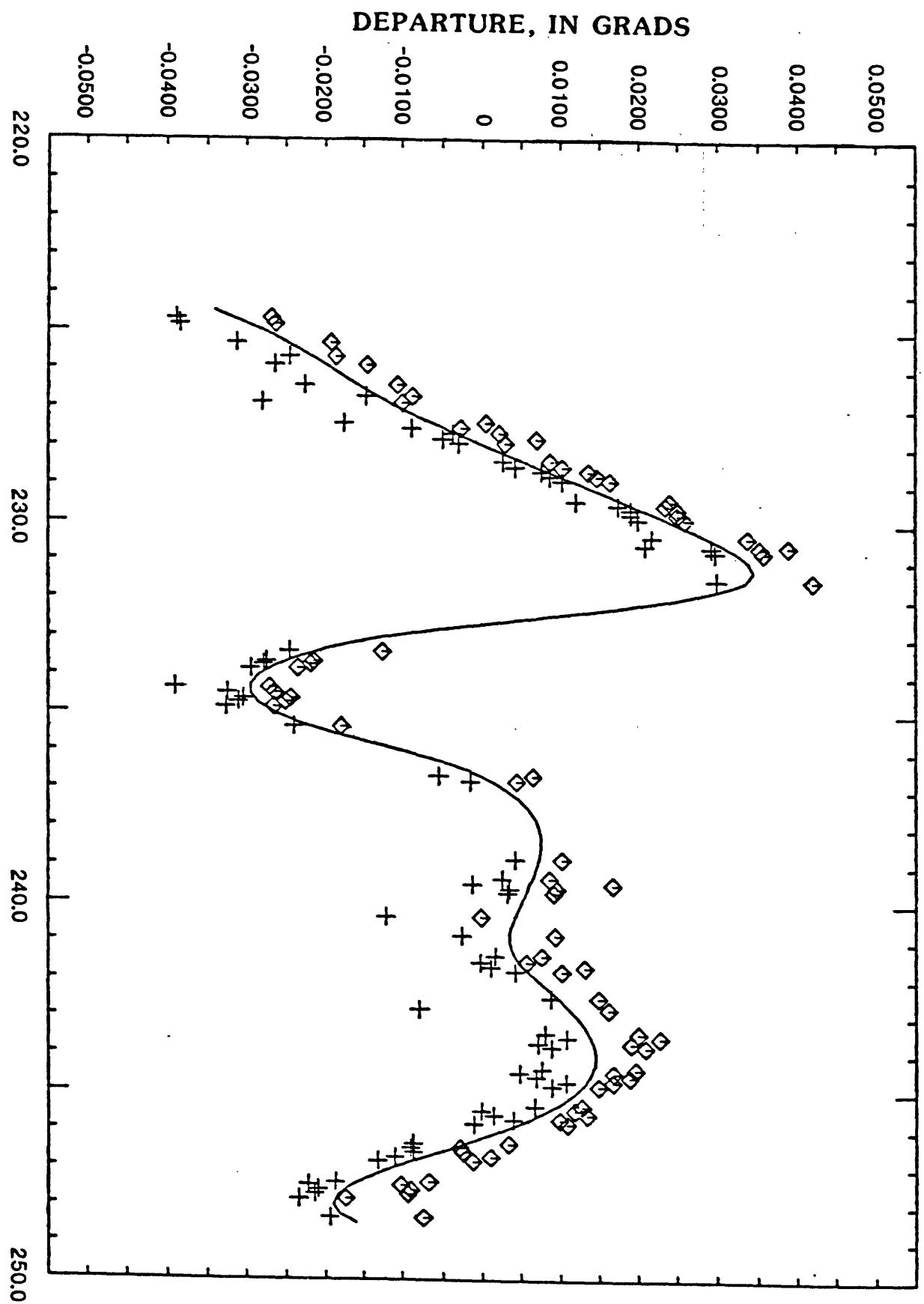


Figure 5.--Departure of azimuth angles from the long-term trend, for marker 10 as surveyed from New Gilbert (G). The ordinates $\Delta\theta + \epsilon$ (squares) and $\Delta\theta - \epsilon$ (crosses) are taken to be the error bar for each sighting, where $\Delta\theta$ is the departure and ϵ is the error associated with the sighting. Shown also is a smooth curve fit by hand to the error bars.

$$\begin{pmatrix} u \\ v \end{pmatrix} = \frac{\dot{rr}}{\sqrt{Mr^2 - F^2}} \begin{pmatrix} m \\ 1 \end{pmatrix} \quad (11)$$

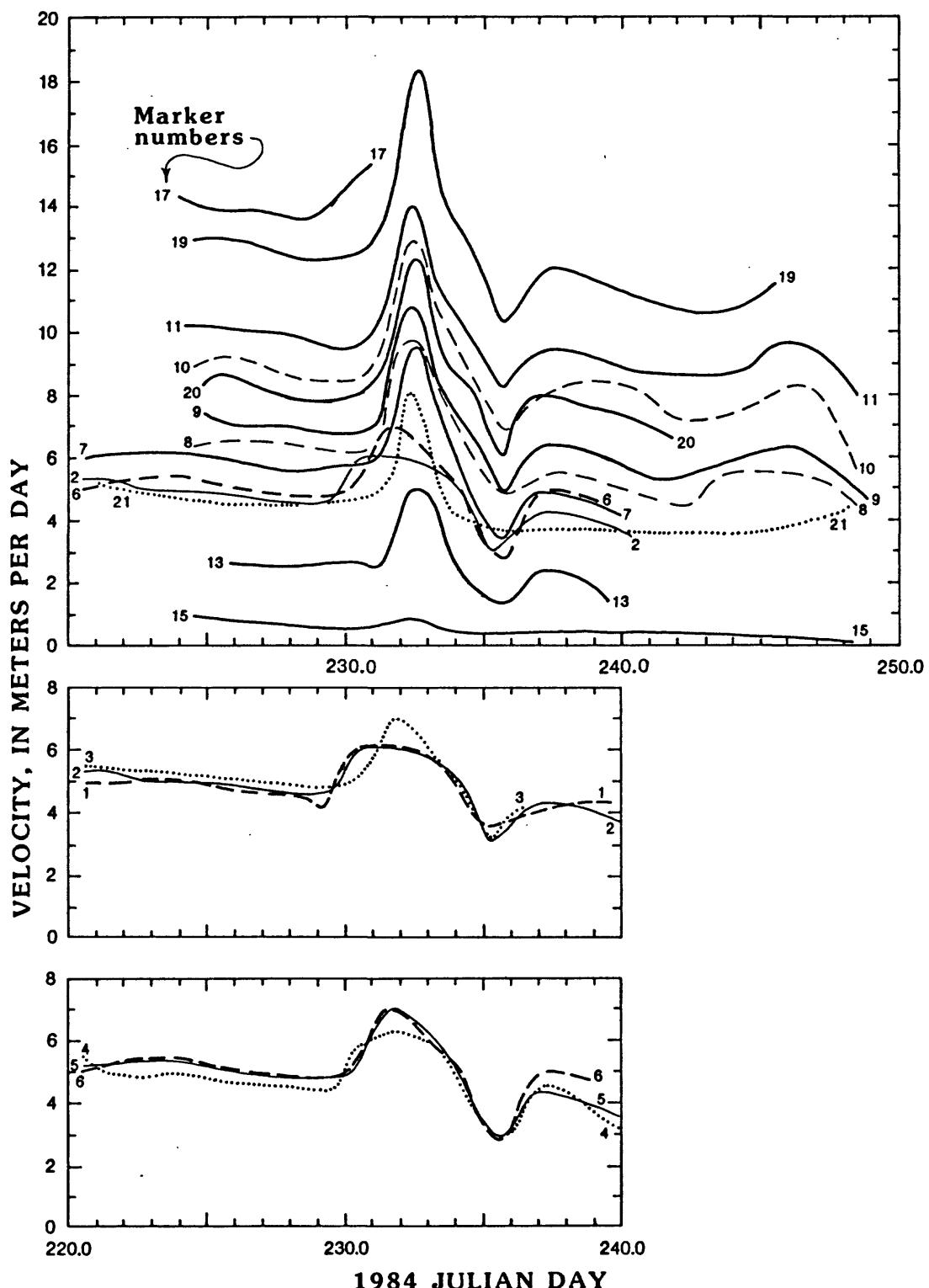
The foregoing involves, essentially, the intersection of a circle with a straight line, the general solution for which has been particularized here--with respect to the sign taken with the radical and the expression of the slope--for the trajectory-instrument configuration at Columbia Glacier.

VELOCITY DETERMINATION

When azimuth angles to a marker were available from both survey stations, they were used (equations 3,4) to establish the marker's x, y trajectory, which was approximated by a straight line (table 2). The azimuth angles θ from the station with the more numerous sightings of a marker were then used (equation 8) to estimate the velocity along the trajectory. To get the derivative $\dot{\theta}$ and to get velocity as a function of time, it is necessary to have θ as a function of time.

A single least-squares cubic polynomial $P(t)$ was used to represent the long-term (period of record) trend of the θ vs t data, and the departures $\Delta\theta$ from the cubic of the individual θ -values were then considered as a function of t . Where ϵ is the error implied by the quality codes assigned to the individual sightings, an error bar was formed by plotting (fig. 5) $\Delta\theta + \epsilon$ and $\Delta\theta - \epsilon$ at the t -coordinate of each θ -value. A smooth curve $f(t)$ was fit by hand to the error bars, $\theta(t) = P(t) + f(t)$ and $\dot{\theta}(t) = \dot{P}(t) + \dot{f}(t)$ being used to estimate the quantities in equation 8. The two velocity components are combined to give the total speed $\sqrt{u^2 + v^2}$ along the trajectory as a function of t in figure 6.

A cubic spline (Reinsch, 1967) was used to smooth the $n = 1,621$ distance values r_i obtained from the EDM. The spline $g(t)$ consists of a separate cubic polynomial on each interval (t_i, t_{i+1}) , has continuity of function value and first two derivatives, and minimizes



1984 JULIAN DAY

Figure 6.--Velocity of markers along their trajectories. Markers 1 through 3 and 4 through 6 are shown separately for clarity. Omitted from this analysis were marker 12, for which frequent sightings were lacking from both survey stations; marker 14, which apparently fell from the serac on which it was placed; and markers 16, 18, and 22, which were each sighted from only one survey station.

$$I = \int_{t_1}^{t_n} [\ddot{g}(t)]^2 dt \quad (12)$$

subject to

$$\frac{1}{n} \sum_{i=1}^n [g(t_i) - r_i]^2 \leq \sigma^2 \quad (13)$$

Where $\sigma = 10$ mm includes the standard error of the instrument--5 mm plus 1 mm for each km of distance (Adams, 1978), and 1 mm error due to recording the time to the nearest minute.

The function value of the spline and its first derivative $\dot{g}(t)$ are used as estimates of the quantities r and \dot{r} in equations 10 and 11. The two velocity components are combined to give the total speed along the trajectory as a function of t in figure 7, which also shows the curve for marker 11 determined from the Survey sightings (fig. 6). The agreement between the two curves is good except near the ends of the interval because the interpolation of $\Delta\theta$ (fig. 5) is less reliable at the ends.

SPEED IN DIRECTION OF TRAVEL,
IN METERS PER DAY

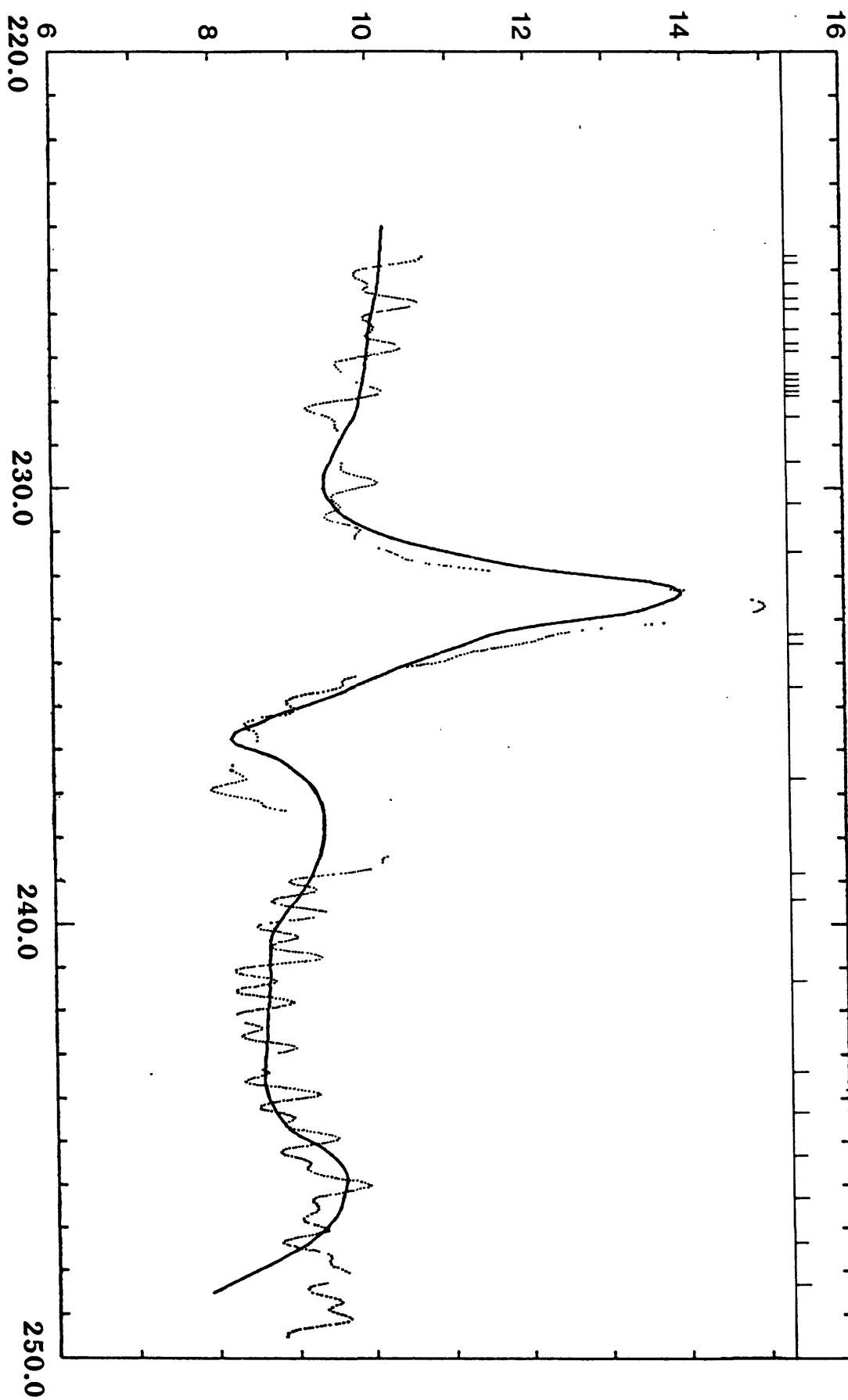


Figure 7.--Velocity of marker 11 along its trajectory determined by two methods.

The velocity (solid) determined by equation 8 from azimuth angles sighted at New Gilbert is shown for comparison with the velocity (dotted) determined by equation 11 from the distance measurements made at the EDM-site. Rake scale at top shows period of record for survey sightings to the marker (fig. 3).

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Appendix 1. Sightings of markers from survey stations.

The time shown \hat{t} is 200 less than the 1984 Julian Day, which is 214.000 at 0000 hours on August 1, 1984 and increases by 1 each day thereafter. The azimuth angle $\hat{\theta}$ is measured in grads to the right of Easy (fig. 2, equation 2). The elevation angle ϕ is measured in grads below the horizontal. The quality codes K_{θ} and K_{ϕ} following the values for the angles indicate the estimated error: 0 for 0.0030 grads, 1 for 0.0060, 2 for 0.0090, and 3 for 0.0120. The instrument height h is in mm above the altitude of the survey station.

Apparently incorrect values from New Gilbert for θ are marker #3 at $t = 27.367$, #6 at 27.374 , #7 at 26.674 , #10 at 40.702 , #19 at 26.872 and 27.901 , #20 at 27.756 , and for ϕ are #2 at 20.833 and 28.372 , #3 at 20.826 , #6 at 25.910 , #7 at 20.744 and 28.376 , #8 at 25.884 , #14 at 28.385 , #15 at 27.398 , #16 at 28.374 ; those from New Quickie for θ are #1 at 28.872 , #4 at 28.876 , #7 at 28.880 , #11 at 27.520 , #12 at 29.547 , #13 at 28.875 , #14 at 28.874 , #15 at 29.556 and for ϕ are #12 at 26.531 , #15 at 26.521 .

\hat{i}	$\hat{\theta}$	K_{θ}	ϕ	K_{ϕ}	h	\hat{i}	$\hat{\theta}$	K_{θ}	ϕ	K_{ϕ}	h	\hat{i}	$\hat{\theta}$	K_{θ}	ϕ	K_{ϕ}	h
MARKER 1 FROM NEW GILBERT																	
20	837	391	3584	2		1670											
MARKER 1 FROM NEW QUICKIE																	
20.	837	150.	6091	1	5.	6554	1	1466									
21.	311	150.	5693	0	5.	6572	0	1466									
21.	432	150.	5613	0	5.	6589	0	1466									
21.	720	150.	5360	0	5.	6604	0	1466									
21.	874	150.	5254	0	5.	6611	0	1466									
23.	476	150.	4031	0	5.	6694	0	1466									
23.	681	150.	3862	0	5.	6702	0	1466									
24.	308	150.	3374	0	5.	6729	0	1466									
24.	410	150.	3282	0	5.	6737	0	1466									
24.	675	150.	3060	0	5.	6764	0	1466									
24.	776	150.	2992	0	5.	6764	0	1466									
24.	890	150.	2900	0	5.	6765	0	1466									
25.	264	150.	2652	0	5.	6789	0	1466									
25.	447	150.	2497	0	5.	6797	0	1466									
25.	609	150.	2383	0	5.	6828	0	1466									
25.	794	150.	2253	0	5.	6825	0	1466									
25.	907	150.	2158	0	5.	6828	0	1466									
26.	299	150.	1857	0	5.	6841	0	1466									
26.	451	150.	1753	0	5.	6855	0	1466									
26.	596	150.	1646	0	5.	6865	1	1466									
26.	767	150.	1530	0	5.	6898	0	1466									
26.	899	150.	1426	0	5.	6863	0	1466									
27.	302	150.	1109	0	5.	6895	0	1510									
27.	445	150.	1020	0	5.	6903	0	1510									
27.	651	150.	0908	0	5.	6934	0	1510									
27.	771	150.	0820	2	5.	6929	2	1510									
27.	887	150.	0811	2	5.	6921	2	1510									
28.	396	150.	0320	0	5.	6956	0	1553									
28.	480	150.	0310	0	5.	6976	0	1553									
28.	594	150.	0215	0	5.	6966	0	1553									
28.	742	150.	0094	0	5.	6982	0	1553									
28.	872	150.	0244	1	5.	6985	0	1553									
29.	326	149.	9735	0	5.	6996	0	1560									
29.	512	149.	9534	0	5.	7010	0	1560									
29.	634	149.	9463	1	5.	7016	0	1560									
29.	772	149.	9409	0	5.	7024	0	1560									
29.	877	149.	9285	0	5.	7028	0	1560									
30.	368	149.	8892	0	5.	7046	0	1560									
30.	528	149.	8659	0	5.	7066	0	1560									
31.	549	149.	8068	0	5.	7098	1	1560									
33.	481	149.	5971	0	5.	7166	0	1560									
33.	590	149.	5869	0	5.	7186	0	1560									
33.	681	149.	5807	0	5.	7170	0	1560									
33.	886	149.	5578	0	5.	7186	0	1560									
MARKER 1 FROM NEW QUICKIE (cont.)																	
34.	351	149.	5262	0	5.	7224	0	1560									
34.	507	149.	5124	0	5.	7233	0	1560									
34.	627	149.	5074	0	5.	7248	0	1560									
34.	771	149.	4960	0	5.	7242	0	1560									
34.	876	149.	4915	0	5.	7251	0	1560									
35.	348	149.	4684	0	5.	7296	1	1560									
35.	483	149.	4550	1	5.	7290	1	1560									
35.	624	149.	4468	1	5.	7279	0	1560									
36.	715	149.	3850	0	5.	7344	0	1560									
39.	367	149.	2102	0	5.	7417	0	1560									
39.	474	149.	2053	1	5.	7416	0	1560									
MARKER 2 FROM NEW GILBERT																	
20.	833	389	1001	2	5.	111	2	1670									
25.	644	389	0136	0	5.	228	0	1520									
26.	365	389	0017	1	5.	180	0	1650									
27.	365	388	9819	2	5.	186	0	1650									
28.	372	388	9690	0	5.	4759	0	1760									
30.	353	388	9391	1	5.	5311	0	1760									
33.	402	388	8767	1	5.	5334	0	1760									
33.	574	388	8713	0	5.	5339	0	1500									
34.	589	388	88550	0	5.	5354	0	1500									
36.	689	388	8279	2	5.	5388	1	1450									
38.	863	388	7985	2	5.	5387	2	1310									
39.	481	388	7938	2	5.	4549	2	1310									
MARKER 2 FROM NEW QUICKIE																	
20.	836	138.	2713	1	6.	2048	1	1466									
21.	308	138.	2278	0	6.	2080	0	1466									
21.	429	138.	2176	0	6.	2093	0	1466									
21.	717	138.	1885	0	6.	2121	0	1466									
23.	474	138.	0305	0	6.	2234	0	1466									
23.	683	138.	0108	0	6.	2248	0	1466									
24.	408	137.	9466	0	6.	2296	0	1466									
24.	774	137.	9128	0	6.	2321	0	1466									
25.	445	137.	8548	0	6.	2378	0	1466									
25.	791	137.	8254	0	6.	2399	0	1466									
26.	451	137.	7679	0	6.	2458	0	1466									
26.	766	137.	7414	0	6.	2475	0	1466									
27.	883	137.	6389	2	6.	2570	2	1510									
28.	477	137.	5999	0	6.	2608	0	1553									
28.	740	137.	5756	0	6.	2620	0	1553									
29.	510	137.	5104	0	6.	2657	0	1560									
29.	770	137.	4946	1	6.	2681	0	1560									
30.	526	137.	4110	1	6.	2744	0	1560									
33.	702	137.	0809	0	6.	2938	0	1560									
MARKER 3 FROM NEW GILBERT																	
20.	835	119.	1972	1	8.	5762	1	1466									
21.	306	119.	1431	0	8.	5860	0	1466									
21.	426	119.	1300	0	8.	5904	0	1466									
21.	715	119.	0945	0	8.	5973	1	1466									
23.	471	118.	9002	0	8.	6341	0	1466									
23.	685	118.	8764	0	8.	6394	0	1466									
24.	406	118.	7976	0	8.	6534	0	1466									
24.	771	118.	7572	0	8.	6619	0	1466									
25.	442	118.	6868	0	8.	6772	0	1466									
25.	788	118.	6492	0	8.	6837	0	1466									
26.	447	118.	5797	0	8.	6980	0	1466									
26.	765	118.	5457	0	8.	7026	0	1466									
27.	878	118.	4234	2	8.	7											

i θ K_θ ϕ K_ϕ h

MARKER 4 FROM NEW GILBERT

20.806 385.8115 2 1.3526 2 1670

MARKER 4 FROM NEW QUICKIE

20.833 101.6321 1 10.3962 1 1466
 21.303 101.5783 0 10.3965 0 1466
 21.424 101.5644 0 10.3991 0 1466
 21.712 101.5304 0 10.3985 0 1466
 21.872 101.5124 0 10.3996 0 1466
 23.469 101.3393 0 10.4053 0 1466
 23.688 101.3145 0 10.4059 0 1466
 24.306 101.2466 0 10.4077 0 1466
 24.401 101.2350 0 10.4074 0 1466
 24.673 101.2028 0 10.4089 0 1466
 24.768 101.1946 0 10.4087 0 1466
 24.887 101.1796 0 10.4093 0 1466
 25.261 101.1432 0 10.4095 0 1466
 25.435 101.1254 0 10.4113 0 1466
 25.608 101.1046 0 10.4110 1 1466
 25.776 101.0864 1 10.4129 0 1466
 25.905 101.0734 0 10.4134 0 1466
 26.292 101.0338 0 10.4135 0 1466
 26.437 101.0165 0 10.4133 0 1466
 26.593 100.9991 0 10.4163 0 1466
 26.738 100.9846 1 10.4153 0 1466
 26.751 100.9875 0 10.4152 0 1466
 26.896 100.9682 0 10.4143 0 1466
 27.293 100.9273 0 10.4178 0 1510
 27.438 100.9132 0 10.4184 0 1510
 27.641 100.8933 0 10.4185 0 1510
 27.762 100.8904 2 10.4221 2 1510
 27.867 100.8701 2 10.4191 2 1510
 28.390 100.8167 0 10.4219 0 1553
 28.462 100.8084 0 10.4237 0 1553
 28.585 100.7974 0 10.4233 0 1553
 28.732 100.7837 1 10.4241 1 1553
 28.876 100.7933 0 10.4226 0 1553
 29.319 100.7264 1 10.4253 0 1560
 29.500 100.7028 0 10.4266 0 1560
 29.628 100.6900 1 10.4265 0 1560
 29.763 100.6797 1 10.4267 0 1560
 29.871 100.6656 1 10.4275 0 1560
 30.363 100.6100 0 10.4277 0 1560
 30.521 100.5853 0 10.4274 0 1560
 31.547 100.4934 1 10.4270 1 1560
 33.471 100.1867 0 10.4208 0 1560
 33.573 100.1680 0 10.4229 1 1560
 33.668 100.1618 0 10.4231 0 1560
 33.876 100.1306 0 10.4233 0 1560
 34.344 100.0841 0 10.4242 1 1560
 34.500 100.0689 0 10.4273 0 1560
 34.619 100.0622 0 10.4265 0 1560
 34.765 100.0490 0 10.4292 0 1560
 34.871 100.0408 1 10.4288 0 1560
 35.340 100.0049 1 10.4299 0 1560
 35.476 99.9944 1 10.4307 0 1560
 35.617 99.9819 0 10.4307 0 1560
 36.707 99.9051 0 10.4359 0 1560
 36.868 99.8869 0 10.4357 0 1560
 39.358 99.6541 0 10.4450 1 1560
 39.468 99.6462 0 10.4498 0 1560

MARKER 5 FROM NEW GILBERT

20.760 384.5623 2 1.4768 2 1670
 24.646 384.5239 0 1.4840 0 1520
 25.655 384.5212 0 1.4856 0 1520
 25.908 384.5155 1 1.4795 0 1650
 26.373 384.5140 1 1.4847 0 1650
 27.371 384.4993 2 1.4849 0 1650
 28.364 384.4923 0 1.4910 0 1760
 29.438 384.4836 1 1.4951 0 1760
 30.358 384.4784 1 1.4983 0 1760
 33.398 384.4405 1 1.5046 0 1760
 33.582 384.4376 1 1.5037 1 1500
 34.596 384.4311 0 1.5061 0 1500

MARKER 5 FROM NEW QUICKIE

20.831 86.3181 1 10.4410 1 1466
 21.295 86.2614 0 10.4419 0 1466
 21.419 86.2488 0 10.4434 0 1466
 21.708 86.2127 0 10.4448 0 1466
 23.465 86.0070 0 10.4495 0 1466
 23.703 85.9780 0 10.4502 0 1466
 24.399 85.8978 0 10.4529 0 1466

i θ K_θ ϕ K_ϕ h

MARKER 5 FROM NEW QUICKIE (cont.)

24.763 85.8550 0 10.4540 0 1466
 25.401 85.7825 0 10.4575 0 1466
 25.769 85.7414 0 10.4590 0 1466
 26.435 85.6675 1 10.4608 0 1466
 26.733 85.6344 0 10.4617 0 1466
 27.865 85.5115 2 10.4653 2 1510
 28.459 85.4478 0 10.4691 0 1553
 28.726 85.4212 0 10.4688 0 1553
 29.495 85.3374 0 10.4722 0 1560
 29.757 85.3116 1 10.4717 0 1560
 30.503 85.2295 0 10.4752 0 1560
 33.463 84.8054 0 10.4777 0 1560
 33.689 84.7773 0 10.4803 0 1560
 34.360 84.6998 0 10.4795 0 1560
 34.753 84.6632 0 10.4837 0 1560
 35.354 84.6210 0 10.4815 1 1560
 36.723 84.5186 1 10.4852 0 1560
 39.374 84.2763 0 10.4913 0 1560

MARKER 6 FROM NEW GILBERT

20.750 382.2991 2 1.7760 2 1670
 24.649 382.2474 0 1.7880 0 1520
 25.660 382.2363 0 1.7917 0 1520
 25.910 382.2353 1 1.7860 0 1650
 26.374 382.2267 1 1.7918 0 1650
 27.374 382.1994 2 1.7914 0 1650
 28.365 382.1991 0 1.7949 0 1760
 29.436 382.1871 1 1.7988 0 1760
 30.360 382.1780 1 1.8013 0 1760
 33.396 382.1258 1 1.8031 0 1760
 33.584 382.1219 0 1.8046 0 1500
 34.599 382.1093 0 1.8085 0 1500
 36.735 382.0889 1 1.8153 0 1450
 38.872 382.0660 2 1.8169 1 1310
 39.483 382.0586 1 1.8204 1 1310
 41.372 382.0456 0 1.8277 0 1750
 43.447 382.0312 1 1.8361 0 1560
 44.385 382.0203 1 1.8379 0 1620
 45.356 382.0105 0 1.8369 0 1620
 46.350 382.0008 1 1.8397 0 1620
 47.381 381.9898 1 1.8425 0 1620
 48.341 381.9828 1 1.8423 0 1620

MARKER 6 FROM NEW QUICKIE

20.829 68.7559 1 9.9711 1 1466
 21.293 68.7085 0 9.9711 0 1466
 21.416 68.6976 0 9.9711 0 1466
 21.706 68.6668 0 9.9699 0 1466
 23.462 68.4951 0 9.9648 0 1466
 23.701 68.4682 0 9.9643 0 1466
 24.397 68.3999 0 9.9637 0 1466
 24.760 68.3627 0 9.9633 0 1466
 25.399 68.3032 0 9.9614 0 1466
 25.764 68.2686 0 9.9591 0 1466
 26.432 68.2070 1 9.9593 0 1466
 26.731 68.1769 0 9.9585 0 1533
 27.862 68.0751 2 9.9580 2 1510
 28.456 68.0214 0 9.9564 0 1553
 28.724 67.9990 0 9.9544 0 1553
 29.493 67.9286 1 9.9546 0 1560
 29.756 67.9081 1 9.9531 0 1560
 30.501 67.8379 0 9.9498 0 1560
 33.462 67.4915 0 9.9238 0 1560
 33.689 67.4694 0 9.9231 0 1560
 34.357 67.4035 0 9.9255 0 1560
 34.751 67.3740 0 9.9285 0 1560
 35.352 67.3359 0 9.9311 1 1560
 36.720 67.2506 0 9.9332 0 1560
 38.972 67.0519 0 9.9247 0 1560

MARKER 7 FROM NEW GILBERT

20.744 377.5678 2 2.0121 2 1670
 24.651 377.4666 0 2.0294 0 1520
 24.824 377.4641 1 1520
 25.310 377.4516 1 1520
 25.666 377.4451 0 2.0307 0 1520
 25.883 377.4394 1 2.0320 0 1650
 26.376 377.4265 1 2.0340 0 1650
 26.674 377.3724 0 1650
 26.858 377.4162 2 1650
 27.378 377.4023 2 2.0388 0 1650
 27.514 377.3997 0 1650
 27.645 377.3993 0 1650
 27.787 377.3923 1 1760

i θ K_θ ϕ K_ϕ h

MARKER 7 FROM NEW GILBERT (cont.)

27.894 377.3905 0 1760
 28.376 377.3792 0 1.9952 0 1760
 29.435 377.3542 1 2.0506 0 1760
 30.361 377.3347 1 2.0532 0 1760
 33.394 377.2434 1 2.0635 0 1760
 33.586 377.2349 0 2.0624 0 1500
 34.601 377.2117 0 2.0699 0 1500
 36.736 377.1725 1 2.0780 0 1450
 38.874 377.1283 2 2.0844 1 1310
 39.484 377.1151 1 2.0895 2 1310

MARKER 7 FROM NEW QUICKIE

20.828 51.6620 1 7.9851 1 1466
 21.413 51.6212 0 7.9839 0 1466
 21.703 51.5984 0 7.9829 0 1466
 21.869 51.5864 0 7.9820 0 1466
 23.460 51.4758 0 7.9773 0 1466
 23.693 51.4594 0 7.9769 0 1466
 24.303 51.4172 0 7.9752 0 1466
 24.395 51.4105 0 7.9744 0 1466
 24.670 51.3889 0 7.9742 0 1466
 24.757 51.3828 0 7.9736 0 1466
 24.885 51.3741 0 7.9733 0 1466
 25.258 51.3516 0 7.9716 0 1466
 25.396 51.3408 0 7.9725 0 1466
 25.605 51.3266 0 7.9725 0 1466
 25.761 51.3157 0 7.9732 0 1466
 25.902 51.3069 0 7.9709 0 1466
 26.290 51.2808 0 7.9695 0 1466
 26.430 51.2721 0 7.9693 0 1466
 26.591 51.2580 0 7.9675 0 1466
 26.729 51.2509 0 7.9694 0 1466
 26.894 51.2422 0 7.9686 0 1466
 27.291 51.2137 0 7.9673 0 1510
 27.435 51.2042 0 7.9677 0 1510
 27.637 51.1904 0 7.9680 0 1510
 27.760 51.1858 2 7.9679 2 1510
 27.859 51.1773 2 7.9673 2 1510
 28.388 51.1439 0 7.9656 0 1553
 28.453 51.1405 0 7.9643 0 1553
 28.583 51.1324 0 7.9650 0 1553
 28.721 51.1231 0 7.9658 0 1553
 28.880 51.1285 0 7.9674 0 1553
 29.317 51.0872 1 7.9635 0 1560
 29.481 51.0753 0 7.9637 0 1560
 29.626 51.0663 1 7.9644 0 1560
 29.753 51.0583 1 7.9644 0 1560
 29.869 51.0504 1 7.9612 0 1560
 30.361 51.0145 0 7.9613 0 1560
 30.498 51.0083 0 7.9619 0 1560
 31.544 50.9372 0 7.9561 0 1560
 33.459 50.7540 0 7.9411 0 1560
 33.555 50.7445 0 7.9405 0 1560
 33.665 50.7385 0 7.9379 0 1560
 33.872 50.7194 1 7.9415 0 1560
 34.342 50.6922 0 7.9388 0 1560
 34.497 50.6825 0 7.9391 1 1560
 34.618 50.6771 0 7.9402 0 1560
 34.762 50.6697 0 7.9394 0 1560
 34.868 50.6635 0 7.9374 0 1560
 35.338 50.6471 0 7.9333 0 1560
 35.473 50.6402 0 7.9387 1 1560
 35.614 50.6280 0 7.9392 0 1560
 36.705 50.5844 1 7.9436 0 1560
 36.865 50.5746 0 7.9415 0 1560
 39.356 50.4420 0 7.9397 0 1560
 39.466 50.4364 0 7.9399 0 1560

MARKER 8 FROM NEW GILBERT

24.681 371.1931 0 2.6665 0 1520
 24.825 371.1880 1 1520
 25.312 371.1678 1 1520
 25.671 371.1508 0 2.6720 0 1520
 25.884 371.1436 1 2.6672 0 1650
 26.378 371.1207 1 2.6738 0 1650
 26.636 371.1121 0 1650
 26.860 371.1017 2 1650
 27.380 371.0774 2 2.6770 0 1650
 27.515 371.0710 0 1650
 27.649 371.0692 0 1650
 27.788 371.0606 1 1760
 27.894 371.0561 0 1760
 28.367 371.0361 0 2.6830 0 1760
 28.510 371.0293 0 1760
 28.634 371.0273 0 1760

i θ K_θ ϕ K_ϕ h

MARKER 8 FROM NEW GILBERT (cont.)

28.757	371.0231	0	1760		
28.876	371.0122	0	1760		
29.433	370.9930	1	2.6892	0	1760
29.503	370.9902	0	1760		
29.629	370.9848	0	1760		
29.757	370.9784	0	1760		
29.883	370.9737	0	1760		
30.363	370.9558	1	2.6928	0	1760
30.588	370.9456	2	1760		
30.625	370.9448	0	1760		
30.750	370.9393	0	1760		
31.493	370.9081	1	2.6973	0	1760
33.387	370.7935	1	2.7077	0	1760
33.589	370.7804	0	2.7074	0	1500
33.711	370.7760	0	1500		
33.834	370.7694	0	1500		
34.335	370.7425	1	1500		
34.463	370.7416	0	1500		
34.603	370.7367	0	2.7135	1	1500
34.715	370.7316	0	1500		
34.835	370.7254	0	1450		
35.343	370.7087	0	1450		
36.644	370.6666	1	1450		
36.794	370.6608	0	2.7258	0	1450
38.835	370.5868	0	2.7290	0	1310
39.335	370.5667	0	1310		
39.485	370.5596	1	2.7333	1	1310
39.598	370.5605	0	1310		
39.718	370.5549	0	1310		
40.340	370.5329	0	1310		
40.696	370.5234	0	1750		
40.833	370.5198	1	1750		
41.376	370.5012	0	2.7468	0	1750
41.556	370.4947	0	1750		
41.683	370.4925	1	1750		
41.803	370.4871	0	1750		
42.511	370.4658	0	1750		
42.799	370.4519	3	1750		
43.448	370.4397	1	2.7604	0	1560
43.556	370.4284	1	1560		
43.701	370.4237	1	1620		
43.799	370.4186	1	1620		
44.387	370.4022	1	2.7619	0	1620
44.474	370.3950	1	1620		
44.600	370.3913	1	1620		
44.721	370.3880	0	1620		
44.833	370.3838	0	1620		
45.357	370.3653	0	2.7652	3	1620
45.467	370.3608	3	1620		
45.588	370.3560	1	1620		
45.715	370.3540	0	1620		
45.835	370.3471	1	1620		
46.351	370.3296	1	2.7688	0	1620
46.469	370.3242	0	1620		
46.582	370.3208	0	1620		
46.714	370.3155	1	1620		
46.827	370.3103	1	1620		
47.381	370.2916	1	2.7752	0	1620
47.462	370.2872	1	1620		
47.583	370.2820	1	1620		
47.708	370.2814	1	1620		
47.832	370.2744	1	1620		
48.350	370.2616	1	2.7782	0	1620

MARKER 8 FROM NEW QUICKIE

24.644	41.0032	0	6.8885	1	1466
25.672	40.9632	1	6.8842	0	1466
26.537	40.9269	0	6.8820	0	1466
27.526	40.8890	0	6.8786	0	1510
28.377	40.8550	2	6.8728	2	1553
29.529	40.8150	0	6.8707	0	1560
30.378	40.7797	0	6.8661	0	1560
33.772	40.6222	1	6.8477	0	1560
34.488	40.5917	0	6.8442	0	1560
39.491	40.4396	0	6.8322	0	1560

MARKER 9 FROM NEW GILBERT

24.684	365.4966	0	3.0944	0	1520
24.829	365.4882	1	1520		
25.315	365.4591	1	1520		
25.672	365.4326	0	3.0975	0	1520
25.885	365.4269	1	3.1001	0	1650
26.381	365.3907	1	3.1015	0	1650
26.679	365.3783	0	1650		

i θ K_θ ϕ K_ϕ h

MARKER 9 FROM NEW GILBERT (cont.)

26.694	365.3666	1	3.1082	0	1650
27.382	365.3294	2	3.1082	0	1650
27.517	365.3200	0	1650		
27.651	365.3175	0	1650		
27.790	365.3064	1	1760		
27.896	365.2984	0	1760		
28.369	365.2686	0	3.1103	0	1760
28.515	365.2615	0	1760		
28.640	365.2561	0	1760		
28.758	365.2479	0	1760		
28.878	365.2418	0	1760		
29.457	365.2074	1	3.1156	0	1760
29.506	365.2032	0	1760		
29.630	365.1979	0	1760		
29.759	365.1882	0	1760		
29.884	365.1810	0	1760		
30.365	365.1543	1	1760		
30.589	365.1400	2	1760		
30.628	365.1392	0	1760		
30.751	365.1304	0	1760		
31.494	365.0852	1	3.1243	0	1760
33.389	364.9225	1	3.1309	0	1760
33.591	364.9069	0	3.1311	0	1500
33.713	364.8996	0	1500		
33.835	364.8863	1	1500		
34.337	364.8539	1	1500		
34.465	364.8506	0	1500		
34.605	364.8440	0	3.1366	0	1500
34.716	364.8356	0	1500		
34.836	364.8274	0	1450		
35.344	364.8022	0	1450		
35.462	364.7953	2	1450		
36.645	364.7405	1	1450		
36.796	364.7330	0	3.1451	0	1450
36.837	364.6195	0	3.1509	0	1310
37.166	364.5899	0	1310		
39.486	364.5833	1	3.1568	1	1310
39.599	364.5808	0	1310		
39.719	364.5733	0	1310		
40.342	364.5387	1	1310		
40.702	364.5220	0	1750		
40.702	364.5220	0	1750		
40.836	364.5196	1	1750		
40.836	364.4918	0	3.1685	0	1750
41.556	364.4818	0	1750		
41.684	364.4776	1	1750		
41.804	364.4712	0	1750		
42.515	364.4379	0	1750		
42.802	364.4192	3	1750		
43.451	364.3920	1	3.1839	0	1560
43.557	364.3847	1	1560		
43.703	364.3796	1	1620		
43.800	364.3718	1	1620		
44.390	364.3433	1	3.1879	0	1620
44.474	364.3357	1	1620		
44.601	364.3296	1	1620		
44.724	364.3240	0	1620		
44.834	364.3179	0	1620		
45.358	364.2917	0	3.1906	0	1620
45.468	364.2833	1	1620		
45.589	364.2778	1	1620		
45.717	364.2713	0	1620		
45.836	364.2652	1	1620		
46.353	364.2360	1	3.1938	0	1620
46.469	364.2280	0	1620		
46.583	364.2229	0	1620		
46.715	364.2168	1	1620		
46.828	364.2085	1	1620		
47.384	364.1823	1	3.2011	0	1620
47.464	364.1741	2	1620		
47.583	364.1723	1	1620		
47.708	364.1651	1	1620		
47.833	364.1565	0	1620		
48.351	364.1368	1	3.2042	0	1620

MARKER 9 FROM NEW QUICKIE

27.524	36.4485	0	6.1835	0	1510
28.374	36.4315	2	6.1820	2	1553
29.531	36.4072	0	6.1757	0	1560
30.380	36.3858	0	6.1715	0	1560
33.767	36.2986	0	6.1499	0	1560
34.485	36.2814	0	6.1467	0	1560
39.488	36.1943	0	6.1317	1	1560

i θ K_θ ϕ K_ϕ h

MARKER 10 FROM NEW GILBERT

24.685	355.3597	1	3.5160	1	1520
24.831	355.3443	1	1520		
25.313	355.2994	1	1520		
25.674	355.2642	0	3.5240	0	1520
25.888	355.2424	1	3.5247	0	1650
27.518	355.0837	0	1650		
27.633	355.0745	0	1650		
27.790	355.0618	1	1760		
27.901	355.0549	0	1760		
28.372	355.0055	0	3.5517	0	1760
28.383	355.0952	2	3.5423	0	1650
28.517	354.9920	0	1760		
28.637	354.9828	0	1760		
28.759	354.9712	0	1760		
28.879	354.9603	0	1760		
29.414	354.9096	1	3.5622	0	1760
29.506	354.9025	0	1760		
29.633	354.8910	0	1760		
29.760	354.8780	0	1760		
29.885	354.8660	0	1760		
30.366	354.8215	1	1760		
31.485	354.7163	1	3.5795	0	1760
33.386	354.4727	1	3.5976	0	1760
33.647	354.4412	0	3.5996	0	1500
33.647	354.4341	0	1500		
33.716	354.3338	0	1500		
34.837	354.3207	0	1450		
34.836	354.2807	0	1450		
36.646	354.1795	1	1450		
36.797	354.1663	0	3.6265	0	1450
38.840	353.9851	0	3.6423	0	1310
39.307	353.9389	0	1310		
40.83					

$i \quad \theta \quad K_\theta \quad \phi \quad K_\phi \quad h$

MARKER 10 FROM NEW QUICKIE

24.655	34.4912	0	5.4167	1	1466
25.666	34.4834	1	5.4176	0	1466
26.533	34.4738	0	5.4175	0	1466
27.522	34.4640	0	5.4169	0	1510
28.370	34.4646	2	5.4155	2	1553
29.536	34.4457	0	5.4150	0	1560
30.381	34.4358	0	5.4151	0	1560
33.764	34.3962	0	5.4116	0	1560
34.483	34.3879	0	5.4074	0	1560
39.485	34.3520	0	5.4139	0	1560

MARKER 11 FROM NEW GILBERT

24.688	345.2078	0	4.0817	0	1520
24.833	345.1897	1			1520
25.317	345.1335	1			1520
25.676	345.0916	0	4.0872	0	1520
25.890	345.0685	1	4.0882	0	1650
26.385	345.0067	1	4.0927	0	1650
26.688	344.9716	0			1650
26.865	344.9446	2			1650
27.385	344.8892	2	4.0979	0	1650
27.519	344.8722	0			1650
27.654	344.8596	0			1650
27.792	344.8430	1			1760
27.898	344.8311	0			1760
28.373	344.7749	0	4.1065	0	1760
29.406	344.6554	1	4.1121	0	1760
30.367	344.5522	1	4.1186	0	1760
31.499	344.4205	1	4.1253	0	1760
33.385	344.1356	1	4.1360	0	1760
33.596	344.1015	1	4.1335	0	1500
34.610	343.9784	0	4.1402	0	1500
36.707	343.7655	2	4.1504	1	1450
38.876	343.5236	2	4.1619	1	1310
39.488	343.4547	2	4.1671	1	1310
41.383	343.2611	1	4.1846	0	1750
43.456	343.0473	1	4.1981	0	1560
44.393	342.9548	0	4.2045	0	1620
45.364	342.8508	0	4.2093	1	1620
46.354	342.7398	1	4.2140	0	1620
47.386	342.6256	2	4.2204	0	1620
48.354	342.5245	1	4.2249	0	1620

MARKER 11 FROM NEW QUICKIE

24.658	33.1292	0	5.0655	1	1466
25.663	33.1252	1	5.0644	0	1466
26.532	33.1212	0	5.0592	0	1466
27.520	33.1113	1	5.0537	0	1510
28.367	33.1198	2	5.0514	2	1553
29.544	33.1134	1	5.0484	0	1560
30.387	33.1035	0	5.0466	0	1560
33.753	33.0872	1	5.0354	1	1560
34.481	33.0798	0	5.0330	1	1560

MARKER 12 FROM NEW GILBERT

24.690	341.0571	0	4.3142	0	1520
24.834	341.0367	1			1520
25.318	340.9742	1			1520
25.678	340.9267	0	4.3216	0	1520
25.893	340.8979	1	4.3268	0	1650
26.387	340.8314	1	4.3311	0	1650
26.690	340.7937	0			1650
26.871	340.7629	2			1650

MARKER 12 FROM NEW QUICKIE

24.660	31.8110	0	4.9099	1	1466
25.660	31.8088	1	4.9075	0	1466
26.531	31.8043	0	4.9114	0	1466
27.506	31.8037	1	4.9034	0	1510
28.353	31.8030	2	4.9012	2	1553
29.547	31.8063	0	4.9000	0	1560
30.388	31.7904	0	4.8986	0	1560
34.475	31.7684	0	4.8863	1	1560

MARKER 13 FROM NEW GILBERT

25.440	391.8712	1	1.3877	1	1520
25.905	391.8714	1	1.3838	0	1650
26.408	391.8684	1	1.3868	0	1650
27.403	391.8651	2	1.3853	0	1650
28.383	391.8587	0	1.3888	0	1760
29.479	391.8547	0	1.3888	0	1760
30.379	391.8522	1	1.3907	0	1760
33.408	391.8334	1	1.3899	0	1760

 $i \quad \theta \quad K_\theta \quad \phi \quad K_\phi \quad h$

MARKER 13 FROM NEW GILBERT (cont.)

33.649	391.8319	0	1.3924	0	1500
34.628	391.8287	0	1.3931	0	1500
36.697	391.8224	1	1.3928	0	1450
39.488	391.8082	2	1.3928	1	1310
41.397	391.8055	0	1.3982	0	1750
43.454	391.8028	1	1.3968	1	1560
44.406	391.7963	1	1.4008	0	1620
45.374	391.7939	0	1.4007	0	1620
46.363	391.7894	1	1.4000	0	1620
47.397	391.7876	1	1.4040	0	1620
48.353	391.7840	1	1.4015	0	1620

MARKER 13 FROM NEW QUICKIE

25.432	102.0918	0	15.8804	0	1466
25.774	102.0593	1	15.8814	1	1466
25.910	102.0484	0	15.8826	0	1466
26.294	102.0127	0	15.8817	0	1466
26.442	101.9997	0	15.8855	0	1466
26.608	101.9844	0	15.8839	0	1466
26.740	101.9704	1	15.8850	0	1466
26.753	101.9762	0	15.8852	0	1466
26.902	101.9572	0	15.8849	0	1466
27.299	101.9203	0	15.8884	0	1510
27.440	101.9077	0	15.8886	0	1510
27.649	101.8914	0	15.8898	0	1510
27.766	101.8887	2	15.8897	2	1510
27.874	101.8666	2	15.8896	2	1510
28.392	101.8217	0	15.8921	0	1553
28.469	101.8234	0	15.8917	0	1553
28.587	101.8049	0	15.8920	0	1553
28.733	101.7928	0	15.8906	0	1553
28.875	101.8049	0	15.8929	0	1553
29.321	101.7445	1	15.8942	0	1560
29.501	101.7196	0	15.8940	0	1560
29.629	101.7085	1	15.8955	0	1560
29.765	101.7004	1	15.8947	0	1560
29.872	101.6880	1	15.8963	0	1560
30.363	101.6370	0	15.8949	0	1560
30.520	101.6191	1	15.8966	0	1560
31.547	101.5339	2	15.8975	0	1560
33.471	101.2259	0	15.8973	0	1560
33.583	101.2121	0	15.9022	1	1560
33.672	101.2087	0	15.8991	0	1560
33.878	101.1773	0	15.9025	0	1560
34.346	101.1390	0	15.9006	0	1560
34.503	101.1256	0	15.9021	0	1560
34.622	101.1202	0	15.9044	0	1560
34.767	101.1082	0	15.9028	0	1560
34.873	101.1025	0	15.9053	0	1560
35.342	101.0751	1	15.9093	1	1560
35.479	101.0702	1	15.9065	0	1560
35.619	101.0582	0	15.9069	0	1560
36.709	100.9980	0	15.9080	0	1560
36.871	100.9817	0	15.9090	0	1560
39.360	100.7874	0	15.9116	0	1560
39.470	100.7849	0	15.9120	0	1560

MARKER 14 FROM NEW GILBERT

25.438	381.2745	1	1.0136	1	1520
26.415	381.2629	0	1.0166	0	1650
27.405	381.2562	2	1.0139	0	1650
28.384	381.2442	0	1.0325	0	1760
29.480	381.2339	0	1.0215	0	1760
30.378	381.2264	1	1.0232	0	1760
25.438	102.1683	0	7.2097	0	1466
25.781	102.1338	1	7.2076	1	1466
25.913	102.1240	0	7.2140	0	1466
26.297	102.0896	0	7.2162	0	1466
26.444	102.0762	0	7.2156	0	1466
26.613	102.0611	0	7.2166	1	1466
26.743	102.0454	1	7.2168	0	1466
26.757	102.0477	0	7.2174	0	1466
26.904	102.0326	0	7.2168	0	1466
27.301	101.9973	0	7.2216	0	1510
27.442	101.9856	0	7.2223	0	1510
27.644	101.9692	0	7.2245	0	1510
27.769					

\hat{t} $\hat{\theta}$ K_θ ϕ K_ϕ h

MARKER 17 FROM NEW GILBERT

24.714	332.2609	0	4.1610	1	1520
24.837	332.2393	1			1520
25.321	332.1694	1			1520
25.690	332.1133	1	4.1700	1	1520
25.895	332.0823	1	4.1742	0	1650
26.392	332.0045	1	4.1811	0	1650
26.688	331.9607	1			1650
26.871	331.9296	2			1650
27.393	331.8510	2	4.1907	0	1650
27.524	331.8299	0			1650
27.658	331.8135	0			1650
27.796	331.7919	1			1760
27.900	331.7749	0			1760
28.368	331.7027	0	4.2057	0	1760
28.519	331.6802	0			1760
28.637	331.6634	0			1760
28.760	331.6476	0			1760
28.881	331.6274	0			1760
29.399	331.5483	1	4.2231	0	1760
29.507	331.5305	0			1760
29.632	331.5108	0			1760
29.761	331.4907	0			1760
29.885	331.4703	0			1760
30.370	331.3925	1	4.2439	0	1760
30.590	331.3551	2			1760
30.630	331.3504	0			1760
30.752	331.3295	0	4.2439	0	1760

MARKER 17 FROM NEW QUICKIE

24.628	35.4431	0	4.6262	1	1466
25.649	35.4232	0	4.6283	0	1466
26.527	35.4027	0	4.6267	0	1466
27.509	35.3824	0	4.6288	0	1510
28.363	35.3494	3	4.6290	2	1553

MARKER 18 FROM NEW QUICKIE

24.625	31.9380	0	4.7001	0	1466
25.645	31.9300	1	4.6956	1	1466
26.526	31.9185	0	4.6936	0	1466
27.503	31.9091	1	4.6896	0	1510
28.351	31.9043	3	4.6873	2	1553
29.546	31.8953	0	4.6813	0	1560
30.389	31.8758	0	4.6854	0	1560
34.473	31.8150	0	4.6841	0	1560

MARKER 19 FROM NEW GILBERT

24.716	333.1033	0	5.1200	1	1520
24.839	333.0803	1			1520
25.322	332.9964	1			1520
25.692	332.9304	1	5.1295	1	1520
25.897	332.8959	1	5.1370	0	1650
26.393	332.8089	1	5.1440	0	1650
26.689	332.7547	1			1650
26.872	332.7610	2			1650
27.395	332.6350	2	5.1592	0	1650
27.526	332.6124	0			1650
27.659	332.5933	0			1650
27.797	332.5673	1			1760
27.901	332.5620	0			1760
28.376	332.4657	0	5.1737	0	1760
28.519	332.4444	0			1760
28.762	332.4082	0			1760
28.881	332.3837	0			1760
29.400	332.2999	1	5.1889	0	1760
29.508	332.2815	0			1760
29.633	332.2605	0			1760
29.762	332.2386	0			1760
29.887	332.2165	0			1760
30.372	332.1347	1	5.2026	0	1760
30.592	332.0966	2			1760
30.631	332.0933	0			1760
30.753	332.0693	0			1760
31.502	331.9385	1	5.2179	0	1760
33.378	331.5217	1	5.2537	0	1760
33.606	331.4742	1	5.2545	0	1500
33.721	331.4524	0			1500
33.837	331.4296	0			1500
34.340	331.3340	1			1500
34.468	331.3160	0			1500
34.617	331.2919	0	5.2708	0	1500
34.719	331.2741	0			1500
34.839	331.2531	0			1450
35.346	331.1746	0			1450

\hat{t} $\hat{\theta}$ K_θ ϕ K_ϕ h

MARKER 19 FROM NEW GILBERT (cont.)

35.467	331.1586	2			1450
36.659	330.9835	1			1450
36.799	330.9639	0	5.3003	0	1450
38.841	330.6349	1	5.3304	1	1310
39.340	330.5554	0			1310
39.481	330.5322	2	5.3408	2	1310
39.601	330.5194	0			1310
39.722	330.4997	0			1310
40.346	330.4081	2			1310
40.701	330.3516	0			1750
40.835	330.3338	1			1750
41.384	330.2502	0	5.3779	0	1750
41.558	330.2253	0			1750
41.685	330.2078	1			1750
41.806	330.1921	0			1750
42.517	330.0890	0			1750
42.809	330.0471	3			1750
43.458	329.9506	1	5.4090	0	1560
43.560	329.9411	1			1560
43.707	329.9196	1			1620
43.803	329.9059	1			1620
44.396	329.8189	1	5.4211	0	1620
44.476	329.8060	1			1620
44.604	329.7888	1			1620
44.725	329.7711	0			1620
44.836	329.7551	0			1620
45.365	329.6731	0	5.4392	0	1620
45.469	329.6537	1			1620
45.592	329.6385	1			1620

\hat{t} $\hat{\theta}$ K_θ ϕ K_ϕ h

MARKER 20 FROM NEW GILBERT (cont.)

39.483	331.8693	2	5.8176	1	1310
39.602	331.8615	0			1310
39.724	331.8492	0			1310
40.347	331.7781	2			1310
40.704	331.7428	0			1750
40.836	331.7347	1			1750
41.385	331.6786	0	5.8515	0	1750
41.559	331.6612	0			1750
41.686	331.6489	1			1750
41.806	331.6380	0			1750

MARKER 20 FROM NEW QUICKIE

24.605	24.9106	0	4.8117	0	1466
25.640	24.9198	0	4.8171	1	1466
26.522	24.9292	0	4.8176	0	1466
27.498	24.9394	1	4.8206	0	1510
28.346	24.9455	2	4.8213	2	1553
29.556	24.9639	0	4.8296	0	1560
30.393	24.9675	0	4.8282	0	1560

MARKER 21 FROM NEW GILBERT

21.726	361.0543	0	2.2046	0	1520
24.739	360.9665	0	2.2182	0	1520
24.846	360.9644	1			1520
25.326	360.9523	1			1520
25.901	360.9364	1	2.2218	0	1650
26.405	360.9204	1	2.2214	0	1650
27.399	360.8939	1	2.2256	0	1650
28.379	360.8675	0	2.2308	0	1760
29.440	360.8400	1	2.2367	0	1760
30.376	360.8120	1	2.2386	0	1760
31.508	360.7789	1	2.2453	0	1760
33.404	360.7055	1	2.2520	0	1760
33.613	360.6965	0	2.2504	0	1500
34.624	360.6704	0	2.2558	0	1500
36.738	360.6251	1	2.2635	0	1450
38.884	360.5726	2	2.2707	1	1310
39.485	360.5579	1	2.2748	1	1310
41.388	360.5187	0	2.2893	0	1750
43.449	360.4707	1	2.2997	0	1560
44.402	360.4538	1	2.3027	0	1620
45.371	360.4313	0	2.3061	0	1620
46.360	360.4086	1	2.3099	0	1620
47.390	360.3844	1	2.3137	0	1620
48.350	360.3597	1	2.3180	0	1620

MARKER 21 FROM NEW QUICKIE

21.724	55.1703	0	5.6040	0	1466
23.479	55.1061	0	5.6046	0	1466
24.892	55.0504	0	5.6041	0	1466
25.797	55.0174	0	5.6044	0	1466
27.529	54.95				

Appendix 2. Laser-measured distances to marker 11.

The time shown \hat{t} is 200 less than the 1984 Julian Day, which is 214.0000 at 0000 hours on August 1, 1984 and increases by 1 each day thereafter. The actual measured distance \hat{r} and the distance r adjusted for variation in atmospheric density are both 3 km more than the value that is given here in mm. Adjusted values for the first four readings are absent because of the unavailability of meteorological data then.

\hat{t}	\hat{r}	r												
21.5729	818739		25.5521	779850	779837	26.2708	772882	772854	27.0521	765347	765318	28.1146	755488	755455
21.5833	818639		25.5625	779742	779729	26.3028	772575	772548	27.0729	765165	765135	28.1250	755401	755368
21.6049	818435		25.5840	779557	779545	26.3229	772365	772340	27.0938	764948	764917	28.1354	755309	755276
21.7069	817399		25.5944	779444	779433	26.3333	772268	772243	27.1042	764873	764841	28.1458	755220	755187
24.7292	787755	787733	25.6042	779351	779341	26.3438	772171	772147	27.1146	764767	764735	28.1563	755128	755094
24.7403	787640	787618	25.6146	779249	779239	26.3542	772074	772051	27.1250	764695	764663	28.1667	755038	755004
24.7500	787541	787518	25.6250	779145	779136	26.3646	771970	771948	27.1354	764602	764570	28.1771	754948	754914
24.7604	787440	787417	25.6354	779038	779029	26.3750	771864	771843	27.1458	764509	764477	28.1875	754858	754824
24.7708	787336	787312	25.6458	778953	778944	26.3958	771663	771643	27.1563	764417	764385	28.1979	754766	754732
24.7813	787212	787188	25.6563	778858	778850	26.4063	771556	771536	27.1771	764229	764197	28.2083	754675	754641
24.7931	787100	787076	25.6667	778730	778722	26.4167	771460	771441	27.1875	764134	764102	28.2188	754589	754555
24.8021	787015	786990	25.6771	778655	778647	26.4271	771377	771358	27.1979	764048	764016	28.2292	754495	754462
24.8125	786916	786891	25.6875	778535	778527	26.4375	771269	771250	27.2083	763949	763917	28.2396	754403	754370
24.8333	786690	786664	25.6979	778452	778444	26.4479	771163	771145	27.2292	763749	763718	28.2500	754316	754283
24.8438	786585	786559	25.7188	778228	778220	26.4688	770964	770946	27.2396	763649	763618	28.2604	754219	754187
24.8542	786474	786448	25.7292	778137	778129	26.4792	770869	770851	27.2500	763552	763522	28.2708	754133	754101
24.8854	786158	786132	25.7396	778006	777998	26.4896	770759	770741	27.2708	763352	763322	28.2813	754038	754006
24.8958	786054	786028	25.7500	777915	777906	26.5000	770673	770656	27.2813	763268	763239	28.2917	753945	753914
24.9174	785842	785816	25.7604	777804	777795	26.5313	770370	770354	27.3021	763077	763049	28.3021	753863	753832
24.9271	785755	785729	25.7708	777680	777670	26.5417	770265	770249	27.3125	762986	762958	28.3542	753386	753357
24.9583	785451	785425	25.7813	777593	777583	26.5625	770074	770058	27.3229	762892	762864	28.3750	753196	753168
24.9688	785334	785307	25.8854	776536	776518	26.5729	769989	769974	27.3333	762779	762752	28.3854	753096	753069
24.9792	785237	785210	25.8958	776444	776425	26.5833	769880	769865	27.3438	762698	762671	28.3958	753008	752981
25.0104	784948	784921	25.9063	776343	776323	26.5938	769788	769773	27.3542	762590	762563	28.4063	752906	752880
25.0208	784855	784828	25.9167	776226	776205	26.6042	769692	769678	27.3646	762490	762463	28.4167	752820	752794
25.0417	784659	784632	25.9271	776127	776105	26.6153	769595	769581	27.5965	760349	760327	28.4271	752746	752721
25.0521	784574	784546	25.9375	776024	776002	26.6250	769498	769485	27.6424	759942	759921	28.4479	752540	752516
25.0625	784479	784451	25.9479	775920	775897	26.6354	769401	769388	27.7160	759240	759219	28.4583	752449	752426
25.0833	784286	784257	25.9583	775834	775811	26.6458	769290	769278	27.7382	759027	759005	28.4688	752348	752325
25.0938	784190	784161	25.9792	775619	775595	26.6667	769090	769079	27.7611	758812	758789	28.4896	752141	752119
25.1250	783887	783857	25.9903	775530	775505	26.6771	768997	768986	27.7861	758559	758535	28.5000	752049	752028
25.1354	783798	783769	26.0000	775429	775404	26.6986	768786	768775	27.8132	758315	758289	28.5208	751861	751840
25.1667	783499	783470	26.0313	775145	775119	26.7083	768697	768686	27.8854	757615	757586	28.5313	751762	751741
25.1771	783398	783369	26.0417	775046	775020	26.7188	768586	768575	27.8958	757496	757467	28.5417	751687	751666
25.2083	783125	783098	26.0521	774936	774910	26.8333	767444	767425	27.9063	757403	757374	28.5521	751586	751565
25.2188	783011	782985	26.0625	774846	774820	26.8438	767357	767337	27.9167	757305	757275	28.5736	751391	751370
25.2500	782722	782698	26.0729	774731	774704	26.8542	767247	767226	27.9271	757206	757176	28.5944	751201	751180
25.2604	782618	782594	26.0833	774644	774617	26.8646	767152	767130	27.9375	757106	757075	28.6042	751110	751090
25.2917	782336	782314	26.0938	774541	774514	26.8750	767024	767001	27.9479	757010	756979	28.6146	751009	750989
25.3021	782236	782215	26.1042	774440	774413	26.8854	766947	766924	27.9583	756904	756873	28.6250	750921	750901
25.3333	781929	781909	26.1146	774344	774317	26.8958	766847	766823	27.9688	756809	756777	28.6354	750826	750806
25.4063	781220	781203	26.1250	774260	774232	26.9063	766741	766717	27.9792	756708	756676	28.6563	750639	750620
25.4167	781119	781102	26.1354	774154	774126	26.9167	766646	766621	27.9896	756613	756581	28.6667	750549	750531
25.4271	781022	781006	26.1458	774078	774050	26.9271	766539	766514	28.0000	756523	756491	28.6771	750451	750433
25.4375	780922	780906	26.1563	773963	773934	26.9375	766440	766415	28.0104	756414	756382	28.6875	750362	750344
25.4479	780822	780807	26.1667	773855	773826	26.9590	766223	766197	28.0208	756329	756297	28.6979	750265	750247
25.4583	780723	780708	26.1778	773767	773738	26.9688	766142	766116	28.0313	756233	756201	29.4479	743372	743345
25.4688	780622	780607	26.1875	773689	773660	26.9792	766023	765997	28.0417	756144	756112	29.4583	743280	743254
25.4792	780532	780517	26.1979	773575	773546	26.9896	765930	765904	28.0521	756051	756019	29.4792	743085	743059
25.4896	780426	780411	26.2083	773464	773435	27.0000	765842	765815	28.0625	755954	755922	29.4896	743003	742978
25.5000	780324	780309	26.2188	773371	773342	27.0104	765749	765727	28.0729	755852	755820	29.5000	742915	742890
25.5104	780228	780214	26.2292	773260	773231	27.0208	765638	765610	28.0833	755755	755722	29.5792	742175	742150
25.5215	780131	780117	26.2396	773179	773150	27.0313	765542	765514	28.0938	755670	755637	29.5938	742037	742011
25.5313	780043	780029	26.2500	773059	773030	27.0417	765454	765425	28.1042	755588	755555	29.6042	741939	741913

\hat{t}	\hat{r}	r	\hat{t}	\hat{r}	r	\hat{t}	\hat{r}	r												
29.6153	741844	741818	30.5833	732910	732882	33.3854	701105	701076	34.5313	689228	689200	35.5625	680491	680464						
29.6257	741753	741727	30.5938	732803	732775	33.3958	700970	700941	34.5417	689138	689111	35.5729	680408	680381						
29.6361	741658	741632	30.6042	732724	732696	33.4063	700867	700839	34.5521	689023	688996	35.5833	680317	680290						
29.6465	741572	741546	30.6146	732631	732603	33.4167	700731	700703	34.5729	688837	688810	35.5938	680248	680222						
29.6563	741474	741448	30.6250	732525	732496	33.4271	700613	700585	34.5833	688734	688707	35.6042	680156	680130						
29.6671	741283	741257	30.6354	732439	732410	33.4375	700483	700455	34.5938	688631	688604	35.6146	680062	680036						
29.6875	741181	741155	30.6679	731883	731854	33.4479	700375	700347	34.6042	688542	688515	35.6250	679995	679969						
29.6979	741092	741066	30.7083	731789	731760	33.4583	700257	700229	34.6146	688452	688425	35.6354	679903	679877						
29.7083	741012	740986	30.7188	731708	731679	33.4688	700125	700098	34.6250	688347	688320	35.6458	679819	679793						
29.7326	740778	740752	30.7292	731615	731587	33.4792	700013	699986	34.6354	688262	688235	35.6563	679745	679719						
29.7347	740760	740734	30.7396	731524	731496	33.4896	699875	699848	34.6458	688166	688139	35.6667	679660	679634						
29.7396	740697	740671	30.7500	731428	731400	33.5000	699781	699754	34.6563	688059	688031	35.6771	679575	679549						
29.7500	740608	740581	30.7604	731321	731293	33.5104	699639	699612	34.6667	687966	687938	35.6875	679473	679447						
29.7604	740512	740485	30.7708	731238	731210	33.5208	699530	699503	34.6771	687881	687853	35.7083	679324	679297						
29.7708	740418	740391	30.7813	731133	731105	33.5313	699391	699365	34.6875	687787	687759	35.7188	679223	679196						
29.7813	740317	740290	30.7924	731038	731010	33.5417	699277	699251	34.6979	687693	687665	35.7396	679054	679026						
29.7917	740223	740195	30.8033	730676	730649	33.5521	699163	699137	34.7083	687597	687568	35.7500	678981	678953						
29.8021	740125	740097	30.8054	730484	730457	33.5625	699038	699012	34.7188	687510	687481	35.7604	678900	678872						
29.8125	740024	739996	30.8646	730391	730364	33.5729	698931	698905	34.7292	687401	687371	35.7917	678642	678613						
29.8229	739992	739900	30.8750	730294	730267	33.5938	698693	698667	34.7396	687334	687304	35.8021	678548	678519						
29.8333	739840	739812	30.8854	730197	730170	33.6042	698563	698537	34.7500	687241	687211	35.8229	678400	678371						
29.8542	739633	739604	30.9375	729712	729685	33.6146	698458	698432	34.7604	687141	687110	36.4063	673724	673693						
29.8646	739535	739506	30.9479	729613	729586	33.6250	698333	698307	34.7708	687072	687041	36.5000	673015	672990						
29.8750	739439	739410	31.0104	729019	728991	33.6354	698213	698186	34.7813	686974	686943	36.5104	672941	672917						
29.8854	739331	739302	31.0313	728825	728797	33.6458	698082	698055	34.7917	686889	686857	36.5208	672858	672835						
29.8958	739232	739203	31.0521	728624	728596	33.6563	697984	697957	34.8021	686788	686757	36.5313	672770	672748						
29.9063	739141	739112	31.0625	728518	728491	33.6667	697851	697824	34.8229	686605	686573	36.5417	672695	672673						
29.9167	739031	739002	31.0729	728423	728396	33.6771	697745	697718	34.8333	686528	686496	36.5521	672628	672607						
29.9271	738934	738906	31.1250	727945	727920	33.6875	697633	697605	34.8438	686437	686406	36.5625	672541	672520						
29.9375	738836	738807	31.1354	727854	727829	33.6979	697573	697499	34.8542	686352	686321	36.5729	672473	672453						
29.9479	738719	738690	31.1563	727659	727634	33.7083	697400	697372	34.8646	686267	686236	36.5833	672373	672354						
29.9583	738625	738596	31.1667	727568	727544	33.7188	697281	697252	34.8750	686168	686137	36.5938	672282	672263						
29.9688	738532	738503	31.4278	725143	725121	33.7292	697161	697132	34.8854	686074	686043	36.6042	672201	672182						
29.9792	738427	738398	31.4792	724617	724595	33.7500	696947	696917	34.8958	685985	685955	36.6146	672121	672102						
29.9896	738327	738298	31.4896	724515	724493	33.7604	696831	696801	34.9063	685899	685869	36.6250	672044	672025						
30.0000	738226	738197	31.5000	724414	724392	33.7708	696733	696702	34.9167	685825	685796	36.6458	671887	671868						
30.0104	738127	738098	31.5104	724301	724279	33.7813	696618	696587	34.9271	685739	685710	36.6563	671804	671785						
30.0208	738031	738002	31.5417	723994	723971	33.7917	696496	696465	34.9375	685634	685605	36.6667	671706	671687						
30.0313	737928	737899	31.5521	723899	723876	33.8021	696373	696341	34.9479	685553	685524	36.6771	671637	671618						
30.0417	737837	737808	31.5625	723785	723762	33.8125	696274	696242	34.9583	685455	685426	36.6875	671540	671520						
30.0521	737741	737712	31.5833	723581	723559	33.8229	696170	696137	34.9688	685385	685356	36.6979	671476	671456						
30.0625	737642	737613	31.6458	722973	722952	33.8333	696051	696018	34.9792	685296	685267	36.7083	671385	671365						
30.0729	737544	737515	31.6667	722770	722749	33.8438	695947	695914	34.9896	685208	685179	36.7188	671293	671272						
30.0833	737449	737420	31.6771	722652	722631	33.8542	695834	695801	35.0000	685125	685095	36.7292	671220	671199						
30.0938	737356	737327	31.6875	722561	722540	33.8646	695722	695688	35.0104	685034	685004	36.7396	671128	671106						
30.1042	737263	737234	31.6979	722468	722447	33.8750	695620	695586	35.0208	684957	684927	36.7500	671054	671032						
30.1146	737165	737136	31.7708	721717	721695	33.8854	695514	695480	35.0313	684855	684825	36.7604	670965	670943						
30.1250	737071	737041	31.7813	721627	721604	33.8958	695399	695365	35.0417	684767	684738	36.7708	670877	670854						
30.1354	736979	736949	31.8125	721309	721286	33.9063	695286	695251	35.0521	684678	684648	36.7813	670802	670779						
30.1458	736880	736850	31.8229	721211	721188	33.9167	695174	695140	35.0625	684578	684549	36.7917	670717	670693						
30.1563	736786	736756	31.8333	721096	721073	33.9271	695076	695041	35.0729	684493	684464	36.8021	670640	670616						
30.1667	736692	736662	31.8438	720973	720950	33.9375	694956	694921	35.0833	684402	684374	36.8125	670549	670525						
30.1771	736594	736564	31.8646	720765	720742	33.9479	694859	694824	35.0938	684323	684295	36.8229	670479	670454						
30.1875	736502	736473	31.8757	720649	720627	33.9583	694748	694713	35.1042	684231	684204	36.8333	670397	670372						
30.1979	736409	736379	31.8958	720435	720413	33.9688	694641	694606	35.1146	684135	684109	36.8438	670320	670295						
30.208																				

37. 2396	667254	667227	39. 4896	646765	646764	40. 8333	635419	635394	41. 8750	626971	626936	43. 4063	614637	614613
37. 2500	667181	667154	39. 5104	646596	646595	40. 8438	635318	635293	41. 8854	626881	626845	43. 4167	614555	614531
37. 2604	667076	667049	39. 5313	646426	646425	40. 8542	635234	635208	41. 8958	626791	626755	43. 4271	614457	614432
37. 2708	666999	666973	39. 5417	646345	646343	40. 8750	635045	635018	41. 9063	626697	626661	43. 4375	614366	614341
37. 2813	666909	666883	39. 5938	645917	645913	40. 8854	634956	634929	41. 9167	626614	626577	43. 4479	614281	614256
37. 2917	666837	666811	39. 6042	645809	645804	40. 8958	634878	634850	41. 9271	626541	626504	43. 4583	614191	614166
37. 3021	666742	666716	39. 6146	645727	645722	40. 9063	634787	634759	41. 9375	626450	626413	43. 4688	614116	614091
37. 3125	666657	666631	39. 6250	645658	645652	40. 9167	634692	634663	41. 9479	626367	626330	43. 4792	614019	613994
37. 3229	666580	666555	39. 6354	645573	645567	40. 9271	634594	634565	41. 9583	626272	626235	43. 4896	613941	613916
37. 3333	666502	666477	39. 6458	645470	645464	40. 9375	634513	634484	41. 9688	626173	626136	43. 5000	613863	613839
37. 3438	666418	666394	39. 6563	645395	645389	40. 9479	634424	634394	41. 9792	626086	626049	43. 5111	613768	613744
37. 3542	666327	666303	39. 6667	645294	645289	40. 9583	634344	634314	41. 9896	626013	625976	43. 5208	613695	613671
37. 3646	666243	666219	39. 6771	645209	645204	40. 9688	634261	634231	42. 0000	625931	625894	43. 5313	613594	613571
37. 3854	666078	666055	39. 6875	645124	645119	40. 9792	634174	634143	42. 0104	625843	625806	43. 5417	613514	613491
37. 4063	665913	665892	39. 6979	645025	645020	40. 9896	634088	634057	42. 0208	625766	625729	43. 5521	613421	613398
37. 4271	665753	665733	39. 7083	644932	644927	41. 0000	634012	633980	42. 0313	625686	625648	43. 5625	613345	613322
37. 4375	665668	665649	39. 7188	644857	644852	41. 0104	633921	633889	42. 0417	625603	625565	43. 5729	613265	613243
38. 4896	655669	655667	39. 7292	644749	644744	41. 0208	633840	633808	42. 0521	625521	625483	43. 5833	613176	613154
38. 5000	655587	655585	39. 7396	644650	644645	41. 0313	633761	633728	42. 0625	625434	625396	43. 5938	613096	613074
38. 5104	655487	655485	39. 7500	644569	644564	41. 0417	633673	633640	42. 0729	625354	625315	43. 6042	613015	612994
38. 5417	655205	655203	39. 8958	643255	643244	41. 0521	633599	633566	42. 0833	625275	625236	43. 6146	612934	612913
38. 5625	655006	655004	39. 9063	643166	643155	41. 0625	633509	633475	42. 0938	625203	625164	43. 6250	612854	612833
38. 5833	654820	654819	39. 9167	643070	643058	41. 0729	633444	633410	42. 1042	625128	625089	43. 6354	612794	612773
38. 6042	654619	654618	39. 9271	642982	642969	41. 0833	633361	633327	42. 3125	623255	623240	43. 6458	612698	612677
38. 6250	654416	654416	39. 9375	642898	642885	41. 0938	633280	633246	42. 3229	623437	623403	43. 6563	612627	612605
38. 7813	652929	652930	39. 9479	642793	642780	41. 1042	633205	633171	42. 3333	623339	623306	43. 6667	612538	612516
38. 7917	652833	652834	39. 9583	642720	642706	41. 1146	633114	633080	42. 3438	623266	623234	43. 6771	612474	612452
38. 8021	652720	652720	39. 9896	642454	642439	41. 1250	633037	633003	42. 3542	623170	623139	43. 6875	612364	612342
38. 8125	652620	652620	40. 0104	642294	642278	41. 1354	632961	632927	42. 3646	623087	623056	43. 6979	612292	612269
38. 8229	652511	652510	40. 0521	641956	641939	41. 1458	632880	632845	42. 3750	623005	622975	43. 7083	612204	612181
38. 8333	652434	652433	40. 0625	641881	641864	41. 1563	632796	632762	42. 3854	622920	622891	43. 7188	612116	612092
38. 8438	652310	652308	40. 0729	641789	641772	41. 1667	632728	632694	42. 3958	622833	622805	43. 7292	612043	612019
38. 8542	652229	652227	40. 0833	641718	641700	41. 1771	632641	632607	42. 4063	622740	622713	43. 7396	611959	611935
38. 8646	652124	652121	40. 0938	641633	641615	41. 1875	632558	632524	42. 4167	622651	622624	43. 7500	611879	611854
38. 8750	652043	652040	40. 1042	641549	641531	41. 1979	632480	632446	42. 4271	622573	622547	43. 7604	611794	611769
38. 8958	651831	651827	40. 1146	641472	641454	41. 2083	632392	632357	42. 4375	622486	622461	43. 7708	611700	611674
38. 9063	651737	651732	40. 1250	641388	641369	41. 2188	632317	632282	42. 4479	622393	622368	43. 7813	611635	611609
38. 9167	651647	651641	40. 1354	641306	641287	41. 2292	632227	632192	42. 4583	622301	622277	43. 7917	611538	611512
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38. 9375	651482	651475	40. 1563	641145	641126	41. 2500	632072	632037	42. 4792	622127	622103	43. 8125	611368	611341
38. 9479	651393	651385	40. 1667	641056	641037	41. 2604	631982	631947	42. 4896	622051	622028	43. 8229	611276	611249
38. 9583	651297	651288	40. 1771	640973	640954	41. 2708	631880	631845	42. 5000	621971	621947	43. 8333	611179	611152
38. 9688	651227	651218	40. 1875	640887	640868	41. 2917	631719	631685	42. 5104	621887	621864	43. 8438	611083	611056
38. 9792	651125	651115	40. 1979	640806	640787	41. 3229	631464	631431	42. 5208	621810	621787	43. 8542	611023	610996
38. 9896	651042	651031	40. 2083	640713	640694	41. 3438	631278	631246	42. 5313	621719	621696	43. 8646	610911	610884
39. 0000	650953	650942	40. 2188	640635	640616	41. 3542	631185	631153	42. 5417	621640	621616	43. 8750	610836	610809
39. 0104	650853	650842	40. 2396	640452	640433	41. 3646	631105	631074	42. 5521	621534	621510	43. 8854	610740	610713
39. 0208	650787	650775	40. 2500	640362	640344	41. 3750	631024	630993	42. 5625	621464	621440	43. 8958	610647	610620
39. 0313	650695	650683	40. 2604	640272	640254	41. 3854	630902	630889	42. 5729	621398	621374	43. 9063	610565	610529
39. 0417	650614	650602	40. 2708	640189	640171	41. 3958	630835	630805	42. 5833	621311	621287	43. 9167	610451	610424
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39. 0625	650439	650426	40. 3021	639919	639902	41. 4271	630578	630549	42. 6146	621074	621050	43. 9375	610272	610244
39. 0729	650350	650337	40. 3125	639830	639813	41. 4375	630481	630452	42. 6250	620997	620973	43. 9479	610185	610156
39. 0833	650257	650243	40. 3229	639747	639731	41. 4479	630408	630379	42. 6354	620909	620885	43. 9583	610082	610053
39. 0938	650180	650166	40. 3333	639650	639634	41. 4583	630317	630288	42. 6458	620817	620793	43. 9688	609999	609969
39. 1042	650088	650074	40. 3438	639555	639539	41. 4688	630240	630211	42. 6563	620746	620722	43. 9792	609908	609878
39. 1146	650000	649985	40. 3542	639462	639446	41. 4792	630153	630125	42. 6667	620654	620630	43. 9896	609808	609777
39. 1250	649908	649893	40. 3646	639357	639341	41. 4896	630061	630033	42. 6771	620581	620557	44. 0000	609722	609690
39. 1354	649825	649810	40. 3750	639272	639256	41. 5000	629991	629963	42. 6875	620505	620481	44. 0104	609640	609608
39. 1458	649740	649724	40. 3854	639197	639181	41. 5104	629912	629884	42. 6979	620411	620387	44. 0208	609529	609497
39. 1563	649651	649635	40. 3958	639091	639075	41. 5208	629827	629799	42. 7083	620344	620321	44. 0313	609445	609412
39. 1667	649565	649549	40. 4063	639007	638991	41. 5313	629741	629714	42. 7188	620266	620243	44. 0417	609348	609315
39. 1771	649473	649456	40. 4271	638839	638823	41. 5417	629657	629630	42. 7292	620183	620160	44. 0521	609266	609233
39. 1875	649375	649358	40. 4375	638752	638736	41. 5521	629579	629552	42. 7396	620091	620068	44. 0729	609097	609063
39. 1979	649278	649261	40. 4479	638665	638649	41. 5625	629517	629491	42. 7500	620016	619993	44. 0833	609099	608975
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39. 2188	649092	649074	40. 4792	638398	638383	41. 5833	629363	629337	42. 7708	619850	619826	44. 1042	608841	

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44.3542	606818	606793	45.3021	598691	598660	46.2604	590203	590163	47.2604	581489	581463	48.5417	570256	570235									
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44.5208	605384	605367	45.4792	597175	597148	46.4271	588748	588715	47.4479	579935	579916	48.7097	568764	568747									
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44.9063	602111	602083	45.8646	593833	593799	46.8229	585317	58528															