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1974 ETHIOPIAN RIFT GEODIMETER SURVEY

P. MOHR

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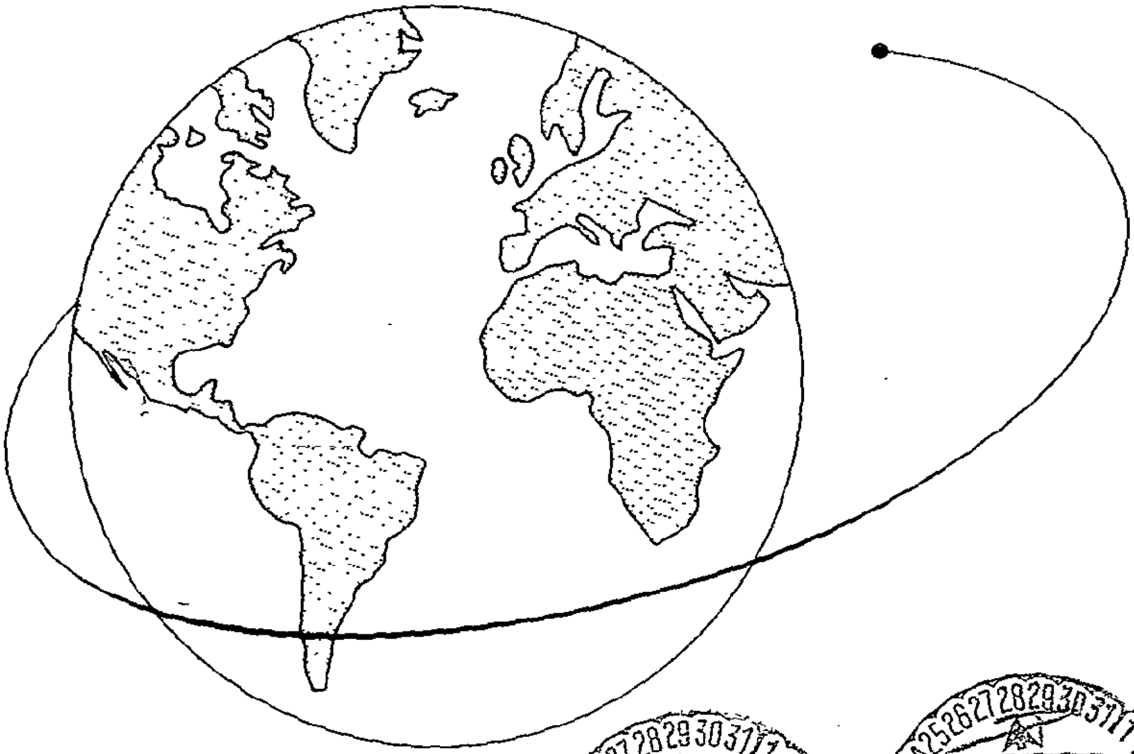

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1974 ETHIOPIAN RIFT GEODIMETER SURVEY

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"The use of statistics in argument is essentially deduction
from insufficient premises" — Hilaire Belloc.

"In explaining obscure matters, imaginary things should
never be postulated as existing" — William of Occam
(version of S. E. Morison)

ABSTRACT

The field techniques and methods of data reduction for five successive geodimeter surveys in the Ethiopian rift valley are enlarged upon, with the considered conclusion that there is progressive accumulation of upper crustal strain, consonant with on-going rift extension. The extension is restricted to the Quaternary volcanotectonic axis of the rift, namely the Wonji fault belt, and is occurring at rates of 3 to 6 mm/yr in the northern sector of the rift valley. Although this concurs with the predictions of plate-tectonic analysis of the Afar triple junction, it is considered premature to endorse such a concurrence on the basis of only 5 years of observations. This is underlined by the detection of local tectonic contractions and expansions associated with geothermal and gravity anomalies in the central sector of the rift valley. There is a hint of a component of dextral slip along some of the rift-floor fault zones, both from geological evidence and from the strain patterns detected in the present geodetic surveys.

1974 ETHIOPIAN RIFT GEODIMETER SURVEY

Paul Mohr

1. INTRODUCTION

A resurvey of the Ethiopian geodimeter networks was undertaken in late 1974, during the same October through December season as for the 1969, 1970, and 1971 surveys; the 1973 survey was singular in being carried out during March and April. Thus, the oldest of the Ethiopian geodimeter lines have been observed over a period of 5 years, perilously short in terms of geodetic studies of crustal deformation. However, with five surveys now complete (see Tables 1 and 2 for some summary information), a great deal has been learned about the behavior, precision, and accuracy of the instruments and the influence of weather conditions on the correction for atmospheric refraction — not to mention the practical experience of organizing and carrying out such surveys both fluently and cheaply, followed by the reduction of the field observations and a never-ending refinement of the least-squares adjustment computations. Yet all this has led to the bonus that we dared hope for at the outset, the detection of progressive motions between stations and new insights into the tectonics of the rift valley in Ethiopia.

The pre-1974 surveys have already been described (Mohr, 1973a, 1974a). This report concentrates on the results and implications of the 1974 survey, designated Project TIKDEM (after the current political slogan of that time and aptly signifying "first" or "best"). During the 1974 survey, the northern and central networks (Figure 1) in the rift valley were remeasured and braced with several new lines between existing stations to improve network geometry. The southern network was not remeasured, as the 1973 survey had

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Table 1. Personnel and statistics for the Ethiopian geodimeter surveys.

Year	Survey	Instrument	Personnel*	Networks measured	Number of lines measured[†]
1969	GEODIS (LELLIT)	Mk6 geodimeter 6756	P. Mohr G. Veis E. Kazakopoulos (Ato Gabreu)	Northern	160
1970	LASER8 (CRACKS)	Mk8 geodimeter 80037	P. Mohr J. Rolff (Ato Girum Mikru) (Ato Gebreberhan Ogubazghi) (Ato Gabreu)	Northern, Central	155
1971	PAPAYA	Mk8 geodimeter 80061	P. Mohr J. Wohn C. Heindel R. Thrall (Ato Girum Mikru)	Northern, Central, Southern	365
1973	AWARRA	Mk8 geodimeter 81006 Ranger 07B 3042	P. Mohr J. Rolff J. Wohn C. Heindel R. Thrall Girum Mikru	Northern, Central, Southern	278
1974	TIKDEM	Mk8 geodimeter 81006	P. Mohr J. Rolff R. Plumb Girum Mikru (Ato Tamrat)	Northern, Central, Afar	514
1976	SHALLA[‡]	Mk8 geodimeter 81006	P. Mohr R. Raynolds (Ato Mikael Tesfaye) (Ato Wondemu)	Northern, Central	176

*Assistant observers' names are in parentheses.

[†] Out of modesty, the statistics on the number of papayas consumed are not included.

[‡] See Postscript, p. 103.

Table 2. Statistics on stations and links in the Ethiopian geodimeter networks at the end of 1974.

Network	Project TIKDEM		Total network	
	New stations	New links	Number of stations	Number of links*
Northern (Adama)	1	17	45	111
Central (Mirrga)	2	4	11	20
Southern (Tosa Sucha)	—	—	7	7
Afar	8	10	8	10
Total	11	31	71	148

514 line measurements
109 main—main lines measured
66 main—auxiliary lines measured

*As defined by Mohr (1974a, p. 27), a link is the general connection between two stations whose specific points (main, auxiliary, etc.) are connected by the actual geodimeter lines.

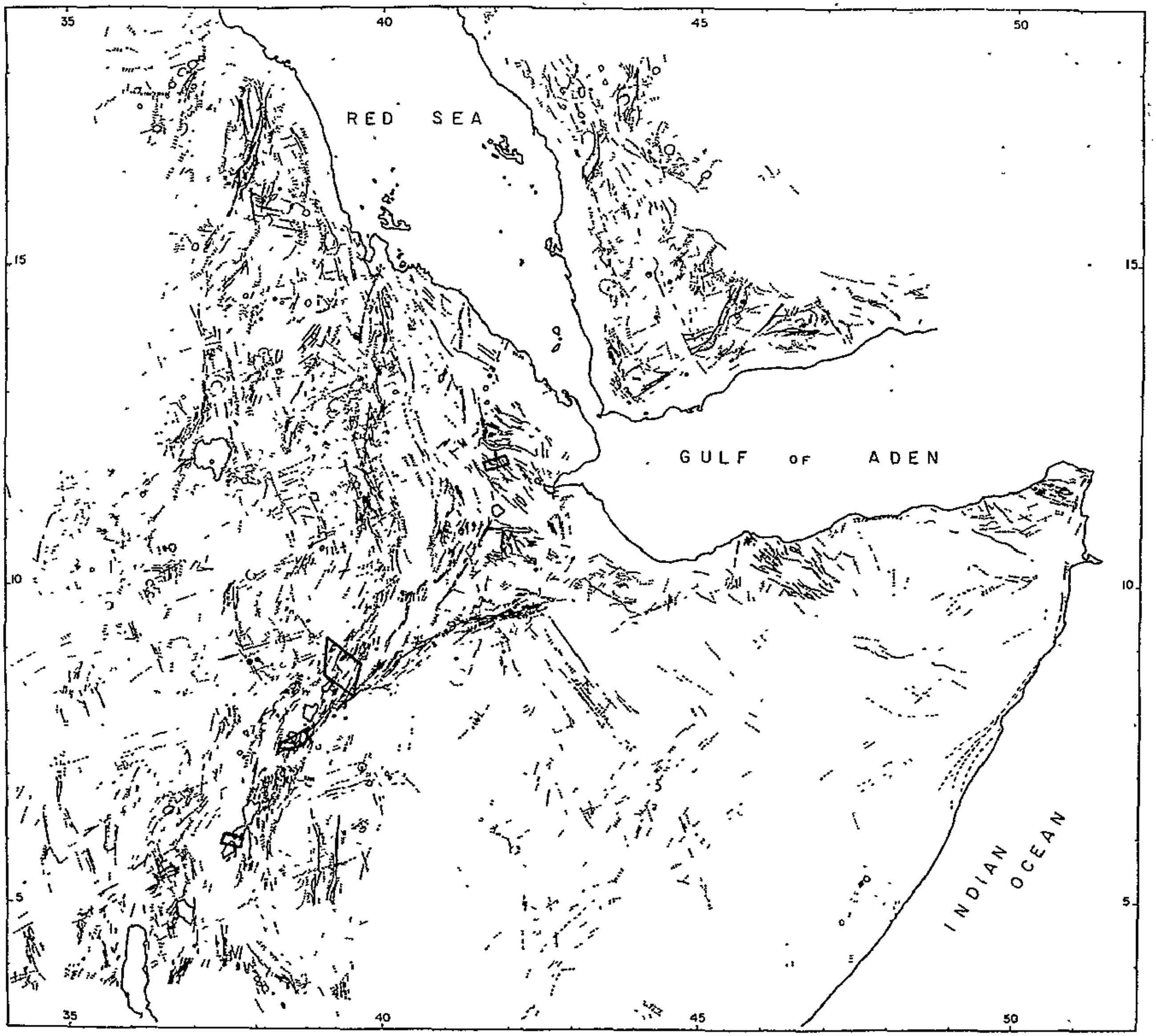

Figure 1. The four Ethiopian rift—Afar geodimeter network areas (outlined in thick trace) and their regional structural setting (Mohr, 1974b).

shown it to be stable since its 1971 inception. Instead, the time was used to install two small nets in central Afar, the well-sung triple junction where the Ethiopian rift, the Red Sea, and the Gulf of Aden spreading lines meet (Figure 1) and where first-order crustal deformation is expected to be an order of magnitude greater than in the Ethiopian rift itself (McKenzie *et al*., 1970; Mohr, 1972; Gouin, 1977).

2. THE PROGRAM

Following the problems encountered with the Smithsonian Astrophysical Observatory's (SAO) geodimeter 81006 during Project AWARRA in spring 1973 (Mohr, 1974a), the instrument was refurbished with a new photomultiplier and control by AGA (Lidingö), and a frequency-monitoring loop was installed by AGA (New Jersey). At the commencement of the 1974 survey, short taped baselines were established for the northern (Adama) and central (Mirrga) networks. Throughout Project TIKDEM, the geodimeter was repeatedly checked by measuring these baselines. This provided only a partial control on instrument consistency; for example, not sought were possible errors due to any varying characteristics across the photomultiplier tube according to the angle of the returning beam, dependent, in turn, on the distance to the retroreflector. It is also regretted that the crystal frequencies were not monitored, lacking a suitable portable frequency counter.

The entire northern (Adama) network was resurveyed in 1974, excepting only the long lines in the southeastern, Sire region (Figure 2), where deteriorating track conditions and the final demise of the Italian bridge over the Kaletta River promised too many bumps for the geodimeter. Several important lines bracing the northern network were installed. These notably included BOKU—WONJI and BOKU—PYLON, requiring vigorous but ecologically localized deforestation on the summit of Gara Boku, GANTI—CINDER, GANTI—AYGU, WONJI—MIETCHI, and THORNS—WONJI. WONJI—RIDGE unfortunately just lacks line of sight, but YELLEM—THORNS and YELLEM—PYLON still look possible with the aid of an axe. The line GALILA—KOKA is now irremediably obscured by luxurious tree growth around the Galila Palace hotel. Lines in the Wolenchiti quadrilateral, forming the northeastern part of the northern network, were repeat-measured at different times of the day during Project TIKDEM to investigate the ground radiation effect in more detail (see Section 3.4). A new station, TCHEESA, was established at the northern end of this quadrilateral (Figure 2),

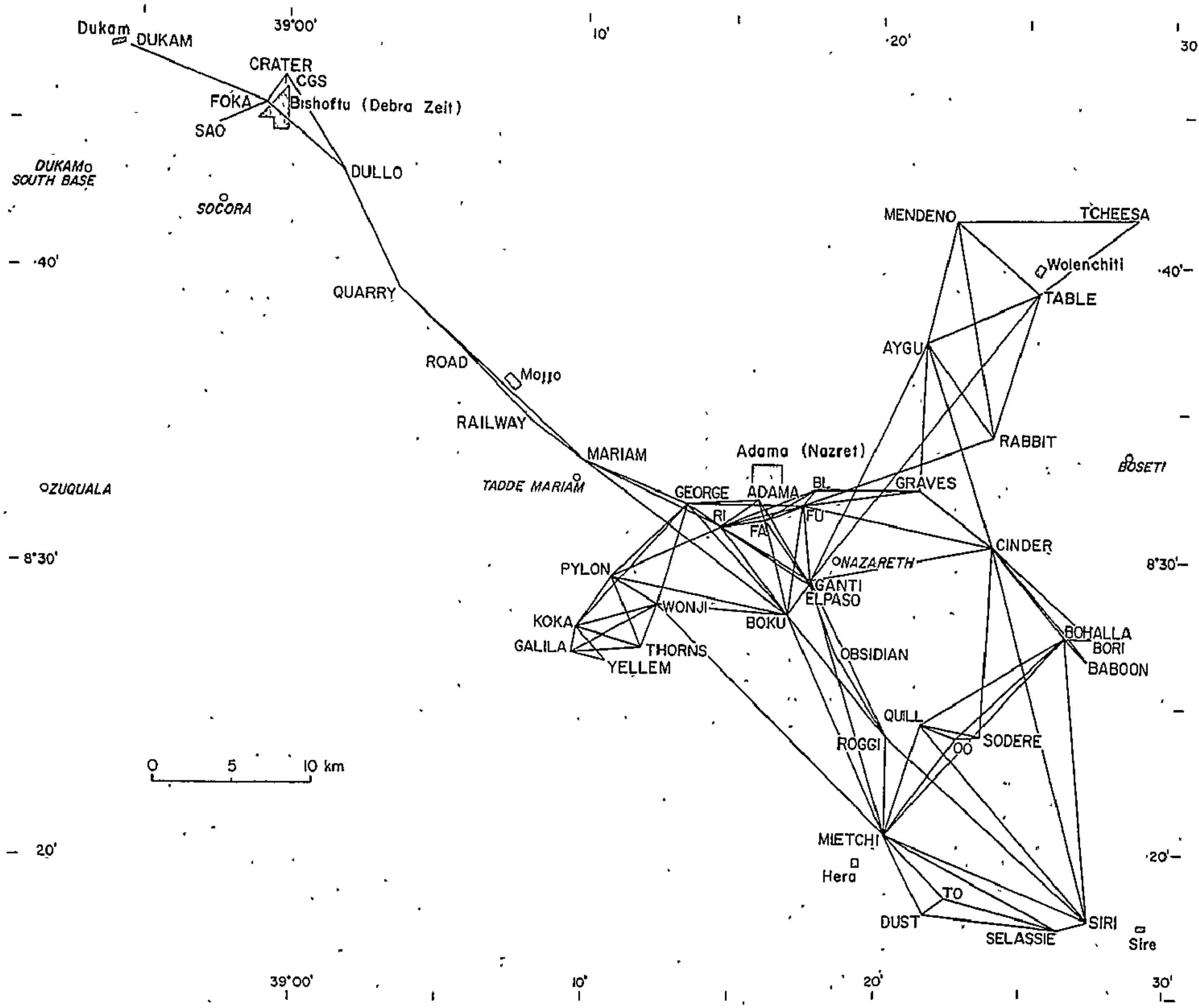

Figure 2. The northern (Adama) network.

on a rholite dome sliced by the young faults of the Wonji fault belt: it has exceptionally fine visibility to the north, where the Ethiopian rift declines into the Afar depression.

The central (Mirrga) network, at latitude 7.5°N, was thoroughly resurveyed in November 1974, most of the lines being repeat-measured on different days. All links interconnecting the seven stations of the southern Mirrga polygon now exist (Figure 3), except GALLA—LANGANA, where acacia trees currently intervene (the alarming rate of local charcoal operations will soon clear this final line of trees). A traverse involving two new stations was made from ARJO, at the southern apex of the Mirrga polygon, west along the Shala caldera's northern rim that forms the land neck between Hora O'a (Lake Shala) and Hora Kunni (Lake Abjata). The southern Mirrga polygon was linked to the northern end of Hora Mirrga (Lake Langano) by two 17-km lines extending the length of the lake.

Early in December 1974, the safari moved down to Afar and warmer climes to establish quadrilaterals across the Guma and Dobi gräben (see Section 6.8 and Mohr, 1971a). Under the prevailing conditions, only narrow, singly braced quadrilaterals could be made, and the number of repeat measurements was restricted because we had no means to recharge the geodimeter batteries.

Throughout Project TIKDEM, accurate and consistent geodimeter measurements of the taped baselines were obtained, indicating that the vagaries of the 1973 survey were not being repeated. In 1974, the nulling of geodimeter 81006 was straightforward, except during high winds experienced on Gara Boku and on two occasions of calm conditions when nulling was sluggish and erratic on frequency 3 of the instrument. The weather was much superior to that of spring 1973, with only occasional dust storms sweeping station FULCRUM and its unfortunate occupants (happily, recent social changes in Ethiopia have removed the threat to this station noted by Mohr, 1974a). In Afar, premonitions for this terra calidissima (Tazieff, 1970) were fortunately not fulfilled, a magnificent desert view of the 29 November eclipse of the moon following a shivering 13°C bivouac.

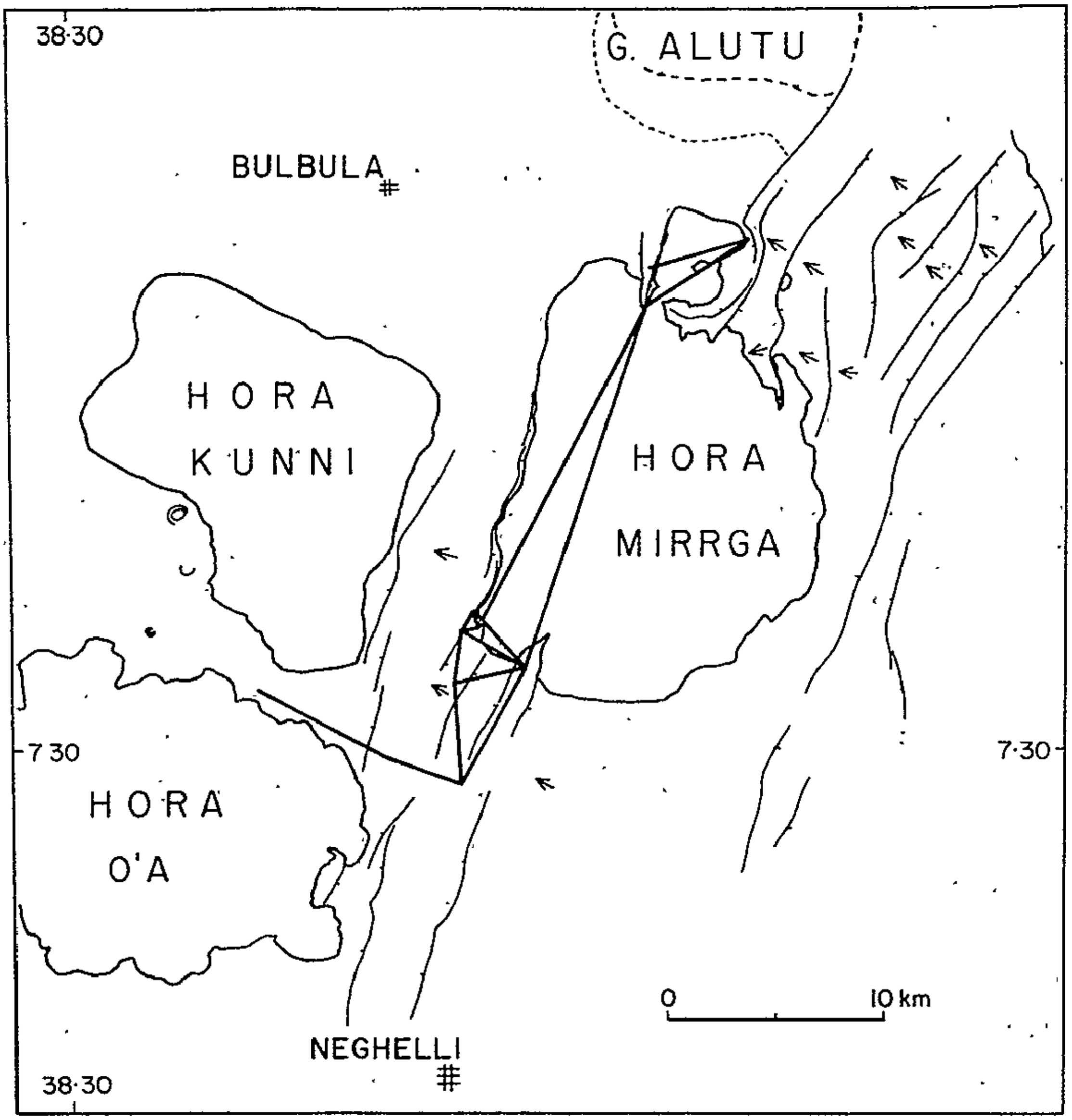

Figure 3. The central (Mirrga) network.

3. REDUCTION OF THE DATA

3.1 Station Elevations and Tripod Height Correction

Elevations of stations in the Adama (Nazret) region of the northern network, derived from the 1969 triangulation survey of E. Kazakopoulos and Mohr, have been adjusted to fit the new Directorate of Overseas Surveys (London) values for Gara Ganti and Gara Mietchi. The adjustment is -8 m at Gara Mietchi for station MIETCHI, and linear interpolation has been made for height adjustments to intervening stations northwestward to DUKAM (Figure 2), where the elevation is held fixed (United States Coast & Geodetic Survey, 1963). T-2 theodolite measurements by J. Rolff, for stations added to the northern network since 1969 and also for the central network, have revealed some important revisions to elevations previously known only from altimeter observations. Station elevations have also been revised from the program of least-squares adjustments of network line lengths. All these revisions are incorporated in the list of station elevations given in Appendix A.

The revised elevations affect the tripod height correction as applied to the geodimeter line lengths. Furthermore, belated account has now been taken of the number of prisms used at the retroreflector station to obtain the height of the optic axis there. These two factors necessitated a recomputation of all the Ethiopian geodimeter line-length observations; the changes rarely exceeded 1 mm, but a maximum of 5 mm was required for a short, steep line at Hora Mirrga. The recomputed data, plus the new data of the 1974 survey, are presented in Appendices B through G.

3.2 Line-Length Precision

Repeated line measurements at single setups, for 147 lines during the 1974 survey, yield a mean standard deviation of ±3.6 mm. When only those lines measured at two or more setups are considered, thereby involving re-erection of the tripods and changed atmospheric conditions, the precision degrades to ±4.8 mm. Statistics on the mean precision of line lengths for all five Ethiopian surveys are listed in Table 3. These statistics divide into 1) precision for all relevant observations during a given survey, and 2) precision restricted to observations for lines longer than 4 km, where atmospheric correction problems begin to loom large.

For replicate measurements at single setups, the order of decreasing precision is for surveys 1971, 1974, 1973 (geodimeter), 1970, and 1973 (Ranger), the limits being ±3.0 and ±5.9 mm, respectively. For lines longer than 4 km, the precision limits degrade to ±3.3 mm (1971) and ±6.0 mm (1973, Ranger). These figures are chiefly indicative of instrument consistency over a period of an hour or so.

The totality of errors resulting from the estimation of atmospheric refractivity and the setting up of the tripods, in addition to instrumental factors, is expressed in the standard deviations for multiple setups. The order of decreasing precision, including now the 1969 survey, which lacked repeated observations at single setups, is for 1974, 1969, 1971, 1970, 1973 (geodimeter), and 1973 (Ranger), with limits of ±4.8 and ±7.7 mm, respectively. The precision obtained during the 1974 survey compares well with similar surveys carried out in other parts of the world (see, e.g., Hofmann, 1968; Decker <u>et al</u>., 1971; Cook and Murphy, 1974) and is in part a tribute to the stability of atmospheric conditions in the Ethiopian rift valley. For highest precision work on the San Andreas fault zone of California, a geodolite instrument (slightly more precise than a geodimeter and also much heavier), used in conjunction with sophisticated aircraft monitoring of atmospheric refractivity, yields an overall precision of ±3.1 mm for a 4-km line and ±3.6 mm for a 10-km line (Savage and Prescott, 1973).

One of the interesting features of Table 3 is that, for the three best surveys (1969, 1971, 1974), there is an improvement in precision when only lines longer than 4 km are considered. This reflects the fact that some of the largest standard deviations are for lines shorter than 2.5 km, particularly

Table 3. Standard deviations (in millimeters) for line-length means for each of the five Ethiopian geodimeter surveys (the number of observations is in parentheses).*

Year	Survey	Single setups		Multiple setups		Multiple setups, ground radiation correction included	
		All lines	Lines > 4.0 km	All lines	Lines > 4.0 km	All lines	Lines > 4.0 km
1969	GEODIS	—	—	5.95 ± 4.4 (44)	5.38 ± 3.8 (31)	5.80 ± 4.6 (45)	5.09 ± 3.7 (32)
1970	LASER8	4.71 ± 3.9 (56)	5.35 ± 4.4 (34)	8.83 ± 4.5 (23)	9.92 ± 4.3 (13)	6.50 ± 5.2 (22)	7.43 ± 6.2 (14)
1971	PAPAYA	2.96 ± 2.2 (128)	3.09 ± 2.3 (77)	7.24 ± 3.7 (17)	7.00 ± 4.0 (11)	6.11 ± 2.3 (18)	6.00 ± 1.9 (12)
1973	AWARRA (Geodimeter)	4.38 ± 2.8 (56)	5.00 ± 3.2 (31)	4.83 ± 2.9 (6)	—	7.00 ± 5.0 (6)	—
1973	AWARRA (Ranger)	5.87 ± 2.8 (83)	5.98 ± 2.6 (41)	8.00 ± 4.2 (9)	—	7.67 ± 4.3 (9)	—
1974	TIKDEM	3.54 ± 2.2 (147)	3.41 ± 2.2 (81)	6.24 ± 3.8 (29)	6.92 ± 4.2 (13)	4.80 ± 2.8 (29)	4.16 ± 2.2 (13)

*Although some of the sample/population ratios are too low to be strictly valid in statistical terms, the data well reflect the relative precisions of all the Ethiopian surveys.

evident in the central network data (Mohr et al., 1975a) and in the data of Cook and Murphy (1974). In many cases, these short lines are also steep, but although errors in the atmospheric correction tend to be larger for steep lines (Savage and Prescott, 1973), the short lengths of the lines, less than 1 km in some instances, make it impossible to explain the deterioration of precision on this basis. We consider (Mohr et al., 1975a) that unequal illumination of a multiprism reflector is contributing to this problem. Serious errors can arise therefrom, not only on steep lines, but on any lines where the prism configuration to a narrow beam is not precisely perpendicular to that beam about either the vertical or the horizontal (perpendicular) axis. The use of a single prism for short steep lines during the 1974 survey of the central network improved precision for these lines by a factor of 2, although observations remain too few to be statistically significant. Future surveys will pay more attention to this matter.

In summary, the mean precision for all the Ethiopian geodimeter surveys, involving line lengths ranging from 0.5 to 25 km, is about ±6 mm. But for the first (1969) and last (1974) surveys, this lowers to about ±5 and ±4 m, respectively.

3.3 Line-Length Means

In obtaining line-length means for a given survey, the individual observations have been weighted according to instrumental "spread," which is the maximum difference between the distances derived from each of the three frequencies of the geodimeter. The smaller the spread is, the better the quality of the observation, and we have derived an empirical formula (Mohr, 1973a) to express this quantitatively:

$$w = 10^{-0.015S} \quad ,$$

where w is the weighting factor and S is the instrumental spread.

In fact, although this weighting formula applies satisfactorily to the 1970, 1971, and 1973 (geodimeter) surveys, it applies less well to the Mk6 geodimeter measurements made during the 1969 survey and notably less well to the 1974 survey, where a few clearly aberrant observations yet have a small instrumental spread. For the sake of overall unity of treatment, we have retained the weighting scheme and deleted the aberrant observations.

3.4 More on the Ground Radiation Correction

Precision is sensitive to the application of the ground radiation correction (GRC), as the data of Table 3 show. This correction attempts to nullify any difference between the mean air temperature along the line path and the averaged air temperature as measured 2 m above the ground at the two ends of the line. The former is the desired quantity, while the latter is the only practicable source available in Ethiopia. The derivation and applicability of the GRC have been discussed by Mohr (1973a, 1974a), and an extended treatment of the problem has recently been given by Maier (1974).

For measurements with a single setup, the GRC effects a very slight or no improvement in precision. This, of course, relates to the short (<1 hour) time scale involved, the GRC being time dependent. It is very important to note, however, that the mean line lengths themselves <u>are</u> significantly changed by applying the GRC,—in direct proportion to their length. Therefore, for intersurvey comparisons of line lengths involving measurements made at various times within a 24-hour cycle, a correct evaluation of the GRC is imperative. This evaluation can be made by measuring given lines throughout several diurnal cycles (Mohr, 1973a); it has not yet been possible to do this in Ethiopia, but multiple-setup measurements of given lines offer us partial information. The improvement in precision resulting from application of the GRC to the multiple-setup line lengths of the five Ethiopian surveys is appreciable (Table 3). The exception of the 1973 geodimeter data, with only six multiple setups and a poorly performing geodimeter, is of dubious significance.

For all the Ethiopian surveys, the average precision before application of the GRC is ±1.0 ppm for a mean line length of 7.5 km. With application of the GRC, this figure reduces to ±0.8 ppm, and for the best (1974) survey, to ±0.55 ppm.

A closer examination of the 1974 data shows that the daytime GRC currently used is capable of further, small refinements, which, however, will require the introduction of line configuration (topography) as a variable, in addition to the present single variable, time. For the 20-km line WONJI—MIETCHI, measured from 1715 to 1800 Local Time (LT) on 23 November 1974 (Black Saturday), there was a progressive decrease of 21 mm in apparent line length during four observations. This would be consistent with a more rapid cooling of the surface layer of the atmosphere compared with the mean temperature of the line path, and works contrary to the applied GRC formula, which presumes a more belated onset of such cooling under average Ethiopian rift conditions (Mohr, 1973a). For the immediately preceding measurements of line WONJI—MIETCHI AUX., during the period 1645 to 1710 LT, the apparent line lengths remained essentially constant, which would place the onset of surface air cooling across the Wonji plains near 1715 LT during November and December.

The same phenomenon is witnessed in the 17-km-long lines traversing Hora Mirrga. For line EUPHORBIA—OOMAY, measured between 1520 and 1615 LT on 13 November 1974, the GRC-corrected line lengths show an erratic possible shortening with time; but for GALLA—OOMAY, measured between 1710 and 1800 LT on the same day, the same progressive trend as for WONJI—MIETCHI is observed (Table 4). Again this indicates an onset of surface air cooling at some time near 1700 LT, and in both instances, we are dealing with long lines that traverse close above a flat surface, one land and the other water.

Examination of repeat-measured lines for Project TIKDEM shows that instrumental drift may be contributing to some of the apparent progressive changes in line length. Table 4 lists all the 1974 lines where such change is discernible: to keep this in proportion, note that only 15 out of a

Table 4. 1974 survey lines showing progressive drift of apparent length with time, during single setups with three or more consecutive measurements.

Line*	Number of observations	Time period (LT)	Wind (km/hr)	Approximate line length (km)	Drift (mm)
RY—MAA	4	1550—1640	10—15	3.9	19[†]
GE—MA	3	0940—1030	10—15	7.3	-25
RI—GE	3	0830—0920	15—25	2.5	-27
AD—RI	3	1145—1230	30	2.9	-8
AD—RI	3	1550—1635	15—25	2.9	-9
BH—CI	4	0830—0920	10	7.2	15
BR—CI	3	1720—1800	10	8.9	9
BB—CI	3	1535—1625	10—15	8.9	-11
BO—PY	3	0820—0900	5—15	11.5	-5
BO—WO	3	0945—1025	10—25	8.3	-13
WO—MI	4	1715—1800	0—5	20.5	-21
GN—MI	3	0835—0920	15?	16.7	13
TA—AY	4	0815—0905	5—10	7.7	7
TA—AY	4	1655—1740	30—40	7.7	-9
LA—TE	3	1630—1700	5?	2.4	-10
GL—OY	3	1710—1800	0—5	16.7	-20
EU—OY	3	1520—1620	0—5	17.6	-13?

*For station abbreviations, see Appendix A.

[†] This apparent drift ceased in the ensuing four measurements of line RY—MA during 1650 to 1720 LT.

total of 147 setups are implicated. The largest drift, -27 mm in 50 min, was observed for the 2.5-km line RIDGE—GEORGE at the kickoff of Project TIKDEM. This cannot possibly be explained by deficiencies in the GRC, and must be instrumental drift whose cause may have been related to operator "rustiness." [As in previous surveys, it was found important to null the geodimeter in the same part of the "green" on the signal-strength dial in order to obtain consistent and accurate results: higher in the green, phototube saturation became evident.]

Lines of intermediate length (∿4 to 10 km) show no consistency between drift sign and time of day, nor of drift magnitude to line length. Only for the longest lines (WONJI—MIETCHI, GALLA—OOMAY, and GANTI—MIETCHI) is a deficiency in the GRC indicated, with apparent drift rates of 1.0 to 1.4 ppm/hr being of negative sense for afternoon measurements and positive sense for morning. For all three long lines, wind speed during measurement was very low; for other lines where wind speed was relatively high (e.g., TABLE—AYGU), no apparent line-length drift was manifest. This suggests that the wind-speed factor incorporated in the GRC (Mohr, 1974a, p. 12) should have a wider spectrum in its effect on the GRC, but until a field experiment is performed that establishes at what point accuracy is highest on the drift curve, this cannot be quantified. Certainly it now appears that surface air temperatures can change more rapidly in Ethiopia than at the GRC test site in Arizona (Mohr, 1973a).

At present, there is no clear warrant for a firm general revision of the daytime GRC as applied to Ethiopian rift trilateration, lacking a datum for line-length accuracy. Further research into this problem is proceeding, by using network adjustments to seek the most accurate line lengths in relation to well-established short lines; but a program specifically devoted to GRC problems in Ethiopia is what is most desirable and, unfortunately, least likely to materialize.

Further enquiry into the intriguing question of when the strongly positive GRC of the early night turns to the negative GRC of the late night and early morning in Ethiopia has led to a re-examination of the post-midnight measurements made during Project GEODIS in 1969. Although the observations are insufficient in number and scattered in locale (Table 5), they suggest that the Ethiopian night-time factor previously applied to the Arizona-derived GRC (Mohr, 1973a, pp. 40-41), based on sparse data from Project PAPAYA in 1971, is too strongly positive from about 2245 LT on. For the interval 2245 to 0130 LT, the previously accepted value for this factor of 0.65T (where T is the local time in hours and integer increments continue beyond 24) was revised to 0.40T in obtaining the data in Appendix B.

Table 5. Project GEODIS, comparison of post-midnight and pre-midnight measurements of given lines (unrevised GRC included).

Line	Time (LT)	Time of pre-midnight comparison (LT)	Approximate line length (km)	Mean line-length difference (mm)	ppm	ppm/hr*
GI—ROA	0130	2345	5.9	6	1.0	0.57
RO—RY	0015	2230	5.8	0	0	0
RY—ROA	0045	2300	5.7	0	0	0
MAA—RY	0015	2115	3.9	33	8.4	2.8†
RI—GE	0015	2315	2.5	19	7.5	7.5†
RI—EP	0100	2000	6.6	16	2.4	0.48
RI—EPA	0015	2030	6.6	8	1.2	0.32
RI—FU	0115	2000	5.3	6	1.1	0.21
GR—CI	0100	2400	5.9	0	0	0
GRA—CI	0030	2330	5.9	3	0.5	0.50
DU—TO	0120	2315	1.7	8	-4.7	-2.2†

*The mean post-midnight rate of drift is 0.25 ppm/hr.

†These cases involved instrumental drift and are excluded from the mean rate of 0.25 ppm/hr expressed in the previous footnote.

From 0130 LT on, this figure then probably declines precipitously and reverses sign somewhere between 0300 and 0400 LT, a period for which we lack any data. It further appears that surface flow of cold air at night can exacerbate the station factor (Mohr, 1974a, p. 11) in the GRC, but the occasions of this phenomenon during Project GEODIS were usually easily recognized and the affected observations have been omitted in obtaining the mean line lengths.

4. INSTRUMENT CALIBRATION AND INTERADJUSTMENT OF ALL ETHIOPIAN SURVEYS

Calibration of SAO geodimeter 81006 by AGA (New Jersey), done immediately before we left for Ethiopia in October 1974, gave a geodimeter constant of 0.215 m, established from ∿2-km baselines of known length. Because of the instrumental gremlins encountered during Project AWARRA in 1973, taped baselines were installed at the start of the 1974 survey at Nazret (Adama) and at Hora Mirrga, against which the instrument was checked every few days (Appendix G). The summary results of this checking were as follows:

	Nazret	Mirrga
Number of tapings	4	2
Mean taped distance (m)	111.984	41.852
Number of setups	8	2
Number of measurements	33	7
Mean geodimeter distance (m)	111.982 ± 0.004	41.849 ± 0.002

The geodimeter distances incorporate an instrumental constant of 0.215 m and a retroreflector constant for a plastic cycle reflector of 0.050 m. The latter figure is not accurate to more than ±2 mm, and on the basis of these data alone, it is not possible to say whether it is the geodimeter constant or the retroreflector constant that is 2 mm short. The taped distances are considered accurate to ±0.001 m.

The geodimeter constant was independently determined at Hora Mirrga according to the method recommended by AGA. This involved measuring a known distance where the digital output numbers of the retroreflector (R) line and the internal calibration (C) line were almost the same; i.e., the out-of-phaseness of incoming and outgoing modulation waves was very similar. Over a taped distance of 35.249 m, R - C for frequency 1 was measured 15 times and yielded a mean value of 0.015 ± 0.004 m, giving a geodimeter constant of 0.214 m, which is in essential agreement with the factory-supplied value.

Thus, we have much greater confidence in the long-term stability of precision for the 1974 survey compared with the 1973 survey, despite the evidence for occasional instrumental drift.

We return to the question of how to link the different Ethiopian surveys to each other, for purposes of line-length comparison, and to determine which survey(s) is the most accurate. At the outset, we note that a survey bias — that is, an offset of consistency from accuracy (Mohr, 1974a, p. 13) — will affect comparisons for individual lines and station coordinates between one survey and another, but it will not significantly affect network adjustment within a particular survey. Furthermore, bias differs from the scale factor in being independent of the distance between any two points. Bias can, of course, be determined from measurements of stable calibration lines at every survey (Decker et al., 1971), preferably of long lines in zones where crustal deformation is absent, but, vita brevis, we have not been able to seek such zones in Ethiopia.

By using the revised line lengths given in Appendices B through G, the mean difference between 21 lines measured with a Mk6 geodimeter during 1969 Project GEODIS and the same 21 lines measured with a Mk8 geodimeter during 1971 Project PAPAYA is -14 ± 6 mm. This is similar to a -18 ± 4-mm difference for five calibration lines in Iceland (Decker et al., 1971), derived by comparing measurements from a Mk6 geodimeter in 1967 with those from a Mk8 geodimeter in 1970 (the same Mk8, 80037, was used in the 1970 survey in Ethiopia). In Ethiopia, the bias has been slightly degraded by some line-length changes. A bias of approximately -13 mm for earlier Mk2 geodimeter measurements in California compared with later Mk8 measurements has recently been described by Savage (1975). It seems that a systematic calibration error may have been made by the manufacturers during the early geodimeter days in the United States.

The 1970 and 1971 Ethiopian surveys are mutually consistent within 2 mm (Mohr, 1974a, p. 21), and the same figure embraces the 1971 and 1974 surveys. In fact, the signs of these statistically insignificant differences are positive both for 1971 relative to 1970 and for 1974 relative to 1971, in concordance with any overall horizontal ground extension in the rift valley.

It is with the 1973 survey that serious problems arise from a gross and time-stepped bias: the following discussion is an extension of that given by Mohr (1974a). For the southern (Arba Minch) network, the mean line-length difference for 1973 relative to 1971 (Δd_{71-73}) is 13.3 ± 4 mm (seven lines). For the central (Mirrga) network, the difference is 15.6 ± 8 mm (18 lines). On the basis of these data, Mohr (1974a) assumed a mean $\Delta d_{71-73} = 14$ mm for the line-length observations in the southern and central networks, and this increment is held to here. However, a possible relationship of Δd_{71-73} to ambient temperature has been discovered for the central network (Mohr et al., 1975b). If the relationship is real, it is puzzling that it did not apply to the preceding survey of the northern network and the subsequent survey of the southern network. During Project AWARRA, the nulling of the geodimeter suffered from a faulty regulator and interference from cycling of the crystal oven thermostat. Perhaps at Hora Mirrga there was a temporary imperfect thermostatic balance in one of the ovens, allowing an influence from ambient temperature, although it seems unlikely.

For the northern network, the nature of the 1973 survey bias is more complex and uncertain. A study of the Δd_{71-73} values reveals no relationship with ambient temperature, line length, or date. The mean line-length difference for any year relative to 1973, excluding aberrant data (e.g., line PYLON—RIDGE for 1973 and BOKU—ADAMA for 1971), turns out to be 24 ± 8 mm for 22 lines, most of which are common with 1971 and some with 1970 or 1969 only. This compares with a previously derived value of 28 mm (Mohr, 1974a) based on Δd_{71-73} for only 11 lines, including the aberrant BOKU—ADAMA. A positive correction of 24 mm has therefore been applied to all the 1973 geodimeter data for the northern network, except for the Wolenchiti quadrilateral, where the correction is 29 mm (see Section 6.2), and the southeastern Sire sector of the network, where a correction of 34 mm seems required. The indirect derivation of these corrections from intersurvey comparisons, rather than from on-the-spot calibration, impels less confidence in the 1973 survey than in the others.

Likewise, a comparison of the 1973 Ranger data for the northern network against the corresponding 1971 geodimeter data reveals a mean bias of Δd_{71-73} = 11 ± 10 mm. A positive correction of 9 mm, applied by Mohr (1974a) to all the 1973 Ranger distances, has been retained. Again, the Δd_{71-73} values fail to show any relationship to ambient temperature, line length, or date. Not only does the 1973 Ranger program show the poorest precision of any of the Ethiopian surveys (Table 3), but some inconsistent Ranger observations can be demonstrated. One of the clearest examples concerns the near-flat triangle linking stations QUILL, OOLAGA, and SODERE, in the center of the northern network:

Line	Δd_{73-71} (mm)	Δd_{74-73} (mm)
QUILL—OOLAGA	8	-3
OOLAGA—SODERE	-2	12
QUILL—SODERE	-3	22

The 1973 Ranger line lengths bear the 9-mm correction. The geometry of the triangle QUILL—OOLAGA—SODERE demands that any line-length changes for the triangle "base" QUILL—SODERE should equal the sum of the changes to QUILL—OOLAGA and OOLAGA—SODERE. This sum is 6 mm for Δd_{73-71} and 9 mm for Δd_{74-73}, values seen to be quite inconsistent with the listed QUILL—SODERE changes. On the other hand, the Δd_{74-71} value of 15 mm for lines QUILL—OOLAGA plus OOLAGA—SODERE agrees quite well with 19 mm for QUILL—SODERE.

A further, extraordinary element in the 1973 geodimeter saga emerges from the Icelandic survey made immediately after that in Ethiopia. We note first that 3 years earlier, in September 1970, geodimeter 80037 was used in Iceland and then was taken to Ethiopia for Project LASER8. The 1970 surveys in both countries gave line lengths agreeing well with preceding and subsequent surveys (allowing for the bias of the Mk6 geodimeter distances). In April 1973, geodimeter 81006 was used in Ethiopia; then it was shipped to

Iceland via AGA (Lidingö). AGA found the geodimeter constant to agree with that determined by AGA (New Jersey) before the Ethiopian survey — leaving the Ethiopian distances 14 to 34 mm too short, as we have seen. In Iceland, geodimeter 81006 was run concurrently with U.S. Geological Survey geodimeter 80058, and excellent agreement was obtained, both giving line lengths consonant with the 1970 values. Thus, it was only in Ethiopia that 81006 was misbehaving itself; both before in the United States and afterward in Iceland, it was dinkum. There is an old Ethiopian saying: "blame it on the altitude," but I can see no explanation for the AWARRA aberration.

Which survey should we take as the most accurate, thus providing a reference for the absolute lengths of the Ethiopian rift lines? I mutedly apologize for reverting to the original reference of the 1970 and 1971 surveys (Mohr, 1973a), now that the biases that misled me (Mohr, 1974a) are so evident. The 1974 survey, with the best precision of any of the Ethiopian surveys and with checks against taped baslines, shows no bias when compared with those of 1970 and 1971. Thus, the observed line lengths for the surveys of 1970, 1971, and 1974 stand (Appendices C, D, and G); the 1969 survey distances are incremented by 14 mm, the 1973 Ranger distances by 9 mm, and the 1973 geodimeter distances by 14 mm for the central and southern networks and 24 mm for the northern network (with some exceptions mentioned elsewhere). Table 6 lists the final line-length means for all remeasured lines of the Ethiopian rift surveys.

Table 6. Final line-length means (in meters) for all remeasured lines of the Ethiopian rift surveys. Standard deviations, except for single measurements, are given in parentheses in millimeters. G and R suffixes for the 1973 measurements indicate geodimeter and Ranger results, respectively.

Line	1969	1970	1971	1973	1974
RY—MA	3929.203 (11)			.230 (15) R	.219 (4)
RY—MAA	3937.595 (23)			.615 (6) R	.597 (8)
MA—GE	7262.541 (10)		.552 (2)	.552 (3) R	.561 (4)
MA—GEA	7259.088 (11)		.097 (3)	.103 (3) R	.109 (1)
MAA—GE	7257.210 (11)			.229 (11) R	.240
MAA—GEA	7253.749			.764 (9) R	.763
MA—RI	9759.	.387 (2)	.376		
GE—RI	2529.968 (15)	.951	.970 (1)	.969 (13) R	.973 (4)
GE—RIA	2540.198 (12)		.187 (2)		.203 (4)
GEA—RI	2530.732		.736	.740 (5) R	.731
GE—AD	4461.186 (4)	.176	.186 (1)	.189 (4) R	.176 (2)
GE—ADA	4470.829		.830 (1)		.823
GE—FUA	7281.	.183 (1)	.176 (3)		.169 (4)
GE—BO	9430.	.850 (1)	.844 (9)		
RI—AD	2865.573 (4)	.568	.569 (6)	.575 (5) G .581 (5) R	.572 (5)
RI—ADA	2874.402		.401 (12)	.417 (1) R	.401
RIA—AD	2878.010			.025 (4) R	.022 (1)
RI—FA	3022.259 (4)	.261 (5)	.259 (4)	.262 (4) G .259 (4) R	.250 (4)
RI—FAB	3011.		.202 (2)	.191 (6) R	.195
RIA—FA	3026.085		.088 (3)		.081 (12)
RI—EPA	6631.497	.490	.506 (3)	.493 (5) R	.506 (8)
RI—GN	6673.		.497 (4)	.498 (10) R	.505 (4)
RI—GNA	6672.			.906 (5) R	.914
RI—FU	5339.768 (4)	.767 (8)			
RI—FUA	5335.163	.188 (2)	.164 (6)	.176 (2) R	.160 (1)
RI—FUB	5337.		.060 (9)	.067 (2) R	
RI—BO	6998.	.211 (14)	.224	.229 (7) R	.234 (6)
RIA—BO	6983.		.096 (4)	.074 (7) R	
AD—FA	1400.898 (3)	.894 (4)	.901 (0)	.904 (13) R	.901 (4)
AD—FAB	1407.		.494 (6)	.492 (7) R	.482
ADA—FA	1398.030		.032 (3)	.047 (3) R	.022 (1)
AD—EPA	6153.628	.611	.623 (6)	.609 (7) R	.625 (2)
AD—GN	6100.		.378 (4)	.385 (8) R	.389
AD—GNA	6101.			.606 (8) R	.610
AD—BO	7427.	.068 (7)	.120	.100 (6) G	.115

Table 6. (Cont.)

Line	1969	1970	1971	1973		1974
FA—EPA	4757.497	.502 (3)	.492 (4)	.486 (8)	R	.494 (5)
FA—GN	4709.		.989 (3)	.001 (3)	R	.987 (1)
FA—GNA	4711.			.104 (3)	R	.099
FA—FU	2365.997 (3)	.005 (8)				
FA—FUA	2358.172	.180 (9)	.170	.180 (14)	R	.167 (5)
FA—FUB	2359.			.600 (6)	R	.579 (6)
FA—FUD	2372.			.340 (4)	R	.322
FA—BO	6066.	.407 (5)	.402 (2)	.414 (5)	G	.433 (5)
				.402 (9)	R	
BO—EPA	2307.	.079 (8)	.091	.086 (5)	R	
BO—GN	2519.		.669 (6)	.671 (6)	R	.667 (8)
BO—GNA	2515.			.540 (3)	R	.532
BO—FUA	6880.	.084	.095	.101 (3)	G	
FUA—GN	4773.		.651 (4)	.648 (4)	R	.662 (1)
FUA—GNA	4776.			.552 (5)	R	.549
RO—MI	6260.920 (2)	.908 (6)		.921	G	
ROA—MI	6236.818	.813 (6)		.813 (5)	G	.816 (6)
RO—BO	9845.	.339 (6)				.346
ROA—BO	9857.	.967 (13)	.970 (1)			.985
DU—MI	5511.386 (1)					.385 (3)
TO—MI	5566.639 (5)			.636 (11)	G	.653 (1)
TO—DU	1709.705 (5)			.709 (4)	G	
TO—DUA	1684.656			.659		
SE—DU	8686.894 (9)					.917 (4)
SE—DUA	8660.086					.108
SE—TO	7489.415 (2)					.406 (4)
QL—SO	3856.		.840 (3)	.837 (7)	R	.859 (1)
QL—OL	2357.		.713 (3)	.721 (9)	R	.718 (5)
OL—SO	1581.		.713 (3)	.711 (6)	R	.723 (4)
OL—MI	7578.		.947 (2)	.956 (4)	G	.951 (5)
WO—GE	6566.		.789 (4)			.794
PY—GE	6642.		.851 (1)	.856 (3)	G	.846 (4)
PY—GEA	6628.			.250	G	.227
PY—RI	7612.		.220 (3)	.250 (10)	G	.226 (0)
PY—RIA	7602.			.898	G	.902
PY—WO	3402.		.653 (2)	.643 (5)	G	.653 (1)
PY—KO	3079.		.988 (6)	.982 (5)	G	.991 (10)
KO—WO	5336.		.867 (5)	.862 (7)	G	.860 (2)
GA—YE	2248.	.293 (0)	.298 (2)			.297 (2)
GA—TH	4608.	.480 (1)	.482 (3)			.483 (2)
KO—YE	2871.	.875 (4)	.893 (2)			.884 (5)
KO—TH	4444.	.656 (2)	.666 (2)			.663 (1)

Table 6. (Cont.)

Line	1969	1970	1971	1973		1974
GR—FU	7315.777 (2)	.770 (25)				
GR—FUA	7318.021	.024	.014 (9)	.015 (3)	R	.025 (1)
GRA—FU	7339.315 (6)	.321 (5)				
GRA—FUA	7341.		.669 (1)	.664 (3)	R	.666 (3)
FUA—CI	12089.	.228 (5)	.215 (6)			.213 (5)
GR—CI	5866.835 (2)		.830 (4)	.819 (7)	R	.839 (2)
GR—CIA	5872.		.140 (1)	.111 (6)	R	.146 (1)
GRA—CI	5876.689 (2)	.679 (1)	.697 (6)			
BH—CI	7233.	.358 (5)	.352 (3)	.357 (8)	R	.368 (6)
BH—CIA	7223.	.525 (4)	.524	.532 (6)	R	.540 (1)
BH—BR	1666.			.386 (11)	G	.382 (2)
BH—BB	2016.			.934 (4)	G	.920 (3)
TA—AY	7678.	.141 (9)	.139 (3)	.141 (11)	G	.135 (5)
TA—ME	6858.	.863 (6)	.868 (6)	.866 (4)	G	.875 (3)
TA—MEA	6854.			.788	G	.813
TA—RA	9418.	.265 (6)	.285 (2)	.285 (8)	G	.287 (2)
TAA—RA	9417.			.816	G	.805
AY—ME	7829.	.052 (10)	.057 (3)	.055 (10)	G	.058 (3)
AYA—ME	7827.			.338	G	.335
AY—RA	7220.	.499 (2)	.508 (7)	.502	G	.513 (4)
AYA—RA	7223.			.246	G	.269
ME—RA	13687.	.799 (1)	.819 (7)	.807 (2)	G	.818 (2)
ME—RAA	13690.			.638	G	.662
BN—BC	1206.		.708 (6)	.709 (4)	G	
BC—KU	3599.		.172 (7)	.172 (3)	G	
BC—TS	7277.		.608 (1)	.609 (1)	G	
BC—TSA	7276.		.511 (3)	.516	G	
BP—SH	2331.		.651 (2)	.648 (3)	G	
BN—SH	2937.		.672 (3)	.667 (2)	G	
KU—TS	3772.		.926 (5)	.928	G	
HO—TE	1022.	.595 (6)	.598 (1)	.591 (4)	G	.586 (1)
HO—GL	764.	.061 (6)	.052 (3)	.062 (1)	G	.045 (4)
HO—EU	3517.	.937 (5)	.926 (3)	.920 (2)	G	.919 (3)
HO—EUA	3524.	.762	.769 (5)	.754	G	
HO—LA	3394.		.055 (1)	.058 (4)	G	.047 (3)
TE—GL	746.	.050 (2)	.044 (4)	.043 (3)	G	.037 (2)
TE—EU	3358.	.123 (5)	.127 (2)	.134 (2)	G	.127 (2)
TE—EUA	3372.	.624	.628 (1)	.628	G	
TE—LA	2434.		.176 (3)	.165 (4)	G	.165 (5)
TE—AR	7257.			.954 (7)	G	.985 (4)

Table 6. (Cont.)

Line	1969	1970	1971	1973		1974
GL—EU	2852.	.132 (6)	.142 (3)	.133 (3)	G	.130 (7)
GL—EUA	2862.	.166 (3)	.172 (4)	.164	G	.169
GL—EUB	2852.			.410 (4)	G	.416
GL—AR	7435.		.784 (3)	.803	G	.815 (4)
GL—ARA	7439.			.594	G	.593
LA—EU	3232.		.699 (1)	.707 (3)	G	.713 (5)
LA—EUA	3259.		.854 (0)	.860	G	.849
LA—EUB	3232.			.904 (1)	G	.899
LA—AR	4851.		.699 (1)	.699 (1)	G	.699 (4)
AR—EU	6206.		.139 (1)	.139 (1)	G	.150 (9)
AR—EUA	6229.		.371	.369 (0)	G	.376
AR—EUB	6206.			.101 (2)	G	.122
OI—AL	4629.	.081 (1)	.089 (3)	.097 (0)	G	.101 (4)
OI—OY	5303.		.659 (3)	.648 (4)	G	.667 (2)

5. NETWORK ADJUSTMENT

5.1 Weighting and Revision of Line Lengths

Weighting of the line-length means entered into the network least-squares adjustments follows the simple relation

$$w = n' sc/\sigma^2 \quad ,$$

where w is the applied weight; n′ is related to n, the number of observations of a given line in a given survey, by $n' = (1/1 + 1/2 + 1/3 + \ldots + 1/n)$; s is the number of setups for a line during a particular survey; c is a consistency factor; and σ is the standard deviation of the observations about the mean line length (a minimum of ±4 mm is accepted; for single observations, the value is taken from Table 3, column 7).

Consistency is a measure of the smoothness of the trend of changes (or stability) in length of a given line throughout several surveys. A consistency factor is applied to the variance (i.e., to the reciprocal of weight) according to the deviation of line lengths from a best-fit line covering a number of years, as follows:

Consistency factor	Maximum deviation (mm)
0.5	±0 to 3
1.0	±3 to 7
2.0	±>7

This scheme admittedly anticipates regular line-length changes of the same sign from one year to the next, but it must be emphasized that it is too weak to obscure moderate "oscillations," as the results will show. Rather, the consistency factor is a device to deweight some manifestly poorer observations, or observations of mixed quality in which the better quality data cannot be identified.

To maintain a complete network for each survey, lengths for any omitted lines of a particular survey have been introduced from the preceding survey, except for the 1969 survey, where gaps are filled from the 1970 survey, and for cases of evidently poor data. These indirect observations were originally deweighted by a factor of 100 for a 1-year gap and 200 for a 2-year gap, but in view of the small rates of crustal deformation in Ethiopia, this is now considered excessive, resulting in such "observations" taking up an undue proportion of the adjustment errors. We now weaken weightings by a factor of 8/yr.

Line lengths fitting least well in a network adjustment have been re-examined from the points of view of 1) any large differences in line lengths at separate setups, 2) abnormal weather conditions that could have modified the temperature gradient of the surface air layer, and thus make a straight application of the GRC inappropriate, 3) first-of-the-day geodimeter measurements when insufficient warmup time for the instrument may have occurred, or 4) observer bias, due to the nulling technique. Line-length revisions considered justified from this process have been discussed and listed for the Mirrga network by Mohr <u>et al</u>. (1975b); for the northern network, the revisions are listed in Table 7. It is important to emphasize that no changes have been made for which a preadjustment reason cannot be found, even though the need for such a change may seem overwhelming: to underline this, erroneous elevations put into the network adjustments can distort and apparently disparage some line lengths whose observations are sound; without ruthless objectivity, the revision process leads to chaotic revisionism.

The magnitude of the average revision of line lengths is about 5 mm, or a little less than 1 ppm in relation to the mean 7-km-long Ethiopian line. Less than 5% of all the observations have been subjected to revision. Where line lengths are considered to be in error but the error cannot be quantified, we have deweighted these lengths, usually by a factor of 2: this process involves less than 1% of the observations. When any line-length revisions are incorporated, and weightings changed, the overall dimensionless sigma (S) should move closer to unity, where

Table 7. Revised line lengths for the northern network.

Survey	Line	Correction (mm)	Reason
1969	GE–RIA	-5	From comparison with GE–RI at same setup.
	AD–RIA	-5	From comparison with AD–RI at same setup.
1970	GE–RI	(erroneous)	Measured in "strong wind"; discard.
	GE–FUA	-6	GRC underestimated on calm morning.
	AD–EPA	11	From comparison with AD–FA and AD–RIB.
	RI–BO	3	"Excellent measurements"; ignore D-spread.
1971	RI–FUB	-4	From comparison with RI–FUA at same setup.
	BO–EPA	-8	From comparison with afternoon BO–RI measurement.
1973	RI–FAB	4	From comparison with RI–FA at same setup.
	FA–EPA	-2	GRC underestimated on calm, hot day.
	FA–FUA,–FUB	(uncertain)	Measured in "dust storm," like that of 1970.
	AD–GN,–GNA	5	From comparison with AD–EPA of same day.
	BO–RIA	(erroneous)	Incompatible Ranger observation.
1974	GE–RI,–RIA	2,-2	Double weight for observer P relative to R.
	EPA–GN	2	Double weight for observer P relative to R.
	FA–GN,–GNA	4	From comparison with FA–EPA on same day.
	RI–GN	-3	Omit aberrant first-of-day observation.
	BO–FA	-3	D-spread weightings unrealistic.

Table 7. (Cont.)

Survey	Line	Correction (mm)	Reason
	BO—GN	1	D-spread weightings unrealistic.
	BO—GNA	-6	From comparison with P observation of BO—GN.
	GE—EPA,—GN,—GNA	-3	29 October rain; GRC halved.
	RIA—AD,—ADA	-1	29 October rain; GRC omitted.
	RIA—FA	-2	29 October rain; GRC omitted.
	RIA—FAB	-3	29 October rain; GRC omitted.

$$S = \sqrt{\frac{\sum[(O - C)/\sigma]^2}{f}}$$

and O - C is the residual of the observed minus the computed line length, σ is the a priori standard deviation about the line-length mean, and f is the number of degrees of freedom in the network (i.e., the number of observations in excess of that required to determine the network geometry). Thus, S is a measure of the mutual compatibility of line-length observations, the reality of their ascribed a priori standard deviations, and the realism of their relative weightings.

5.2 Adjustment Techniques

The method of adjustment most commonly used in the Ethiopian work is the so-called classical method (Mohr et al., 1975a,b). In this method, one station is held fixed as the origin of the coordinate system, and a second station is used to define the x (and thus y) axis along which that station is constrained to move in the adjustment. Station elevations are held fixed, even when known only from altimeter observations, to provide sufficient degrees of freedom for a unique solution without sacrificing accuracy. Excepting lines ELPASO AUX.—GANTI and EPLASO AUX.—GANTI AUX., none of the Ethiopian geodimeter lines slopes more than 4^g from horizontal, and more than half slope at less than 2^g. Thus, line lengths will not be significantly changed by vertical movements short of a meter.

The origin station for a given network is chosen 1) for its bedrock stability, so that it is least likely to be affected by atectonic ground motions, and 2) for its geological situation, often selected at the margin of a graben, basin, or other tectonic unit. This then aids in the interpretation of relative motions of the remaining stations. The second station is usually selected so that the x axis connecting it with the origin station runs either perpendicular or parallel to the regional geological structures, depending on whether normal crustal extension or longitudinal shear is expected to be occurring.

At most of the Ethiopian stations, the main point is accompanied by one or more auxiliary points, all separated by a few or tens of meters. The auxiliary points were originally — and, as it has since been proved, wisely — installed as a security measure against vandalism. They are now included in the survey observations and network adjustments because they add a further test on the precision of the field techniques under the assumption, generally justified, that there are no relative motions between main and auxiliary points at a given station. The treatment of main—auxiliary pairs (or triads) in the network adjustments has been discussed in some detail by Mohr et al., 1975b). Unfortunately, the introduction of auxiliary points into the adjustments also introduces a deficiency, in that although the main—auxiliary distances are known from taped measurements, the azimuths and declinations have not yet been observed.* We currently fix the main—auxiliary distances in the adjustments and leave the azimuths free to vary, even though this is geologically unrealistic. Declinations are held fixed, but at values derived from best fits in the adjustments. As a check on the precision of the line-length observations, additional network computations have been made with the main—auxiliary distances free to vary: the best-fit distances thus computed differ from the taped distances within about ±2 mm (Mohr et al., 1975b).

The Ethiopian geodetic data have also been subjected to free-net adjustment techniques (Mohr et al., 1975b). No station is fixed as origin, nor is a second station constrained along the x axis. Instead, all stations are adjusted to a position of "least strain" with respect to the interstation distance observations. Station z values remain fixed, however. It is necessary to remove net rotations from the solutions before intersurvey comparisons are made. Although free-net adjustment provides a more rational way of distributing errors among all the stations of a network, geological interpretation of apparent station vectors is more difficult in the absence of a reference frame. We have also applied compromise free-net-classical techniques to some of the Ethiopian networks: for example, a selected origin station is held fixed, but no second station is constrained to the x axis.

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*Since rectified in the 1976 survey.

A study of a posteriori line lengths resulting from the network adjustments can be useful when it is desired to concentrate attention on specific lines, perhaps those crossing geological structures of interest or those that can assist in resolving ambiguities in our interpretation of apparent station motions. Computed a posteriori line-length sigmas give a useful indication of the compatibility of the line-length observations: they can also be combined for any given line through $\sigma = (\sigma_1^2 + \sigma_2^2)^{1/2}$ to determine the standard deviation for the change in the best-fit line length from one survey to another.

The final results presented in Section 6 have not been reaped from a single sowing of least-squares-adjustment computations. Dizens (decimal "dozens") of steps have been laboriously executed, following revision of weightings, line lengths, and station elevations, plus the addition or exclusion of an auxiliary point, etc. One lesson we have learned is to build in single steps from the simplest and most reliable elements of the network, so that erroneous or less precise data can be identified and handled. Put them all in the stew at the start, and you're in there with them.

5.3 Station-Coordinate Errors

Although we deal here with the statistical errors deriving from the variance-covariance matrix of the least-squares adjustment, we again (see Mohr et al., 1976) reiterate the premise of Sclater et al. (1976, p. 1865) that "stated error [from statistical adjustment can be] unreasonably small and an underestimation of the actual errors in the original [observations].". The stated errors are as comprehensive as the data put into their derivation, and no more.

Standard error curves (Bjerhammar, 1973) are used to express the network-derived uncertainties in the coordinates of each station. An error curve has an advantage over an error ellipse in that the envelope represents a confidence limit at azimuths other than those parallel to the ellipse axes. The error curves presented in this work are based on a two-dimensional combination of linear standard deviations, and thus present about a 45%

confidence envelope. This confidence limit is the one most generally used in geodesy, but it can be argued that in work of our attempted precision and resolution, it would be more useful to double the parameters of the error curve to yield a confidence envelope of about 85%.

Whilst it would be most useful to show error curves for each survey at each station in assessing the statistical likelihood that apparent station motions are real, in Ethiopia where any motions are close to the limit of resolution, the superpositioning of detail becomes obfuscating. Practicable alternatives include a pairing of error curves, such that each indicated curve sums the errors of time-adjacent surveys for each station (but this still superposes many lines). Or there is the simplified method of marking only the intercept of the error curve on the individual vector (or its projection, where the error is larger than the vector). Or, following Mohr et al. (1975b), a list can be made showing the computed confidence limit to which each station vector penetrates for each time-pair of surveys (but this loses the benefit of graphical impression).

The method chosen here is a compromise. It combines the error curves of the beginning and end surveys and ignores the errors of the intervening surveys. This method shows the confidence to be placed in the overall station vector, but gives no information on the confidence to be placed in the intervening progression of motions. We justify this approach by the argument that the motions are small enough that the maximum available duration is required to ascertain them with any confidence:, secular variations of motion are generally beyond the resolution of our present methods. In combining error curves, we thus far simplify our computations by taking a mean azimuth for the ellipse long axis: we also assume that there is no correlation between successive surveys — any correlation will, of course, reduce the summated errors.

6. RESULTS

6.1 The Adama Graben, Northern Network

6.1.1 Background

The Adama graben is situated near the geographical axis of the Ethiopian rift valley at latitude 8°35'N. It is a 5-km-wide depression forming the eastern margin of the northernmost part of the Gadamsa sector of the Wonji fault belt (WFB) (Mohr and Wood, 1976). The graben is bordered east by the narrow Dàlecha horst (Figure 4) and west by the broader zone of faulting comprising the Mojjo-Adama horst, imposed on the Mukie volcanic massif (Mohr, 1973b). The geology is described more fully in a later section. The important town of Nazret (Adama) is situated on the floor of the graben, and residents report having felt minor earthquakes in the past.

The geodimeter network here, covering the southern sector of the Adama graben, illustrates some of the problems of network design that have beset the Ethiopian rift work. In 1969, when the initial traverse of the rift valley was instigated, the value of networks in elucidating two-dimensional as opposed to one-dimensional strain fields was underestimated. Nevertheless, the geology and topography of the Adama graben were attractive enough to deviate our attention in 1969 from making a single traverse to constructing a simple network (see Figure 3 in Mohr, 1973a). The geometry of this network, where we established a station on each fault block (Figure 4), was dictated by the distribution of topographic eminences and access tracks. Furthermore, some hills, notably cinder cones, lacked a solid bedrock in which to install station-marker bolts.

In 1970, the construction of a track up Gara Boku, to service the new television relay station thereon, enabled us to put a point near the summit (station BOKU), which greatly improved the geometry of the Adama graben

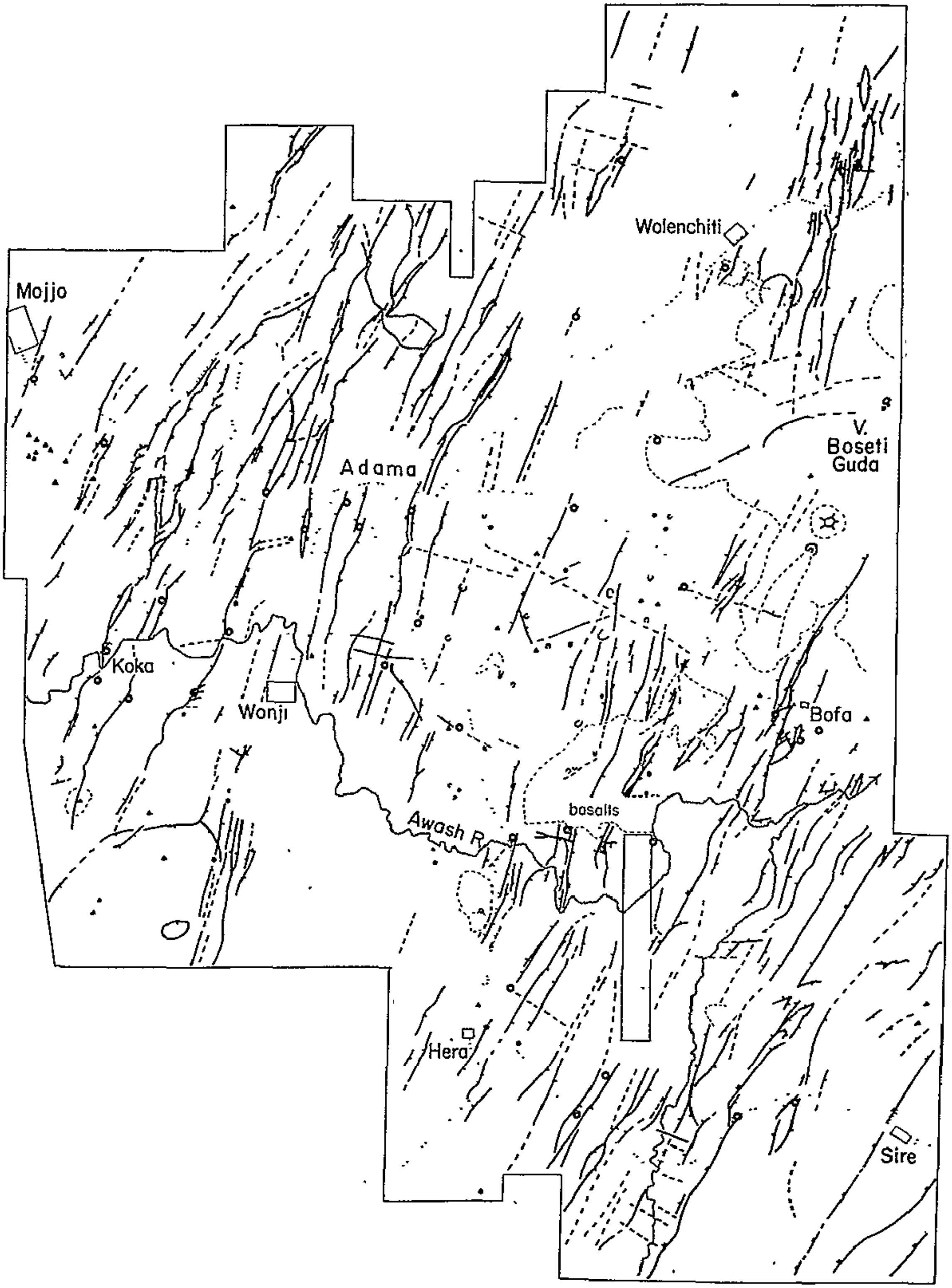

Figure 4. Tectonic map of the northern network region between Mojjo (some 70 km southeast of Addis Ababa) and the rift-plateau escarpment at Siré.

network (see Figure 9 in Mohr, 1973a). The high and exposed nature of this station, however, has already been noted in regard to its detrimental effect on the performance of the geodimeter, buffeting winds causing excessive vibration. In 1971, further improvement in network geometry came from the installation of a station on the summit of Gara Ganti (GANTI), immediately above ELPASO but with visibility to FULCRUM on the same, eastern margin of the graben. The present geometry of the Adama graben network (Figure 5) is still far from ideal, lacking a station southwest of the RIDGE—BOKU line: the measurement of the new line BOKU—WONJI in 1974 helped alleviate this defect, and lines from WONJI to other graben stations will be established in a later survey.

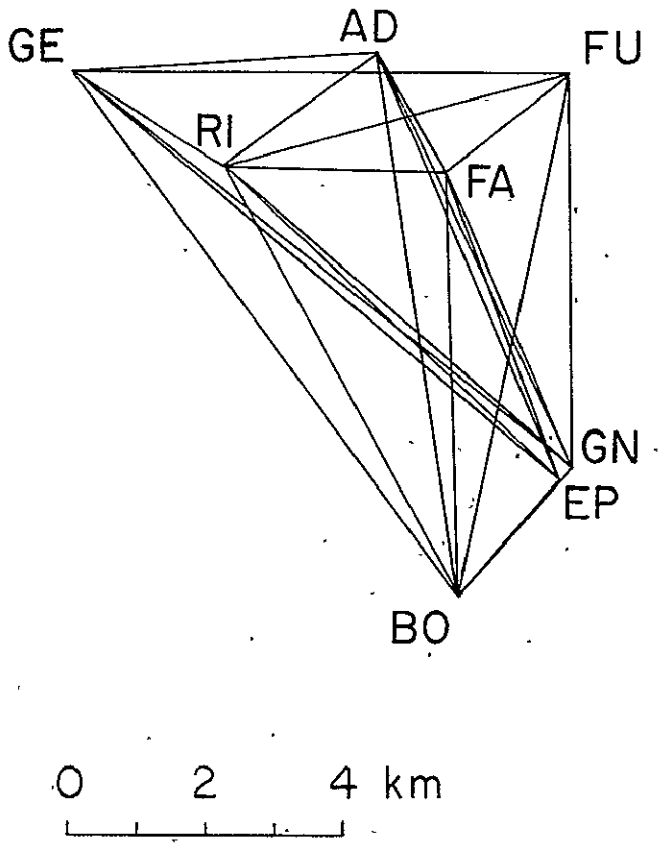

Figure 5. The geodimeter links comprising the Adama graben network.

It is perhaps not amiss, in view of possible criticism of the Ethiopian geodimeter network designs, to point out that our surveys have been accomplished on slender budgets. We have not had the assistance of helicopters or aircraft, we have had the use of only one four-wheeled-drive vehicle; and "we" has comprised two, occasionally as many as four, personnel for both geodimeter and retroreflector parties.

6.1.2 Network adjustment

At present, the Adama graben network incorporates eight stations, all of which have at least one auxiliary point additional to the main point. All the main—main lines have been measured, excepting ADAMA—FULCRUM (where huts intervene) and ELPASO—FULCRUM and GEORGE—FARENJI (where hillsides intervene).

From the basic observations listed in Table 6, the Adama graben network was first adjusted by means of the classical technique, in which station RIDGE was chosen as the origin and station FULCRUM as defining the x axis. RIDGE lies on the western rim of the graben, and FULCRUM on the eastern rim (Figure 4). The x axis is thus oriented at about 70^g to the graben faults, or 085^g from true North.

Initial attempts to adjust a network of 11 points (seven main plus four auxiliary) were unsuccessful, owing to the inextricable interplay of several sources of error. Therefore, we restarted with a reasonable mimimum of eight points: RIDGE, FULCRUM AUX., ELPASO AUX., FARENJI, GEORGE, and ADAMA, plus the two most precisely determined auxiliary points RIDGE AUX. and ADAMA AUX. [Note: The main points at ELPASO and FULCRUM were found destroyed in 1969 and 1970, respectively, so that ELPASO AUX. and FULCRUM AUX. have become the "main" points in both cases.] Station elevations were obtained from the 1969 triangulation survey of Kazakopoulos (see Mohr, 1974a, Appendix B) and were held fixed in the least-squares adjustment of station coordinates. In the first, eight-point adjustment, mean a posteriori line-length sigmas ranged from ±2.7 mm (1969 survey) to ±6.5 mm (1970 survey). However, the 1970 survey lacked observations for several of the network lines, and weakly weighted "observations" from other surveys were perforce introduced to obtain redundancy. The resulting large error curves reflected the poor geometrical configuration at this stage.

Throughout the ensuing, station-by-station buildup of the Adama network scheme, ill-fitting observations were identified from a comparison of O - C line-length residuals with the ascribed a priori variances. These identifications incidentally led to the discovery of a few errors in transposing and punching of the field data. Further, instances were found of an ill-fitting observation in the adjustment coinciding with abnormal weather conditions, justifying a modification of the GRC applied to the field data. In other instances, instrumentally aberrant measurements could be identified in multisetup observations. This combing process was continued through the adjustment program. A posteriori line-length revisions, and reasons for the revisions, are listed in Table 7; no revisions were made unless an a priori reason could be adduced, despite any compelling need for revision.

It quickly became apparent that the Adama graben network was sensitive to strain in the vertical dimension and that the triangulated elevations could be improved.* So, by holding the elevations of RIDGE, FULCRUM AUX., and GEORGE fixed at the observed values, the elevations of the other five points were freed for each of the surveys, and thus averaged best-fit elevations were determined (Table 8). The substitution of these best-fit elevations in the network adjustments greatly improved the a posteriori line-length sigmas for all surveys except that of 1969, where the triangulated values fit well. The mean sigmas now range from ±1.4 mm (1971) to ±4.5 mm (1969). The geometry

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*The vertical-angle measurements made in 1969 were not reversed, and therefore an atmospheric refraction coefficient of 0.08 was assumed.

Table 8. Best-fit relative elevations (in meters) derived from least-squares adjustments for the Adama graben network (RI—FUA reference frame).

Station	Triangulated elevation	8-point network	10-point network	11-point network
RI	0*			
GE	50.1		(held fixed)	
FUA	-82.3		(held fixed)	
EPA	10.9	7.1	5.9	6.2
FA	-95.6	-93.2	-93.2	-93.2
AD	-94.1	-94.0	-93.8	-93.8
RIA	1.4	0.6	0.6	0.6
ADA	-94.2	-94.1	-93.8	-93.9
BO	144.3	—	141.0	142.0
GN	48.5	—	47.4	47.6
GNA	49.1	—	—	48.2

* Reference station.

of the Adama network is such that strain from ill-fitting elevations shows particularly in the FARENJI—FULCRUM AUX. link.

The eight-point network adjustment, incorporating the revised best-fit elevations, shows interesting features. First, a similarity of the 1969 and 1971 station coordinates strongly suggests that the 1970 coordinates, displaced by as much as 30 mm from the others, were more weakly determined than their standard error curves would indicate. The eight-point network evidently does not have sufficient redundancy to overcome the influence of poor observations. Second, for the 1971 and 1974 surveys, despite essentially unchanged line lengths for the excellently observed ELPASO AUX.—FARENJI, ELPASO AUX.—ADAMA, and FARENJI—ADAMA links, changes for the links from these stations to RIDGE and GEORGE have the effect of pulling stations ADAMA and FARENJI (1974) about 20 mm to the northwest. The very high correlation coefficient for this apparent motion again indicates that spurious or exaggerated effects can arise from adjusting too small a network: lacking any buildup of the network, there is need to go beyond the vector diagram and its error curves, to the original observations themselves in interpreting apparent station motions.

The addition of station BOKU to the Adama network in 1970, to form a nine-point network, has given a greatly improved geometry. Nevertheless, as already emphasized (Mohr, 1973a, 1974a), BOKU is an exposed hilltop station uncongenial to the geodimeter. Winds of 60 kph or stronger tend to be the rule, and as a result, instrumental nulling is very sluggish; even when the system is set to calibrate, it "hunts" for a unique phase offset. [A diary entry for 7 April 1973 reads "Tremendous dust clouds crossing FULCRUM and MIETCHI... When will we ever learn, that geodimeter on BOKU n.b.g."] Yet the unmatched visibility and BOKU's geometric position in the network have prevailed for its retention as a retroreflector station. Mean a posteriori line-length sigmas in the nine-point adjustment range between ±2.1 mm (1971) and ±6.7 mm (1970). The relative poverty of the 1970 observations is revealed in the fact that, if only the better fitting RIDGE—BOKU observations are put into the adjustment, station coordinates change by as much as 4 mm. The apparent northwest motions of stations ADAMA and FARENJI through 1974, discussed above, are now matched by that of ELPASO AUX. in the RIDGE—FULCRUM AUX. reference frame.

Station GANTI was added to the Adama graben network in 1973; it has proved to be an excellent observing station, combining all-round visibility with a stable observing platform for the geodimeter except in unusually high winds. Again, average best-fit elevations were obtained from adjusting the now 10-point network (Table 8). Mean a posteriori line-length sigmas for this network ranged between ±2.3 mm (1971) and ±5.9 mm (1970). In the 1974 survey adjustment, sigmas for lines involving station BOKU were appreciably higher than for the other lines: the 1974 survey desires a BOKU elevation about 2 m higher than for the other surveys and is thus strained by the mean BOKU elevation fixed on the basis of all the surveys. In the 10-point adjustment, the error curves for the station coordinates are appreciably reduced from the eight- and nine-point adjustments, owing to the tightening of the geometry. The aberrancy of the 1970 coordinates is also notably reduced, except for stations GEORGE and FULCRUM AUX.

Finally, the addition of point GANTI AUX. completes the present 11-point Adama graben network. This point is identical with the Directorate of Overseas Surveys (London) trigonometric point on the summit of Gara Ganti and is well tied to the main point GANTI. After again obtaining and substituting best-fit elevations (Table 8), where a progressive increase in the elevations of BOKU and GANTI of 1.0 ± 0.7 m/yr from 1970 to 1974 is not regarded as real(!), a posteriori sigmas are ±2.7 mm for 1971 and ±4.2 mm for 1974: errors for the 1973 and 1974 surveys are appreciably reduced compared with the 10-point analysis.

The station-vector analysis of the Adama graben network was made on the basis of an 11-point adjustment for the 1971, 1973, and 1974 surveys (for 1971, the GANTI AUX. observations are those of 1973 deweighted by a factor of 12), a 10-point adjustment for the 1970 survey (the GANTI observations of 1971 were added, deweighted by a factor of 8), and a nine-point adjustment for the 1969 survey (the 1970 BOKU observations were added, deweighted by a factor of 8).

The analysis of the Adama graben network was then repeated, using a modified free-net adjustment in which station FULCRUM AUX. was freed from constraint along the x axis. Net rotation for each survey, relative to 1974 as a reference (lacking any astronomical azimuth observations), was removed graphically, although SAO has a computer program for this purpose. A posteriori line-length sigmas are marginally reduced, as expected, compared with the classical analysis: ±2.7 mm for the 1971 survey and ±4.1 mm for the 1974 survey.

6.1.3 Apparent station vectors

Station vectors from the classical solution (Figure 6) and partial free-net solution (Figure 7) are presented for the successive surveys of 1969, 1970, 1971, 1973, and 1974. The data of Figure 7 are reproduced in Figure 8, but with the less satisfactory station coordinates of 1970 and 1973 omitted.

Annual scale changes for the Adama graben network are less than 5 × 10^{-7}, excluding an apparent 1970 scale change of 12 × 10^{-7} relative to both 1969 and 1971. [Note: In the Wolenchiti quadrilateral, discussed below, the 1970 scale is smaller than that of 1971.] As the vectors and error curves of Figures 6, 7, and 8 indicate, no significant extension nor compression acted perpendicular to the normal faults of the Adama graben during 1969 through 1974. There has, however, been possible longitudinal motion of stations GANTI and BOKU, dextral with respect to the graben western margin, at rates of 4 and 5 mm/yr, respectively, along the 220^g rift azimuth. Although these data conflict with the apparent motion of station ELPASO AUX., situated on the western shoulder of Gara Ganti, in fact the 1969 coordinates of ELPASO AUX. were less well established at the apex of a minimally redundant network.

The postulated dextral slip along the eastern margin of the Adama graben does not include the most northerly station on this margin, FULCRUM, which shows a nonsignificant sinistral motion. Although intervening transverse tectonics exist (Figure 4) that could accommodate this discrepancy, there is also the possibility that removal of rotation from the Adama network has hidden a dextral motion of station FULCRUM as well. Improvement of the geometry of the network through incorporation of station WONJI in the southwest is required to resolve this problem. However, dextral slip east of the Adama graben is rendered even more probable by the observation that lines BOKU—ROGGI and BOKU—ROGGI AUX., projecting southeast from the Adama graben network (Figure 2), show a regular extension during the period 1970 to 1974 of 3 ± 2 mm/yr along an azimuth of 157^g.

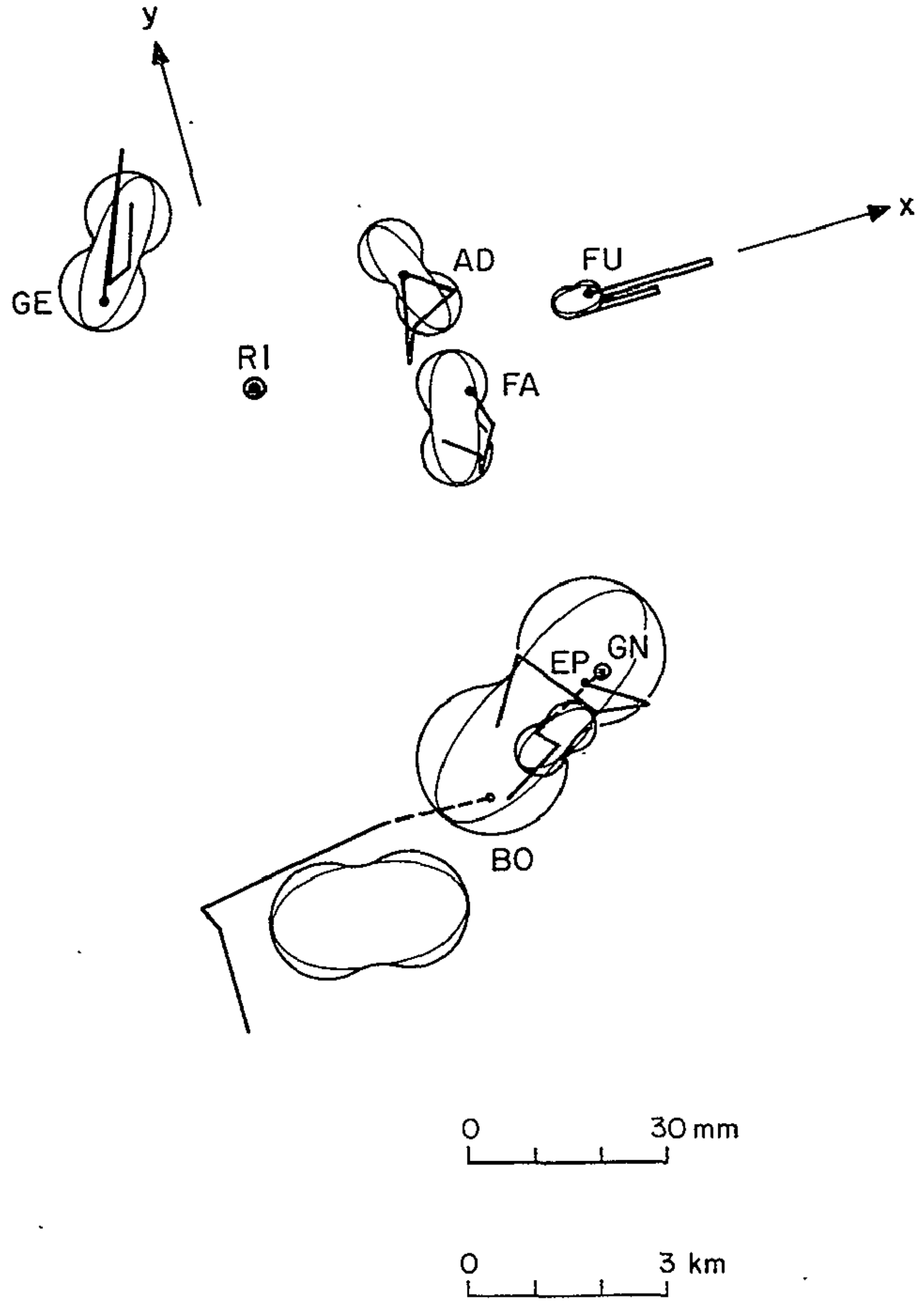

Figure 6. Adama graben network: apparent station vectors for 1969 to 1974, classical solution. Station RIDGE is fixed as the origin, and station FULCRUM is constrained to define the x axis. The error curves mark the 1σ (∿45%) confidence envelope. Vectors start from the station in the sequence 1969-1970, 1970-1971, 1971-1973, and 1973-1974.

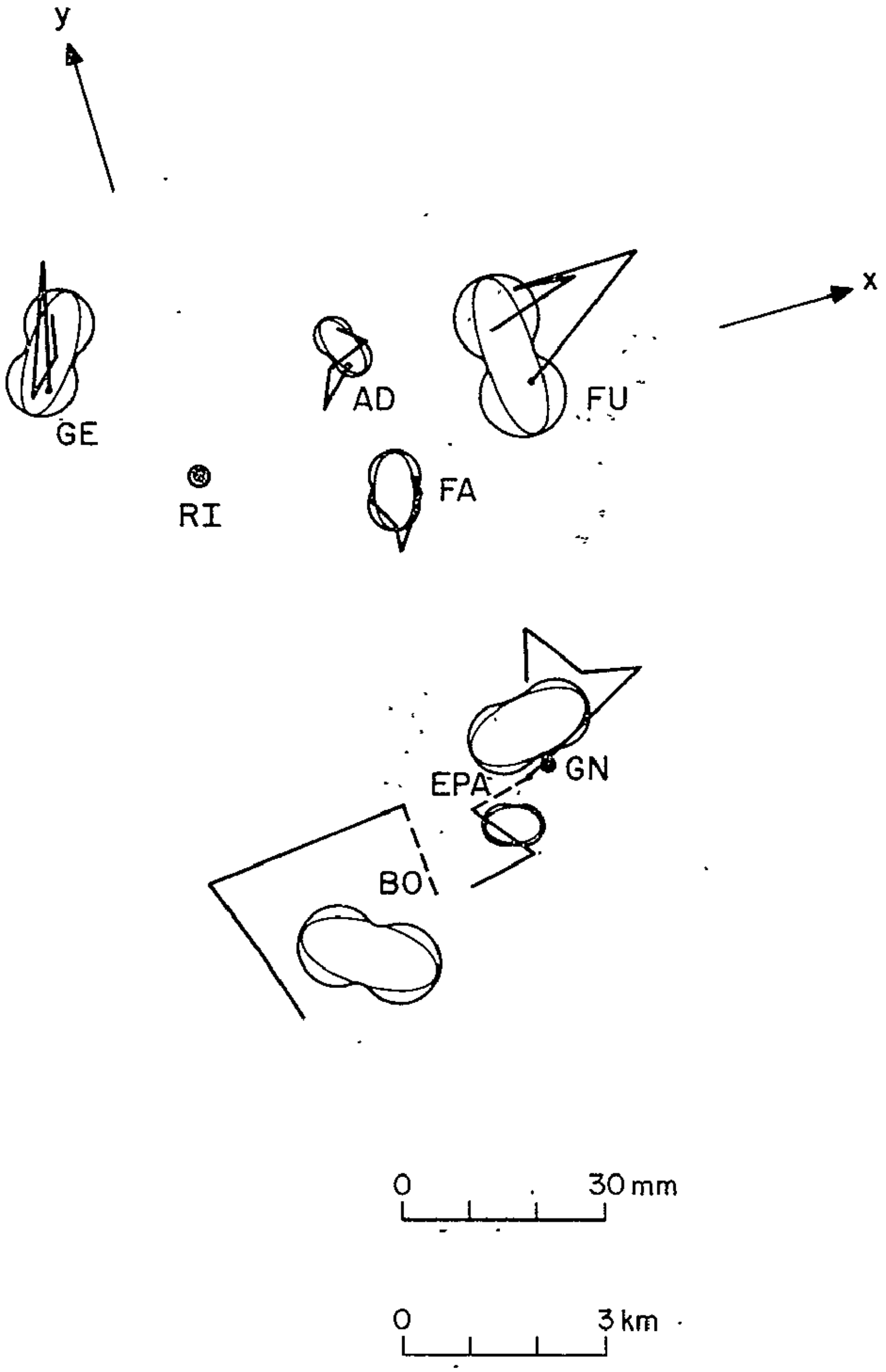

Figure 7. Adama graben network: apparent station vectors for 1969 to 1974, partial free-net solution. Station RIDGE is fixed as the origin. The error curves mark the 1σ (∿45%) confidence envelope.

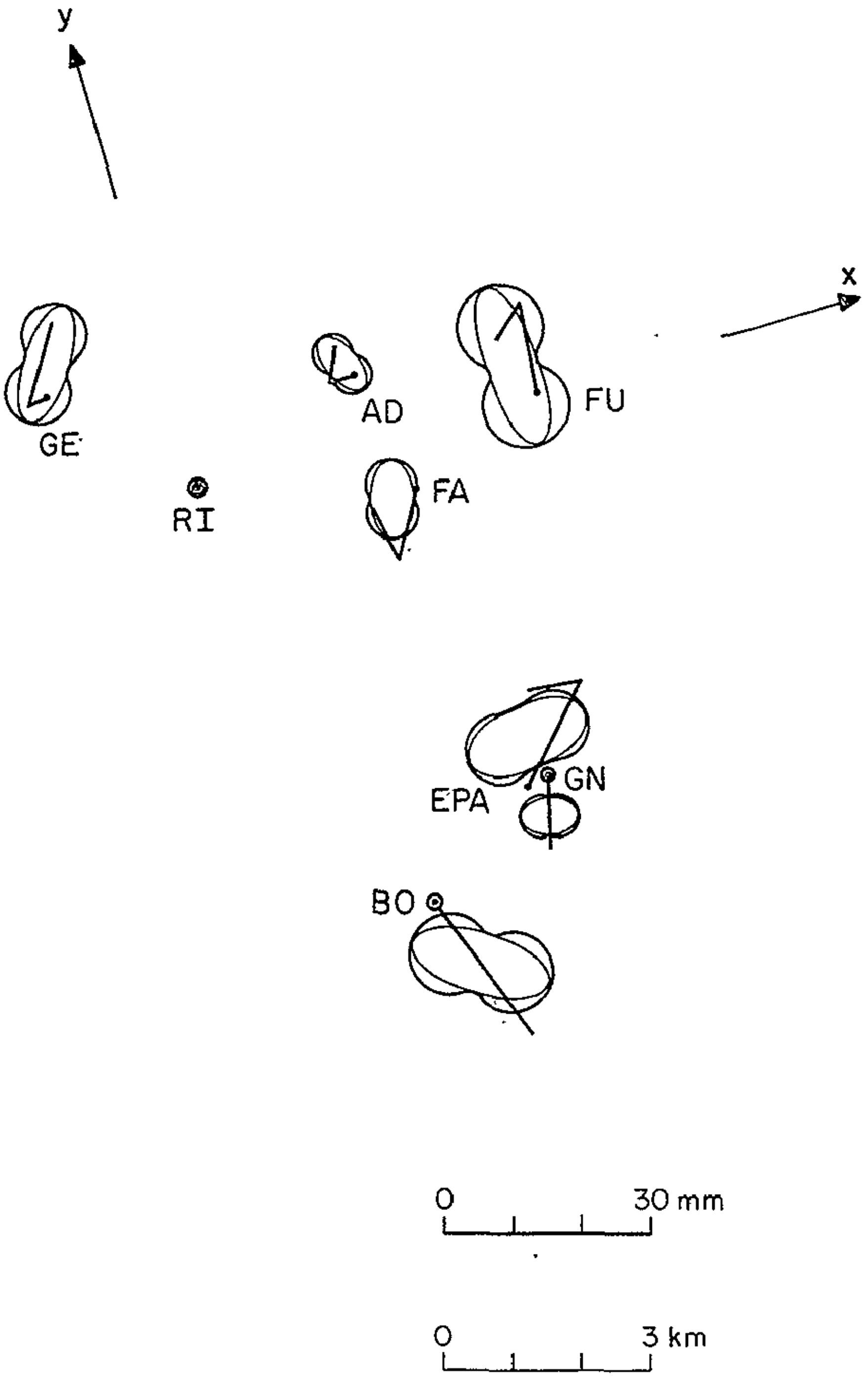

Figure 8. Adama graben network; Figure 7 modified to include only the three more reliable surveys of 1969, 1971, and 1974. Station vectors proceed from the station with the 1969-1971 vector, except for BOKU and GANTI, where there is only the one vector of 1971-1974.

Discussion of the geological significance of the station vectors and line-length changes in the Adama graben and other Ethiopian rift networks is given in Section 8.

6.2 The Wolenchiti Quadrilateral, Northern Network

6.2.1 Background

The Wolenchiti quadrilateral forms the northeastern part of the northern network, at latitude 8°40'N, near the axis of the rift valley. The quadrilateral straddles the Wolenchiti valley, a broad, flat depression bounded by the imposing volcanic massif of Boseti Gudda on the east and by the narrow Dalecha horst that separates the valley from the Adama graben farther to the west (Figure 4). The doubly braced quadrilateral comprises six links, the lengths of which range from 7 to 14 km. The four stations TABLE, MERKO,* AYGU, and RABBIT were installed as single (main) points in 1970 (Mohr, 1973a). Auxiliary points were added in 1973, one at each station, but not all the main—auxiliary lines have yet been measured.† The quadrilateral has been surveyed four times, starting with 1970.

The greatest apparent station motions in any part of the Ethiopian rift geodimeter networks have previously been ascribed to the Wolenchiti quadrilateral (Mohr, 1973a, 1974a; Mohr _et al_., 1975a), so a re-evaluation in the light of the new, 1974 survey is appropriate.

6.2.2 Network adjustment

Using the classical least-squares adjustment technique on a doubly braced quadrilateral — whereby one station is fixed as the origin, a second is constrained to define the x axis, and all the station z values (elevations) are held fixed — we have an excess of observations over unknowns of 1. This network design is thus the simplest with which redundancy can be obtained.

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* Renamed from the too light-hearted MENDENO.

† Completed in 1976.

Correspondingly, it is more susceptible to distortion from any poor or erroneous observations than are more complex polygons, such as the Adama graben or Mirrga networks.

No statistically significant biases in line lengths exist between the 1970, 1971, and 1974 surveys, but for the 1973 data, an empirical increment of 29 mm has been applied to all the lines of the Wolenchiti quadrilateral to bring them to the same scale as for the other three surveys. This problem, as well as its instrumental causes, has been discussed by Mohr (1974a, pp. 14-21).

Station TABLE, on the eastern side of the valley, has been chosen as the origin in the adjustments, and station MERKO, on the western margin of the valley, defines the x axis to which it is constrained. Line TABLE—MERKO has a geographical azimuth of 348^g (Figure 2), fairly close to being perpendicular to the 015 to 025^g trend of the Quaternary faulting of the rift floor. The two long sides of the quadrilateral, MERKO—AYGU and TABLE—RABBIT, run nearly parallel to the regional fault trend.

The mutual fit of the observations is expressed in the mean a posteriori line-length sigmas, which are ±2.5 mm (1970), ±0.8 mm (1971), ±3.2 mm (1973), and ±4.6 mm (1974). These figures are critically influenced by the fixing of the station z values. These were observed by Rolff in 1974 using a T-2 theodolite, but more precise values can be derived by freeing RABBIT - z in making the adjustment. The mean elevation of RABBIT perpendicular to the TABLE—MERKO—AYGU plane is 124.483 ± 0.005 m for the 1970, 1971, and 1973 surveys, while for 1974, the figure is 124.590 m. Since there is no geological reason for believing that station RABBIT rose by 10 cm relative to the other stations during the 1973 to 1974 interval, all four surveys have been adjusted with RABBIT - z = 124.50 m, which introduces a correspondingly greater strain in the 1974 adjustment. For RABBIT - z = 124.59, the 1974 mean a posteriori sigma reduces to ±2.6 mm: at RABBIT - z = 124.50, the adjustment applies positive corrections to the observed 1974 lengths of the diagonals

RABBIT—MERKO and TABLE—AYGU, in a manner that cannot be reconciled with the excellent observations of these lines.

6.2.3 Apparent station vectors

The apparent station vectors for the Wolenchiti quadrilateral from 1970 to 1974 are shown in Figure 9. Relative to station TABLE, station AYGU shows no significant motion during this period. Station MERKO, constrained nearly perpendicular to the rift fault trend, shows an x-component motion of 3 ± 2 mm/yr away from TABLE, or 3 ± 1 mm/yr if the lower quality 1973 survey data are excluded. The a posteriori sigmas for the TABLE—MERKO line lengths are ±2.5 mm (1970), ±0.7 mm (1971), ±0.7 mm (1973), and ±4.4 mm (1974), which combine for the intersurvey pairs as follows:

Period	TABLE—MERKO line-length change (mm)
1970—1971	4 ± 2.6
1971—1973	-2 ± 1.0
1973—1974	8 ± 4.5

If the problem-beset 1973 survey is deweighted, the apparent extension of line TABLE—MERKO becomes regular and is significant at the 80% confidence level. Note that the apparent extension of this line can be eliminated if all the 1970 line lengths are scaled up by 5 mm (double what is required to match the 1970 and 1971 scales for lines not involving station RABBIT), but this is then detrimental to the otherwise stable position of station AYGU from 1970 to 1974.

Previous studies of the Wolenchiti quadrilateral have shown that the greatest apparent motions affect station RABBIT, south of TABLE, on the Boseti Gudda lava apron. Mohr et al. (1975a) obtained vectors of 22 ± 2 mm at 206^g between 1970 and 1971 and 23 ± 10 mm at 320^g between 1971 and 1973. The apportioning of weights in the least-squares adjustment does not critically affect these data. More important is the evaluation of the GRC (Section 3.4): if this correction is omitted, then the vectors for RABBIT become 14 ± 5 mm at

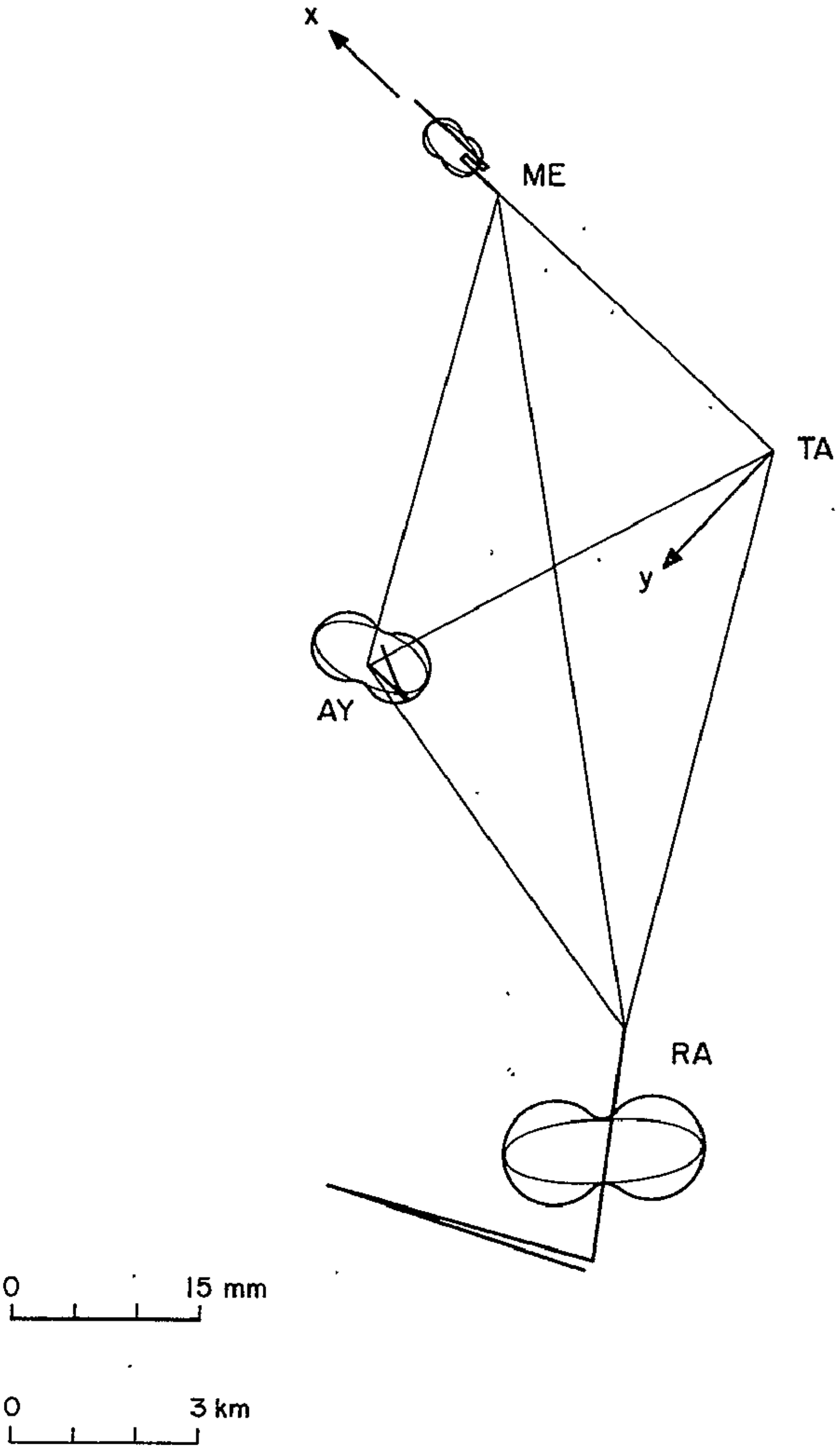

Figure 9. Apparent station vectors in the Wolenchiti quadrilateral, 1970 to 1974. Error curves show the 1σ (∿45%) confidence envelope. Vectors start from the station in the sequence 1970-1971, 1971-1973, and 1973-1974.

215^g between 1970 and 1971 and 3 ± 2 mm at 385^g between 1971 and 1973. However, experience with the GRC in other parts of the northern network gives confidence in its general validity, and indeed both a priori and a posteriori sigmas increase, in some instances dramatically, if this correction is omitted.

The results of the latest survey are revealed in the apparent station vectors shown in Figure 9. The 1974 station coordinates for RABBIT do not differ significantly from those of 1971, strongly suggesting that those of 1973 are spurious. One of the biggest problems discussed in previous accounts of the Wolenchiti quadrilateral was the violent change in the apparent vector of RABBIT from 1970–1971 to 1971–1973. In now discounting such a change, the lower reliability of the 1973 survey data is further emphasized; even more, it shows that a doubly braced quadrilateral, with its minimal redundancy, can yield overly optimistic error curves. The 1973 error ellipse for RABBIT has axial lengths of 6.5 and 1.7 mm, the long axis oriented close to east–west.

If the increment to the observed line-length means for 1973 is altered from the accepted value of 29 mm (Δd_{71-73} = 29 ± 2 mm for the Wolenchiti lines, excluding RABBIT–AYGU and RABBIT–MERKO, one or both of which is suspected to be erroneous in the 1973 survey) to 24 and 34 mm, for example, the resulting station coordinates for RABBIT and MERKO, respectively, become more consistent with the other surveys; but in both cases, the consistency is obtained at the drastic expense of the stability or smoothness of motion of the other two stations (TABLE being held fixed as origin). The 1973 line-length data are not correctable through a simple increment, and yet, before we condemn them, we recall that RABBIT - z for 1973 precisely matches that for 1970 and 1971, with 1974 being the misfit. Further resurveys and the incorporation of the auxiliary points are required to clarify these problems.

Significant motion of station RABBIT apparently occurred only during the interval 1970 to 1971. This immediately raises the question of whether the 1970 data are reliable. The 1970 line lengths for the TABLE–MERKO–AYGU triangle fit excellently with the later surveys, and although the precision of the 1970 Ethiopian rift lines is poorer than that for 1971 (see Section 3; an earlier model of the Mk8 geodimeter was employed in 1970), there seems no reason to dismiss the 1970 RABBIT data. Using the revised station elevations and line lengths, the 1970 to 1971 vector for RABBIT is 19 mm at 209^g, which yields a component of 13-mm extension along the AYGU—RABBIT azimuth. From 1971 to 1974, line AYGU—RABBIT apparently extended at the nonsignificant rate of 1.5 mm/yr.

6.3 The South Wolenchiti Valley, Northern Network

A traverse of the southern end of the Wolenchiti valley comprises, from west to east, stations FULCRUM, GRAVES, CINDER, and BOHALLA. Although there are links between the first three of these stations and AYGU and RABBIT in the Wolenchiti quadrilateral, they have been observed only once and therefore cannot be used in an analysis for crustal strain accumulation. The traverse is considered in isolation here, noting that it is virtually perpendicular to the faulting of the rift floor (Figures 2 and 4).

The FULCRUM—GRAVES link was considered by Mohr (1973a, 1974a) to show no significant line-length changes from 1969 to 1973, suppressing an anomalously 15 ± 6-mm greater length of the three lines of this link in 1970 compared with 1969 and 1971. Despite the unfortunate demise of the main point at FULCRUM and damage to GRAVES AUX., the results of the 1974 survey show conclusively that indeed there were no significant line-length changes in the FULCRUM—GRAVES link from 1969 to 1974. Recomputation of the data for the pre-1974 surveys, incorporating revisions discussed earlier, also largely removes the anomaly in the 1970 line lengths (see Table 6). Therefore, it can be said that the 1970 ground cracking near AYGU was not associated with any long-term strain change in the rift floor 9 km to the south-southwest.

The progressive line-length shortening for the GRAVES—CINDER link between 1969 and 1973 (Mohr, 1974a) did not continue into 1974. Indeed, the evidence for this apparent shortening now appears insupportable, given the similarity of the 1971 and 1974 line lengths (the latter are possibly longer than the former), pointing further to the unreliability of the 1973 Ranger measurements, in this case about 2 cm short. Because of the stability of the FULCRUM—GRAVES link, the data for both the FULCRUM—CINDER and the GRAVES—CINDER links intimate the stability of the last-named also from 1969 to 1974, although line-length errors are peculiarly large for this grazing traverse.

East of the Gara Bolalo basalt fissure line, which was active during the late Pliocene (Mohr, 1974a) and upon which station CINDER is located, the geodimeter traverse to BOHALLA encounters the Boseti segment of the WFB (Mohr and Wood, 1976). The BOHALLA—CINDER link was previously considered stable (Mohr, 1974a), but the results of the 1974 survey hint at a progressive extension of about 3 mm/yr from 1970 to 1974, or 5 mm/yr from 1971 to 1974 (Table 6). Though yet barely significant statistically, the consistency for the lines BOHALLA—CINDER and BOHALLA—CINDER AUX. (inclusive of the 1973 Ranger observations!) warrants the careful attention of future surveys for it is very similar to the extension rate tentatively determined for the northern sector of the Wolenchiti valley. This would require that the line or zone of extension jumps laterally within the Wonji fault belt.

The freshest faulting at the southern end of the Boseti segment of the WFB is traversed by the lines BOHALLA—BORI and BOHALLA—BABOON (Figures 2 and 4; line BORI—BABOON has not yet been measured). As these lines were established only in 1973, it is premature to interpret the apparent shortening of BOHALLA—BABOON by ∿1 cm between 1973 and 1974 as due to sinistral movement associated with the intervening graben faults.

6.4 The Sodere Triangle, Northern Network

The Sodere triangle comprises stations SODERE, OOLAGA, and QUILL, which form a very flat triangle oriented ESE—WNW perpendicular to the WFB faults, some 10 km south of the CINDER—BOHALLA traverse discussed above. Quaternary basalts have issued from aligned cones and buried fissures immediately north of the triangle, covering some of the WFB faults, but even the youngest lavas have themselves been cut by later faulting. The Sodere area is renowned for its prolific hot springs, fountaining from a very young fault that cuts a rhyolite dome (United Nations, 1973).

The Sodere triangle was installed in 1971 and remeasured in 1973 and 1974. We have already shown (Section 4) that the 1973 Ranger observations are mutually inconsistent, from a comparison of the triangle base QUILL—SODERE with the summed changes of lines QUILL—OOLAGA and OOLAGA—SODERE. However, the 1971 and 1974 observations pass this test with flying colors; they reveal a significant component of crustal extension, perpendicular to the WFB, of 6 mm/yr for this 4-km wide zone (Table 6). The greater part of this extension appears to be occurring between OOLAGA and SODERE, rather than between QUILL and OOLAGA, suggesting that it is the Sodere fault itself that is active.

Although the Sodere triangle is linked north to the BOHALLA—CINDER traverse and south to stations MIETCHI and SIRI, the only remeasured line is OOLAGA—MIETCHI. This line reveals no significant change in length from 1971 to 1974, implying that if the zone of extension at Sodere continues farther south, it passes east of Gara Mietchi (Figures 2 and 4). The lack of significant length change in line ROGGI—MIETCHI between 1969 and 1974 confirms this.

6.5 The Kaletta Valley, Northern Network

The west—east geodimeter traverse across the Kaletta valley, at the eastern margin of the rift valley floor, is from station MIETCHI via DUST and TOPLESS to station SELASSIE (Figures 2 and 4). The Kaletta gorge is excavated in 5-m.y.-old welded tuffs (Morbidelli et al., 1975) and declines north-northeast, parallel to the rift margin faults immediately to the east. Station SELASSIE is situated on the top of the first of four large fault blocks, which are stepped up to form the 850-m-high eastern margin of the rift there. The SELASSIE block is capped by late Pliocene basalts (Mohr and Potter, 1976).

Between Gara Mietchi and the Kaletta gorge, faults are few and small in throw and have appreciably denuded scarps. Stations DUST and TOPLESS are located on the rim of the biggest of these east-facing scarps. The Kaletta valley was once about 4 km wide and merely entrenched with meanders a few tens of meters deep, but an intervening episode of uplift resulted in the present dramatic and continuing entrenchment. Gara Mietchi is composed of rhyolite domes that have been intensely altered by hydrothermal activity along faults projecting south from the Sodere region, but without signs of any late Quaternary movements.

Stations MIETCHI and SELASSIE are about 13 km apart; DUST and TOPLESS form a closely spaced, south–north pair some 8 km west of SELASSIE and a little south of the MIETCHI–SELASSIE link. The 1973 observations (Table 6) were too short, not by the general 24-mm value applied to the geodimeter measurements in the northern network, but by about 34 mm. Unfortunately, the Kaletta valley lines have not been measured in all the surveys, and the expected stability of line DUST–TOPLESS, parallel to the faulting, rests on an acceptance of this revision to the 1973 observations. Then, lines MIETCHI–DUST and MIETCHI–TOPLESS differ surprisingly in showing no significant change in the former case, but an increment of 14 mm in the latter during the period 1969 to 1974. Accepting the revised 1973 values, the apparent extension of line MIETCHI–TOPLESS occurred during the 1973 to 1974 interval.

Lines SELASSIE–DUST and SELASSIE–TOPLESS offer a clue to understanding this disparity. SELASSIE–TOPLESS apparently <u>shortened</u> by 9 mm from 1969 to 1974, and the uncertainties in this observation and that of MIETCHI–TOPLESS are such that both could be explained by an eastward movement of point TOPLESS by $\sim$1 cm. Whether this could be local ground movement or tectonic displacement cannot be ascertained from the existing data, but the former is not unfeasible, given that the TOPLESS bolt is installed in the travertine pavement on Gara Talicha.

The interpretation of apparent TOPLESS motion is not so simple, however. Lines SELASSIE—DUST and SELASSIE—DUST AUX. show a consistent and clearly significant extension perpendicular to the regional faulting of 4.5 mm/yr during the period 1969 to 1974. Even if it were local ground movement that shifted TOPLESS eastward, line SELASSIE—TOPLESS should still show an extension of 8 (22 - 14) mm over the 1969 to 1974 interval, instead of the observed 9-mm shortening. If likely tectonic extension has occurred between stations SELASSIE and DUST, it must be amazingly localized not to have affected line SELASSIE—TOPLESS (Figure 2) or, indirectly, line DUST—TOPLESS. In spite of these severe limitations, it can still be proposed that the Sodere zone of crustal extension transposes left into the Kaletta gorge region.

6.6 The Adama-Mojjo Traverse, Northern Network

Geodimeter links connecting Adama west with Mojjo traverse the Gadamsa segment of the WFB (Figures 2 and 4). It is a region of faulting and uplift superimposed on the southern shoulder of Gara Mukie, a denuded Pliocene volcanic center that erupted the silicic tuffs now forming the bedrock of the region. The traverse proceeds west-northwest from station GEORGE, via MARIAM on an obsidian dome immediately south of the village of Tedi, to RAILWAY, east of Mojjo. Six to seven major faults are crossed between GEORGE and MARIAM, all except one being upthrown west. West of MARIAM, only a few small denuded fault scarps are crossed until reaching the basalt fissure line on which RAILWAY is located. The GEORGE—MARIAM and MARIAM—RAILWAY links are essentially perpendicular to the rift-floor faulting.

Link GEORGE—MARIAM comprises the four lines GEORGE—MARIAM, GEORGE—MARIAM AUX., GEORGE AUX.—MARIAM, and GEORGE AUX.—MARIAM AUX. All four were measured in 1969, 1973, and 1974, and two of them in 1971. The 1969 observations were unfortunately subject to large uncertainties (the 7-km distance is near the limit of operation of a Mk6 geodimeter), but there remains a consistent suggestion of a progressive extension for link GEORGE—MARIAM between 1969 and 1974 (Table 6). The total extension is 19 ± 3 mm, or a mean rate of 4 mm/yr.

Link MARIAM—RAILWAY is composed of the two lines MARIAM—RAILWAY and MARIAM AUX.—RAILWAY. The 1969 observations of these lines were subject to peculiarly large errors, perhaps due to unequal illumination of multiprism reflectors on this steep line path. Although there is a hint of a slight extension of the MARIAM—RAILWAY link, it is not statistically significant (Table 6).

The reduction of the Koka network, comprising stations PYLON, WONJI, KOKA, GALILA, THORNS, and YELLEM and well tied to the main northern network, is not given here, as no significant line-length changes are evident, at least for the interval 1971 to 1974. The network is situated immediately north of Gadamsa caldera (Thrall, 1975), straddling a sector of the WFB where the faulting is strongly and freshly developed (Figures 2 and 4). However, the progressive annual extension detected farther north at the GEORGE—MARIAM link is not found at Koka, indicating that extensional activity either is longitudinally limited or else is concentrated at the western fringe of the WFB. The Koka network does not cross the Koka Dam fault itself, which passes immediately west of the network.

6.7 The Central (Mirrga) Network

6.7.1 Background

A detailed account of the Mirrga network, its establishment, remeasurements, geology, and analysis has been given by Mohr et al. (1975b). The salient points are presented here, together with a modified interpretation of the apparent station vectors.

The Mirrga network comprises a polyhedral net at the southern end of Hora Mirrga (Lake Langano), connected along the length of the lake with two lines traversing a circular collapse structure at the northern end of Hora Mirrga (Figure 3). The southern polyhedron was begun with four stations in 1970: HOTEL, TERMITE, GALLA, and EUPHORBIA. All six interconnecting lines were measured, plus the lines to an auxiliary point 28 m east of the main point EUPHORBIA. The geometry of the network conformed to an expectation of crustal extension perpendicular to the prominent rift faulting of this region (Figure 10), but was severely constrained by station intervisibility requirements on the flat floor of the rift.

In 1971, two more stations, LANGANA and ARJO, were added south of the 1970 net. All interconnecting lines were measured except for GALLA–LANGANA, where acacia tress intervened. In 1973, auxiliary points were added at LANGANA AUX. and ARJO AUX., and by the end of the 1974 survey, these were connected to all other station main points (except for HOTEL and TERMITE) but not to EUPHORBIA AUX. nor to each other.* At EUPHORBIA, a second auxiliary point, EUPHORBIA AUX. B, was added close to the main point because of suspected corrosion of the latter. The southern Mirrga polygon was thoroughly remeasured in 1974, with multiple setups of the instrumentation for most of the lines (Figure 11). Two new stations, SHALA and HARORESA, were added west from ARJO, along the northern rim of O'a (Shala) caldera.

At the northern end of Hora Mirrga, a single line was installed across O'itu Bay in 1970, between stations O'ITU and ALUTU. In 1971, a second station, OOMAY, was established on the Basuma Peninsula (Figure 12), but it lacks intervisibility with ALUTU. To set up a network here requires the use of a boat to put new stations on the Laki Peninsula. Also in 1974, the southern Mirrga polyhedron was connected from GALLA and EUPHORBIA, the length of the lake to OOMAY.

6.7.2 Network adjustment

There is no significant scale difference among the 1970, 1971, and 1974 surveys, but the 1973 geodimeter survey is aberrant in showing line lengths to average 15.6 ± 8 mm shorter than for the 1971 survey and 18 ± 13 mm shorter than for the 1974 survey. In discussing the nature of the 1973 deviancy, Mohr (1974a) concluded that the application of a 14-mm correction to the 1973 observations was the best solution to a nigh-intractable problem. As mentioned in Section 4, however, further investigation has revealed the possible influence

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* Interconnections were completed in 1976.

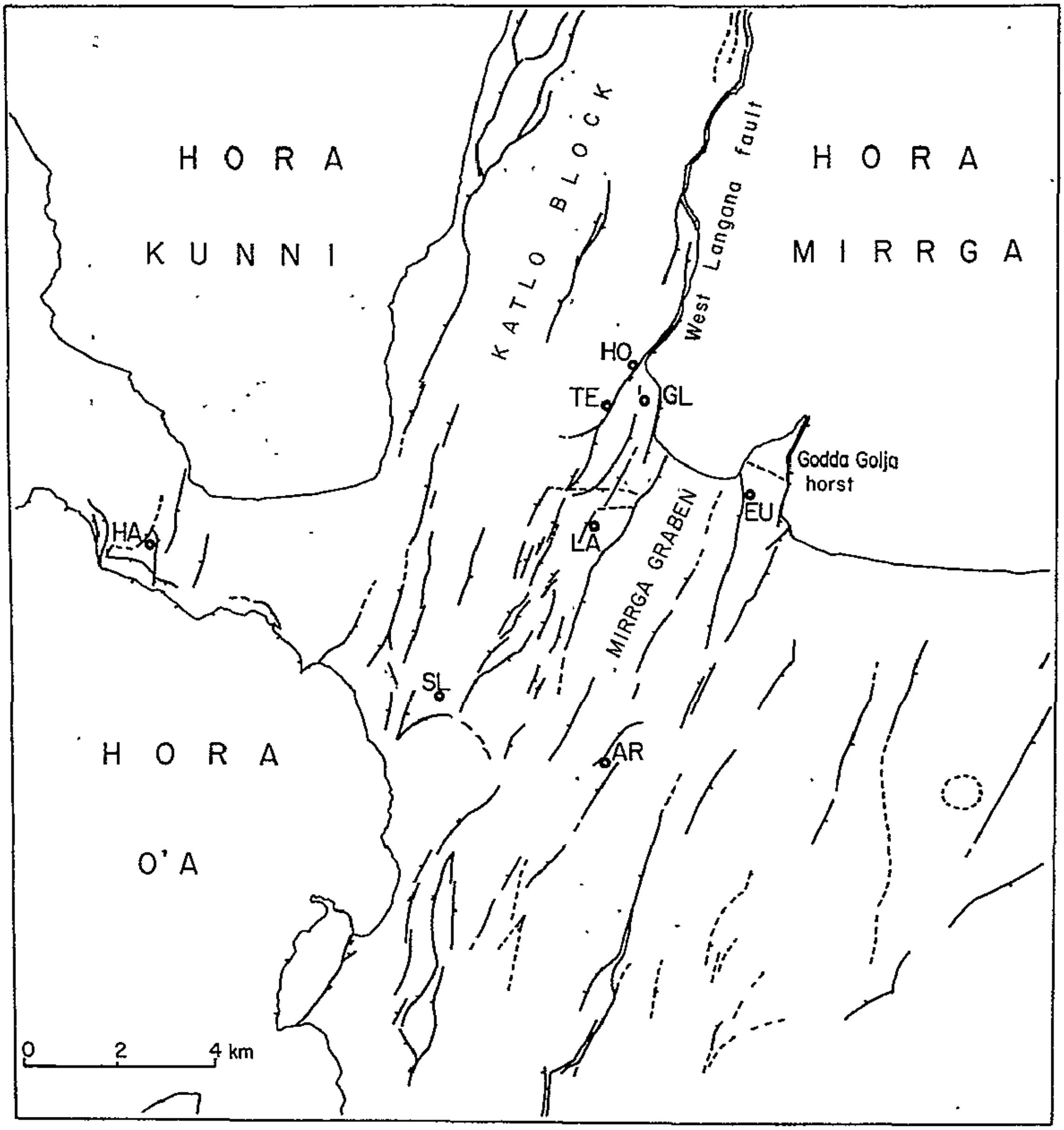

Figure 10. Southern Mirrga fault map and geodimeter stations.

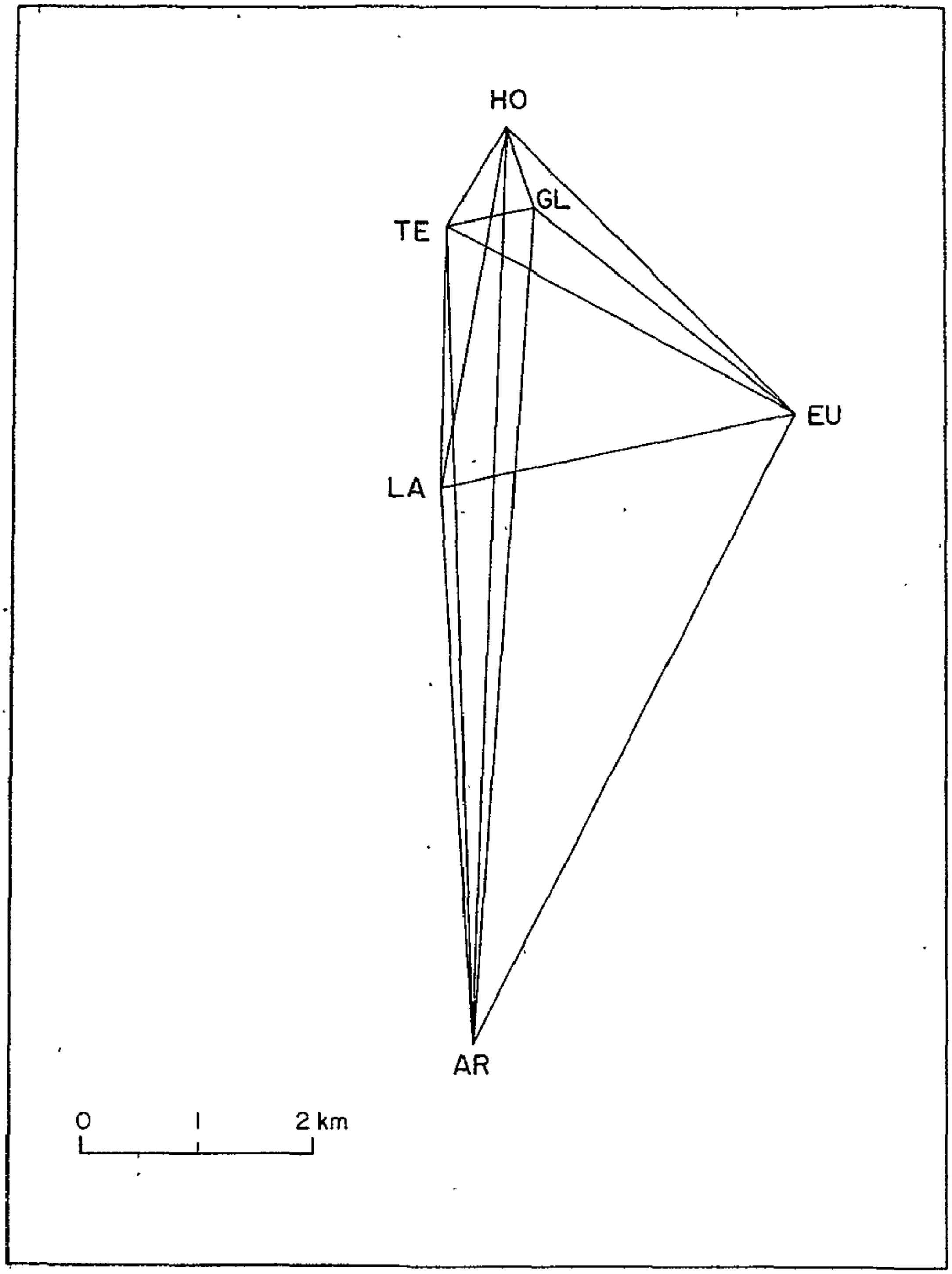

Figure 11. The geodimeter links comprising the southern Mirrga network.

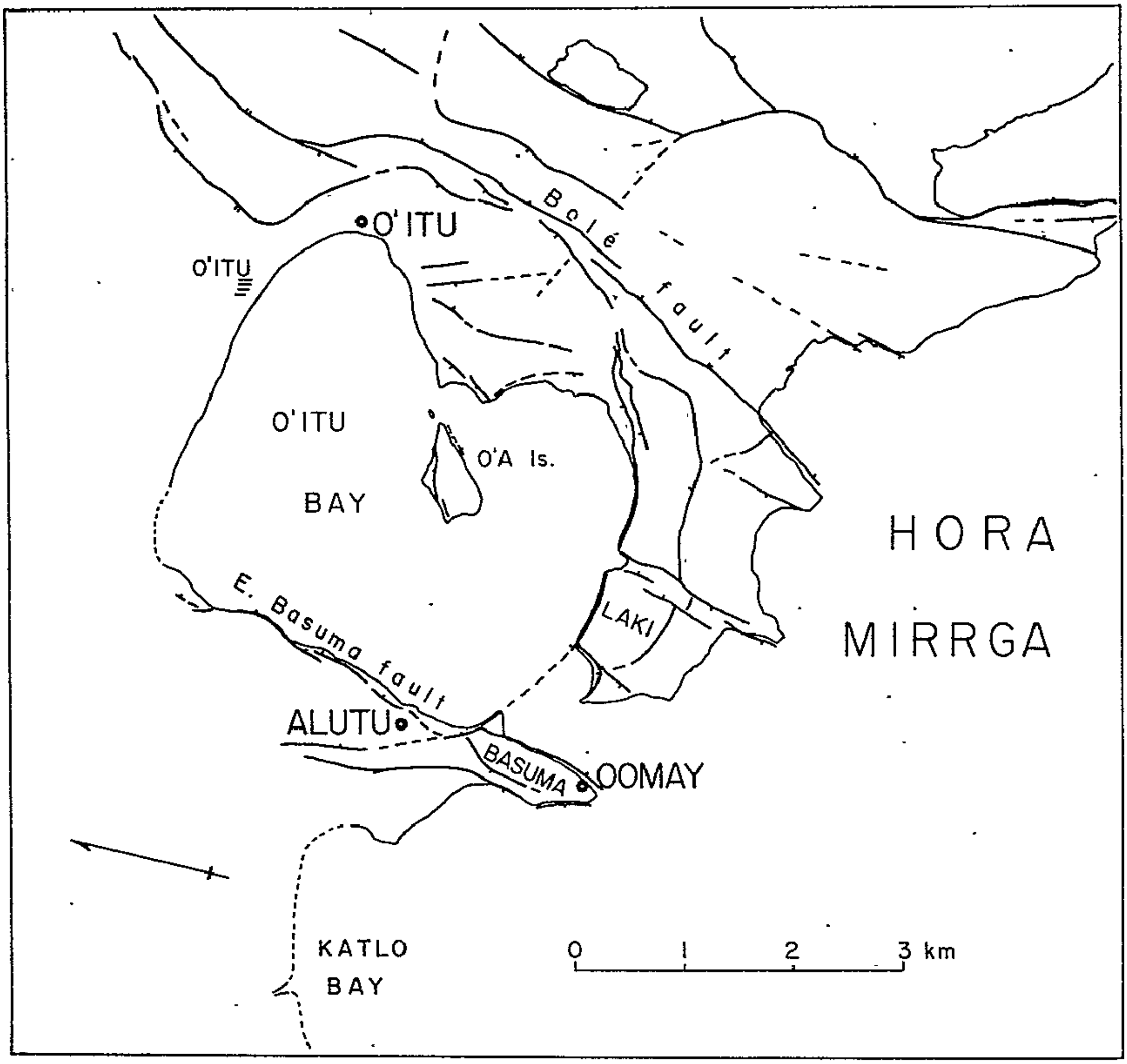

Figure 12. O'itu Bay fault map and geodimeter stations.

of ambient temperature in effecting the 1973 bias. Two sets of 1973 data were therefore used in the initial adjustments: 1973I, where the final line-length means are incremented by 14 mm, and 1973II, where the final lengths are subject to the empirically derived increment of (62 - 1.85T) mm, where T is the recorded air temperature (°C) at the geodimeter. The 1973II values give slightly superior fits in the adjustment of the Mirrga polygon, as well as a more regular progression of apparent line-length changes with time, and have been used in the analysis that follows.

The mean precision of the Mirrga line lengths, obtained from multiple-setup observations, is ±5.8 mm, being worst for 1973 (±6.9 mm) and best for 1974 (±4.6 mm). For 1974, this mean precision is an improvement over ±6.1 mm before application of the GRC.

Adjustment of the southern Mirrga polyhedron has exposed line-length observations that fit poorly with the bulk of the observations. Rescrutiny of these observations and of field notes has in some instances justified a revision of certain line lengths, listed in Mohr et al. (1975b, Table 3). It must once again be emphasized that no revision has been applied where independent support for such a revision is lacking, however pressing the need of the least-squares adjustment. A large proportion of the line-length revisions concerns point ARJO AUX., on an apex of the polyhedron and weakly linked to the rest of the network.

The first analyses of the southern Mirrga polyhedron employed station EUPHORBIA as the origin and TERMITE on the x axis to which it was constrained. The choice of this EU-TE coordinate system was guided by an expectation of crustal extension perpendicular to the faulting (Figure 10). Three adjustment schemes were investigated: 1) the main—auxiliary pairs at EUPHORBIA, LANGANA, and ARJO were allowed to adjust with virtual independence within each pair; 2) the main—auxiliary distances were fixed at their 1974 taped values, but the azimuths remained virtually free; and 3) both distances and azimuths were held fixed, the latter extracted from best fits in scheme 2 [azimuth and declination observations were made during the 1976 survey].

The results of adjustments in this EUTE coordinate system showed that, compared with a completely relaxed relationship within each of the main—auxiliary pairs, fixing the main—auxiliary distance improved the adjustment (expressed in the dimensionless sigma and in the a posteriori line-length sigmas), but that the additional fixing of the main—auxiliary azimuths tended to degrade the adjustment again (see Mohr et al., 1975b, for details). We have here an interplay between an increase in the number of "observations," and thus the degrees of freedom, which leads to a smaller sigma other conditions remaining equal, and a misfit resulting from inclusion of these merely estimated azimuth "observations." There is, of course, the real possibility of relative motion between a main and an auxiliary point, especially when the fierce solar insolation during the Ethiopian day is considered, but the installation of the steel-bolt markers in solid bedrock renders motion over such short distances unlikely.*

With the realization from the results of the EUTE system analysis, verified from further investigations using free-net adjustments, that apparent station motions in the southern Mirrga region had components along the direction of the rift faulting, the coordinate system was changed to check this out. Station TERMITE was chosen as the origin, and HOTEL, situated 1 km farther north along the shared rim of the West Langano fault, was used to define a y axis almost coincident with the EUTE system y axis. A disadvantage of this TEHO system reference frame is the short length of line TERMITE—HOTEL itself. Not only will inaccuracies in the measurement of this line proportionately affect the network solutions for the other stations, but any actual motion of HOTEL perpendicular to the y axis will cause a marked apparent rotation of the other stations. Until additional stations are established on the same fault rim as for TERMITE and HOTEL, or line TERMITE—HOTEL is given an astronomical azimuth, we are left with the arbitrary removal of any net rotational vector of the Mirrga polyhedron about the origin at TERMITE. That removal was not completed by Mohr et al. (1975b) and results in the modified strain-field interpretation given below.

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* This unlikelihood is confirmed from 1976 survey observations.

6.7.3 Apparent station vectors

Apparent station vectors are presented here for the EUTE, free-net, and TEHO reference frames (see Figures 13, 14, and 15). The motion of station HOTEL, previously considered to mark a gradual outward tilting of the rim of the West Langano fault eastward (Mohr, 1973a, 1974a), is now seen to be part of an equidimensional contraction of the HOTEL—TERMITE—GALLA triangle (Figures 13 and 14). The apparent rate of shrinkage of the triangle averages 3 mm/yr at the apices, or a strain rate of $10^{-5.2}$/yr for this area.

The revised TEHO system vectors (Figure 15) make the concept of progressive dextral shear along the West Langano fault less attractive (cf. Mohr et al., 1975b). The mean south-southwest component of motion of stations GALLA, LANGANA, and ARJO relative to TERMITE and HOTEL is revised from 4 ± 1 to 7 ± 5 mm/yr, clearly much closer to the limits of significance. Indeed, station EUPHORBIA is now seen not to be participating in such dextral motion relative to the West Langano fault, and the apparent motion of GALLA may be restricted to the shrinkage mentioned above. We are therefore left with a westerly motion of station LANGANA at 8 mm/yr, perpendicular to the rift faults and best expressed independently of the HOTEL—TERMITE—GALLA triangle shrinkage in the free-net analysis (Figure 14), and with a southeast motion of station ARJO at a mean rate of 11 mm/yr, again for the interval 1971 to 1974, although the ARJO error curve suggests that only the southerly directed component of this motion may be significant.

At the northern end of Hora Mirrga, the two lines O'ITU—ALUTU and O'ITU—OOMAY traverse O'itu Bay and the East Basuma fault (Figure 12) at azimuths of 082 and 062^g, respectively, oblique to the 020^g trend of the Wonji fault belt in this region. The geodimeter data show a regular annual lengthening of line O'ITU—ALUTU, at a rate of 5 ± 2 mm/yr from 1970 to 1974. Ignoring what may be a spurious 1973 observation, line O'ITU—OOMAY shows a lengthening of ∿3 mm/yr during the period 1971 to 1974.

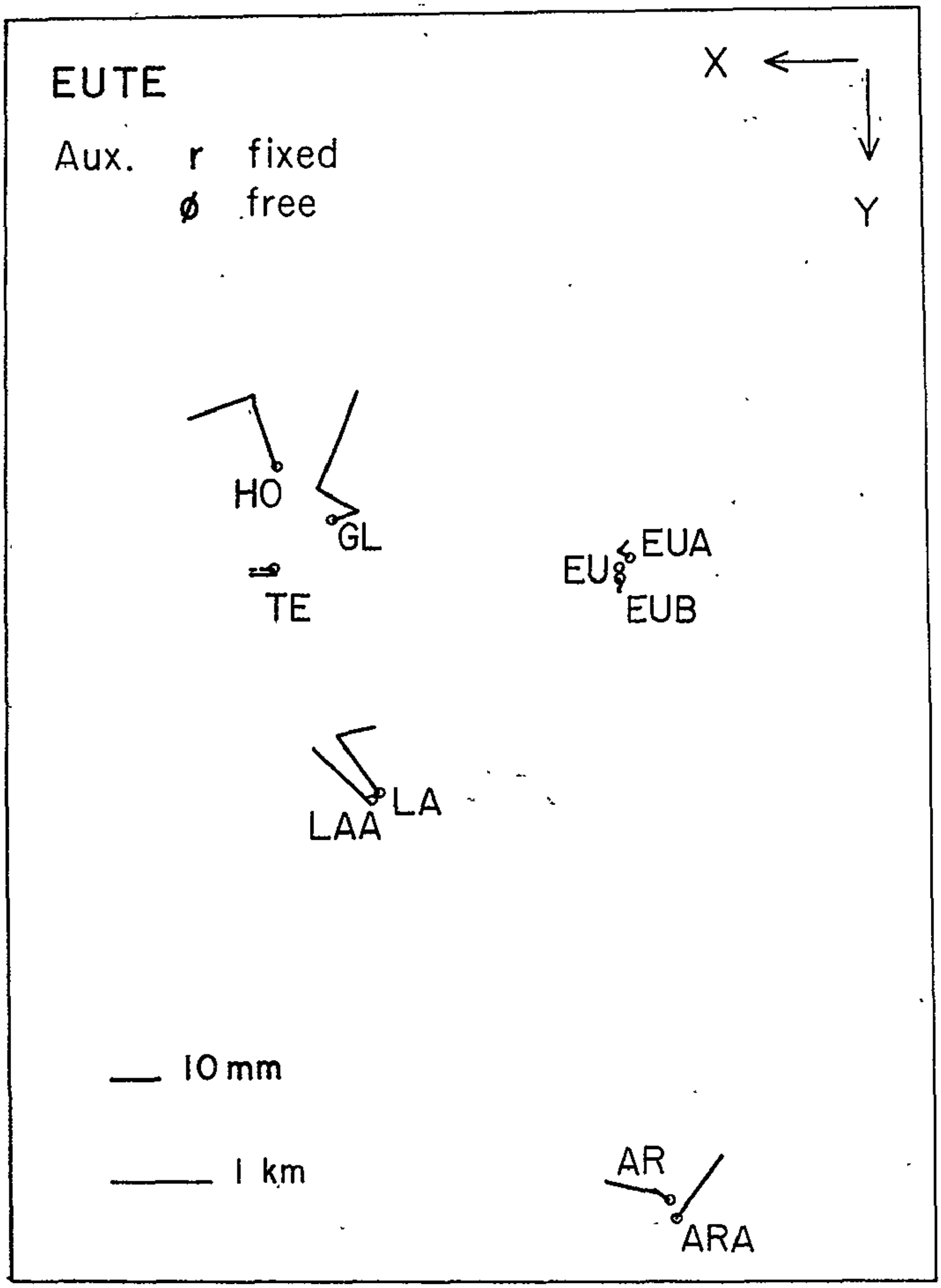

Figure 13. Southern Mirrga: apparent station vectors (directed into the stations), EUTE reference frame. The vectors are successively for the periods 1970-1971, 1971-1973, and 1973-1974 (only the last two at stations LANGANA and ARJO and the last one for LANGANO AUX. and ARJO AUX.).

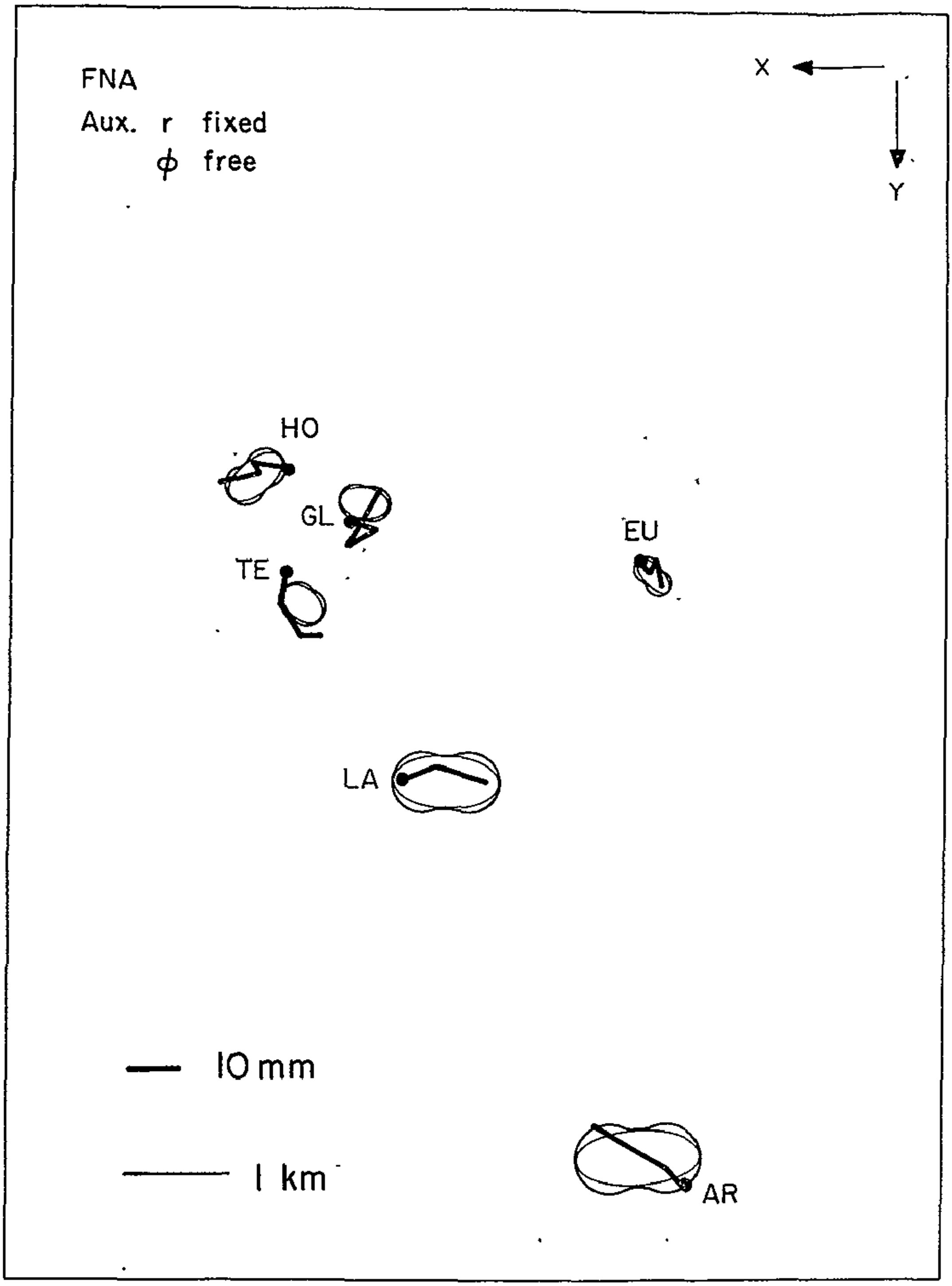

Figure 14. Southern Mirrga: apparent station vectors (directed into the stations), free-net reference frame. The error curves are double the size used elsewhere in this report and represent the 2σ (∿85%) confidence envelope. Time intervals are the same as for Figure 13.

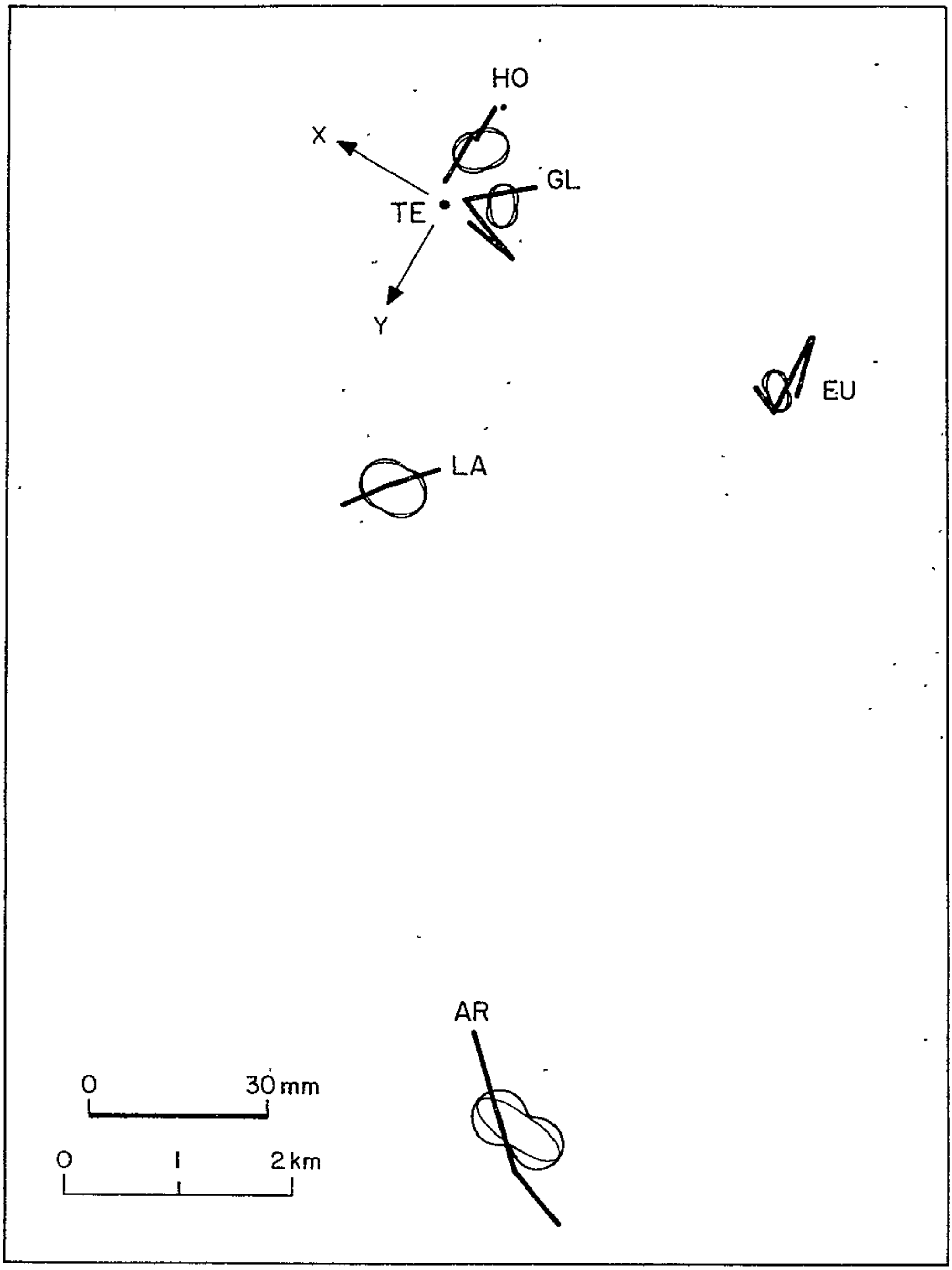

Figure 15. Southern Mirrga: apparent station vectors (directed out from the stations), TEHO reference frame. The error curves show the 1σ (∿45%) confidence envelope. Time intervals are the same as for Figure 13.

6.8 The Eastern Afar Networks

During Project TIKDEM, two simple nets were established in eastern Afar, traversing the Dobi and Guma gräben (Figure 16). In both instances, the nets are singly braced quadrilaterals (the second brace has no line of sight), providing an undue gap between the ideal and the possible configuration; it was the best that could be done with the equipment and time available. It is hoped that we can remeasure and expand the Afar networks in the not too distant future.

The Dobi and Guma gräben are situated amidst the tectonic complexities of eastern Afar, but it can be remarked that the regional northwest—southeast alignment of the Dobi graben is offset 30 km west from the northwest-projected axis of the actively spreading Asal graben in T.F.A.I. (Centre d'Etudes Geologiques et de Developpement, 1974; Needham et al., 1976). The Dobi and Guma gräben both show very sharply preserved fault scarps along their margins, and some reactivation may have occurred in association with the large 1969 Sardo earthquakes, centered 25 km west of central Dobi (Dakin et al., 1971; Gouin, 1975). Gulf of Tajura earthquakes have been reported to be felt in the Dobi-Guma area.

Although the graben faults are essentially normal in character, Mohr (1971a), in analyzing the fracture pattern of the Dobi graben, concluded that it implied a minor component of sinistral longitudinal shear, afterwards borne out by the observed fault-plane slips in the Sardo earthquakes (Dakin et al., 1971). Despite the limitations of our network geometry, the resolution of the proportion of longitudinal and extensional components in future ground motions should be feasible.

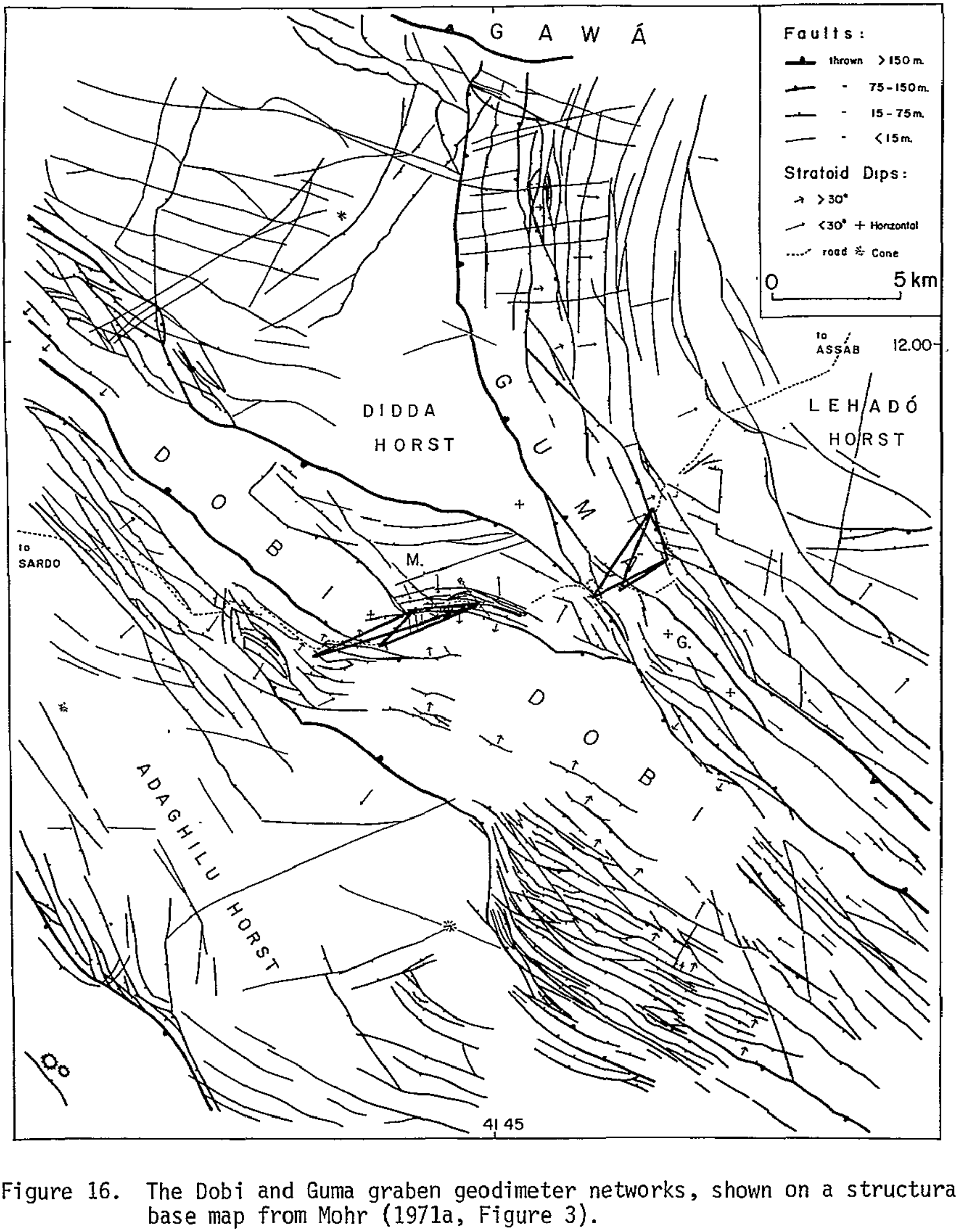

Figure 16. The Dobi and Guma graben geodimeter networks, shown on a structural base map from Mohr (1971a, Figure 3).

7. GEOLOGY

7.1 Geology of the Northern Network Region

7.1.1 General discussion

The Geological Survey of Ethiopia is currently preparing a 1:250,000 geological sheet map of the Nazareth (Adama) sector of the rift valley. Until this official sheet is complete, there remains much redundant terminology in the stratigraphic and tectonic ascriptions of different authors recently writing on rift geology. Here we shall concentrate on the structures and rock units themselves, briefly noting the multiplicity of terminology.

Although volcanism on the plateau began between 28 and 22 m.y. ago, both east of the present rift valley (Morbidelli *et al.*, 1975; Kunz *et al.*, 1975) and to the west (Zanettin *et al.*, 1974; Jones and Rex, 1974; McDougall *et al.*, 1975), the oldest rocks found exposed inside the rift margins in the Adama region are welded ash-flow tuffs dated at around 5.3 m.y. (Mohr, 1974a; Morbidelli *et al.*, 1975). Such rocks are exposed, for example, at the lowest level in the Kaletta valley along the eastern side of the rift floor, and on the southern slopes of Mt. Mukie, between Mojjo and Adama. These rocks would be ascribed to the Balchi Series of Justin-Visentin *et al.* (1974), the Nazareth or Pre-Wonji Series of Pilger and Rösler (1974), and the Twit Series of Mohr (Mohr and Gouin, 1967). The Mukie ash-flow tuffs extend east at least as far as the Wolenchiti region; the subsequent development of the Wolenchiti basin and Boseti Gudda volcano has hidden the easterly limit of their extent. The source of the old ash-flow tuffs in the Kaletta and Awash (Sodere) valleys is not known but probably was on the present plateau rim, most likely from an early, pre-rift eruptive phase of Chilalo volcano.

Silicic centers initiated later than Mukie were active in many parts of the present rift floor, prior to the faulting of the Wonji fault belt. The WFB was formed, according to Pilger and Rösler, between 1.8 and 1.6 m.y. during the "Nazareth taphrogenetic phase." These silicic centers include the Gadamsa and Boku calderas (Thrall, 1975), the Bishotfu caldera (Dakin, 1977), and perhaps the now partly buried caldera on Boseti Gudda (Brotzu et al., 1974), all on the rift floor. Although no radiometric ages are yet available, an age range of 5 to 2 m.y. is presumed. The Chilalo and Badda centers continued to be active on the eastern margin of the proto-rift throughout this time (Kunz et al., 1975; Mohr and Potter, 1976), erupting both basalt and trachyte in company with Wachacha and Yerer trachytes on the western margin (Miller and Mohr, 1966; Morton and Rex, 1975). Thus, before the rift valley graben had been formed, there was widespread silicic volcanism across the entire region, between latitudes 7° and 9°N, during the late Pliocene—early Pleistocene. Restricted basaltic volcanism during this time formed, for example, small lava fields immediately southwest of Adama and in the Bofa region. These "Welenkiti basalts" of Pilger and Rösler (1974) are ascribed by these authors to the post-WFB Wonji Series, but a single radiometric analysis has given an age of 3.5 ± 0.9 m.y. (Mohr, 1974a). The basalts are certainly cut by the youngest WFB faults.

The margin faults of the rift valley at Sire, on the eastern side of the rift, must have formed later than 1.9 m.y. ago according to radiometric ages of the faulted volcanics (Morbidelli et al., 1975). Although this may date only the final episode of the awesome rift-margin faulting, nevertheless it indicates contemporaneity with the initiation of the WFB (Pilger and Rösler, 1974; Barberi et al., 1975).

After the formation of the WFB, volcanism continued but with a strong tendency to localization upon the fault belt itself. Both flood alkali basalt-mugearite and trachyte-pantellerite lavas (Brotzu et al., 1974) have been erupted since 1.6 m.y. on the southern terminus of the Boseti segment of the WFB and on the Gadamsa segment south of Gadamsa caldera (Di Paola, 1973; Mohr and Wood, 1976).

Clastic lacustrine sediments with accumulations in excess of 50 m (the maximum exposed) were deposited in tectonic troughs to the east and west of the fault-sliced southern shoulder of Mt. Mukie, and more thinly on the shoulder itself. The precise age of these ?Pliocene—Quaternary sediments is not well known (Taieb, 1974), but must be essentially older than the youngest, weakly welded ash-flow tuffs and basalts-mugearites and yet, in part at least, younger than the WFB whose faults they blanket. Faults that cut Holocene sediments are distinctly rare, even along the WFB axis, where such displacements are seldom in excess of a meter. The faulting of the rift floor is therefore revealed to have been episodic: whether this is the result of episodic short-term or of continuous long-term strain accumulation is not yet known.

7.1.2 The Wolenchiti valley

The Wolenchiti quadrilateral covers a near-planar valley, termed here the Wolenchiti valley or basin. The valley is bounded by the Boseti volcanic massif to the east and the Dalecha horst to the west, which in turn forms the eastern boundary of the Adama graben (Figure 4). It is a NNE—SSW elongated, saucer-shaped depression of internal surface drainage. Wolenchiti town lies on the northeastern rim of the basin, whence there is a rapid topographic decline northeastward down into the Tabo valley, presaging approach to the Afar depression.

On the eastern side of the Wolenchiti basin, the volcanoes of Boseti Guddà and Boseti Baricha rise to about 1000 m above plains level. Baricha is situated 7 km north-northeast of Gudda, and both are located on a major, north-northeast-trending line of fracturing that obliquely traverses the rift floor (Brotzu <u>et al</u>., 1974; Mohr, 1974b). Brotzu <u>et al</u>. recognize two episodes in the evolution of the volcanic complex: an earlier, stratovolcanic cone with a 4-km-diameter summit caldera has had superimposed on its eastern flank a pile of younger lavas and subordinate pyroclastic rocks. In each episode, there has been a petrochemical evolution from less to more silicic pantellerites with time (see also Dakin and Gibson, 1971). Brotzu <u>et al</u>. (1974) consider that the first episode was associated with a northeast-trending tectonism and the second, with a north-northeast trending tectonism, although they do not exclude contemporaneous interplay at Boseti Baricha. The same authors obtained a K-Ar age from a near-summit lava on Boseti Gudda of 1.6 ± 0.3 m.y., suggesting the upper time limit to the second volcanotectonic episode.

Associated with the earlier episode of Boseti silicic volcanism is the appearance of the Jinjimma cone, on the outer northern slopes of the caldera. Alkali basalts of transitional affinity (Brotzu et al., 1974) built up this cone and issued forth as a thick, 1-km-long flow reaching to the edge of the present site of Wolenchiti town. Geodimeter station TABLE is situated on this flow. Jinjimma cone, like the earlier Boseti massif in general, has been sliced by the north-northeast faulting associated with the later volcanic episode. The largest fault cutting the cone is upthrown east by more than 100 m on topographic evidence alone, and the exhumation of the cone on the eastern side of the fault proves at least a further 100-m burial of Jinjimma by the sediments of the Wolenchiti basin (Figure 17). The minimum total throw is therefore 200 m. The youngest volcanism of the Boseti chain post-dates the main north-northeast fault episode(s): dark mugearites issued from vents on the saddle between Gudda and Baricha and flowed north around both the eastern and western flanks of Baricha. Similar lavas erupted from fissures in the Tabo valley, north of Boseti Baricha; these lavas are cut by some very fresh faults, and there are native traditions of earthquakes felt here during the last 50 yr.

On the western side of the Wolenchiti basin, the Dalecha horst is irregularly developed along its length (Figure 18). The throw of the east-bounding fault varies from a few to about 100 m; where the throw is greatest, a lip or apex is superimposed on the horst rim (Mohr, 1973b). The horst is composed of welded rhyolitic ash-flow tuffs, although in the vicinity of geodimeter station MERKO, they include darker, possibly hybrid rocks that may be intrusive into the tuffs. The welded tuffs comprising the Dalecha horst, and forming the exposed bedrock of the entire Adama region, probably emanated from the Mukie center 15 km due north of Adama. Pilger and Rösler (1974) and Meyer et al. (1975) ascribe these rocks to their Nazareth Series, for which they estimate an age range of 5 to 2 m.y.

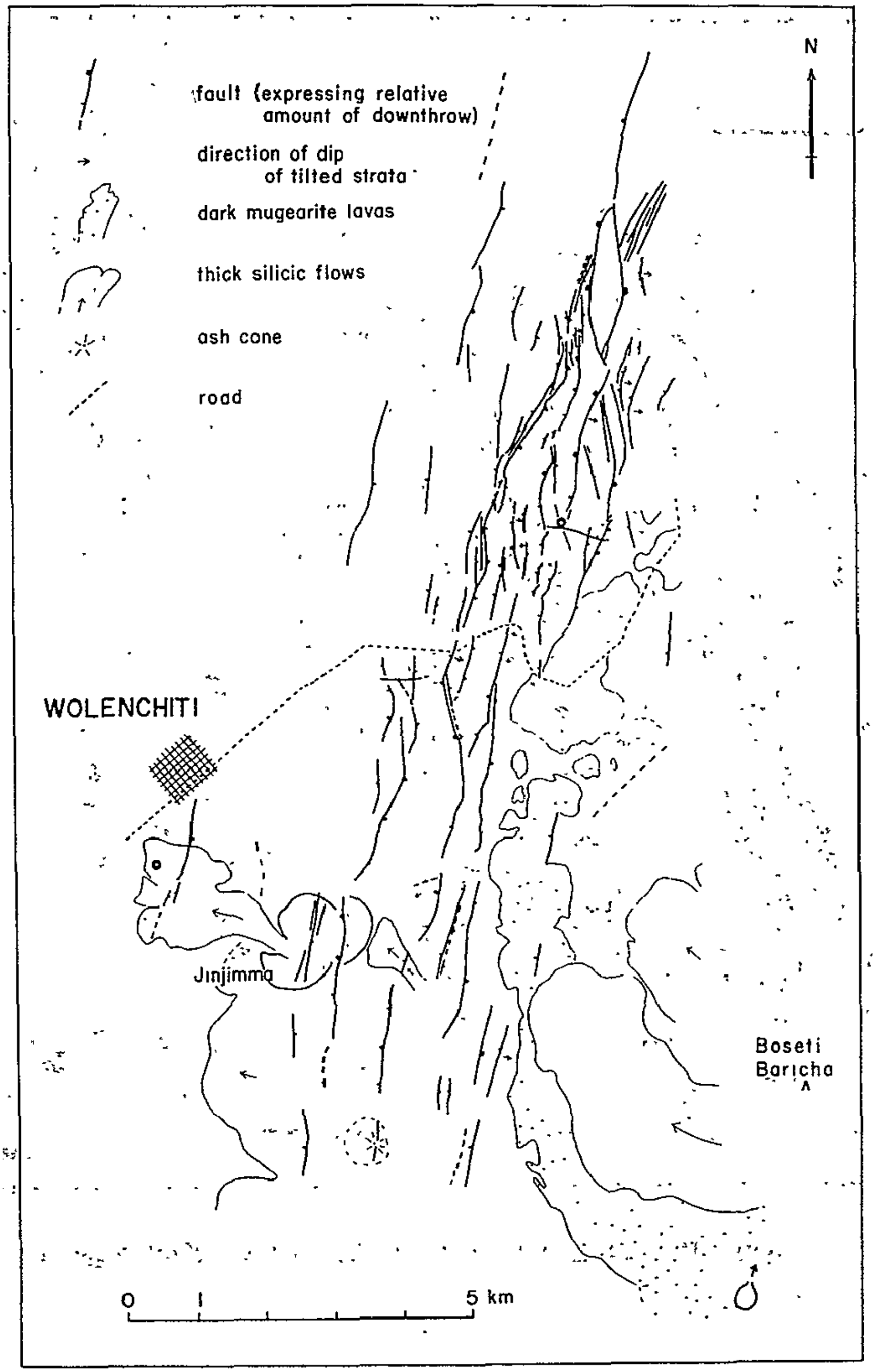

Figure 17. Structural map of the Wolenchiti region.

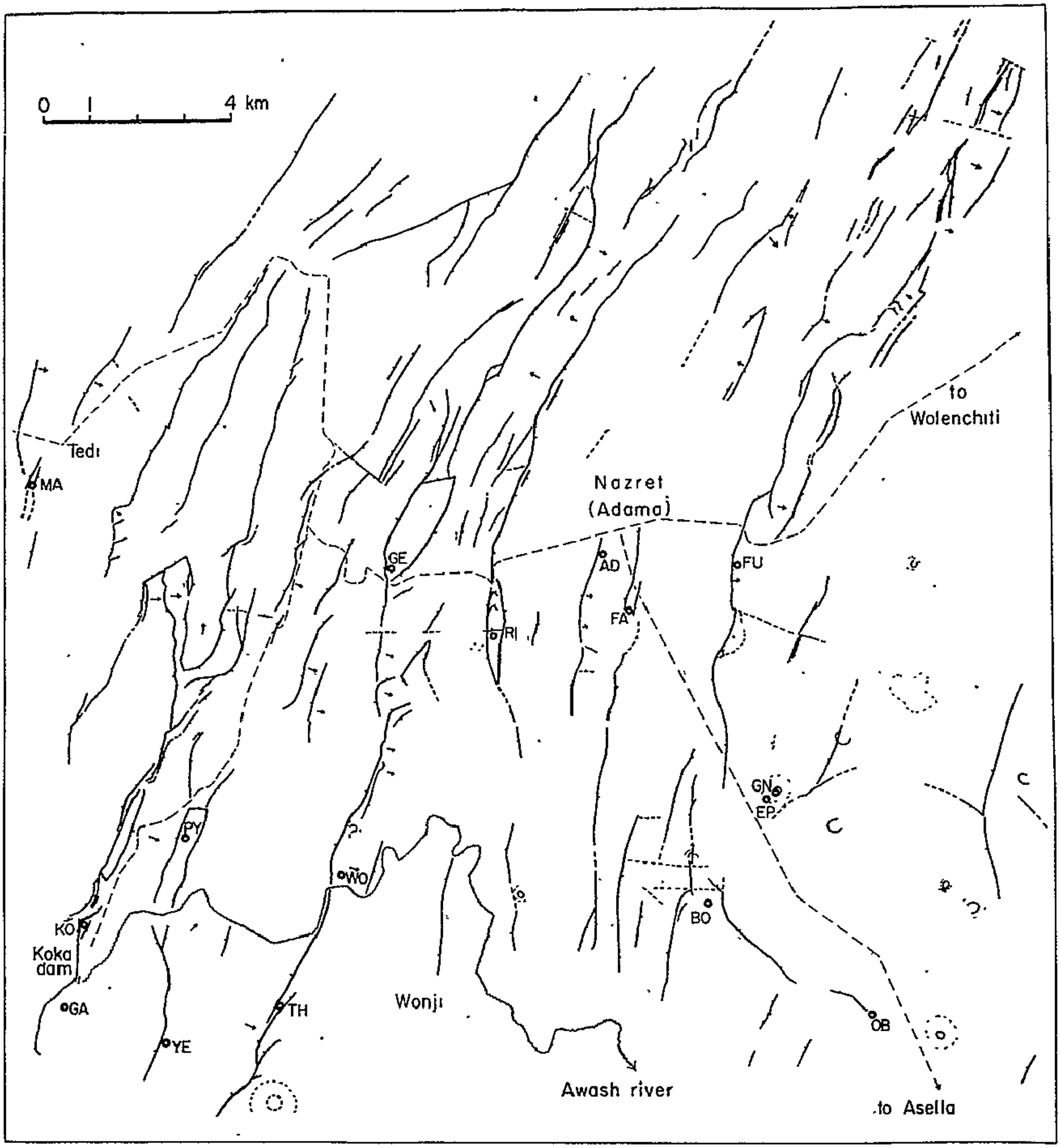

Figure 18. Structural map of the Adama graben region.

The Dalecha horst and Adama graben are situated where the WFB is offset east from the northern termination of the Gadamsa segment into the Boseti segment of that belt (Mohr and Wood, 1976). The offset can be approximately located at the southern end of the Wolenchiti basin, where a low basaltic shield extends east-southeast from near Adama to Bofa (Figure 4; Pilger and Rösler, 1974). The faulting of the Boseti sector of the WFB is complex and includes parallel or subparallel fault units within the belt. Thus, south of Boseti Gudda, two units of faulting 4 km apart trend 025^g via Bofa and the Ghilli plains of the Hera region (Figure 4). But north of Boseti Gudda, an intensely faulted unit, within which geodimeter station TCHEESA is situated, trends 010 to 020^g along the western side of the main Boseti volcanic axis: a map of this faulting is presented in Figure 17.

The Tcheesa fault unit, as it can conveniently be termed, runs along the margin between the Mukie volcanic massif to the west and the Tabo valley to the east. The fault density may reach 10/km. Prominent features are a 500- to 1000-m-wide graben along the western side of the unit crossed obliquely by two lozenge-shaped horsts in the north. The horsts are composed of massive flood basalts that remain horizontal; but elsewhere, and particularly along the eastern side of the graben, the faulted blocks are tilted down east. The horsts intersect a zone of very intense slicing, which is offset dextrally at the horsts in possible association with a subset of north-northwest faulting (Figure 17). The detailed stress field that caused this fault pattern has not yet been elucidated. The faulting produced a drastic change in the drainage pattern, but in its turn has now had its scarps appreciably denuded and partially buried by sedimentation. However, some of the faults have evidently been renewed in post-sediment times and even postdate superimposed obsidian-crusted welded-tuff domes, as at Gara Chisa (Tcheesa).

The Wolenchiti basin itself is remarkably free from visible fault displacements. Solid-rock exposures in the basin are restricted to the drainage gullies around the fringes of the basin, notably on the western side below the Dalecha horst. There moderately sorted, indurated silts and sands are observed to dip east toward the axis of the basin at 15 to 20^g. This is much steeper than the surface slope of the valley, indicating subsidence of the Wolenchiti basin at some time(s) during the general sedimentation episode. Near geodimeter station MERKO, the tilted silts become strongly bedded and contain layers of coarser, gravelly material and large angular blocks of basalt of possible but unidentified maar origin. The age of the sediments is not yet known but may lie in the 300,000- to 200,000-yr interval (see Gassé, 1975). In the southeastern part of the Wolenchiti basin, thick pumiceous deposits appear to have been derived from Boseti Gudda, carried by the prevailing northeasterly winds.

The Wolenchiti basin is subject to episodic local ground cracking and subsidence, to the extent that the Chemin de Fer has sought to reroute the Adama-Metahara sector of the line out of the basin. The penultimate 1970 episode occurred about 3 km southeast of geodimeter station AYGU, precisely on a north-northeast projection of a minor horst on the basin floor, 2 km to the south-southwest. The cracks invariably appear near the end of the rainy season (August). They tend to be precisely linear and may exceed 100 m in length. The majority trend north-northeast, parallel to the rift-floor faults, but a second set of cracks may be developed near-perpendicular to these. No large (>1 cm) horizontal displacements are observed across or along the cracks, but vertical subsidence of as much as several meters suggests subsidence into underground drainage tunnels. Gouin and Mohr (1967) consider that any such tunnels are ephemeral — otherwise, subsidence would continue to occur with each successive rainy season — and that their excavation must follow upon tectonic movement (see also Gouin, 1971). However, Prof. J. R. Underwood (written communication, 1974) states that he has observed polygonal fracture systems in playas of western Texas, where lowering of the water table due to continued drought causes drying and shrinkage at depth. Within a day of severe rain, these Texan fractures develop into fissures along lines of water-seepage erosion. The polygonal pattern is modified near graben margins, to become linear and parallel to the bounding faults.

Microseismic and geodetic measurements offer the best means of resolving the problem of whether the Wolenchiti ground cracks are due to dessication alone or whether they have tectonic precursors. Nevertheless, it has to be admitted that the tectonic hypothesis is not favored by the stability of geodimeter station AYGU (Section 6.2.3), situated only 2 km from the 1970 ground cracks.

In summary, the geological evolution of the Wolenchiti region proceeded as follows: the eruption of the Balchi/Nazareth rhyolitic welded tuffs from the Mt. Mukie center began about 6 m.y. ago. These rocks now form the basement of the Adama graben, including the Dalecha horst. Early faulting of the rift floor was then accompanied by effusion of flood basalts, comprising the older Wonji Series of Pilger and Rösler (1974) and exposed, for example, in the Bofa region and on the western margin of the Tabo valley. The first stage in the ensuing buildup of Boseti Gudda volcano was terminated by caldera subsidence; it is likely that the buildup of Boseti Baricha started with the second stage of volcanism at Boseti Gudda. Near the time of termination of this silicic volcanism, about 1.6 m.y. ago, there was intense normal faulting along the en-echelon sectors of the Wonji fault belt, including the Boseti volcanic line. Very fluid mugearites have been erupted since the major faulting episode, from the Boseti saddle whence they ran down into the Tabo valley, but the youngest faults displace even these mugearites. The Wolenchiti valley may have originated as a moat due to crustal loading from the growth of Boseti Gudda, since which time it has undergone progressive subsidence and sedimentary infill, possibly in response to on-going extensional tectonism transferred to this new line of crustal weakness.

7.1.3 The Adama graben

The stratigraphy of the Adama graben is best elucidated from exposures made in new road cuttings between Tedi and Adama. There is a triparite sequence:

3. Weakly welded tuff, thicker and more crystal-rich in east. 2 to 4 m.

2. Massive pumiceous sediments with occasional well-bedded horizons and paleosols. 10 to 20 m (thickening east, but also thickens to 50 m west beyond Tedi).

1. Strongly welded tuff. 40 m +, base not exposed.

Although units 2 and 3 have been eroded off the horsts and higher blocks, all three are presumed to lie beneath the Adama graben. The succession within the graben is complicated by feldspar-phyric basalts that issued from vents on the subsequent western margin of the graben. The basaltic eruptions commenced near the termination of sedimentation of unit 2, but they appear to have continued after deposition of welded-tuff unit 3 to yield a maximum thickness exceeding 50 m. All the volcanic units of the Adama graben predate the faulting that has formed the present topography. Although earlier fault episodes are not yet proved, the distribution of basaltic vents shows that the present fault scarps follow earlier lines of structural weakness.

The pre-WFB drainage pattern of the Adama region has been obscured by the subsequent lacustrine sedimentation within the gräben and basins, but an ancient meander is preserved on the upfaulted Koka block, some 2 km northeast of Koka Dam. Holocene faulting is not in evidence to the extent found north of Wolenchiti, for example, but the on-going denudation and sedimentation of the Awash drainage system will have rapidly obliterated evidence of such faulting in most of the region.

The Adama graben is about 5 km wide and at least 30 km long (Figure 18). It extends from the Awash river plains in the south to the eastern slopes of Mt. Mukie in the north. The graben is perched on the eastern margin of the Gadamsa WFB segment; this segment passes north along an upfaulted zone of the rift floor, via the Mojjo-Adama horst of Mohr (1973b), to the extinct and denuded volcanic center of Mt. Mukie. The western boundary fault of the graben throws 100 to 150 m up to the west; the visible displacement of the eastern boundary fault is about 25 m in the south, increasing to 50 to 70 m in the north, where the narrow Dalecha horst separates the graben from the lower lying Wolenchiti basin.

The western boundary of the Adama graben is formed by what is probably the most important and persistent line of faulting in the Gadamsa WFB segment.

The line extends from the western rim of Gadamsa caldera, north across the Awash valley, where the river has breached the fault scarp in a deep gorge, and along the western side of the graben to Mt. Mukie. There is a change in the direction of throw at the southern end of the graben: upthrow is to the east in the Awash valley and farther south, and to the west in the north of the graben. The transition is effected via a very interesting fault pattern (Figure 18). This pattern cannot be termed en echelon, because the main fault line, though broken, is not laterally displaced at the transition sector. Instead, the direction of throw is changed between collinear fault termini that have each curved and switched, in this instance to the left, producing a local right offset. In addition, a superimposed horst has been built on the inner, upthrown block of each of the curved termini: geodimeter stations GEORGE and RIDGE are situated, respectively, on the northern and southern terminal horsts.

The eastern boundary fault zone of the Adama graben terminates south in the Awash valley, near the western rim of the old Boku caldera. The fault displacements are relatively small in the south, but larger along the margin of the Wolenchiti basin owing to the intervention of the Dalecha horst between the basin and the Adama graben. However, the Dalecha horst has been obliterated by erosion along the northern half of the Wolenchiti basin, and drainage is now able to escape east from the graben into the basin. Farther north still, the horst is resumed at station MERKO and beyond.

Some of the smaller scale features of the Adama graben fault zones may be briefly noted. Upwarping of the upthrown side of the largest faults is a general phenomenon, except where a closely parallel fault develops a horst. What can be termed splay or hook faults on the upthrown block are a common feature (Figure 18): their development suggests that the direction of maximum extension (least horizontal compressive stress) was not quite perpendicular to the trend of the major faults; the obliquity has been such as to produce a small component of dextral shear along some larger faults. Dextral displacement is displayed in an intrusive basaltic ring on Gara Boku and the eastern boundary fault of the Adama graben, as well as in a sliced basalt cone farther south in Gadamsa caldera (Di Paola, 1973). Another characteristic feature of the larger faults of the Adama region, noted by Mohr (1973b), is the occurrence of a narrow horst on the rim of the upthrown block: these narrow horsts are typically about 100 m wide. We are not aware of any satisfactory explanation for their existence.

The floor of the Adama graben is cut by some small but persistent faults, of which the two most important carry geodimeter stations ADAMA and FARENJI on their upthrown, eastern sides. Preserved throws are between 2 and 10 m. The Farenji fault changes its direction of throw farther south toward the Awash river.

7.2 Geology of the Central Network Region

Reconnaissance observations on the faulting and volcanic stratigraphy of the Mirrga-O'a (Langano-Shala) region have been published by Mohr (1966) and Lloyd (United Nations, 1973), and both these authors have since made more detailed studies with reference to faulting and to geothermal areas, respectively.

Hora Mirrga is situated in the central sector of the main Ethiopian rift valley, immediately north of parallel 7°30'N. The lake lies against the foot of the eastern boundary escarpment of the rift. However, as the Wonji fault belt and its associated volcanoes also run close to the eastern escarpment at this latitude, the Hora Mirrga region straddles the zone of most recent tectonism.

The stratigraphy of the Mirrga region is complex, owing to the interdigitation of ash-flow tuffs and lavas from several major volcanic centers both on the rift floor and on the present rim of the eastern plateau. These centers were active during the late Pliocene—early Pleistocene, at which time the relief between rift and plateau was much more subdued than now; minor activity on the rift volcanoes continued into the Holocene (United Nations, 1973). The greater part of the Mirrga region comes under the influence of the O'a (Shala) caldera: the stratigraphy of O'a is currently being studied in some detail by R. Raynolds and Mohr, but owing to deep burial by rift sediments, only the uppermost units are exposed by the young faults at Hora Mirrga. A severely welded lower ash-flow unit, in many places crusted with obsidian, is overlain by a weakly welded unit that forms the exposed bedrock west and south of Hora Mirrga. At the northern end of Hora Mirrga, at O'itu Bay, ash-flow tuffs grading up into trachytes may have been derived from plateau centers or from an early Alutu center: these rocks are overlain by ?mid-Pleistocene sediments, all of which are cut by the Wonji belt faults. The faulting was penecontemporaneous with localized basalt eruptions. Basalts are not found south or west of Hora Mirrga, but late Pleistocene–Holocene basalts and maars occur on the southwestern flanks of O'a caldera.

The major faults of the rift margins are essentially of early–mid-Pleistocene age (Meyer et al., 1975), and taking the rift as a whole, they form a gently curving envelope convex to the west. A slight disparity between the western and the eastern margins causes the rift to widen from 75 km at latitude 8½°N to 80 or 85 km near latitude 8°N, before narrowing to about 65 km at latitude 6°N. Focusing more precisely, there is a distinct structural "knee" just south of 8°N (Mohr, 1974b). South of the knee, the Pleistocene margin faults and the Holocene faults of the rift floor trend north-northeast, parallel to each other; north of the knee, the young floor faults continue north-northeast, via right en-echelon offsets, but the margin faults swing to a northeast trend (Figure 1). The knee occurs where a southward projection of the western Afar margin faulting, crossing the rift floor along a pronounced line of young faults and Holocene lavas (Mohr and Potter, 1976), intercepts the southwest-trending eastern margin of the rift and turns it to south-southwest. The knee inflects in the vicinity of the Alutu volcanic center, between Lake Zway and Hora Mirrga, where a complex interaction of northwest and northeast fault trends, east of O'itu Bay, forms a mosaic of west-tilted blocks facing the eastern margin of the rift. The Mirrga area is therefore close to an important structural node in the Ethiopian rift: the significance of this node is not yet known, but it might possibly reflect the transition from a structural regime dominated by the exigencies of the Afar triple-plate junction to a regime dominated by a pre-existing anisotropy in the continental crust of southern Ethiopia.

Whatever the cause of the knee in the plan of the Pleistocene rift margin faults, the Holocene tectonism of the rift floor traverses it without apparent change of style. It is this youngest tectonism that we expect to find reflected in the on-going strain field being analyzed by our geodetic method. The Holocene faulting of the rift floor is concentrated into the 5- to 15-km-wide WFB (Mohr, 1960). The Mirrga geodimeter network has been installed across this belt, whose nature can now be described in more detail.

7.2.1 Southern Mirrga region

The Wonji fault belt, at the southern end of Hora Mirrga, is some 8 km wide. A typical figure for the number of faults comprising the belt here is 13 (Figure 10). The faults trend north-northeast and have throws commonly in the range 25 to 50 m. West upthrows tend to be larger than east upthrows, a fact related to the gentle westward tilting of the faulted blocks.

In the vicinity of the geodimeter network, the WFB comprises the following units, from west to east:

1. The 4-km-wide Katlo block, bounded west by the Kunni fault and east by the West Langano fault (Mohr, 1966). Stations HOTEL and TERMITE lie on the eastern rim of this block.

2. The 1-km-wide Galla block, associated with the most intense faulting of this section of the WFB. Stations GALLA and LANGANA lie in the middle of this block.

3. The 2-km-wide Mirrga graben, upon the floor of which earlier, higher lake shore lines are preserved, the sediments of which may be obscuring older faulting.

4. The 1-km-wide Godda Goja horst, forming the promontory running north into Hora Mirrga. Station EUPHORBIA lies on this horst.

East from this horst to the rift margin, less abundant faults occur, which are distinctly more denuded than those of the WFB. On the opposite side of the WFB, west of the Katlo block, fresh faults are rare, only the Haroresa horst being notable on the Kunni-O'a land bridge (Figure 10).

Immediately south of the geodimeter network, the WFB intercepts the eastern margin of the O'a (Shala) caldera, which Di Paola (1973) considers to be of Pliocene age. Despite the size and volcanological importance of the caldera, the Holocene faults transect it undeflected and undiminished, precisely as observed also at the extinct Gadamsa caldera, north of Lake Zway (Thrall, 1975). The WFB is offset 20 km in a dextral sense at O'a caldera, before continuing from the southern side of this caldera south to Corbetti caldera (Di Paola, 1973). The faults of the Mirrga sector of the belt tend to peter out southward, and those that persist become increasingly denuded in the Neghelle and Shashamanne regions (United Nations, 1973, Figure 39). Strong geomorphic evidence suggests that some of the Wonji belt faults are impressed on pre-existing faults: trench cuts across sediments lying against the downthrown side of such a fault could quickly determine the truth of the matter and could give valuable information on the frequency and relative magnitudes of earthquake displacements (Allen, 1975).

The crustal blocks formed by the WFB in the southern Mirrga region have a westerly tilt, whether they be horst or graben. The Katlo block has a planar surface tilted down west at 0.8^g. The Galla block is tilted in the same direction but more steeply, at about 1^g on the east side of the block, increasing to over 2^g approaching the West Langano fault. The tilting requires, as is evident in the field, that greater throws tend to be found on east-facing than on the west-facing fault scarps. West-upthrown faults predominate between the WFB and the eastern margin of the rift, attesting to antithetic structure of a type commonly found associated with the Ethiopian rift and Afar margins (Mohr, 1971b; Black, 1976).

The close spacing of the WFB faults, and the tilting of the faulted blocks, is consonant with the crustal thinning indicated from gravity data

(Searle and Gouin, 1972). The density contrast used by these authors results in a crustal model showing a narrow intrusion of more dense material rising through the crust to within about 5 km of the surface, directly beneath the WFB at Hora Mirrga (Searle and Gouin, 1972, Figures 4 and 5). At least part of this dense, axial intrusion into the rift block may be of pre-Holocene age, judging from its apparent prolongation into sectors of older faulting: the axial intrusion of the Kenya rift valley is considered by Baker and Wohlenberg (1971) to be of Miocene—mid-Pliocene age. The relative contributions of crustal extension and stoping, in the emplacement of rift-axis intrusions, remain undetermined (Mohr, 1973b), but almost certainly both processes have operated, and caution must be applied to interpreting the width of the intrusion as a direct measure of rift extension.

All the faults examined in the southern Mirrga area without exception are normal faults. No cogent evidence for any transcurrent displacements has yet been found, though conditions for its recognition are unfavorable. No indubitable slickensides have been discovered. The curvilinear plan characteristic of normal faults is a common feature of the area: the fault segments are convex to the downthrown side, average about 5 km in length, and often terminate at intersections with one or more other fault segments to form a "chain" of such segments.

The biggest fault in the southern Mirrga area is the West Langano fault (WLF). The WLF displaces the uppermost massive, weakly welded O'a ignimbrite (Mohr, 1966), which displays vertical cooling joints, the resulting individual blocks being 5 to 15 m square with gently curviplanar separating surfaces. Between geodimeter stations HOTEL and TERMITE, both situated on the rim of the WLF (Figure 10), the joint planes trend close to 50^g to the fault strike, producing a saw-toothed plan to the fault and rendering impossible pure transcurrent slip along such a surface. However, E. H. Lloyd (written communication, 1976) considers that post-faulting wave action from the once deeper Galla lakes (Grove _et al_., 1975) has incised an originally planar WLF fault scarp. We prefer the view that near the surface, the fault originally utilized the rock joints.

The WLF, north of station HOTEL, is bordered on its downthrown side by a very narrow horst a mere 10 to 30 m wide and rising some 45 m above the lake at its eastern foot. The escarpment of the WLF rises to 80 m above lake level, and the intervening "chasm" between this fault and the horst is marked by occasional gaping fissures (gjár), further evidence of at least a component of crustal extension acting perpendicular to the faulting.

In addition to the characteristic, segmented chain plan of the WLF, the termini of some individual segments pass into flexures that themselves rapidly die out as the next segment develops en echelon alongside. Such en-echelon offsets are quite common among the faults of the Wonji belt and are very predominantly to the left, compatible with a component of dextral shear along the belt. Dextral-shear components on normal faults of the Wonji fault belt have been observed farther north (Di Paola, 1973; see Section 6.1). Regarding the large-scale, right-hand offsets of the Wonji fault belt as a whole, it is less likely that they result from longitudinal sinistral displacement between the Ethiopian and Somalian plateaus (Gibson, 1969; Mohr, 1968) than a sideways "jumping" of the axis of rift extension, as in southwest Iceland (Klein et al., 1973). The offsets are thus considered to have a quasi-transform character (Schaefer, 1975; Mohr and Wood, 1976).

7.2.2 Northern Mirrga region

The West Langano fault dies out northward before reaching the northern shore of Hora Mirrga. The eastward translation of the WFB into the O'itu Bay faulting occurs on the lake bottom and involves a 5-km dextral offset.

O'itu Bay occupies a center of circular tectonics (Figure 12) first described by Mohr (1966). A good reconnaissance geological map of the region, including Alutu volcano immediately north of Hora Mirrga (Dakin and Gibson, 1971), has been presented by Lloyd (United Nations, 1973, Figure 43). Lloyd considers O'itu Bay to be part of a small graben that extends north under the Alutu massif to Debra Tsion island in Lake Zway. The graben is "the result of recent rejuvenated movement on a zone of deep tectonic instability" (United Nations, 1973, p. 85). Lloyd also suspects sinistral transcurrent displacements on some of the north-northeast-trending faults, without adducing evidence for this suspicion.

Most of the major faults of the O'itu region are upthrown west, notably the East Basuma fault on the western side of the bay and the Bolé fault east of the bay. The entire tract of country between O'itu Bay and the rift margin escarpment farther east is a mosaic of strong antithetic faulting (Mohr, 1966; Di Paola, 1973; United Nations, 1973), the faults being more freshly preserved and of larger displacement than those east of the WFB at the southern end of Hora Mirrga. Nevertheless, they appear more denuded than the freshest Wonji belt faults passing through O'itu Bay itself, though admittedly it is difficult to formulate an eastern limit to the belt here. Alutu volcano, currently dormant according to Dakin and Gibson (1971), has largely buried the O'itu Bay graben to the north and, in this masking of the youngest WFB tectonism, differs from the possibly senescent O'a caldera.

The O'itu Bay graben appears to have been the site of circular subsidence, though Lloyd (personal communication, 1976) finds no volcanic products to suggest it is a volcanic center of caldera type. Hot springs and fumaroles are currently active on the northern and eastern (Bolé fault) sides of O'itu Bay (United Nations, 1973) and also at the focus of the tectonic circle, on Geysir Island. According to H. Goetz (quoted in Gouin, 1977), a large geyser was born on this island in conjunction with the 1906 rift-valley earthquake, but it is now (Mohr, 1966) a pathetic remnant of its reputed former glory. O'itu Bay is the site of a small but clear-cut positive gravity anomaly, anomaly #7 of Searle and Gouin (1972).

The eastern and western margins of O'itu Bay have a narrow, strongly emphasized horst-like character, a factor weighing on the logistics of geodimeter operations. The north-northeast-trending Basuma horst limits the bay to the west, and the arcuate Bolé horst forms the main eastern limit. These two horsts appear to be tectonic emphases of a pre-existing rim, which is still preserved in its original state, with an outer dip slope, as the Laki Peninsula (Figure 12).

7.2.3 Age, rate, and episodicity of faulting

We have no quantitative data on these vital topics. Trenching and carbon dating of sediments (see, e.g., Laury and Albritton, 1975) would add an essential dimension for interpretation of our geodimeter data. On the geomorphic evidence, surely the age of the most recent fault movements in the Mirrga region is to be measured in hundreds rather than thousands of years — for example, the formation of the small horst on the face of the West Langano fault. Miss Alayne Street (written communication, 1976) has identified Holocene WFB faults affecting the eastern wall of O'a caldera.

Molnar et al. (1970) found that microseismic activity along the Wonji fault belt between latitudes 7° and 9°N was at an extremely low level during 800 hours of recording in 1969. These authors confessed surprise at this result, considering the manifold evidence of young faulting and volcanism and comparison with other, microseismically active tectonic zones of the world. They put forward two possible explanations: 1) an episodicity of fault and related seismic activity, with intervening periods of quiescence lasting at least "several decades," and 2) aseismic deformation of the crust, although this seems not to be the case farther south in the rift system (Molnar and Aggarwal, 1971; Rykounov et al., 1972). With the proviso that their data are meager, Molnar et al. (1970) conclude that microseismic activity is low in narrow zones of predominantly normal faulting, in comparison with broad zones such as the Basin and Range Province in the western United States. It is certainly feasible that aseismic creep is being facilitated in the geothermally active crust of the Mirrga region. Nevertheless, an earthquake swarm occurred along the Katlo block of western Mirrga during May 1962 (Gouin, 1977).

If the rift crustal strain is only episodic, then no significant line-length changes can be expected from the geodimeter program until such an episode occurs. But if there is progressive strain accumulation or aseismic deformation, then the geodimeter program will come into its own.

8. DISCUSSION AND CONCLUSIONS

8.1 Northern Network

Geodimeter lines perpendicular or near-perpendicular to the rift-trend faults in the northern sector of the rift valley were susceptible to lengthening at or above the threshold value of 3 mm/yr during the interval 1969 to 1974. Other lines have remained stable, and only one dubious instance of line shortening is recorded.

The instances of line lengthening are entirely restricted to the Wonji fault belt, which here is offset by 25 km right en echelon from the Gadamsa to the Boseti segment of the belt. Although the present network design is not ideal for a detailed analysis of the pattern of this crustal widening within the WFB, it is quite sufficient to suggest that the zones(s) of active widening in the belt are of the order of 15 km in length and jump laterally from one to the next along the belt. These zones may well prove to be single faults in most instances, but it would require a more focused geodetic technique (e.g., by using strain meters) to determine this. Evidently, the zones of active widening must shift after a certain time interval, much greater than the time of the Ethiopian observing program, such that over an integrated period of perhaps a few millenia the whole width of the WFB is participating in crustal widening. On an even longer time scale, it is probable that the pattern of the WFB itself is evolving, migrating west according to Mohr (1967).

When examined in detail, the pattern of active widening at the southern end of the Boseti segment of the WFB is one of left-offset zones, from north to south: Tcheesa fault zone and Wolenchiti valley, Bofa and Sodere fault zones, and Kaletta fault zone. At the northern end of the Gadamsa segment of the WFB, there is a less well-ascertained right offset in the zone of active crustal widening.

During the 5-year period of geodimeter observations, crustal widening has been progressive except for a singular instance of stop-go motion in the southern part of the Wolenchiti basin. It must be admitted that this stop-go motion is recognized in part because it matches the progressive motion to the north (and southeast); there may be stop-go motion elsewhere in the northern network that is currently regarded as reflecting only instrumental aberrations, but to discern any such motions will require a longer observing period than the present 5 years. The mean annual rates of widening range between 3 and 6 mm/yr, in excellent agreement with geological estimates for Holocene extension in the rift of 5 mm/yr (Mohr, 1973b) and with 3 to 4 mm/yr across the rift structures of southwestern Afar (Schaefer, 1975). These figures translate into approximate strain rates of 6 to 16 × 10^{-7}/yr.

The region of offset between the Gadamsa and Boseti segments of the WFB includes the Adama graben, where no significant widening has been detected. However, from the evidence of geology, it is suspected that, on a much longer time scale than our geodetic program, zones of widening are interpolated across the WFB offset. The larger rift-floor faults, in the WFB and in the region of offset, can show evidence of small longitudinal displacements, both as a direct displacement of geological features and from a hook-fault fracture pattern (Section 7.1). These displacements are of the order of a few tens of meters, less than the vertical throw on the same fault plane. They are almost exclusively of dextral sense.

The geodetic program has confirmed the likelihood that a small component of longitudinal dextral shear is a feature of the on-going evolution of the rift. Thus, dextral shear at 3 to 5 mm/yr is possibly revealed along the eastern boundary fault zone of the Adama graben, and it is not associated with any contemporaneous crustal widening. In the Wolenchiti valley, geodimeter station RABBIT has apparently shifted south with respect to the three stations to the northwest, again implying dextral longitudinal shear (at ∿5 mm/yr), although there is no visible fault capable of taking up such shear on the western flanks of Boseti volcano. Perhaps transverse fractures, observed during the 1970 Aygu ground cracking, are playing a role here. It must be emphasized that longitudinal rift displacements must be relatively short-term effects; otherwise, over a million years, they would build up kilometers of horizontal dislocation for which there is currently no firm geological evidence.

What is the role of plate tectonics in all this? Despite the abrupt change of scale from continental-sized plates to the fine structure of the Ethiopian rift valley floor, there should be an expression of a common deformation rate _if_ the Nubia—Somali plate boundary can indeed be narrowed to the WFB (McKenzie _et al_., 1970; Mohr, 1973b). With regrettable irony, the results of 5 years of geodimeter observations at the northern end of the Ethiopian rift concur with the geometrical requirements of plate-tectonic analysis of the Red Sea and Gulf of Aden (Le Pichon _et al_., 1973), allowing for a quickening of pace during the late Quaternary (Mohr, 1973b, 1975). Regrettable, because I do not wish the geodetic results to be taken as a confirmation of plate tectonics, first because of the limitations on the present precision of the geodetic method, and second because the spatial and temporal patterns of strain accumulation along the Nubia—Somali plate boundary are unknown. Before plate tectonics is introduced into the interpretation of the Ethiopian rift geodimeter data, the period of observation should at least match those for the San Andreas fault of California (Savage and Burford, 1973) and the Alpine fault of New Zealand (Lensen, 1971), and the networks should be multiplied and also enlarged to two or three times their present dimensions to cover the rift margins. I shall not live to see this! I cannot avoid mentioning that a component of dextral shear along the rift conforms further with the plate analysis of Le Pichon _et al_. (1973), but if the WFB offsets are proto-transform faults (Schaefer, 1975; Mohr and Potter, 1976), then present-day shear can better be regarded as reflecting the jostling of tectonic subunits within the rift.

The strain-release pattern in the Ethiopian rift is well presented by Gouin (1977), who shows, however, that despite earthquake records going back a few centuries in parts of Ethiopia, the recurrence period of earthquakes at a given locality is greater even than this (see also Lensen, 1971; cf.

Björnsson et al., 1977). We therefore cannot claim, on the basis of the seismic map alone, that any particular sector of the rift or Afar is not now subject to strain accumulation/release. A similar conclusion was reached by Molnar et al. (1970) from observations of microseismicity in the Ethiopian rift. In fact, reports of seismicity felt during the last few decades come from all three rift network areas.

Unless some strain is being released by aseismic creep, the geodimeter observations on crustal widening across the WFB indicate that a single fault with a throw of a few meters would be produced by complete release of accumulated strain after an interval of about 1000 years.

8.2 Central Network

The central network is smaller than the northern network, and so we do not have so satisfactory a picture of regional crustal deformation here. Indeed, the only certain features are some localized contractions and expansions related to geothermal and gravity anomalies around the Hora Mirrga basin. There is no clearly evident pattern of crustal widening across the WFB at this latitude, but the 1962 Mirrga earthquake swarm may still be affecting the resumption of regional strain accumulation.

Although the possibility of dextral slip along the faults of the Mirrga segment of the WFB was mooted by Mohr et al. (1975a,b), this concept is now less attractive. Only at the southern end of the network is longitudinal ground motion in evidence, and the tectonic nature of this is not proved. So we are left with two-dimensional crustal contraction affecting an area at the southern end of the West Langano fault, at a maximum strain rate of $10^{-5.2}$/yr, and with east—west crustal widening at a regular 5 mm/yr for 4 years across O'itu Bay, near the Mirrga—Alutu WFB offset. These two changes, respectively, may be related to magmatic withdrawal/cooling and to magmatic intrusion (Mohr et al., 1975b), in which case added weight is given to the prognostication (Mohr, 1974a) that strain-field analysis would be premature for the Ethiopian rift regarding any regional, let alone plate-tectonic, implications.

Integrated plate-tectonic motions bear no relationship to crustal strain changes in the central and southern Ethiopian rift networks in the intervals 1970 to 1974 and 1971 to 1973, respectively (Mohr, 1974a). Nevertheless, future surveys and earthquakes are awaited with curiosity. We conclude, prematurely but necessarily, in view of the cosmic brevity of the surveyor's life, either that plate motions and rifting are stop-go beyond the time scale of our work and/or that the Nubia–Somali plate boundary is of finite width, perhaps several tens of kilometers (miles, to you dear old British Empire loyalists!).

ACKNOWLEDGMENTS

The Ethiopian rift geodimeter program was born of an idea of Professor Fred L. Whipple, with much early encouragement and assistance from Dr. C. A. Lundquist, Prof. R. W. Decker, and Prof. George Veis. The gentlemen listed on page 2, who have participated so energetically and selflessly in one or another of the field surveys, know the gratitude I owe them. Their comradeship has been a priceless boon, amidst both setbacks and successes, as has the rejuvenating climate and native hospitality of that immeasurably beautiful rift valley. Behind all these surveys has stood a rock, Prof. Pierre Gouin, who in so many ways large and small has facilitated the authorization of our surveys and their simple but ill-financed logistics, boosting our morale with his own inimitable humor that so many times transmuted disappointments into successful resolve. Back at the Smithsonian Astrophysical Observatory, I owe a particularly warm gratitude to Mr. Antanas Girnius for performing the data reduction and network-adjustment computations with exemplary enthusiasm and efficiency. Mr. J. Latimer has kindly advised on programing of the least-squares adjustments. My wife and children have tolerated my absences in Ethiopia rather beyond the call of duty.

†

I wish to express my deepest-felt tribute to Dr. W. H. ("Bill") Morton, shot dead on the outskirts of Addis Ababa, 10 March 1977. Bill was one of Ethiopia's best and most promising geologists, perhaps its very best field geologist. He was also a man of the highest principles, straightforward, generous, modest, and always thought-provoking. His loss to Ethiopian science is immeasurable, but a token insight can be gained from a request he made to me after the 1976 geodimeter survey: could I extend the next survey up to the Addis Ababa region, to assist earthquake prediction in that populous area as well as in the scientifically more attractive rift valley. Indeed his thoughts were for the Ethiopian people, the real people, and our loss is also theirs.

POSTSCRIPT

In October through December 1976, I organized and led a geological expedition to the Ethiopian rift, during which the opportunity was taken to remeasure some of the geodimeter lines. In the short time allotted to this work, attention was concentrated on lines that the previous surveys had indicated to be susceptible to length changes. The azimuths and declinations of main–auxiliary point pairs were also observed. The results of the 1976 survey will be published elsewhere after they have been reduced and analyzed.* Strain-tensor analysis will be introduced in addition to the conventional displacement-vector analysis.

The 1976 survey concludes my Ethiopian rift geodimeter work under the auspices of the Smithsonian Astrophysical Observatory. Valete!

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* For the sake of completeness, the raw observational data of the 1976 survey are given in Appendix H.

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APPENDIX A

STATION ABBREVIATIONS, REVISED ELEVATIONS, AND MAIN-AUXILIARY POINT PARAMETERS

APPENDIX A

STATION ABBREVIATIONS, REVISED ELEVATIONS, AND MAIN—AUXILIARY POINT PARAMETERS

The elevations of all stations established in 1969 are quoted to the nearest meter, with the U.S. Coast & Geodetic Survey triangulation base at DUKAM used as reference. Adjustment has been made to conform with the results of triangulation and spot-height elevations obtained from the Directorate of Overseas Surveys (London) for their 1:50000 topographic mapping. Additionally, T2 theodolite angles observed by Mr. J. Rolff have been used to obtain elevations of some post-1969 stations, again quoted to the nearest meter. All other stations are quoted to the nearest 5 m (these values are in parentheses), as their elevations are currently known only from altimeter observations. Station elevations in the central and southern geodimeter networks are given relative to lake elevations of 1582 m (Hora Mirrga) and 1169 m (Lake Margherita), respectively.

Station	Local name (if any)	Abbreviation and year of installation		Elevation (m)	Main point to auxiliary point (if any)[*] d (slope) (m)	Δh (m)	azimuth (g)
DUKAM	Dukam	DK	9[†]	1937.4	(This station is now extinct.)		
FOKA	Gara Foka	FO	9	2013			
DULLO	Gara Dullo	DL	9	1925			
SAO	Bishoftu	SA	9	1924			
CRATER		CR	9	1920			
CGS	Bishoftu	CG	9	1886			
GITCHI	Gitchi	GI	9	1882			
ROAD	Keraru	RD	9	1806	(This station is now extinct.)		
RAILWAY	Mojjo	RY	9	1802			

[*] d = distance; Δh = height difference.

[†] 9 = 1969, 0 = 1970, 1 = 1971, 3 = 1973, 4 = 1974, 6 = 1976.

Station	Local name (if any)	Abbreviation and year of installation	Elevation (m)	Main point to auxiliary point (if any)* d (slope) (m)	Δh (m)	azimuth (g)
MARIAM	Tedi	MA 9[†]	1945	15.046	0.46	200
GEORGE	Kimbibit	GE 9	1776	15.120	3.07	240
RIDGE		RI 9	1726	20.062	-1.36	205
ADAMA	Adama	AD 9	1631	9.727	0.09	081
FARENJI	Adama	FA 9	1632	15.607	0.28	237 (FA—FAB)
ELPASO	Gara Ganti	EP 9	1733	(EPA — main point, EP, extinct)		
GANTI	Gara Ganti	GN 1	1774.5	4.172	-0.63	243
FULCRUM	Soloki	FU 9	1643	3.722	0.21	148 (FUA—FUB)
				(main point, FU, extinct)		
BLOSSOM	Soloki	BL 3	(1660)			
GRAVES	Wurufa	GR 9	1471	42.24		
CINDER	Gara Bolalo	CI 9	1557	24.443	1.11	220
BOHALLA	Bofa	BH 0	(1405)			
BORI	Bori	BR 3	(1425)			
BABOON		BB 3	(1385)			
BOKU	Gara Boko	BO 0	1869	2.306	0.34	103
OBSIDIAN	Wofi	OB 9	1625			
ROGGI	Chebuti	RO 9	1553			
MIETCHI	Gara Mietchi	MI 9	1831	15.31		
TOPLESS	Gara Talicha	TO 9	1706			
DUST	Ghilli	DU 9	1714			
SELASSIE	Biet Selassie	SE 9	1846			
SIRI	Kara	SI 1	(1900)	5.067		366
QUILL		QL 1	1539			
SODERE	Sodere	SO 1	1371			
OOLAGA	Ulaga	OL 1	1436	1.967		173
PYLON	Tedecha	PY 1	1661			
WONJI	Hida	WO 1	1609			
KOKA	Koka	KO 0	(1630)			
GALILA	Tafu	GA 0	1645			
YELLEM	Ati Bora	YE 0	(1610)			
THORNS	Emmanuel	TH 0	(1625)			

Station	Local name (if any)	Abbreviation and year of installation		Elevation (m)	Main point to auxiliary point (if any)* d (slope) (m)	Δh (m)	azimuth (g)
TABLE	Jinjimma	TA	0[†]	1520	2.408	-0.32	129
AYGU	Gara Egu	AY	0	1526	2.777	-0.39	158
MERKO	Marko	ME	0	1590	6.023	1.33	204
RABBIT	Nyeh	RA	0	1598	2.972	-0.46	206
TCHEESA	Gara Chisa	TC	4	1461	2.497	-0.11	116
SOGIDO	Sogido	SG	6	(1310)			
KUSULU	Kusulu	KS	6	(1265)	3.800	0.59	180
HOTEL	Ashalamo	HO	0	1644	2.2805		
TERMITE	Ashalamo	TE	0	1629	1.425		395
GALLA	Ashalamo	GL	0	1600	2.360	0.09	314
EUPHORBIA	Godda Golja	EU	0	1600	28.260	-0.675	067
LANGANA	Doli	LA	1	1635	2.246	-0.10	242
ARJO	Arjo	AR	1	1714	3.934	-0.38	221
SHALLA	Galli	SL	4	(1680)			
HARORESA	Haroresa	HA	4	(1775)			
CHITU	Chitu	CU	6	(1630)			
SHIBIBO	Shibibo	SB	6	(1620)			
KORKORSA	Korkorsa	KK	6	(1625)			
O'ITU	O'itu	OI	0	(1585)			
ALUTU		AL	0	(1590)		-1.53	298
OOMAY	Basuma	OY	1	(1650)	8.965	1.40	243
BMC	Arba Minch	BC	1	(1345)			
BMP	Arba Minch	BP	1	(1345)			
BMN	Arba Minch	BN	1	(1285)			
SHECHA	Shecha	SH	1	(1440)			
DUBI		DB	1	(1170)			
KULFO	Kulufo River	KU	1	(1145)			
TOSASUCHA	Nech Sar	TS	1	(1260)	1.878		009

Station	Local name (if any)	Abbreviation and year of installation	Elevation (m)	Main point to auxiliary point (if any)*		
				d (slope) (m)	Δh (m)	azimuth (g)
PARADISO	Il Paradiso	PAR 4[†]	424			
GUMA W	Guma graben	GUW 4	367			
GUMA SE	Guma graben	GUS 4	306			
GUMA NE	Guma graben	GUN 4	415			
DOBI XE	Dobi graben	DOX 4	279			
DOBI IE	Dobi graben	DOE 4	159			
DOBI IW	Dobi graben	DOW 4	115			
DOBI MW	Dobi graben	MAW 4	307			

APPENDIX B

GEODIS 1969 GEODIMETER OBSERVATIONS

Code	Geodimeter Sta.	Retroreflector Sta.	Date	Time	Temp.	Spread		Corrected D	Final D	Line Average	
AC	(DUKAM)	FOKA	1969 OCT 11	2120	12.8	63	49	9394.758	9394.771 *		
AE	FOKA	(DUKAM)	1969 OCT 13	2020	16.9	28	12	9394.788	9394.798		
AE	FOKA	(DUKAM)	1969 OCT 13	2020	16.9	20	10	9394.780	9394.790		
AH	(DUKAM)	FOKA	1969 OCT 14	1845	15.6	50	34	9394.781	9394.789		
AH	(DUKAM)	FOKA	1969 OCT 14	1845	15.6	53	29	9394.777	9394.785	9394.788	.011
										.790	.005
AD	DUKAM AUX A	FOKA	1969 OCT 11	2325	12.8	40	23	9396.471	9396.485 *		
AI	DUKAM AUX A	FOKA	1969 OCT 14	1930	15.6	37	9	9396.489	9396.499		
AI	DUKAM AUX A	FOKA	1969 OCT 14	1930	15.6	37	24	9396.493	9396.503	9396.496	.009
										.500	.003
AK	FOKA	DULLO	1969 OCT 15	2115	14.4	17	24	6400.689	6400.694		
AK	FOKA	DULLO	1969 OCT 15	2115	14.4	42	25	6400.702	6400.707		
AM	DULLO	FOKA	1969 OCT 16	1930	19.2	42	45	6400.686	6400.689		
GD	DULLO	FOKA	1969 NOV 25	1945	16.8	23	25	6400.713	6400.717		
GF	DULLO	FOKA	1969 NOV 26	1930	17.2	22	23	6400.714	6400.718	6400.706	.013
AL	DULLO AUX A	FOKA	1969 OCT 16	2000	19.2	25	13	6402.905	6402.910	6402.910	0.000
AJ	FOKA AUX A	DULLO	1969 OCT 15	2030	14.4	23	5	6372.959	6372.964	6372.964	0.000
AF	SAO	FOKA	1969 OCT 13	2340	15.6	19	17	3237.860	3237.865		
AG	FOKA	SAO	1969 OCT 13	2220	16.1	39	34	3237.870	3237.875	3237.868	.007
FZ	CRATER	FOKA	1969 NOV 24	2100	15.6	24	15	2049.220	2049.222		
FZ	CRATER	FOKA	1969 NOV 24	2100	15.6	38	14	2049.218	2049.220		
FZ	CRATER	FOKA	1969 NOV 24	2100	15.6	38	27	2049.220	2049.221		
FZ	CRATER	FOKA	1969 NOV 24	2100	15.6	32	14	2049.216	2049.218	2049.220	.002
GA	CRATER AUX A	FOKA	1969 NOV 24	2130	15.6	26	16	2043.230	2043.232	2043.232	0.000
GE	DULLO	CRATER	1969 NOV 25	2015	14.7	11	19	7003.345	7003.351		
GG	DULLO	CRATER	1969 NOV 26	2130	15.8	6	6	7003.349	7003.356	7003.354	.004
GH	DULLO AUX A	CRATER	1969 NOV 26	2215	15.2	16	6	7003.340	7003.348	7003.348	0.000
AN	DULLO	QUARRY	1969 OCT 16	2200	17.5	25	34	7888.290	7888.299		
AQ	QUARRY	DULLO	1969 OCT 17	2030	19.4	21	6	7888.286	7888.294		
FQ	QUARRY	DULLO	1969 NOV 22	2045	17.1	33	31	7888.305	7888.313	7888.300	.010
AP	QUARRY AUX A	DULLO	1969 OCT 17	2130	19.2	31	15	7886.402	7886.411	7886.411	0.000
AO	DULLO AUX A	QUARRY	1969 OCT 16	2245	17.8	6	3	7889.210	7889.220	7889.220	0.000
FY	CRATER	CGS	1969 NOV 24	2245	15.3	32	13	513.360	513.361		
FY	CRATER	CGS	1969 NOV 24	2245	15.3	12	21	513.360	513.361		
GI	CGS	CRATER	1969 NOV 27	0030	13.7	36	15	513.351	513.352		
GI	CGS	CRATER	1969 NOV 27	0030	13.7	83	28	513.351	513.351		
GI	CGS	CRATER	1969 NOV 27	0030	13.7	83	22	513.350	513.351		
GI	CGS	CRATER	1969 NOV 27	0030	13.7	13	21	513.351	513.352	513.356	.005
GB	CRATER AUX A	CGS	1969 NOV 24	2215	15.3	34	13	505.960	505.961		
GB	CRATER AUX A	CGS	1969 NOV 24	2215	15.3	54	11	505.962	505.963		
GB	CRATER AUX A	CGS	1969 NOV 24	2215	15.3	54	10	505.959	505.960		
GB	CRATER AUX A	CGS	1969 NOV 24	2215	15.3	18	14	505.964	505.965	505.962	.002
AR	QUARRY	ROAD	1969 OCT 18	1900	21.1	26	5	5865.774	5865.781		
AT	ROAD	QUARRY	1969 OCT 18	2100	20.3	33	19	5865.771	5865.780	5865.781	.001
AY	QUARRY	ROAD AUX A	1969 OCT 22	0130	13.3	6	11	5907.212	5907.221		
AY	QUARRY	ROAD AUX A	1969 OCT 22	0130	13.3	18	24	5907.214	5907.223		
AZ	ROAD AUX A	QUARRY	1969 OCT 21	2345	13.9	14	13	5907.210	5907.220		
AZ	ROAD AUX A	QUARRY	1969 OCT 21	2345	13.9	17	22	5907.208	5907.219	5907.221	.002
AS	QUARRY AUX A	ROAD	1969 OCT 18	1945	20.6	13	18	5865.449	5865.456	5865.456	0.000
AU	RAILWAY	ROAD	1969 OCT 20	2045	19.4	16	23	5774.464	5774.476 *		
AV	ROAD	RAILWAY	1969 OCT 20	1900	20.0	27	24	5774.447	5774.456		
AV	ROAD	RAILWAY	1969 OCT 20	1900	20.0	27	24	5774.438	5774.447		
BD	ROAD	RAILWAY	1969 OCT 23	0015	16.7	21	12	5774.431	5774.444		
BD	ROAD	RAILWAY	1969 OCT 23	0015	16.7	28	18	5774.435	5774.448		
BE	RAILWAY	ROAD	1969 OCT 22	2230	17.2	38	28	5774.442	5774.456		
BE	RAILWAY	ROAD	1969 OCT 22	2230	17.2	35	25	5774.438	5774.451	5774.454	.011
										.451	.002
AW	ROAD	RAILWAY AUX A	1969 OCT 20	1945	20.0	41	31	5774.367	5774.377		
AX	RAILWAY AUX A	ROAD	1969 OCT 20	2130	19.4	50	52	5774.389	5774.401 *		
BC	RAILWAY AUX A	ROAD	1969 OCT 22	2315	17.2	47	37	5774.358	5774.372		
BC	RAILWAY AUX A	ROAD	1969 OCT 22	2315	17.2	37	24	5774.356	5774.370	5774.378	.014
										.375	.004

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*Aberrant measurement.

Code	Geodimeter Sta.	Retroreflector Sta.	Date	Time	Temp.	Spread		Corrected D	Final D	Line Average	
BA	ROAD AUX A	RAILWAY	1969 OCT 21	2300	16.1	28	28	5734.986	5735.000		
BB	RAILWAY	ROAD AUX A	1969 OCT 22	0045	12.8	16	6	5734.982	5734.995		
BB	RAILWAY	ROAD AUX A	1969 OCT 22	0045	12.8	38	18	5734.984	5734.996		
BB	RAILWAY	ROAD AUX A	1969 OCT.22	0045	12.8	23	24	5734.982	5734.994		
BB	RAILWAY	ROAD AUX A	1969 OCT 22	0045	12.8	38	24	5734.983	5734.995	5734.996	.002
BF	RAILWAY	MARIAM	1969 OCT 22	2045	18.9	24	24	3929.177	3929.181		
BF	RAILWAY	MARIAM	1969 OCT 22	2045	18.9	33	24	3929.170	3929.175		
BG	MARIAM	RAILWAY	1969 OCT 23	2030	19.4	40	38	3929.183	3929.187		
BG	MARIAM	RAILWAY	1969 OCT 23	2030	19.4	47	36	3929.177	3929.181		
BU	MARIAM	RAILWAY	1969 OCT 28	2330	16.0	27	23	3929.193	3929.199		
BU	MARIAM	RAILWAY	1969 OCT 28	2330	16.0	22	13	3929.194	3929.200	3929.189	.010
BI	MARIAM AUX A	RAILWAY	1969 OCT 23	2115	18.9	15	11	3937.559	3937.564		
BT	MARIAM AUX A	RAILWAY	1969 OCT 29	0015	16.4	6	21	3937.590	3937.595	3937.580	.022
BH	RAILWAY AUX A	MARIAM	1969 OCT 22	2130	18.3	32	18	3929.874	3929.879	3929.879	0.000
BK	MARIAM	GEORGE	1969 OCT 23	2215	18.5	33	30	7262.507	7262.513		
BY	MARIAM	GEORGE	1969 OCT 28	2000	18.4	16	12	7262.526	7262.531		
CA	GEORGE	MARIAM	1969 OCT 29	2300	18.3	19	14	7262.523	7262.530	7262.527	.010
BX	MARIAM	GEORGE AUX A	1969 OCT 28	2215	17.1	17	22	7259.079	7259.085		
BX	MARIAM	GEORGE AUX A	1969 OCT 28	2215	17.1	12	27	7259.078	7259.084		
BX	MARIAM	GEORGE AUX A	1969 OCT 28	2215	17.1	4	27	7259.082	7259.088		
BX	MARIAM	GEORGE AUX A	1969 OCT 28	2215	17.1	25	21	7259.074	7259.080		
BZ	GEORGE AUX A	MARIAM	1969 OCT 29	2330	17.9	20	13	7259.061	7259.068		
BZ	GEORGE AUX A	MARIAM	1969 OCT 29	2330	17.9	16	27	7259.060	7259.066		
BZ	GEORGE AUX A	MARIAM	1969 OCT 29	2330	17.9	22	5	7259.063	7259.069		
BZ	GEORGE AUX A	MARIAM	1969 OCT 29	2330	17.9	16	14	7259.062	7259.068		
BZ	GEORGE AUX A	MARIAM	1969 OCT 29	2330	17.9	20	20	7259.061	7259.067		
BZ	GEORGE AUX A	MARIAM	1969 OCT 29	2330	17.9	14	38	7259.060	7259.067		
BZ	GEORGE AUX A	MARIAM	1969 OCT 29	2330	17.9	22	25	7259.062	7259.068		
BZ	GEORGE AUX A	MARIAM	1969 OCT 29	2330	17.9	14	38	7259.060	7259.067	7259.073	.008
BJ	MARIAM AUX A	GEORGE	1969 OCT 23	2300	19.1	10	17	7257.179	7257.185		
BV	MARIAM AUX A	GEORGE	1969 OCT 28	2045	17.2	7	16	7257.196	7257.202		
BV	MARIAM AUX A	GEORGE	1969 OCT 28	2045	17.8	14	20	7257.195	7257.200	7257.196	.009
BW	MARIAM AUX A	GEORGE AUX A	1969 OCT 28	2130	17.1	35	7	7253.729	7253.735	7253.735	0.000
BR	RIDGE	GEORGE	1969 OCT 27	2000	19.0	18	10	2529.936	2529.938		
CC	GEORGE	RIDGE	1969 OCT 29	2145	17.9	20	16	2529.951	2529.954		
CC	GEORGE	RIDGE	1969 OCT 29	2145	17.9	17	19	2529.954	2529.957		
CS	RIDGE	GEORGE	1969 NOV 01	2215	19.6	14	11	2529.965	2529.968		
EB	RIDGE	GEORGE	1969 NOV 14	0015	17.2	22	10	2529.961	2529.964		
EB	RIDGE	GEORGE	1969 NOV 14	0015	17.2	12	13	2529.964	2529.967		
EC	RIDGE	GEORGE	1969 NOV 13	2315	17.3	31	21	2529.933	2529.936		
EC	RIDGE	GEORGE	1969 NOV 13	2315	17.3	25	21	2529.936	2529.939	2529.954	.013
BS	RIDGE AUX A	GEORGE	1969 OCT 27	2045	18.5	20	25	2540.182	2540.184		
CT	RIDGE AUX A	GEORGE	1969 NOV 1	2300	19.6	21	25	2540.198	2540.201	2540.192	.012
CB	GEORGE AUX A	RIDGE	1969 OCT 29	2115	19.1	26	26	2530.716	2530.718		
CB	GEORGE AUX A	RIDGE	1969 OCT 29	2115	19.1	15	17	2530.715	2530.718	2530.718	0.000
CE	GEORGE	ADAMA	1969 OCT 29	1930	21.1	24	21	4461.164	4461.169		
CE	GEORGE	ADAMA	1969 OCT 29	1930	21.1	36	21	4461.161	4461.167		
CV	ADAMA	GEORGE	1969 NOV 1	2115	20.3	15	15	4461.169	4461.175		
CV	ADAMA	GEORGE	1969 NOV 1	2115	20.3	33	14	4461.168	4461.175	4461.172	.004
CU	ADAMA AUX A	GEORGE	1969 NOV 1	2030	20.3	5	13	4470.809	4470.815		
CU	ADAMA AUX A	GEORGE	1969 NOV 1	2030	20.3	9	32	4470.808	4470.814	4470.815	.001
CD	GEORGE AUX A	ADAMA	1969 OCT 29	2015	20.2	3	7	4470.534	4470.540		
CD	GEORGE AUX A	ADAMA	1969 OCT 29	2015	20.2	17	9	4470.531	4470.537	4470.539	.002
CI	RIDGE	ADAMA	1969 OCT 30	2115	20.0	32	20	2865.559	2865.564		
CX	ADAMA	RIDGE	1969 NOV 1	1900	21.6	5	17	2865.557	2865.560		
CX	ADAMA	RIDGE	1969 NOV 1	1900	21.6	9	16	2865.553	2865.556	2865.559	.004
CW	ADAMA AUX A	RIDGE	1969 NOV 1	1930	21.2	14	15	2874.385	2874.388	2874.388	0.000
CH	RIDGE AUX A	ADAMA	1969 OCT 30	2145	19.4	22	26	2877.997	2878.001		
CH	RIDGE AUX A	ADAMA	1969 OCT 30	2145	19.4	12	13	2877.996	2878.001	2878.001	0.000
CK	RIDGE	(EL PASO)	1969 OCT 30	2000	21.0	23	10	6625.339	6625.345		
CZ	(EL PASO)	RIDGE	1969 NOV 4	0100	16.9	22	26	6625.349	6625.356		
CZ	(EL PASO)	RIDGE	1969 NOV 4	0100	17.5	17	12	6625.353	6625.360	6625.354	.008
CJ	RIDGE	EL PASO AUX A	1969 OCT 30	2030	20.3	12	6	6631.474	6631.480		
CY	EL PASO AUX A	RIDGE	1969 NOV 4	0015	17.6	13	15	6631.479	6631.486	6631.483	.004

Code	Geodimeter Sta.	Retroreflector Sta.	Date	Time	Temp.	Spread		Corrected D	Final D	Line Average	
CL	RIDGE AUX A	(EL PASO)	1969 OCT 30	1930	21.2	15	13	6615.419	6615.424		
CL	RIDGE AUX A	(EL PASO)	1969 OCT 30	1930	21.1	15	17	6615.413	6615.418	6615.421	.004
BQ	FARENJI	RIDGE	1969 OCT 25	2230	18.1	23	10	3022.220	3022.225 *		
CG	RIDGE	FARENJI	1969 OCT 30	2315	17.9	13	11	3022.235	3022.241		
EZ	FARENJI	RIDGE	1969 NOV 17	2140	16.7	29	15	3022.242	3022.247		
EZ	FARENJI	RIDGE	1969 NOV 17	2140	16.7	29	6	3022.245	3022.250		
FA	FARENJI	RIDGE	1969 NOV 17	2110	16.7	15	17	3022.235	3022.240		
FA	FARENJI	RIDGE	1969 NOV 17	2110	16.7	15	9	3022.240	3022.245	3022.241 .245	.009 .004
BP	(FARENJI AUX.)	RIDGE	1969 OCT 25	2315	18.1	32	10	3015.089	3015.095	3015.095	0.000
CF	RIDGE AUX A	FARENJI	1969 OCT 30	2230	18.6	37	30	3026.065	3026.071	3026.071	0.000
DX	(FULCRUM)	RIDGE	1969 NOV 10	2000	18.7	18	19	5339.746	5339.750		
DX	(FULCRUM)	RIDGE	1969 NOV 10	2000	18.7	18	20	5339.749	5339.753		
EA	RIDGE	(FULCRUM)	1969 NOV 14	0115	15.0	36	19	5339.751	5339.755		
EA	RIDGE	(FULCRUM)	1969 NOV 14	0115	15.0	27	19	5339.751	5339.755	5339.753	.002
DY	FULCRUM AUX A	RIDGE	1969 NOV 10	1930	19.2	9	13	5335.146	5335.149		
DY	FULCRUM AUX A	RIDGE	1969 NOV 10	1930	19.2	17	28	5335.146	5335.149	5335.149	0.000
CR	ADAMA	(EL PASO)	1969 OCT 31	2130	21.4	5	18	6145.048	6145.058		
DB	(EL PASO)	ADAMA	1969 NOV 3	2300	18.1	11	24	6145.062	6145.073	6145.065	.011
DA	EL PASO AUX A	ADAMA	1969 NOV 3	2330	18.2	24	29	6153.603	6153.614	6153.614	0.000
CQ	ADAMA AUX A	(EL PASO)	1969 OCT 31	2100	21.2	2	30	6141.502	6141.511	6141.511	0.000
BN	FARENJI	ADAMA	1969 OCT 25	2145	19.0	42	10	1400.877	1400.880		
BN	FARENJI	ADAMA	1969 OCT 25	2145	19.0	42	3	1400.876	1400.879		
CP	ADAMA	FARENJI	1969 OCT 31	1930	22.8	28	14	1400.880	1400.882		
CP	ADAMA	FARENJI	1969 OCT 31	1930	22.8	28	30	1400.882	1400.884		
EW	FARENJI	ADAMA	1969 NOV 17	2310	15.6	20	23	1400.880	1400.884		
EX	FARENJI	ADAMA	1969 NOV 17	2255	15.8	36	6	1400.880	1400.884		
EY	FARENJI	ADAMA	1969 NOV 17	2225	16.1	30	14	1400.887	1400.890		
EY	FARENJI	ADAMA	1969 NOV 17	2225	16.1	33	22	1400.884	1400.888	1400.884	.004
BO	(FARENJI AUX.)	ADAMA	1969 OCT 25	2100	19.4	26	15	1406.448	1406.451		
BO	(FARENJI AUX.)	ADAMA	1969 OCT 25	2100	19.4	31	6	1406.442	1406.445	1406.448	.004
CO	ADAMA AUX A	FARENJI	1969 OCT 31	2015	22.5	13	16	1398.015	1398.017		
CO	ADAMA AUX A	FARENJI	1969 OCT 31	2015	22.5	18	27	1398.011	1398.014	1398.016	.002
BM	FARENJI	(EL PASO)	1969 OCT 25	1900	20.9	25	22	4749.002	4749.007 *		
BM	FARENJI	(EL PASO)	1969 OCT 25	1900	20.9	34	11	4748.997	4749.002 *		
DD	(EL PASO)	FARENJI	1969 NOV 3	2200	17.8	26	10	4749.016	4749.024		
DD	(EL PASO)	FARENJI	1969 NOV 3	2200	17.8	30	16	4749.016	4749.024		
FD	FARENJI	(EL PASO)	1969 NOV 17	1820	19.6	21	15	4749.019	4749.024		
FD	FARENJI	(EL PASO)	1969 NOV 17	1820	19.6	16	6	4749.023	4749.028		
FD	FARENJI	(EL PASO)	1969 NOV 17	1820	19.6	16	6	4749.021	4749.026		
FD	FARENJI	(EL PASO)	1969 NOV 17	1820	19.6	21	11	4749.019	4749.023	4749.021 .025	.010 .002
BL	(FARENJI AUX.)	(EL PASO)	1969 OCT 25	1945	20.7	42	32	4744.391	4744.397		
BL	(FARENJI AUX.)	(EL PASO)	1969 OCT 25	1945	20.7	21	15	4744.394	4744.400	4744.399	.002
DC	EL PASO AUX A	FARENJI	1969 NOV 3	2115	17.6	8	10	4757.472	4757.480		
DC	EL PASO AUX A	FARENJI	1969 NOV 3	2115	17.6	12	3	4757.479	4757.486	4757.483	.004
DE	(EL PASO)	OBSIDIAN	1969 NOV 3	1945	19.2	21	12	4725.827	4725.833		
DJ	OBSIDIAN	(EL PASO)	1969 NOV 5	2000	21.0	12	7	4725.832	4725.838	4725.836	.004
DK	OBSIDIAN AUX A	(EL PASO)	1969 NOV 05	2030	20.4	14	11	4739.131	4739.138		
DK	OBSIDIAN AUX A	(EL PASO)	1969 NOV 05	2030	20.4	21	21	4739.126	4739.133	4739.136	.004
DF	EL PASO AUX A	OBSIDIAN	1969 NOV 3	2015	17.9	19	9	4716.767	4716.773		
DF	EL PASO AUX A	OBSIDIAN	1969 NOV 3	2015	17.9	19	4	4716.770	4716.776	4716.775	.002
DW	(FULCRUM)	FARENJI	1969 NOV 10	2045	18.1	24	11	2365.984	2365.987		
DW	(FULCRUM)	FARENJI	1969 NOV 10	2045	18.1	17	14	2365.981	2365.984		
DW	(FULCRUM)	FARENJI	1969 NOV 10	2045	18.1	29	25	2365.983	2365.986		
DW	(FULCRUM)	FARENJI	1969 NOV 10	2045	18.1	35	14	2365.979	2365.982		
FB	FARENJI	(FULCRUM)	1969 NOV 17	2025	18.1	29	15	2365.978	2365.980		
FB	FARENJI	(FULCRUM)	1969 NOV 17	2025	18.1	13	18	2365.977	2365.980		
FB	FARENJI	(FULCRUM)	1969 NOV 17	2025	18.1	29	6	2365.977	2365.980		
FB	FARENJI	(FULCRUM)	1969 NOV 17	2025	18.1	13	18	2365.980	2365.982	2365.983	.003

Code	Geodimeter Sta.	Retroreflector Sta.	Date	Time	Temp.	Spread		Corrected D	Final D	Line Average	
DV	FULCRUM AUX A	FARENJI	1969 NOV 10	2130	18.1	23	25	2358.156	2358.159		
DV	FULCRUM AUX A	FARENJI	1969 NOV 10	2130	18.1	23	2	2358.154	2358.157	2358.158	.001
FC	(FARENJI AUX.)	(FULCRUM)	1969 NOV 17	1940	18.4	23	15	2375.145	2375.147		
FC	(FARENJI AUX.)	(FULCRUM)	1969 NOV 17	1940	18.4	23	19	2375.148	2375.150	2375.148	.002
FF	GRAVES	(FULCRUM)	1969 NOV 18	2145	17.8	3	20	7315.756	7315.762		
FG	(FULCRUM)	GRAVES	1969 NOV 20	1900	21.1	4	21	7315.761	7315.765	7315.763	.002
FE	GRAVES AUX A	(FULCRUM)	1969 NOV 18	2235	18.3	17	24	7339.298	7339.304		
FE	GRAVES AUX A	(FULCRUM)	1969 NOV 18	2235	18.3	17	13	7339.300	7339.307		
FM	(FULCRUM)	GRAVES AUX A	1969 NOV 21	2100	16.6	22	19	7339.289	7339.295		
FM	(FULCRUM)	GRAVES AUX A	1969 NOV 21	2100	16.6	23	9	7339.293	7339.298	7339.301	.005
FN	FULCRUM AUX A	GRAVES	1969 NOV 21	2000	16.7	17	10	7318.002	7318.007	7318.007	0.000
FI	GRAVES	CINDER	1969 NOV 22	0100	16.8	24	18	5866.813	5866.819		
FI	GRAVES	CINDER	1969 NOV 22	0100	16.8	27	22	5866.814	5866.821		
FK	GRAVES	CINDER	1969 NOV 21	2400	16.5	21	15	5866.815	5866.821		
FK	GRAVES	CINDER	1969 NOV 21	2400	16.5	21	17	5866.818	5866.824	5866.821	.002
FJ	GRAVES AUX A	CINDER	1969 NOV 22	0030	16.8	37	28	5876.668	5876.674		
FJ	GRAVES AUX A	CINDER	1969 NOV 22	0030	16.8	37	28	5876.670	5876.677		
FL	GRAVES AUX A	CINDER	1969 NOV 21	2330	16.8	27	22	5876.666	5876.673		
FL	GRAVES AUX A	CINDER	1969 NOV 21	2330	16.8	27	19	5876.669	5876.676	5876.675	.002
DI	OBSIDIAN	ROGGI	1969 NOV 5	2400	17.6	47	30	6074.160	6074.174		
DI	OBSIDIAN	ROGGI	1969 NOV 5	2400	17.6	30	17	6074.170	6074.183		
DI	OBSIDIAN	ROGGI	1969 NOV 5	2400	17.6	35	29	6074.170	6074.183		
DI	OBSIDIAN	ROGGI	1969 NOV 5	2400	17.6	43	17	6074.163	6074.177		
DR	ROGGI	OBSIDIAN	1969 NOV 07	2315	16.7	21	15	6074.162	6074.177		
DR	ROGGI	OBSIDIAN	1969 NOV 07	2315	16.7	3	12	6074.158	6074.173		
DR	ROGGI	OBSIDIAN	1969 NOV 07	2315	16.7	22	25	6074.163	6074.178		
DR	ROGGI	OBSIDIAN	1969 NOV 07	2315	16.7	3	25	6074.161	6074.175	6074.177	.004
DH	OBSIDIAN	ROGGI AUX A	1969 NOV 5	2230	18.6	7	14	6089.909	6089.923		
DH	OBSIDIAN	ROGGI AUX A	1969 NOV 5	2230	18.6	26	5	6089.908	6089.923		
DS	ROGGI AUX A	OBSIDIAN	1969 NOV 07	2300	17.4	6	14	6089.908	6089.923		
DS	ROGGI AUX A	OBSIDIAN	1969 NOV 07	2300	17.4	22	5	6089.906	6089.921	6089.923	.001
DG	OBSIDIAN R.M.	ROGGI	1969 NOV 06	0045	17.2	35	24	6081.086	6081.099	6081.099	0.000
DU	ROGGI	MIETCHI	1969 NOV 07	1930	19.2	14	19	6260.901	6260.907		
EE	ROGGI	MIETCHI	1969 NOV 13	2015	17.7	20	18	6260.897	6260.904	6260.906	.002
ED	ROGGI	MIETCHI AUX A	1969 NOV 13	2100	17.3	11	6	6254.943	6254.950	6254.950	0.000
DT	ROGGI AUX A	MIETCHI	1969 NOV 07	2015	18.6	14	22	6236.794	6236.801		
DT	ROGGI AUX A	MIETCHI	1969 NOV 07	2015	18.6	11	16	6236.797	6236.804		
DT	ROGGI AUX A	MIETCHI	1969 NOV 07	2015	18.6	14	22	6236.795	6236.802		
DT	ROGGI AUX A	MIETCHI	1969 NOV 07	2015	18.6	14	12	6236.800	6236.807	6236.804	.003
DZ	MIETCHI	TOPLESS	1969 NOV 12	2015	19.0	26	45	5566.620	5566.626		
DZ	MIETCHI	TOPLESS	1969 NOV 12	2015	19.0	21	18	5566.621	5566.627		
EH	TOPLESS	MIETCHI	1969 NOV 14	2045	17.9	14	8	5566.622	5566.629		
EH	TOPLESS	MIETCHI	1969 NOV 14	2045	17.9	14	16	5566.625	5566.631		
EJ	TOPLESS	MIETCHI	1969 NOV 14	1900	19.4	26	6	5566.611	5566.617		
EJ	TOPLESS	MIETCHI	1969 NOV 14	1900	19.4	13	15	5566.618	5566.623	5566.625	.005
EG	TOPLESS AUX A	MIETCHI	1969 NOV 24	2130	17.3	23	12	5576.984	5576.991		
EG	TOPLESS AUX A	MIETCHI	1969 NOV 24	2130	17.3	29	16	5576.988	5576.995		
EI	TOPLESS AUX A	MIETCHI	1969 NOV 14	1945	18.9	15	4	5576.992	5576.998		
EI	TOPLESS AUX A	MIETCHI	1969 NOV 14	1945	18.9	30	17	5576.993	5576.999	5576.996	.004
EF	DUST	MIETCHI	1969 NOV 14	2315	14.6	30	3	5511.364	5511.373		
EF	DUST	MIETCHI	1969 NOV 14	2315	14.6	2	21	5511.362	5511.371		
FX	DUST	MIETCHI	1969 NOV 14	2345	13.7	37	24	5511.364	5511.371		
FX	DUST	MIETCHI	1969 NOV 14	2345	13.7	22	25	5511.365	5511.373	5511.372	.001
FW	DUST AUX A	MIETCHI	1969 NOV 15	0030	13.6	9	23	5521.135	5521.142	5521.142	0.000
EP	DUST	TOPLESS	1969 NOV 16	0120	13.6	32	29	1709.682	1709.686		
EP	DUST	TOPLESS	1969 NOV 16	0120	13.6	19	12	1709.684	1709.688		
EV	TOPLESS	DUST	1969 NOV 16	2315	15.4	36	33	1709.692	1709.696		
EV	TOPLESS	DUST	1969 NOV 16	2315	15.4	13	7	1709.690	1709.694	1709.691	.005
EO	DUST AUX A	TOPLESS	1969 NOV 16	0150	12.4	34	26	1684.639	1684.643		
EO	DUST AUX A	TOPLESS	1969 NOV 16	0150	12.4	16	2	1684.639	1684.642		
EO	DUST AUX A	TOPLESS	1969 NOV 16	0150	12.4	34	13	1684.637	1684.640		
EO	DUST AUX A	TOPLESS	1969 NOV 16	0150	12.4	29	26	1684.642	1684.646	1684.642	.003

Code	Geodimeter Sta.	Retroreflector Sta.	Date	Time	Temp.	Spread		Corrected D	Final D	Line Average	
EU	TOPLESS AUX A	DUST	1969 NOV 16	2345	15.8	47	36	1739.338	1739.342		
EU	TOPLESS AUX A	DUST	1969 NOV 16	2345	15.8	43	41	1739.343	1739.347		
EU	TOPLESS AUX A	DUST	1969 NOV 16	2345	15.8	56	41	1739.340	1739.344		
EU	TOPLESS AUX A	DUST	1969 NOV 16	2345	15.8	34	36	1739.341	1739.345	1739.345	.002
EL	TOPLESS	SELASSIE	1969 NOV 15	1940	18.3	16	22	7489.385	7489.397		
EL	TOPLESS	SELASSIE	1969 NOV 15	1940	18.3	24	19	7489.386	7489.399		
ET	SELASSIE	TOPLESS	1969 NOV 16	1900	18.9	17	22	7489.391	7489.402		
ET	SELASSIE	TOPLESS	1969 NOV 16	1900	18.9	20	12	7489.394	7489.405	7489.401	.003
ES	SELASSIE AUX A	TOPLESS	1969 NOV 16	1940	18.6	17	11	7469.987	7469.999	7469.999	0.000
EK	TOPLESS AUX A	SELASSIE	1969 NOV 15	2015	17.9	33	16	7466.233	7466.246		
EK	TOPLESS AUX A	SELASSIE	1969 NOV 15	2015	17.9	13	15	7466.232	7466.245		
EK	TOPLESS AUX A	SELASSIE	1969 NOV 15	2015	17.9	33	7	7466.231	7466.245		
EK	TOPLESS AUX A	SELASSIE	1969 NOV 15	2015	17.9	22	28	7466.232	7466.246	7466.245	.001
EN	DUST	SELASSIE	1969 NOV 15	2220	16.0	17	27	8686.851	8686.872		
EN	DUST	SELASSIE	1969 NOV 15	2220	16.0	16	18	8686.853	8686.874		
EQ	SELASSIE	DUST	1969 NOV 16	2100	17.8	31	29	8686.870	8686.887		
EQ	SELASSIE	DUST	1969 NOV 16	2100	17.8	24	29	8686.874	8686.891	8686.880	.009
ER	SELASSIE AUX A	DUST	1969 NOV 16	2020	18.2	28	32	8662.805	8662.820		
ER	SELASSIE AUX A	DUST	1969 NOV 16	2020	18.2	11	12	8662.805	8662.821	8662.821	.001
EM	DUST AUX A	SELASSIE	1969 NOV 15	2250	15.5	19	15	8660.051	8660.072	8660.072	0.000
DO	NORTHWEST(X)	SOUTHEAST(0)	1969 NOV 06	1900	16.1	22	15	198.525	198.525		
DP	NORTHWEST(X)	SOUTHEAST(0)	1969 NOV 06	1945	15.6	30	37	198.525	198.525		
DQ	NORTHWEST(X)	SOUTHEAST(0)	1969 NOV 06	2030	15.3	21	20	198.525	198.525		
DQ	NORTHWEST(X)	SOUTHEAST(0)	1969 NOV 06	2030	15.3	21	9	198.523	198.524		
DQ	NORTHWEST(X)	SOUTHEAST(0)	1969 NOV 06	2030	15.3	21	29	198.524	198.525		
DQ	NORTHWEST(X)	SOUTHEAST(0)	1969 NOV 06	2030	15.3	21	16	198.524	198.524		
FS	NORTHWEST(X)	SOUTHEAST(0)	1969 NOV 23	2400	16.1	13	28	198.526	198.526		
FS	NORTHWEST(X)	SOUTHEAST(0)	1969 NOV 23	2400	16.1	16	12	198.520	198.521		
FS	NORTHWEST(X)	SOUTHEAST(0)	1969 NOV 23	2400	16.1	16	33	198.522	198.523		
FS	NORTHWEST(X)	SOUTHEAST(0)	1969 NOV 23	2400	16.1	13	25	198.524	198.524		
FT	NORTHWEST(X)	SOUTHEAST(0)	1969 NOV 23	2330	16.1	31	22	198.527	198.528		
FT	NORTHWEST(X)	SOUTHEAST(0)	1969 NOV 23	2330	16.1	28	17	198.524	198.525		
FT	NORTHWEST(X)	SOUTHEAST(0)	1969 NOV 23	2330	16.1	28	38	198.526	198.527		
FT	NORTHWEST(X)	SOUTHEAST(0)	1969 NOV 23	2330	16.1	31	7	198.525	198.525	198.525	.002
AA	NORTHWEST(XV)	SOUTHEAST(0)	1969 OCT 10	2130	14.4	35	34	297.822	297.823		
AB	NORTHWEST(XV)	SOUTHEAST(0)	1969 OCT 10	2230	14.4	26	24	297.831	297.831		
DL	NORTHWEST(XV)	SOUTHEAST(0)	1969 NOV 06	2330	13.9	30	32	297.830	297.831		
DM	NORTHWEST(XV)	SOUTHEAST(0)	1969 NOV 06	2245	14.2	26	29	297.832	297.832		
DN	NORTHWEST(XV)	SOUTHEAST(0)	1969 NOV 06	2200	14.4	34	31	297.823	297.824		
FU	NORTHWEST(XV)	SOUTHEAST(0)	1969 NOV 23	2230	16.1	26	27	297.821	297.822		
FV	NORTHWEST(XV)	SOUTHEAST(0)	1969 NOV 23	2200	16.8	20	21	297.818	297.819	297.826	.005

APPENDIX C

LASER8 1970 GEODIMETER OBSERVATIONS

Code	Geodimeter Sta.	Retroreflector Sta.	Date	Time	Temp.	Spread	Corrected D	Final D	Line Average	
IB	RIDGE	MARIAM	1970 NOV 03	1740	20.9	4 R	9759.383	9759.387		
IC	RIDGE	MARIAM	1970 NOV 03	1755	20.6	32 R	9759.380	9759.384	9759.387	.002
KY	BOKU	MARIAM	1970 NOV 14	1530	22.9	31 M	16322.443	16322.453		
KZ	BOKU	MARIAM	1970 NOV 14	1540	22.7	22 M	16322.428	16322.438	16322.444	.011
IA	RIDGE	GEORGE	1970 NOV 03	1615	24.2	16 R	2529.949	2529.951	2529.951	0.000
HF	RIDGE R.M.	GEORGE	1970 NOV 01	0815	19.9	13 M	2532.075	2532.073		
HG	RIDGE R.M.	GEORGE	1970 NOV 01	0835	20.1	8 M	2532.070	2532.068	2532.070	.004
HO	ADAMA	GEORGE	1970 NOV 02	1610	25.8	23 R	4461.171	4461.176	4461.176	0.000
JF	(FULCRUM)	GEORGE	1970 NOV 09	1745	21.5	14 R	7279.910	7279.913	7279.913	0.000
HS	FULCRUM AUX A	GEORGE	1970 NOV 03	0730	17.5	19 M	7281.194	7281.188		
HT	FULCRUM AUX A	GEORGE	1970 NOV 03	0805	17.8	24 M	7281.195	7281.190	7281.189	.001
JG	BOKU	GEORGE	1970 NOV 10	0800	18.7	19 M	9430.882	9430.873 *		
JH	BOKU	GEORGE	1970 NOV 10	0815	19.1	30 M	9430.857	9430.849		
LA	BOKU	GEORGE	1970 NOV 14	1630	24.0	31 M	9430.844	9430.851	9430.860 .850	.013 .001
HZ	RIDGE	ADAMA	1970 NOV 03	1150	24.7	9 M	2865.567	2865.568	2865.568	0.000
HH	RIDGE R.M.	ADAMA	1970 NOV 01	0920	22.0	4 M	2866.130	2866.128		
HI	RIDGE R.M.	ADAMA	1970 NOV 01	0940	22.3	29 M	2866.134	2866.133		
HP	ADAMA	RIDGE R.M.	1970 NOV 02	1640	24.8	26 R	2866.101	2866.104	2866.123	.016
HY	RIDGE	EL PASO AUX A	1970 NOV 03	1105	23.1	20 M	6631.490	6631.490	6631.490	0.000
HM	RIDGE R.M.	EL PASO AUX A	1970 NOV 01	1245	24.4	7 R	6629.400	6629.404		
HN	RIDGE R.M.	EL PASO AUX A	1970 NOV 01	1310	24.4	35 R	6629.422	6629.426	6629.410	.016
IV	RIDGE	FARENJI	1970 NOV 07	1750	22.2	30 R	3022.266	3022.268		
KG	FARENJI	RIDGE	1970 NOV 12	1610	22.9	18 R	3022.256	3022.259		
KH	FARENJI	RIDGE	1970 NOV 12	1624	22.5	17 R	3022.255	3022.259	3022.261	.005
HJ	RIDGE R.M.	FARENJI	1970 NOV 01	1015	23.2	17 M	3021.619	3021.618		
HK	RIDGE R.M.	FARENJI	1970 NOV 01	1030	23.5	36 M	3021.616	3021.616		
HL	RIDGE R.M.	FARENJI	1970 NOV 01	1140	23.9	2 R	3021.606	3021.607	3021.612	.006
JD	(FULCRUM)	RIDGE	1970 NOV 09	1700	22.8	31 R	5339.760	5339.762		
JE	(FULCRUM)	RIDGE	1970 NOV 09	1715	22.3	40 R	5339.771	5339.773	5339.767	.008
HU	FULCRUM AUX A	RIDGE	1970 NOV 03	0930	20.2	6 M	5335.191	5335.189		
HV	FULCRUM AUX A	RIDGE	1970 NOV 03	0850	20.5	8 M	5335.189	5335.186	5335.188	.002
JI	BOKU	RIDGE	1970 NOV 10	0855	20.2	11 M	6998.221	6998.216		
JJ	BOKU	RIDGE	1970 NOV 10	0910	20.7	4 M	6998.204	6998.200		
LB	BOKU	RIDGE	1970 NOV 14	1700	23.0	31 M	6998.222	6998.227	6998.211	.014
HR	ADAMA	EL PASO AUX A	1970 NOV 02	1800	22.0	7 R	6153.607	6153.611	6153.611	0.000
HQ	ADAMA	FARENJI	1970 NOV 02	1725	24.3	27 R	1400.889	1400.891		
IU	ADAMA	FARENJI	1970 NOV 07	1700	25.2	15 M	1400.894	1400.896	1400.894	.004
JK	BOKU	ADAMA	1970 NOV 10	0940	21.2	23 M	7427.073	7427.069		
JL	BOKU	ADAMA	1970 NOV 10	1000	21.5	26 M	7427.080	7427.076		
KX	BOKU	ADAMA	1970 NOV 14	1108	22.4	13 R	7427.062	7427.063	7427.068	.007
KI	FARENJI	EL PASO AUX A	1970 NOV 12	1700	22.2	29 R	4757.500	4757.505		
KJ	FARENJI	EL PASO AUX A	1970 NOV 12	1715	21.9	11 R	4757.497	4757.501	4757.502	.003
JO	BOKU	EL PASO AUX A	1970 NOV 10	1110	23.4	12 M	2307.080	2307.081		
JP	BOKU	EL PASO AUX A	1970 NOV 10	1130	23.5	20 M	2307.072	2307.072		
KT	BOKU	EL PASO AUX A	1970 NOV 14	0918	19.7	41 R	2307.088	2307.087	2307.079	.008
JB	(FULCRUM)	FARENJI	1970 NOV 09	1605	24.3	39 R	2365.995	2365.998		
JC	(FULCRUM)	FARENJI	1970 NOV 09	1625	23.9	20 R	2366.007	2366.009	2366.005	.008
HW	FULCRUM AUX A	FARENJI	1970 NOV 03	0945	22.9	12 M	2358.175	2358.174		
HX	FULCRUM AUX A	FARENJI	1970 NOV 03	1000	23.3	20 M	2358.188	2358.187	2358.180	.009

Code	Geodimeter Sta.	Retroreflector Sta.	Date	Time	Temp.	Spread	Corrected D	Final D	Line Average	
JM	BOKU	FARENJI	1970 NOV 10	1030	22.9	42 M	6066.401	6066.400		
JN	BOKU	FARENJI	1970 NOV 10	1040	22.9	4 M	6066.410	6066.409		
KU	BOKU	FARENJI	1970 NOV 14	0950	20.8	8 R	6066.410	6066.407	6066.407	.005
IE	GRAVES	(FULCRUM)	1970 NOV 04	0845	21.9	21 M	7315.810	7315.806		
KP	GRAVES	(FULCRUM)	1970 NOV 13	1315	24.4	25 R	7315.767	7315.770	7315.789	.025
IF	GRAVES AUX A	(FULCRUM)	1970 NOV 04	0930	23.0	32 M	7339.330	7339.328		
KO	GRAVES AUX A	(FULCRUM)	1970 NOV 13	1250	24.8	30 R	7339.318	7339.321	7339.324	.005
ID	GRAVES	FULCRUM AUX A	1970 NOV 04	0830	21.3	13 M	7318.046	7318.042	7318.042	0.000
IN	FULCRUM AUX A	CINDER	1970 NOV 06	0830	21.8	9 R	12089.238	12089.231		
IO	FULCRUM AUX A	CINDER	1970 NOV 06	0845	22.0	15 R	12089.231	12089.224	12089.228	.005
IP	(FULCRUM)	RABBIT	1970 NOV 07	0850	20.5	25 M	12573.427	12573.420		
IQ	(FULCRUM)	RABBIT	1970 NOV 07	0905	21.3	20 M	12573.414	12573.409		
IW	(FULCRUM)	RABBIT	1970 NOV 08	0820	19.7	46 M	12573.467	12573.460*		
IY	(FULCRUM)	RABBIT	1970 NOV 08	0900	21.3	9 M	12573.413	12573.407	12573.416 .410	.025 .007
IR	FULCRUM R.M.	RABBIT	1970 NOV 07	0925	21.7	27 M	12578.435	12578.431		
IX	FULCRUM R.M.	RABBIT	1970 NOV 08	0840	20.6	3 M	12578.464	12578.457	12578.449	.018
JS	BOKU	(FULCRUM)	1970 NOV 10	1715	22.3	12 R	6902.400	6902.403		
JT	BOKU	(FULCRUM)	1970 NOV 10	1738	21.9	7 R	6902.399	6902.401		
KV	BOKU	(FULCRUM)	1970 NOV 14	1020	21.4	33 R	6902.417	6902.416	6902.404	.008
KW	BOKU	FULCRUM AUX A	1970 NOV 14	1035	21.7	24 R	6880.085	6880.084	6880.084	0.000
IG	GRAVES AUX A	CINDER	1970 NOV 04	1125	26.5	33 R	5876.679	5876.680		
IH	GRAVES AUX A	CINDER	1970 NOV 04	1150	26.7	16 R	5876.676	5876.678	5876.679	.001
JU	AYGU	CINDER	1970 NOV 11	0825	18.3	19 R	13466.942	13466.931*		
JV	AYGU	CINDER	1970 NOV 11	0840	20.4	26 R	13466.922	13466.912	13466.923 .912	.013
KK	BOHALLA	CINDER	1970 NOV 13	1050	23.7	16 M	7233.362	7233.362		
KL	BOHALLA	CINDER	1970 NOV 13	1100	23.9	8 M	7233.355	7233.355	7233.358	.005
KM	BOHALLA	CINDER AUX A	1970 NOV 13	1110	24.3	29 M	7223.521	7223.521		
KN	BOHALLA	CINDER AUX A	1970 NOV 13	1118	24.4	11 M	7223.526	7223.527	7223.525	.004
ML	ROGGI	MIETCHI	1970 NOV 21	1640	24.5	34 R	6260.907	6260.912		
MM	ROGGI	MIETCHI	1970 NOV 21	1652	24.4	36 R	6260.897	6260.903	6260.908	.006
MN	ROGGI AUX A	MIETCHI	1970 NOV 21	1710	23.9	18 R	6236.804	6236.810		
MO	ROGGI AUX A	MIETCHI	1970 NOV 21	1720	23.5	30 R	6236.813	6236.818	6236.813	.006
JQ	BOKU	ROGGI	1970 NOV 10	1610	24.0	38 R	9845.333	9845.344		
JR	BOKU	ROGGI	1970 NOV 10	1635	23.8	27 R	9845.324	9845.336		
KQ	BOKU	ROGGI	1970 NOV 14	0815	15.6	48 R	9845.396	9845.383*	9845.349 339	.025 .006
KR	BOKU	ROGGI AUX A	1970 NOV 14	0835	16.3	53 R	9857.993	9857.982		
KS	BOKU	ROGGI AUX A	1970 NOV 14	0845	16.8	10 R	9857.973	9857.963	9857.967	.013
HC	TABLE	AYGU	1970 OCT 30	1112	25.2	9 M	7678.142	7678.143		
HD	TABLE	AYGU	1970 OCT 30	1146	25.6	6 M	7678.132	7678.135		
JY	AYGU	TABLE	1970 NOV 11	1130	23.9	12 R	7678.146	7678.148		
JZ	AYGU	TABLE	1970 NOV 11	1150	23.6	23 R	7678.131	7678.134		
KC	AYGU	TABLE	1970 NOV 12	1023	24.7	18 M	7678.179	7678.178*		
KD	AYGU	TABLE	1970 NOV 12	1030	25.1	21 M	7678.174	7678.172*		
MJ	AYGU	TABLE	1970 NOV 21	1010	24.0	14 M	7678.158	7678.156		
MK	AYGU	TABLE	1970 NOV 21	1022	24.4	22 M	7678.154	7678.152	7678.151 .141	.016 .009
HA	TABLE	MERKO	1970 OCT 30	0915	23.0	4 M	6858.870	6858.863		
HB	TABLE	MERKO	1970 OCT 30	0920	23.5	3 M	6858.877	6858.870		
IM	MERKO	TABLE	1970 NOV 05	1325	27.7	8 M	6858.851	6858.859		
JA	TABLE	MERKO	1970 NOV 08	1240	26.1	15 R	6858.849	6858.855	6858.863	.006
IS	TABLE	RABBIT	1970 NOV 07	1037	23.1	23 M	9418.263	9418.262		
IT	TABLE	RABBIT	1970 NOV 07	1050	23.4	21 M	9418.261	9418.261		
IZ	TABLE	RABBIT	1970 NOV 08	1005	22.8	16 M	9418.276	9418.272	9418.265	.006

Code	Geodimeter Sta.	Retroreflector Sta.	Date	Time	Temp.	Spread	Corrected D	Final D	Line Average	
II	MERKO	AYGU	1970 NOV 05	0950	24.8	14 M	7829.049	7829.045		
IJ	MERKO	AYGU	1970 NOV 05	1000	24.8	22 M	7829.045	7829.042		
KA	AYGU	MERKO	1970 NOV 12	0858	21.0	25 M	7829.069	7829.062		
KB	AYGU	MERKO	1970 NOV 12	0906	21.4	18 M	7829.067	7829.060	7829.052	.010
JW	AYGU	RABBIT	1970 NOV 11	0955	21.4	9 R	7220.500	7220.497		
JX	AYGU	RABBIT	1970 NOV 11	1020	22.0	25 R	7220.482	7220.481 *		
KE	AYGU	RABBIT	1970 NOV 12	1155	23.0	19 M	7220.498	7220.500		
KF	AYGU	RABBIT	1970 NOV 12	1220	23.4	35 M	7220.497	7220.500		
MH	AYGU	RABBIT	1970 NOV 21	0835	19.0	17 M	7220.517	7220.512 *		
MI	AYGU	RABBIT	1970 NOV 21	0847	19.4	20 M	7220.506	7220.501	7220.499	.010
									.499	.002
IK	MERKO	RABBIT	1970 NOV 05	1205	26.1	13 M	13687.791	13687.798		
IL	MERKO	RABBIT	1970 NOV 05	1220	26.4	11 M	13687.791	13687.800	13687.799	.001
LC	GALLA	HOTEL	1970 NOV 17	0745	16.3	24 R	764.074	764.073 *		
LD	GALLA	HOTEL	1970 NOV 17	0800	16.8	8 R	764.067	764.066		
LS	HOTEL	GALLA	1970 NOV 18	0910	19.4	8 M	764.061	764.061		
LT	HOTEL	GALLA	1970 NOV 18	0920	19.3	13 M	764.054	764.054	764.063	.008
									.061	.006
LE	GALLA	TERMITE	1970 NOV 17	0835	18.2	3 R	746.049	746.048		
LF	GALLA	TERMITE	1970 NOV 17	0850	18.6	26 R	746.049	746.048		
LW	TERMITE	GALLA	1970 NOV 18	1720	23.1	18 M	746.052	746.053		
LX	TERMITE	GALLA	1970 NOV 18	1730	22.7	6 M	746.050	746.051	746.050	.002
LG	GALLA	EUPHORBIA	1970 NOV 17	0935	21.2	20 R	2852.126	2852.124		
LH	GALLA	EUPHORBIA	1970 NOV 17	0945	21.2	28 R	2852.131	2852.129		
LO	EUPHORBIA	GALLA	1970 NOV 17	1815	22.2	17 M	2852.136	2852.140		
LP	EUPHORBIA	GALLA	1970 NOV 17	1822	22.0	13 M	2852.131	2852.134		
MC	EUPHORBIA	GALLA	1970 NOV 19	0945	19.7	13 R	2852.133	2852.131	2852.132	.006
MD	EUPHORBIA AUX A	GALLA	1970 NOV 19	1010	20.9	16 R	2862.170	2862.168		
ME	EUPHORBIA AUX A	GALLA	1970 NOV 19	1022	21.1	6 R	2862.165	2862.164	2862.166	.003
LQ	HOTEL	TERMITE	1970 NOV 18	0830	18.6	15 M	1022.596	1022.594		
LR	HOTEL	TERMITE	1970 NOV 18	0845	19.1	4 M	1022.599	1022.598		
LU	TERMITE	HOTEL	1970 NOV 18	1630	24.7	18 M	1022.593	1022.595		
LV	TERMITE	HOTEL	1970 NOV 18	1645	24.5	38 M	1022.583	1022.584	1022.595	.006
LI	EUPHORBIA	HOTEL	1970 NOV 17	1627	25.4	27 M	3517.927	3517.932		
LJ	EUPHORBIA	HOTEL	1970 NOV 17	1637	25.1	7 M	3517.928	3517.932		
LY	EUPHORBIA	HOTEL	1970 NOV 19	0815	17.8	12 R	3517.943	3517.939		
LZ	EUPHORBIA	HOTEL	1970 NOV 19	0826	18.1	15 R	3517.947	3517.943	3517.937	.005
LK	EUPHORBIA AUX A	HOTEL	1970 NOV 17	1645	24.8	14 M	3524.758	3524.762	3524.762	0.000
LM	EUPHORBIA	TERMITE	1970 NOV 17	1735	23.3	20 M	3358.114	3358.118		
LN	EUPHORBIA	TERMITE	1970 NOV 17	1742	23.0	13 M	3358.116	3358.120		
MA	EUPHORBIA	TERMITE	1970 NOV 19	0900	18.9	10 R	3358.132	3358.128		
MB	EUPHORBIA	TERMITE	1970 NOV 19	0912	19.3	18 R	3358.130	3358.126	3358.123	.005
LL	EUPHORBIA AUX A	TERMITE	1970 NOV 17	1722	23.7	12 M	3372.620	3372.624	3372.624	0.000
MF	ALUTU	OITU	1970 NOV 19	1700	25.1	19 M	4629.079	4629.082		
MG	ALUTU	OITU	1970 NOV 19	1715	24.6	8 M	4629.079	4629.081	4629.081	.001
MP	GALILA	YELLEM	1970 NOV 22	1000	21.8	47 R	2248.294	2248.293		
MQ	GALILA	YELLEM	1970 NOV 22	1015	22.6	12 R	2248.294	2248.293	2248.293	0.000
MR	GALILA	THORNS	1970 NOV 22	1110	23.6	45 R	4608.478	4608.479		
MS	GALILA	THORNS	1970 NOV 22	1122	23.9	14 R	4608.479	4608.480	4608.480	.001
MT	GALILA	KOKA	1970 NOV 22	1240	26.2	22 M	1664.013	1664.014		
MU	GALILA	KOKA	1970 NOV 22	1250	26.7	13 M	1664.003	1664.004	1664.008	.007
MV	KOKA	YELLEM	1970 NOV 22	1610	26.0	30 M	2871.874	2871.877		
MW	KOKA	YELLEM	1970 NOV 22	1620	25.8	36 M	2871.869	2871.872	2871.875	.004
MX	KOKA	THORNS	1970 NOV 22	1710	24.5	5 M	4444.650	4444.655		
MY	KOKA	THORNS	1970 NOV 22	1715	24.1	11 M	4444.654	4444.658	4444.656	.002

APPENDIX D

PAPAYA 1971 GEODIMETER OBSERVATIONS

Code	Geodimeter Sta.	Retroreflector Sta.	Date	Time	Temp.	Spread	Corrected D	Final D	Line Average	
DG	MARIAM	GEORGE	1971 NOV 07	1710	24.2	4 M	7262.550	7262.553		
DH	MARIAM	GEORGE	1971 NOV 07	1720	23.9	1 W	7262.548	7262.550		
DI	MARIAM	GEORGE	1971 NOV 07	1730	23.5	2 M	7242.552	7262.554	7262.552	.002
DJ	MARIAM	GEORGE AUX A	1971 NOV 07	1745	22.9	3 W	7259.096	7259.099		
DK	MARIAM	GEORGE AUX A	1971 NOV 07	1800	22.4	6 M	7259.093	7259.095	7259.097	.003
DL	MARIAM	RIDGE	1971 NOV 07	1830	21.3	18 M	9759.374	9759.376		
DM	MARIAM	RIDGE	1971 NOV 07	1840	20.7	24 W	9759.374	9759.376	9759.376	0.000
VR	RIDGE	GEORGE	1971 OCT 18	1600	26.5	5 M	2529.969	2529.971		
VS	RIDGE	GEORGE	1971 OCT 18	1610	26.3	6 M	2529.966	2529.969	2529.970	.001
VP	RIDGE AUX A	GEORGE	1971 OCT 18	1520	26.7	26 M	2540.182	2540.185		
VQ	RIDGE AUX A	GEORGE	1971 OCT 18	1535	26.7	23 M	2540.186	2540.188	2540.187	.002
VT	RIDGE	GEORGE AUX A	1971 OCT 18	1625	25.7	36 M	2530.734	2530.736	2530.736	0.000
YN	ADAMA	GEORGE	1971 OCT 25	1650	24.5	10 T	4461.181	4461.186		
YO	ADAMA	GEORGE	1971 OCT 25	1700	24.2	12 M	4461.183	4461.187	4461.186	.001
YP	ADAMA AUX A	GEORGE	1971 OCT 25	1715	23.7	7 T	4470.825	4470.830		
YQ	ADAMA AUX A	GEORGE	1971 OCT 25	1730	23.3	12 M	4470.825	4470.829	4470.830	.001
XK	FULCRUM AUX A	GEORGE	1971 OCT 22	0755	18.4	5 T	7281.180	7281.174		
XL	FULCRUM AUX A	GEORGE	1971 OCT 22	0805	19.2	7 T	7281.184	7281.178	7281.176	.003
EF	PYLON	GEORGE	1971 NOV 08	1900	21.6	15 M	6642.843	6642.851		
EG	PYLON	GEORGE	1971 NOV 08	1910	21.3	5 W	6642.843	6642.851		
EH	PYLON	GEORGE	1971 NOV 08	1925	21.2	7 M	6642.843	6642.852	6642.851	.001
FA	GEORGE	WONJI	1971 NOV 10	1715	25.1	15 M	6566.788	6566.792		
FB	GEORGE	WONJI	1971 NOV 10	1725	24.7	0 W	6566.789	6566.793		
FC	GEORGE	WONJI	1971 NOV 10	1740	24.3	5 M	6566.781	6566.784		
FD	GEORGE	WONJI	1971 NOV 10	1750	24.0	6 W	6566.783	6566.786	6566.789	.004
AH	BOKU	GEORGE	1971 NOV 01	0800	19.3	18 M	9430.849	9430.841		
AI	BOKU	GEORGE	1971 NOV 01	0810	19.5	7 M	9430.862	9430.854		
AJ	BOKU	GEORGE	1971 NOV 01	0825	19.7	9 M	9430.843	9430.836	9430.844	.009
FP	RIDGE	ADAMA	1971 NOV 11	1735	22.7	4 M	2865.560	2865.562		
FQ	RIDGE	ADAMA	1971 NOV 11	1745	22.4	6 W	2865.564	2865.565		
FR	RIDGE	ADAMA	1971 NOV 11	1800	22.2	4 M	2865.561	2865.563		
VE	RIDGE	ADAMA	1971 OCT 17	1730	24.9	2 M	2865.564	2865.566		
VE	RIDGE	ADAMA	1971 OCT 17	1730	24.9	3 M	2865.564	2865.567		
VF	RIDGE	ADAMA	1971 OCT 17	1745	24.4	11 T	2865.564	2865.566		
VM	RIDGE	ADAMA	1971 OCT 18	0935	24.1	11 M	2865.577	2865.575		
VN	RIDGE	ADAMA	1971 OCT 18	0945	24.3	12 M	2865.581	2865.579		
WY	RIDGE	ADAMA	1971 OCT 20	2100	19.1	3 M	2865.569	2865.574		
WZ	RIDGE	ADAMA	1971 OCT 20	2115	19.0	7 M	2865.568	2865.573	2865.569	.006
VG	RIDGE	ADAMA AUX A	1971 OCT 17	1800	23.6	4 M	2874.391	2874.393		
VO	RIDGE	ADAMA AUX A	1971 OCT 18	1000	25.4	5 M	2874.411	2874.410	2874.401	.012
VU	RIDGE	EL PASO AUX A	1971 OCT 18	1715	24.9	1 M	6631.500	6631.504		
VV	RIDGE	EL PASO AUX A	1971 OCT 18	1725	24.6	12 M	6631.505	6631.508	6631.506	.003
FL	RIDGE	FARENJI	1971 NOV 11	1625	24.0	27 W	3022.265	3022.267		
FM	RIDGE	FARENJI	1971 NOV 11	1635	23.7	17 M	3022.251	3022.253		
FN	RIDGE	FARENJI	1971 NOV 11	1645	23.5	8 W	3022.252	3022.254		
FO	RIDGE	FARENJI	1971 NOV 11	1700	23.4	7 M	3022.253	3022.255		
VC	RIDGE	FARENJI	1971 OCT 17	1640	26.0	7 M	3022.256	3022.259		
VD	RIDGE	FARENJI	1971 OCT 17	1655	25.7	21 T	3022.258	3022.261		
VK	RIDGE	FARENJI	1971 OCT 18	0850	21.7	4 M	3022.263	3022.259		
VL	RIDGE	FARENJI	1971 OCT 18	0855	22.3	2 M	3022.263	3022.260		
WC	FARENJI	RIDGE	1971 OCT 19	1550	25.9	41 T	3022.263	3022.266		
WD	FARENJI	RIDGE	1971 OCT 19	1605	25.6	18 M	3022.262	3022.264		
XA	RIDGE	FARENJI	1971 OCT 20	2230	16.5	8 M	3022.253	3022.259		
XB	RIDGE	FARENJI	1971 OCT 20	2245	16.3	8 M	3022.253	3022.259	3022.259	.004
WQ	FARENJI AUX B	RIDGE	1971 OCT 20	1015	23.2	16 W	3011.205	3011.204		
WR	FARENJI AUX B	RIDGE	1971 OCT 20	1030	23.3	11 M	3011.202	3011.201	3011.202	.002
WE	FARENJI	RIDGE AUX A	1971 OCT 19	1620	25.6	12 M	3026.087	3026.090		
WF	FARENJI	RIDGE AUX A	1971 OCT 19	1630	25.4	6 M	3026.084	3026.086	3026.088	.003

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Code	Geodimeter Sta.	Retroreflector Sta.	Date	Time	Temp.	Spread	Corrected D	Final D	Line Average	
VA	RIDGE	FULCRUM AUX A	1971 OCT 17	1550	26.9	18 M	5335.159	5335.161		
VA	RIDGE	FULCRUM AUX A	1971 OCT 17	1550	26.9	18 M	5335.160	5335.163		
VH	RIDGE	FULCRUM AUX A	1971 OCT 18	0740	18.7	2 M	5335.163	5335.158		
VI	RIDGE	FULCRUM AUX A	1971 OCT 18	0755	19.6	4 M	5335.164	5335.160		
XE	RIDGE	FULCRUM AUX A	1971 OCT 21	1510	26.4	8 T	5335.168	5335.171		
XF	RIDGE	FULCRUM AUX A	1971 OCT 21	1520	26.3	7 M	5335.170	5335.173	5335.164	.006
XC	RIDGE	FULCRUM AUX B	1971 OCT 21	0000	16.1	12 M	5337.054	5337.060		
XD	RIDGE	FULCRUM AUX B	1971 OCT 21	0005	15.9	3 M	5337.051	5337.057		
XG	RIDGE	FULCRUM AUX B	1971 OCT 21	1530	26.0	14 T	5337.071	5337.074		
XH	RIDGE	FULCRUM AUX B	1971 OCT 21	1545	25.9	10 M	5337.072	5337.074	5337.065	.009
VB	RIDGE	FULCRUM R.M.	1971 OCT 17	1605	26.7	16 M	5339.918	5339.921		
VJ	RIDGE	FULCRUM R.M.	1971 OCT 18	0810	20.3	3 M	5339.916	5339.912		
XI	RIDGE	FULCRUM R.M.	1971 OCT 21	1605	25.4	11 T	5339.912	5339.913		
XJ	RIDGE	FULCRUM R.M.	1971 OCT 21	1620	25.2	25 T	5339.920	5339.921	5339.916	.005
ED	PYLON	RIDGE	1971 NOV 08	1815	22.6	9 M	7612.214	7612.222		
EE	PYLON	RIDGE	1971 NOV 08	1825	22.3	11 W	7612.209	7612.218	7612.220	.003
VW	RIDGE	GANTI	1971 OCT 18	1745	23.7	5 M	6673.497	6673.499		
VX	RIDGE	GANTI	1971 OCT 18	1755	23.4	7 M	6673.492	6673.494	6673.497	.004
AK	BOKU	RIDGE	1971 NOV 01	0900	21.6	16 M	6998.251	6998.248 *		
AL	BOKU	RIDGE	1971 NOV 01	0910	21.7	47 H	6998.207	6998.203		
AZ	BOKU	RIDGE	1971 NOV 01	1850	20.1	23 T	6998.221	6998.224		
BA	BOKU	RIDGE	1971 NOV 01	1900	20.0	41 H	6998.196	6998.198	6998.226 .216	.023 .013
AM	BOKU	RIDGE AUX A	1971 NOV 01	0925	21.9	42 M	6983.096	6983.093		
AN	BOKU	RIDGE AUX A	1971 NOV 01	0935	22.4	36 H	6983.099	6983.098	6983.096	.004
WS	ADAMA	EL PASO AUX A	1971 OCT 20	1510	26.7	18 M	6153.614	6153.620		
WT	ADAMA	EL PASO AUX A	1971 OCT 20	1530	26.7	39 M	6153.621	6153.628	6153.623	.006
WG	FARENJI	ADAMA	1971 OCT 19	1705	25.3	1 M	1400.899	1400.901		
WH	FARENJI	ADAMA	1971 OCT 19	1715	24.7	9 T	1400.899	1400.901	1400.901	0.000
WO	FARENJI AUX B	ADAMA	1971 OCT 20	0920	22.9	11 W	1407.500	1407.498		
WP	FARENJI AUX B	ADAMA	1971 OCT 20	0935	23.1	6 M	1407.491	1407.490	1407.494	.006
WI	FARENJI	ADAMA AUX A	1971 OCT 19	1735	24.2	12 M	1398.032	1398.034		
WJ	FARENJI	ADAMA AUX A	1971 OCT 19	1745	24.0	6 M	1398.028	1398.030	1398.032	.003
WU	ADAMA	GANTI	1971 OCT 20	1545	25.8	26 H	6100.377	6100.382		
WV	ADAMA	GANTI	1971 OCT 20	1605	25.4	5 M	6100.372	6100.376	6100.378	.004
AO	BOKU	ADAMA	1971 NOV 01	1015	23.2	41 M	7427.121	7427.120		
AP	BOKU	ADAMA	1971 NOV 01	1025	23.2	45 H	7427.132	7427.132*	7427.126 .120	.008
WK	FARENJI	EL PASO AUX A	1971 OCT 20	0755	18.6	7 M	4757.497	4757.489		
WL	FARENJI	EL PASO AUX A	1971 OCT 20	0805	19.6	10 M	4757.503	4757.495	4757.492	.004
AV	BOKU	EL PASO AUX A	1971 NOV 01	1655	22.6	17 T	2307.098	2307.099		
AW	BOKU	EL PASO AUX A	1971 NOV 01	1715	22.3	15 H	2307.111	2307.112*	2307.106 .099	.009
VY	FARENJI	FULCRUM AUX A	1971 OCT 19	1440	26.5	26 T	2358.140	2358.142 *		
VZ	FARENJI	FULCRUM AUX A	1971 OCT 19	1455	26.6	13 M	2358.169	2358.170	2358.159 .170	.020
WA	FARENJI	FULCRUM R.M.	1971 OCT 19	1510	26.9	5 M	2367.392	2367.393		
WB	FARENJI	FULCRUM R.M.	1971 OCT 19	1520	26.6	4 M	2367.389	2367.391	2367.392	.001
WM	FARENJI	GANTI	1971 OCT 20	0830	20.0	3 M	4709.996	4709.991		
WN	FARENJI	GANTI	1971 OCT 20	0840	20.1	14 M	4709.992	4709.987	4709.989	.003
AQ	BOKU	FARENJI	1971 NOV 01	1110	23.5	94 M	6066.404	6066.405		
AR	BOKU	FARENJI	1971 NOV 01	1125	23.4	37 M	6066.402	6066.402	6066.402	.002
XP	GRAVES	FULCRUM AUX A	1971 OCT 22	1530	27.3	17 M	7318.025	7318.028		
XQ	GRAVES	FULCRUM AUX A	1971 OCT 22	1540	27.1	16 M	7318.013	7318.016		
XX	GRAVES	FULCRUM AUX A	1971 OCT 23	0800	19.8	7 T	7318.017	7318.011		
XY	GRAVES	FULCRUM AUX A	1971 OCT 23	0810	20.3	9 H	7318.024	7318.019		
ZM	GRAVES	FULCRUM AUX A	1971 OCT 28	2050	18.1	12 M	7318.008	7318.014		
ZN	GRAVES	FULCRUM AUX A	1971 OCT 28	2100	16.8	10 H	7318.009	7318.015		
ZO	GRAVES	FULCRUM AUX A	1971 OCT 28	2120	15.4	13 M	7317.992	7317.998	7318.014	.009

Code	Geodimeter Sta.	Retroreflector Sta.	Date	Time	Temp.	Spread	Corrected D	Final D	Line Average	
XV	GRAVES AUX A	FULCRUM AUX A	1971 OCT 22	1655	25.6	6 M	7341.665	7341.669		
XW	GRAVES AUX A	FULCRUM AUX A	1971 OCT 22	1705	25.6	11 H	7341.668	7341.670	7341.669	.001
XR	GRAVES	FULCRUM AUX B	1971 OCT 22	1555	26.9	26 H	7316.550	7316.553		
XS	GRAVES	FULCRUM AUX B	1971 OCT 22	1610	26.8	22 M	7316.553	7316.556	7316.555	.002
XT	GRAVES AUX A	FULCRUM AUX B	1971 OCT 22	1625	26.7	24 M	7340.051	7340.054		
XU	GRAVES AUX A	FULCRUM AUX B	1971 OCT 22	1640	26.3	4 H	7340.046	7340.050	7340.051	.003
YJ	FULCRUM AUX A	CINDER	1971 OCT 24	1650	23.9	18 M	12089.221	12089.223		
YK	FULCRUM AUX A	CINDER	1971 OCT 24	1710	23.7	51 T	12089.222	12089.225		
YR	FULCRUM AUX A	CINDER	1971 OCT 26	0815	20.6	10 M	12089.221	12089.212		
YS	FULCRUM AUX A	CINDER	1971 OCT 26	0825	21.1	9 W	12089.220	12089.212		
YT	FULCRUM AUX A	CINDER	1971 OCT 26	0840	21.3	4 M	12089.220	12089.213	12089.215	.006
YL	FULCRUM AUX B	CINDER	1971 OCT 24	1730	23.4	40 M	12098.829	12098.831		
YM	FULCRUM AUX B	CINDER	1971 OCT 24	1740	23.0	15 T	12098.816	12098.818	12098.822	.009
WW	FULCRUM AUX A	GANTI	1971 OCT 20	1640	24.5	19 M	4773.653	4773.654		
WX	FULCRUM AUX A	GANTI	1971 OCT 20	1655	24.2	14 H	4773.669	4773.670 *		
XM	FULCRUM AUX A	GANTI	1971 OCT 22	0900	21.3	34 T	4773.651	4773.650		
XN	FULCRUM AUX A	GANTI	1971 OCT 22	0920	21.8	59 W	4773.638	4773.637		
XO	FULCRUM AUX A	GANTI	1971 OCT 22	0930	21.9	25 T	4773.647	4773.647	4773.656	.012
									.651	.004
AX	BOKU	FULCRUM AUX A	1971 NOV 01	1755	21.3	21 T	6880.094	6880.095		
AY	BOKU	FULCRUM AUX A	1971 NOV 01	1805	21.0	33 H	6880.111	6880.112 *	6880.102	.012
									.095	
XZ	GRAVES	CINDER	1971 OCT 23	0915	24.5	15 T	5866.831	5866.827		
YA	GRAVES	CINDER	1971 OCT 23	0930	24.3	13 H	5866.829	5866.826		
ZP	GRAVES	CINDER	1971 OCT 28	2230	16.9	8 M	5866.824	5866.832		
ZQ	GRAVES	CINDER	1971 OCT 28	2245	16.8	6 H	5866.826	5866.834	5866.830	.004
YB	GRAVES	CINDER AUX A	1971 OCT 23	0940	24.7	12 T	5872.142	5872.139		
YC	GRAVES	CINDER AUX A	1971 OCT 23	0955	25.0	29 H	5872.143	5872.141	5872.140	.001
YD	GRAVES AUX A	CINDER	1971 OCT 23	1015	26.5	26 T	5876.704	5876.703		
YE	GRAVES AUX A	CINDER	1971 OCT 23	1030	26.5	43 H	5876.707	5876.706		
ZR	GRAVES AUX A	CINDER	1971 OCT 28	2310	17.1	5 M	5876.684	5876.693		
ZS	GRAVES AUX A	CINDER	1971 OCT 28	2325	17.2	23 H	5876.687	5876.696	5876.697	.006
YU	GRAVES	AYGU	1971 OCT 26	1020	25.4	2 T	9216.859	9216.857		
YV	GRAVES	AYGU	1971 OCT 26	1030	25.6	6 H	9216.858	9216.857	9216.857	0.000
DA	SODERE	CINDER	1971 NOV 06	1655	26.2	11 M	11778.551	11778.559		
DB	SODERE	CINDER	1971 NOV 06	1710	25.9	12 T	11778.555	11778.562		
DC	SODERE	CINDER	1971 NOV 06	1720	25.7	3 M	11778.555	11778.563	11778.561	.002
DD	SODERE	CINDER AUX A	1971 NOV 06	1735	25.3	13 T	11756.221	11756.227		
DE	SODERE	CINDER AUX A	1971 NOV 06	1745	24.9	8 M	11756.220	11756.225		
DF	SODERE	CINDER AUX A	1971 NOV 06	1800	24.4	6 T	11756.223	11756.227	11756.226	.001
EX	SIRI	CINDER	1971 NOV 10	1110	24.2	21 H	24358.245	24358.247		
EY	SIRI	CINDER	1971 NOV 10	1120	24.2	36 T	24358.242	24358.245		
EZ	SIRI	CINDER	1971 NOV 10	1135	24.7	34 H	24358.239	24358.244	24358.246	.002
YF	BOHALLA	CINDER	1971 OCT 23	1140	26.3	10 M	7233.352	7233.354		
YG	BOHALLA	CINDER	1971 OCT 23	1150	26.0	20 M	7233.346	7233.348		
YG	BOHALLA	CINDER	1971 OCT 23	1150	26.0	20 M	7233.351	7233.353	7233.352	.003
YH	BOHALLA	CINDER AUX A	1971 OCT 23	1210	26.2	89 W	7223.536	7223.538		
YI	BOHALLA	CINDER AUX A	1971 OCT 23	1230	26.3	19 M	7223.522	7223.524	7223.525	.010
CU	SIRI	ROGGI AUX A	1971 NOV 06	1000	22.7	8 M	17400.553	17400.545		
CV	SIRI	ROGGI AUX A	1971 NOV 06	1010	22.8	41 H	17400.550	17400.543		
CW	SIRI	ROGGI AUX A	1971 NOV 06	1020	23.0	16 M	17400.551	17400.546	17400.545	.002
BG	BOKU	ROGGI AUX A	1971 NOV 02	1030	23.1	10 T	9857.973	9857.971		
BH	BOKU	ROGGI AUX A	1971 NOV 02	1040	23.2	34 W	9857.970	9857.969	9857.970	.001
BE	BOKU AUX A	ROGGI AUX A	1971 NOV 02	0945	22.9	11 W	9856.446	9856.440		
BF	BOKU AUX A	ROGGI AUX A	1971 NOV 02	1005	22.9	42 T	9856.451	9856.447	9856.442	.005
CO	SELASSIE	MIETCHI	1971 NOV 06	0750	17.7	7 M	12617.135	12617.117		
CP	SELASSIE	MIETCHI	1971 NOV 06	0800	17.9	11 H	12617.127	12617.110		
CQ	SELASSIE	MIETCHI	1971 NOV 06	0815	17.7	2 M	12617.126	12617.110	12617.112	.004

Code	Geodimeter Sta.	Retroreflector Sta.	Date	Time	Temp.	Spread	Corrected D	Final D	Line Average	
BQ	OOLAGA	MIETCHI	1971 NOV 03	0820	18.7	12 M	7578.949	7578.944		
BR	OOLAGA	MIETCHI	1971 NOV 03	0830	18.6	18 H	7578.928	7578.923 *		
BS	OOLAGA	MIETCHI	1971 NOV 03	0840	18.7	27 H	7578.927	7578.922 *		
BT	OOLAGA	MIETCHI	1971 NOV 03	0850	18.9	1 M	7578.952	7578.948		
BU	OOLAGA	MIETCHI	1971 NOV 03	0900	18.8	18 M	7578.952	7578.948	7578.940 .947	.013 .002
CR	SIRI	MIETCHI	1971 NOV 06	0845	18.4	18 M	14052.186	14052.178		
CS	SIRI	MIETCHI	1971 NOV 06	0900	18.6	13 H	14052.194	14052.187		
CT	SIRI	MIETCHI	1971 NOV 06	0910	18.6	11 M	14052.190	14052.183		
CT	SIRI	MIETCHI	1971 NOV 06	0910	18.6	8 M	14052.189	14052.182	14052.183	.004
BB	BOKU AUX A	MIETCHI	1971 NOV 02	0810	17.9	11 T	15203.635	15203.624		
BC	BOKU AUX A	MIETCHI	1971 NOV 02	0825	18.2	14 T	15203.644	15203.634		
BD	BOKU AUX A	MIETCHI	1971 NOV 02	0835	18.6	6 W	15203.635	15203.626	15203.628	.005
BI	BOHALLA	MIETCHI	1971 NOV 02	1645	24.2	10 M	16768.246	16768.254		
BJ	BOHALLA	MIETCHI	1971 NOV 02	1700	23.9	13 T	16768.244	16768.250		
BK	BOHALLA	MIETCHI	1971 NOV 02	1715	23.6	24 T	16768.220	16768.226 *		
BL	BOHALLA	MIETCHI	1971 NOV 02	1725	23.4	18 M	16768.252	16768.257	16768.248 .253	.014 .004
FE	SIRI	SELASSIE	1971 NOV 11	0910	18.3	8 T	1951.105	1951.103		
FF	SIRI	SELASSIE	1971 NOV 11	0920	18.2	10 M	1951.108	1951.106		
FG	SIRI	SELASSIE	1971 NOV 11	0930	18.4	1 M	1951.105	1951.104		
FH	SIRI	SELASSIE	1971 NOV 11	0940	18.5	4 T	1951.104	1951.103	1951.104	.001
FI	SIRI	SELASSIE AUX A	1971 NOV 11	1010	20.2	6 H	1980.152	1980.151		
FJ	SIRI	SELASSIE AUX A	1971 NOV 11	1020	20.5	4 T	1980.151	1980.150		
FK	SIRI	SELASSIE AUX A	1971 NOV 11	1030	20.1	5 H	1980.147	1980.146	1980.149	.003
EA	PYLON	WONJI	1971 NOV 08	1645	25.9	4 M	3402.648	3402.652		
EB	PYLON	WONJI	1971 NOV 08	1700	25.5	10 W	3402.650	3402.653		
EC	PYLON	WONJI	1971 NOV 08	1715	25.3	3 M	3402.652	3402.655	3402.653	.002
DT	KOKA	PYLON	1971 NOV 08	1135	25.6	17 W	3079.979	3079.980		
DU	KOKA	PYLON	1971 NOV 08	1150	25.8	21 T	3079.985	3079.986		
DV	KOKA	PYLON	1971 NOV 08	1200	26.2	20 W	3079.989	3079.991		
DW	KOKA	PYLON	1971 NOV 08	1220	26.5	14 T	3079.992	3079.994	3079.988	.006
EO	GALILA	WONJI	1971 NOV 09	1110	25.6	6 M	6263.277	6263.277		
EP	GALILA	WONJI	1971 NOV 09	1120	25.7	11 T	6263.276	6263.277		
EQ	GALILA	WONJI	1971 NOV 09	1130	26.0	8 M	6263.280	6263.282		
ER	GALILA	WONJI	1971 NOV 09	1140	26.3	9 T	6263.276	6263.277	6263.278	.003
DX	KOKA	WONJI	1971 NOV 08	1300	27.4	12 W	5336.860	5336.863		
DY	KOKA	WONJI	1971 NOV 08	1320	28.1	13 T	5336.862	5336.865		
DZ	KOKA	WONJI	1971 NOV 08	1330	28.5	15 T	5336.869	5336.872	5336.867	.005
ZE	TABLE	GANTI	1971 OCT 28	0745	18.4	8 M	22963.107	22963.073		
ZF	TABLE	GANTI	1971 OCT 28	0800	18.6	23 M	22963.108	22963.078	22963.075	.004
AS	BOKU	GANTI	1971 NOV 01	1610	22.9	0 T	2519.672	2519.672		
AT	BOKU	GANTI	1971 NOV 01	1625	22.8	12 T	2519.661	2519.662		
AU	BOKU	GANTI	1971 NOV 01	1635	22.7	26 H	2519.673	2519.674	2519.669	.006
CC	QUILL	SODERE	1971 NOV 04	1720	24.5	2 W	3856.841	3856.843		
CD	QUILL	SODERE	1971 NOV 04	1735	24.1	2 T	3856.836	3856.838		
CE	QUILL	SODERE	1971 NOV 04	1755	23.5	5 T	3856.838	3856.839	3856.840	.003
BV	OOLAGA	QUILL	1971 NOV 03	0955	22.9	6 M	2357.715	2357.714		
BW	OOLAGA	QUILL	1971 NOV 03	1005	23.3	14 H	2357.702	2357.702 *		
BX	OOLAGA	QUILL	1971 NOV 03	1020	23.3	21 H	2357.711	2357.710		
BY	OOLAGA	QUILL	1971 NOV 03	1035	23.3	17 M	2357.720	2357.719		
CF	QUILL	OOLAGA	1971 NOV 04	1830	22.1	3 T	2357.711	2357.713		
CG	QUILL	OOLAGA	1971 NOV 04	1840	21.5	2 T	2357.712	2357.714		
CH	QUILL	OOLAGA	1971 NOV 04	1850	21.0	5 H	2357.709	2357.712	2357.712 .713	.005 003
CX	SIRI	QUILL	1971 NOV 06	1050	23.1	9 M	16380.135	16380.135		
CY	SIRI	QUILL	1971 NOV 06	1100	23.3	11 H	16380.133	16380.133		
CZ	SIRI	QUILL	1971 NOV 06	1110	23.5	11 M	16380.136	16380.137	16380.135	.002

Code	Geodimeter Sta.	Retroreflector Sta.	Date	Time	Temp.	Spread	Corrected D	Final D	Line Average	
BM	BOHALLA	QUILL	1971 NOV 02	1825	23.3	10 M	10605.552	10605.558		
BN	BOHALLA	QUILL	1971 NOV 02	1835	23.2	14 T	10605.552	10605.558		
BO	BOHALLA	QUILL	1971 NOV 02	1845	23.0	15 M	10605.555	10605.562		
BP	BOHALLA	QUILL	1971 NOV 02	1850	22.9	6 T	10605.554	10605.560		
CI	BOHALLA	QUILL	1971 NOV 05	1655	25.7	7 M	10605.566	10605.572		
CJ	BOHALLA	QUILL	1971 NOV 05	1705	25.4	9 W	10605.567	10605.572	10605.564	.007
BZ	OOLAGA	SODERE	1971 NOV 04	1555	27.0	10 W	1581.708	1581.710		
CA	OOLAGA	SODERE	1971 NOV 04	1610	26.9	3 W	1581.715	1581.716		
CB	OOLAGA	SODERE	1971 NOV 04	1625	26.7	9 T	1581.709	1581.711	1581.713	.003
CK	BOHALLA	OOLAGA	1971 NOV 05	1740	24.6	7 M	9274.235	9274.242		
CL	BOHALLA	OOLAGA	1971 NOV 05	1750	24.1	24 W	9274.221	9274.228		
CM	BOHALLA	OOLAGA.	1971 NOV 05	1805	23.7	9 W	9274.233	9274.242		
CN	BOHALLA	OOLAGA	1971 NOV 05	1815	23.3	5 M	9274.228	9274.238	9274.239	.007
ES	SIRI	BOHALLA	1971 NOV 10	0900	22.3	14 T	18019.117	18019.105		
ET	SIRI	BOHALLA	1971 NOV 10	0920	22.6	23 H	18019.124	18019.114		
EU	SIRI	BOHALLA	1971 NOV 10	0930	22.7	10 T	18019.130	18019.121		
EV	SIRI	BOHALLA	1971 NOV 10	0945	22.9	7 H	18019.127	18019.120		
EW	SIRI	BOHALLA	1971 NOV 10	0955	23.5	13 T	18019.135	18019.129	18019.118	.009
ZB	TABLE	AYGU	1971 OCT 27	1000	23.3	5 M	7678.142	7678.139		
ZC	TABLE	AYGU	1971 OCT 27	1005	23.5	27 H	7678.143	7678.140		
ZD	TABLE	AYGU	1971 OCT 27	1015	23.3	13 M	7678.144	7678.142		
ZJ	TABLE	AYGU	1971 OCT 28	1200	26.3	16 W	7678.132	7678.134		
ZK	TABLE	AYGU	1971 OCT 28	1215	26.4	12 T	7678.141	7678.143		
ZL	TABLE	AYGU	1971 OCT 28	1225	26.1	10 W	7678.135	7678.137	7678.139	.003
AF	MERKO	TABLE	1971 OCT 31	1810	23.7	1 T	6858.857	6858.866		
AG	MERKO	TABLE	1971 OCT 31	1820	23.4	1 M	6858.859	6858.869		
YW	TABLE	MERKO	1971 OCT 26	1650	25.9	6 T	6858.866	6858.876		
YX	TABLE	MERKO	1971 OCT 26	1705	25.5	7 W	6858.876	6858.884 *		
YY	TABLE	MERKO	1971 OCT 26	1725	25.1	17 T	6858.861	6858.869		
YZ	TABLE	MERKO	1971 OCT 27	0815	21.4	10 M	6858.870	6858.857		
ZA	TABLE	MERKO	1971 OCT 27	0825	21.6	10 T	6858.881	6858.868	6858.870	.008
									.868	.006
ZG	TABLE	RABBIT	1971 OCT 28	1010	23.6	21 T	9418.289	9418.286		
ZH	TABLE	RABBIT	1971 OCT 28	1025	24.1	14 W	9418.285	9418.283		
ZI	TABLE	RABBIT	1971 OCT 28	1040	24.2	10 T	9418.286	9418.285	9418.285	.002
AB	MERKO	AYGU	1971 OCT 31	1650	25.5	6 M	7829.053	7829.061		
AC	MERKO	AYGU	1971 OCT 31	1700	25.3	23 T	7829.050	7829.058		
AD	MERKO	AYGU	1971 OCT 31	1710	25.1	4 M	7829.049	7829.057		
AE	MERKO	AYGU	1971 OCT 31	1715	24.9	11 T	7829.045	7829.053	7829.057	.003
ZT	RABBIT	AYGU	1971 OCT 29	1545	26.7	45 M	7220.492	7220.497		
ZT	RABBIT	AYGU	1971 OCT 29	1545	26.7	47 M	7220.494	7220.499		
ZU	RABBIT	AYGU	1971 OCT 29	1605	26.4	21 W	7220.469	7220.474 *		
ZV	RABBIT	AYGU	1971 OCT 29	1630	26.0	15 W	7220.498	7220.501		
ZW	RABBIT	AYGU	1971 OCT 29	1645	25.9	6 M	7220.508	7220.511		
ZX	RABBIT	AYGU	1971 OCT 29	1650	25.7	6 M	7220.509	7220.512	7220.502	.014
									.508	.007
AA	MERKO	RABBIT	1971 OCT 31	1530	26.5	16 T	13687.810	13687.826		
ZY	MERKO	RABBIT	1971 OCT 31	1505	26.5	16 T	13687.796	13687.813		
ZZ	MERKO	RABBIT	1971 OCT 31	1520	26.5	19 M	13687.803	13687.819	13687.819	.007
HA	GALLA	HOTEL	1971 NOV 18	1655	25.6	8 T	764.053	764.054		
HB	GALLA	HOTEL	1971 NOV 18	1710	25.6	18 W	764.047	764.048		
HC	GALLA	HOTEL	1971 NOV 18	1720	25.6	14 T	764.053	764.054	764.052	.003
HD	GALLA	TERMITE	1971 NOV 18	1750	25.3	12 W	746.040	746.041		
HE	GALLA	TERMITE	1971 NOV 18	1810	24.9	13 T	746.047	746.048		
HF	GALLA	TERMITE	1971 NOV 18	1820	24.7	7 W	746.042	746.043	746.044	.004
FZ	EUPHORBIA	GALLA	1971 NOV 17	0955	20.4	9 M	2852.143	2852.141		
GA	EUPHORBIA	GALLA	1971 NOV 17	1005	20.3	3 H	2852.142	2852.140		
GB	EUPHORBIA	GALLA	1971 NOV 17	1015	20.4	3 M	2852.146	2852.145	2852.142	.003
GI	EUPHORBIA AUX A	GALLA	1971 NOV 17	1745	25.1	5 W	2862.170	2862.173		
GJ	EUPHORBIA AUX A	GALLA	1971 NOV 17	1800	24.5	5 T	2862.173	2862.176		
GK	EUPHORBIA AUX A	GALLA	1971 NOV 17	1815	24.3	3 W	2862.164	2862.168	2862.172	.004
HG	ARJO	GALLA	1971 NOV 19	0745	18.1	5 M	7435.800	7435.783		
HH	ARJO	GALLA	1971 NOV 19	0800	18.6	5 H	7435.797	7435.782		
HI	ARJO	GALLA	1971 NOV 19	0810	19.0	4 M	7435.803	7435.788	7435.784	.003

Code	Geodimeter Sta.	Retroreflector Sta.	Date	Time	Temp.	Spread	Corrected D	Final D	Line Average	
GW	HOTEL	TERMITE	1971 NOV 18	1535	25.7	7 T	1022.597	1022.598		
GX	HOTEL	TERMITE	1971 NOV 18	1545	25.6	4 W	1022.597	1022.598		
GY	HOTEL	TERMITE	1971 NOV 18	1600	25.5	8 T	1022.598	1022.599		
GZ	HOTEL	TERMITE	1971 NOV 18	1610	25.5	7 W	1022.595	1022.597	1022.598	.001
FS	EUPHORBIA	HOTEL	1971 NOV 17	0755	17.8	4 M	3517.930	3517.924		
FT	EUPHORBIA	HOTEL	1971 NOV 17	0805	18.3	7 H	3517.929	3517.924		
FU	EUPHORBIA	HOTEL	1971 NOV 17	0815	18.6	5 M	3517.933	3517.927		
FV	EUPHORBIA	HOTEL	1971 NOV 17	0825	18.5	7 H	3517.936	3517.931	3517.926	.003
GC	EUPHORBIA AUX A	HOTEL	1971 NOV 17	1540	25.2	2 T	3524.764	3524.768		
GD	EUPHORBIA AUX A	HOTEL	1971 NOV 17	1550	25.0	5 W	3524.762	3524.766		
GE	EUPHORBIA AUX A	HOTEL	1971 NOV 17	1605	25.0	11 W	3524.771	3524.775	3524.769	.005
GQ	LANGANA	HOTEL	1971 NOV 18	0915	21.6	1 M	3394.057	3394.055		
GR	LANGANA	HOTEL	1971 NOV 18	0925	22.0	4 H	3394.057	3394.055		
GS	LANGANA	HOTEL	1971 NOV 18	0935	21.8	1 M	3394.058	3394.056	3394.055	.001
FW	EUPHORBIA	TERMITE	1971 NOV 17	0900	20.1	3 M	3358.133	3358.129		
FX	EUPHORBIA	TERMITE	1971 NOV 17	0915	20.3	5 H	3358.130	3358.127		
FY	EUPHORBIA	TERMITE	1971 NOV 17	0925	20.4	10 M	3358.129	3358.126	3358.127	.002
GF	EUPHORBIA AUX A	TERMITE	1971 NOV 17	1645	25.2	1 T	3372.622	3372.628		
GG	EUPHORBIA AUX A	TERMITE	1971 NOV 17	1700	24.4	12 T	3372.622	3372.628		
GH	EUPHORBIA AUX A	TERMITE	1971 NOV 17	1710	25.4	6 W	3372.622	3372.627	3372.628	.001
GT	LANGANA	TERMITE	1971 NOV 18	1000	21.6	10 M	2434.180	2434.179		
GU	LANGANA	TERMITE	1971 NOV 18	1010	21.6	13 H	2434.175	2434.174		
GV	LANGANA	TERMITE	1971 NOV 18	1020	21.9	2 M	2434.176	2434.175	2434.176	.003
GL	LANGANA	EUPHORBIA	1971 NOV 18	0745	17.6	4 M	3232.705	3232.699		
GM	LANGANA	EUPHORBIA	1971 NOV 18	0755	17.9	8 H	3232.706	3232.700		
GN	LANGANA	EUPHORBIA	1971 NOV 18	0805	18.0	4 M	3232.703	3232.698	3232.699	.001
GO	LANGANA	EUPHORBIA AUX A	1971 NOV 18	0815	18.4	11 H	3259.859	3259.854		
GP	LANGANA	EUPHORBIA AUX A	1971 NOV 18	0825	19.1	11 M	3259.858	3259.854	3259.854	0.000
HM	ARJO	EUPHORBIA	1971 NOV 19	0935	20.6	8 H	6206.146	6206.140		
HN	ARJO	EUPHORBIA	1971 NOV 19	0945	20.8	6 M	6206.143	6206.138		
HO	ARJO	EUPHORBIA	1971 NOV 19	0955	21.0	8 H	6206.144	6206.139	6206.139	.001
HP	ARJO	EUPHORBIA AUX A	1971 NOV 19	1010	21.4	3 M	6229.374	6229.371	6229.371	0.000
IV	OITU	ALUTU	1971 NOV 25	0845	18.2	1 M	4629.090	4629.087		
IW	OITU	ALUTU	1971 NOV 25	0900	18.9	1 T	4629.095	4629.092		
IX	OITU	ALUTU	1971 NOV 25	0915	19.5	3 M	4629.089	4629.087	4629.089	.003
IY	OITU	OOMAY	1971 NOV 25	1025	21.9	5 T	5303.658	5303.657		
IZ	OITU	OOMAY	1971 NOV 25	1040	23.0	6 M	5303.660	5303.659		
JA	OITU	OOMAY	1971 NOV 25	1050	23.6	13 T	5303.663	5303.663	5303.659	.003
EI	GALILA	YELLEM	1971 NOV 09	0810	19.2	2 M	2248.301	2248.298		
EJ	GALILA	YELLEM	1971 NOV 09	0820	19.3	3 H	2248.300	2248.297		
EK	GALILA	YELLEM	1971 NOV 09	0830	19.4	2 M	2248.303	2248.300	2248.298	.002
EL	GALILA	THORNS	1971 NOV 09	0910	20.5	4 M	4608.483	4608.479		
EM	GALILA	THORNS	1971 NOV 09	0920	21.2	20 H	4608.489	4608.485		
EN	GALILA	THORNS	1971 NOV 09	0930	21.8	9 M	4608.488	4608.484	4608.482	.003
DN	KOKA	YELLEM	1971 NOV 08	0845	21.5	9 H	2871.894	2871.891		
DO	KOKA	YELLEM	1971 NOV 08	0900	21.7	6 T	2871.897	2871.894		
DP	KOKA	YELLEM	1971 NOV 08	0910	22.4	4 H	2871.898	2871.895	2871.893	.002
DQ	KOKA	THORNS	1971 NOV 08	0955	23.0	9 T	4444.667	4444.665		
DR	KOKA	THORNS	1971 NOV 08	1005	23.4	6 H	4444.666	4444.664		
DS	KOKA	THORNS	1971 NOV 08	1015	23.9	5 T	4444.669	4444.668	4444.666	.002
HJ	ARJO	LANGANA	1971 NOV 19	0835	19.6	2 M	4851.705	4851.699		
HK	ARJO	LANGANA	1971 NOV 19	0845	19.8	6 H	4851.703	4851.698		
HL	ARJO	LANGANA	1971 NOV 19	0855	20.1	7 M	4851.706	4851.700	4851.699	.001
HQ	BMN	SHECHA	1971 NOV 21	0915	24.4	2 M	2937.678	2937.675		
HR	BMN	SHECHA	1971 NOV 21	0925	24.4	3 H	2937.673	2937.670		
HS	BMN	SHECHA	1971 NOV 21	0935	24.6	5 M	2937.673	2937.670	2937.672	.003

Code	Geodimeter Sta.	Retroreflector Sta.	Date	Time	Temp.	Spread	Corrected D	Final D	Line Average	
HT	BMN	BMC	1971 NOV 21	1020	26.7	17 T	1206.716	1206.715		
HU	BMN	BMC	1971 NOV 21	1040	27.9	13 H	1206.715	1206.715		
HV	BMN	BMC	1971 NOV 21	1050	27.9	13 T	1206.711	1206.711		
IH	BMC	BMN	1971 NOV 22	1835	23.5	1 H	1206.705	1206.707		
II	BMC	BMN	1971 NOV 22	1845	23.5	4 T	1206.700	1206.702		
IJ	BMC	BMN	1971 NOV 22	1900	22.8	0 H	1206.700	1206.702	1206.708	.006
IE	BMP	SHECHA	1971 NOV 22	1710	25.3	8 T	2331.648	2331.652		
IF	BMP	SHECHA	1971 NOV 22	1715	24.7	7 H	2331.648	2331.652		
IG	BMP	SHECHA	1971 NOV 22	1730	24.0	6 T	2331.645	2331.648	2331.651	.002
HW	BMC	DUBI	1971 NOV 21	1720	25.7	17 M	6490.017	6490.024		
HX	BMC	DUBI	1971 NOV 21	1735	25.3	12 M	6490.015	6490.021		
HY	BMC	DUBI	1971 NOV 21	1745	24.5	6 M	6490.017	6490.023	6490.023	.002
HZ	KULFO	BMC	1971 NOV 22	0920	23.3	13 M	3599.171	3599.167		
IA	KULFO	BMC	1971 NOV 22	0935	23.5	14 W	3599.174	3599.171		
IB	KULFO	BMC	1971 NOV 22	0950	24.0	11 M	3599.173	3599.170		
IC	KULFO	BMC	1971 NOV 22	1000	24.7	13 W	3599.184	3599.182		
ID	KULFO	BMC	1971 NOV 22	1010	25.0	11 M	3599.182	3599.180		
IU	BMC	KULFO	1971 NOV 23	1900	23.3	4 M	3599.160	3599.166	3599.172	.007
IP	BMC	TOSASUCHA	1971 NOV 23	1645	24.8	2 M	7277.600	7277.608		
IQ	BMC	TOSASUCHA	1971 NOV 23	1700	24.7	2 H	7277.599	7277.607		
IR	BMC	TOSASUCHA	1971 NOV 23	1705	24.7	4 H	7277.601	7277.609	7277.608	.001
IS	BMC	TOSASUCHA AUX A	1971 NOV 23	1715	24.7	3 H	7276.505	7276.513		
IT	BMC	TOSASUCHA AUX A	1971 NOV 23	1725	24.5	4 M	7276.502	7276.509	7276.511	.003
IK	KULFO	TOSASUCHA	1971 NOV 23	0930	22.3	5 W	3772.922	3772.920		
IL	KULFO	TOSASUCHA	1971 NOV 23	0950	21.9	8 H	3772.926	3772.924		
IM	KULFO	TOSASUCHA	1971 NOV 23	1005	21.8	5 W	3772.933	3772.932		
IN	KULFO	TOSASUCHA	1971 NOV 23	1020	22.0	2 H	3772.925	3772.924		
IO	KULFO	TOSASUCHA	1971 NOV 23	1035	22.5	8 W	3772.932	3772.931	3772.926	.005

APPENDIX E

AWARRA 1973 RANGER OBSERVATIONS

Code	Ranger III Sta.	Retroreflector Sta.	Date	Time	Temp.	Corrected D	Final D	S.D.	No.
CQ	MARIAM	RAILWAY	1973 MAR 30	1610	30.1	3929.218	3929.221 3929.221	.017 H .015	(30)
CR	MARIAM AUX A	RAILWAY	1973 MAR 30	1645	29.5	3937.603	3937.605 3937.606	.009 W .006	(20)
CV	MARIAM	GEORGE	1973 MAR 30	1820	27.9	7262.541	7262.543 7262.543	.004 W .003	(21)
CU	MARIAM	GEORGE AUX A	1973 MAR 30	1810	28.2	7259.091	7259.094 7259.094	.004 M .003	(20)
CS	MARIAM AUX A	GEORGE	1973 MAR 30	1750	28.9	7257.219	7257.221 7257.220	.010 W .011	(20)
CT	MARIAM AUX A	GEORGE AUX A	1973 MAR 30	1755	28.6	7253.754	7253.756 7253.755	.010 M .009	(20)
AA	RIDGE	GEORGE	1973 MAR 25	1545	29.9	2529.970	2529.971 2529.971	.016 R .013	(20)
AR	RIDGE	GEORGE	1973 MAR 27	0815	22.3	2529.954	2529.952 2529.952	.008 W .006	(20)
AB	RIDGE	GEORGE AUX A	1973 MAR 25	1610	30.1	2530.727	2530.728 2530.728	.011 H .008	(20)
AS	RIDGE	GEORGE AUX A	1973 MAR 27	0830	22.6	2530.736	2530.734 2530.735	.010 M .010	(20)
BG	ADAMA	GEORGE	1973 MAR 28	0850	23.8	4461.185	4461.180 4461.180	.005 H .004	(20)
AC	RIDGE	ADAMA	1973 MAR 25	1635	30.1	2865.574	2865.576 2865.576	.004 W .003	(20)
AT	RIDGE	ADAMA	1973 MAR 27	1000	26.8	2865.575	2865.574 2865.574	.007 G .006	(20)
BE	ADAMA	RIDGE	1973 MAR 28	0800	21.4	2865.571	2865.567 2865.567	.004 H .003	(20)
AD	RIDGE	ADAMA AUX A	1973 MAR 25	1700	29.9	2874.405	2874.408 2874.408	.004 R .004	(20)
AU	RIDGE	ADAMA AUX A	1973 MAR 27	1009	27.3	2874.411	2874.410 2874.409	.012 M .008	(20)
BF	ADAMA	RIDGE AUX A	1973 MAR 28	0810	22.3	2878.020	2878.016 2878.016	.005 M .004	(21)
AE	RIDGE	FARENJI	1973 MAR 25	1725	29.6	3022.251	3022.253 3022.252	.002 H .001	(20)
AV	RIDGE	FARENJI	1973 MAR 27	1030	26.4	3022.247	3022.246 3022.247	.005 W .004	(20)
AW	RIDGE	FARENJI AUX B	1973 MAR 27	1045	26.5	3011.182	3011.182 3011.182	.007 W .006	(20)
AF	RIDGE	FARENJI AUX C	1973 MAR 25	1725	29.3	3012.008	3012.010 3012.010	.003 W .002	(20)
AZ	RIDGE	EL PASO AUX A	1973 MAR 27	1155	27.7	6631.483	6631.484 6631.484	.006 W .005	(20)
AX	RIDGE	GANTI	1973 MAR 27	1120	27.5	6673.488	6673.489 6673.489	.012 M .010	(20)
AY	RIDGE	GANTI AUX A	1973 MAR 27	1135	27.5	6672.896	6672.897 6672.897	.007 G .005	(20)
AG	RIDGE	FULCRUM AUX A	1973 MAR 25	1805	28.6	5335.165	5335.167 5335.167	.002 W .002	(20)
AH	RIDGE	FULCRUM AUX B	1973 MAR 25	1820	28.3	5337.056	5337.058 5337.058	.002 G .002	(20)
BC	RIDGE	FULCRUM AUX C	1973 MAR 27	1650	29.3	5334.033	5334.034 5334.033	.013 R .008	(20)
BD	RIDGE	FULCRUM AUX D	1973 MAR 27	1715	29.2	5335.403	5335.404 5335.404	.013 W .011	(20)

Code	Ranger III Sta.	Retroreflector Sta.	Date	Time	Temp.	Corrected D	Final D	S.D.	No.
BA	RIDGE	BLOSSOM	1973 MAR 27	1605	29.9	6366.189	6366.192 6366.191	.009 W .006	(20)
BB	RIDGE	BLOSSOM AUX A	1973 MAR 27	1620	29.8	6367.781	6367.784 6367.784	.008 W .007	(20)
BY	BOKU	RIDGE	1973 MAR 29	1030	28.1	6998.221	6998.221 6998.220	.008 M .007	(20)
BZ	BOKU	RIDGE AUX A	1973 MAR 29	1040	28.4	6983.066	6983.065 6983.065	.008 R .007	(14)
AN	FARENJI	ADAMA	1973 MAR 26	1745	30.3	1400.903	1400.904 1400.904	.004 H .004	(20)
BH	ADAMA	FARENJI	1973 MAR 28	0922	25.8	1400.886	1400.885 1400.885	.008 M .007	(20)
BI	ADAMA	FARENJI AUX B	1973 MAR 28	0930	26.0	1407.485	1407.483 1407.483	.010 H .007	(22)
AO	FARENJI	ADAMA AUX A	1973 MAR 26	1755	29.7	1398.037	1398.038 1398.038	.003 G .003	(20)
BL	ADAMA	EL PASO AUX A	1973 MAR 28	1045	28.1	6153.593	6153.592 6153.595	.004 M .007	(3)
DC	ADAMA	EL PASO AUX A	1973 APR 01	0940	27.4	6153.609	6153.605 6153.605	.010 M .009	(20)
DD	ADAMA AUX A	EL PASO AUX A	1973 APR 01	0955	28.1	6150.073	6150.071 6150.070	.009 R .008	(20)
BJ	ADAMA	GANTI	1973 MAR 28	1004	26.9	6100.373	6100.371 6100.371	.009 M .008	(23)
BK	ADAMA	GANTI AUX A	1973 MAR 28	1015	27.0	6101.593	6101.591 6101.592	.009 H .008	(20)
DA	FARENJI	EL PASO AUX A	1973 APR 01	0855	25.1	4757.483	4757.477 4757.477	.010 M .008	(20)
DB	FARENJI AUX B	EL PASO AUX A	1973 APR 01	0907	25.3	4752.318	4752.314 4752.314	.008 R .007	(20)
AP	FARENJI	GANTI	1973 MAR 26	1830	27.7	4709.990	4709.991 4709.992	.003 R .003	(20)
AQ	FARENJI	GANTI AUX A	1973 MAR 26	1840	27.4	4711.092	4711.095 4711.095	.003 R .003	(20)
AI	FARENJI	FULCRUM AUX A	1973 MAR 26	1540	31.1	2358.169	2358.171 2358.171	.015 R .014	(13)
AJ	FARENJI	FULCRUM AUX B	1973 MAR 26	1600	30.9	2359.590	2359.591 2359.591	.007 R .006	(10)
AK	FARENJI	FULCRUM AUX C	1973 MAR 26	1615	31.1	2370.994	2370.994 2370.995	.007 H .006	(20)
AL	FARENJI	FULCRUM AUX D	1973 MAR 26	1625	30.9	2372.330	2372.331 2372.331	.005 G .004	(20)
AM	FARENJI	BLOSSOM	1973 MAR 26	1710	30.8	3520.700	3520.702 3520.702	.005 R .004	(20)
BW	BOKU	FARENJI	1973 MAR 29	0935	26.3	6066.396	6066.392 6066.393	.010 M .009	(20)
BX	BOKU	FARENJI AUX B	1973 MAR 29	0950	27.0	6056.446	6056.443 6056.442	.010 R .009	(10)

Code	Ranger III Sta.	Retroreflector Sta.	Date	Time	Temp.	Corrected D	Final D	S.D.	No.
BV	BOKU	EL PASO AUX A	1973 MAR 29	0825	22.2	2307.080	2307.078 2307.077	.006 .005	G (20)
CW	FULCRUM AUX A	GANTI	1973 APR 01	0745	21.2	4773.642	4773.639 4773.639	.004 .004	R (20)
CZ	FULCRUM AUX B	GANTI	1973 APR 01	0815	23.0	4770.750	4770.747 4770.747	.005 .005	R (20)
CX	FULCRUM AUX A	GANTI AUX A	1973 APR 01	0750	22.2	4776.546	4776.543 4776.543	.005 .005	G (20)
CY	FULCRUM AUX B	GANTI AUX A	1973 APR 01	0808	22.5	4773.627	4773.625 4773.625	.006 .005	M (20)
BT	BOKU	GANTI	1973 MAR 29	0800	22.0	2519.664	2519.662 2519.662	.007 .006	M (21)
BU	BOKU	GANTI AUX A	1973 MAR 29	0810	22.0	2515.532	2515.530 2515.531	.004 .003	R (20)
CB	BLOSSOM	FULCRUM AUX A	1973 MAR 29	1605	31.4	1305.416	1305.416 1305.416	.008 .006	H (20)
CH	BLOSSOM AUX A	FULCRUM AUX A	1973 MAR 29	1650	30.5	1310.519	1310.519 1310.519	.004 .004	H (20)
CA	BLOSSOM	FULCRUM AUX B	1973 MAR 29	1555	30.8	1306.134	1306.134 1306.135	.011 .009	W (20)
CG	BLOSSOM AUX A	FULCRUM AUX B	1973 MAR 29	1645	30.7	1311.261	1311.262 1311.261	.006 .004	W (20)
CC	BLOSSOM	FULCRUM AUX C	1973 MAR 29	1615	30.9	1248.604	1248.604 1248.604	.007 .005	W (20)
CF	BLOSSOM AUX A	FULCRUM AUX C	1973 MAR 29	1635	30.8	1253.421	1253.421 1253.421	.004 .003	H (20)
CD	BLOSSOM	FULCRUM AUX D	1973 MAR 29	1625	30.7	1247.536	1247.536 1247.536	.006 .006	G (20)
CE	BLOSSOM AUX A	FULCRUM AUX D	1973 MAR 29	1630	30.7	1252.350	1252.350 1252.350	.004 .003	W (20)
CL	FULCRUM AUX A	GRAVES	1973 MAR 29	1820	29.1	7318.004	7318.006 7318.006	.003 .003	H (20)
CK	FULCRUM AUX A	GRAVES AUX A	1973 MAR 29	1815	29.1	7341.653	7341.655 7341.655	.004 .003	W (20)
CM	FULCRUM AUX B	GRAVES	1973 MAR 29	1830	28.4	7315.785	7315.788 7315.788	.004 .003	W (20)
CN	FULCRUM AUX B	GRAVES AUX A	1973 MAR 29	1838	27.8	7339.431	7339.433 7339.433	.006 .005	W (20)
CI	BLOSSOM AUX A	GRAVES	1973 MAR 29	1735	30.7	6514.655	6514.656 6514.656	.005 .004	H (20)
CJ	BLOSSOM AUX A	GRAVES AUX A	1973 MAR 29	1745	30.3	6532.841	6532.843 6532.843	.002 .002	H (20)
DE	GRAVES	CINDER	1973 APR 01	1605	33.0	5866.806	5866.810 5866.810	.009 .007	W (20)
DF	GRAVES	CINDER AUX A	1973 APR 01	1620	32.6	5872.099	5872.102 5872.102	.007 .006	R (12)
CO	BOHALLA	CINDER	1973 MAR 30	0945	28.9	7233.350	7233.347 7233.348	.010 .008	R (20)
CP	BOHALLA	CINDER AUX A	1973 MAR 30	1010	29.3	7223.525	7223.523 7223.523	.008 .006	W (19)

Code	Ranger III Sta.	Retroreflector Sta.	Date	Time	Temp.	Corrected D	Final D	S.D.	No.
BO	QUILL	SODERE	1973 MAR 28	1625	33.1	3856.824	3856.828	.008	W (20)
							3856.828	.007	
BM	QUILL	OOLAGA	1973 MAR 28	1545	32.7	2357.703	2357.704	.010	R (30)
							2357.705	.008	
BS	OOLAGA	QUILL	1973 MAR 28	1755	31.0	2357.717	2357.718	.004	R (20)
							2357.718	.004	
BN	QUILL	OOLAGA AUX A	1973 MAR 28	1600	32.5	2359.108	2359.110	.006	R (20)
							2359.110	.005	
BR	OOLAGA AUX A	QUILL	1973 MAR 28	1745	31.4	2359.126	2359.127	.005	W (20)
							2359.127	.004	
BP	OOLAGA	SODERE	1973 MAR 28	1655	33.1	1581.700	1581.702	.007	W (20)
							1581.702	.006	

APPENDIX F

AWARRA 1973 GEODIMETER OBSERVATIONS

Code	Geodimeter Sta.	Retroreflector Sta.	Date	Time	Temp.	Spread	Corrected D	Final D	Line Average
FU	PYLON	GEORGE	1973 APR 10	1045	27.5	5 T	6642.831	6642.831	
FV	PYLON	GEORGE	1973 APR 10	1105	27.8	18 T	6642.830	6642.830	
FW	PYLON	GEORGE	1973 APR 10	1120	28.3	9 R	6642.835	6642.836	6642.832 .003
FX	PYLON	GEORGE AUX A	1973 APR 10	1140	28.9	6 R	6628.225	6628.226	6628.226 0.000
EA	RIDGE	ADAMA	1973 APR 06	0745	22.5	4 M	2865.556	2865.551	
EB	RIDGE	ADAMA	1973 APR 06	0800	23.3	19 W	2865.549	2865.545	
EC	RIDGE	ADAMA	1973 APR 06	0815	23.8	4 M	2865.558	2865.554	2865.551 .005
ED	RIDGE	FARENJI	1973 APR 06	0845	24.9	16 W	3022.241	3022.238	
EE	RIDGE	FARENJI	1973 APR 06	0905	25.7	15 M	3022.243	3022.241	
EF	RIDGE	FARENJI	1973 APR 06	0920	26.0	31 M	3022.235	3022.233	3022.238 .004
EG	RIDGE	FULCRUM AUX C	1973 APR 06	0955	27.4	22 M	5334.026	5334.025	
EH	RIDGE	FULCRUM AUX C	1973 APR 06	1010	27.5	8 W	5334.029	5334.029	5334.027 .003
EI	RIDGE	FULCRUM AUX D	1973 APR 06	1030	27.6	20 M	5335.395	5335.394	
EJ	RIDGE	FULCRUM AUX D	1973 APR 06	1045	27.7	9 W	5335.388	5335.388	5335.390 .004
FY	PYLON	RIDGE	1973 APR 10	1225	29.0	133 T	7612.227	7612.231	
FZ	PYLON	RIDGE	1973 APR 10	1240	29.1	240 T	7612.207	7612.211	
GA	PYLON	RIDGE	1973 APR 10	1255	29.2	102 R	7612.218	7612.224	7612.226 .010
GB	PYLON	RIDGE AUX A	1973 APR 10	1315	29.3	3 R	7602.868	7602.874	7602.874 0.000
EY	BOKU	ADAMA	1973 APR 07	1605	30.2	46 M	7427.059	7427.067	
EZ	BOKU	ADAMA	1973 APR 07	1620	30.1	18 R	7427.068	7427.075	7427.073 .006
FA	BOKU	FARENJI	1973 APR 07	1645	29.3	34 R	6066.382	6066.386	
FB	BOKU	FARENJI	1973 APR 07	1700	29.1	30 M	6066.391	6066.393	6066.390 .005
HK	GRAVES	FULCRUM AUX C	1973 APR 14	0840	23.6	6 T	7329.598	7329.593	
HL	GRAVES	FULCRUM AUX C	1973 APR 14	0855	24.6	5 R	7329.590	7329.586	
HM	GRAVES	FULCRUM AUX C	1973 APR 14	0910	25.4	15 T	7329.588	7329.585	7329.588 .004
HN	GRAVES	FULCRUM AUX D	1973 APR 14	0940	25.8	25 R	7328.223	7328.221	7328.221 0.000
FC	BOKU	FULCRUM AUX A	1973 APR 07	1735	28.0	26 M	6880.078	6880.079	
FD	BOKU	FULCRUM AUX A	1973 APR 07	1745	27.9	30 R	6880.075	6880.075	6880.077 .003
HO	GRAVES	BLOSSOM AUX A	1973 APR 14	1020	27.7	23 T	6514.638	6514.637	
HP	GRAVES	BLOSSOM AUX A	1973 APR 14	1040	28.0	26 R	6514.632	6514.632	
HQ	GRAVES	BLOSSOM AUX A	1973 APR 14	1055	28.2	18 T	6514.646	6514.646	6514.639 .007
HR	BOHALLA	BORI	1973 APR 15	1035	30.4	21 H	1666.350	1666.350	
HS	BOHALLA	BORI	1973 APR 15	1045	30.7	10 W	1666.363	1666.363	
HT	BOHALLA	BORI	1973 APR 15	1100	30.8	18 H	1666.372	1666.372	1666.362 .011
HU	BOHALLA	BABOON	1973 APR 15	1145	31.5	10 W	2016.905	2016.906	
HV	BOHALLA	BABOON	1973 APR 15	1200	31.4	3 H	2016.909	2016.909	
HW	BOHALLA	BABOON	1973 APR 15	1210	32.0	4 W	2016.913	2016.914	2016.910 .004
GX	ROGGI	MIETCHI	1973 APR 13	1000	19.8	4 R	6260.900	6260.897	6260.897 0.000
GT	ROGGI AUX A	MIETCHI	1973 APR 13	0840	18.2	2 R	6236.791	6236.785	
GU	ROGGI AUX A	MIETCHI	1973 APR 13	0855	18.8	12 W	6236.793	6236.788	
GV	ROGGI AUX A	MIETCHI	1973 APR 13	0910	19.3	10 R	6236.800	6236.795	6236.789 .005
GW	ROGGI AUX A	MIETCHI R.M.	1973 APR 13	0935	19.7	18 W	6234.553	6234.549	6234.549 0.000
FM	TOPLESS	MIETCHI	1973 APR 09	1215	27.8	22 T	5566.589	5566.590	
FN	TOPLESS	MIETCHI	1973 APR 09	1225	28.0	14 W	5566.610	5566.611	
FO	TOPLESS	MIETCHI	1973 APR 09	1245	28.0	67 T	5566.598	5566.598	5566.602 .011
FP	TOPLESS	MIETCHI R.M.	1973 APR 09	1305	28.0	23 W	5566.227	5566.228	5566.228 0.000
GY	OOLAGA	MIETCHI	1973 APR 13	1052	21.0	14 W	7578.929	7578.929	
GZ	OOLAGA	MIETCHI	1973 APR 13	1105	21.5	35 R	7578.936	7578.936	
HA	OOLAGA	MIETCHI	1973 APR 13	1130	23.0	98 W	7578.963	7578.964*	
HC	OOLAGA	MIETCHI	1973 APR 13	1205	25.4	19 W	7578.911	7578.913*	7578.926 .021 .932 .004
HB	OOLAGA	MIETCHI R.M.	1973 APR 13	1150	24.5	5 R	7575.710	7575.711	7575.711 0.000

Code	Geodimeter Sta.	Retroreflector Sta.	Date	Time	Temp.	Spread	Corrected D	Final D	Line Average	
FI	TOPLESS	DUST	1973 APR 09	0945	26.0	20 W	1709.675	1709.674		
FJ	TOPLESS	DUST	1973 APR 09	1005	26.0	6 T	1709.679	1709.679		
FK	TOPLESS	DUST	1973 APR 09	1015	26.2	6 W	1709.673	1709.672	1709.675	.004
FL	TOPLESS	DUST AUX A	1973 APR 09	1030	26.9	9 W	1684.625	1684.625	1684.625	0.000
FQ	PYLON	WONJI	1973 APR 10	0810	23.6	9 T	3402.626	3402.621		
FR	PYLON	WONJI	1973 APR 10	0830	23.7	15 T	3402.618	3402.614		
FS	PYLON	WONJI	1973 APR 10	0900	24.5	26 R	3402.627	3402.624	3402.619	.005
FT	PYLON	WONJI AUX A	1973 APR 10	0915	25.8	73 R	3400.159	3400.157	3400.157	0.000
HH	KOKA	PYLON	1973 APR 13	1835	24.4	14 T	3079.961	3079.963		
HI	KOKA	PYLON	1973 APR 13	1850	24.0	20 H	3079.957	3079.960		
HJ	KOKA	PYLON	1973 APR 13	1905	23.8	5 T	3079.951	3079.954	3079.958	.005
HD	KOKA	WONJI	1973 APR 13	1650	28.4	25 T	5336.841	5336.845		
HE	KOKA	WONJI	1973 APR 13	1710	28.0	18 H	5336.835	5336.838		
HF	KOKA	WONJI	1973 APR 13	1725	27.5	23 T	5336.830	5336.832	5336.838	.007
HG	KOKA	WONJI AUX A	1973 APR 13	1745	27.3	2 H	5335.236	5335.238	5335.238	0.000
EN	TABLE	AYGU	1973 APR 06	1810	30.2	12 W	7678.101	7678.106		
EO	TABLE	AYGU	1973 APR 06	1825	29.8	44 R	7678.121	7678.127		
EP	TABLE	AYGU	1973 APR 06	1840	29.7	28 W	7678.109	7678.114	7678.112	.011
EK	TABLE	MERKO	1973 APR 06	1600	32.1	25 W	6858.833	6858.842		
EL	TABLE	MERKO	1973 APR 06	1615	31.6	10 R	6858.843	6858.852		
EM	TABLE	MERKO	1973 APR 06	1645	31.5	19 R	6858.831	6858.839		
EQ	TABLE	MERKO	1973 APR 07	0835	26.8	21 W	6858.838	6858.827		
ER	TABLE	MERKO	1973 APR 07	0850	27.2	22 M	6858.834	6858.824		
ES	TABLE	MERKO	1973 APR 07	0905	27.7	17 W	6858.839	6858.830	6858.837	.011
ET	TABLE	MERKO AUX A	1973 APR 07	0920	27.7	24 M	6854.767	6854.759	6854.759	0.000
EU	TABLE	RABBIT	1973 APR 07	1125	30.5	37 M	9418.240	9418.242		
EV	TABLE	RABBIT	1973 APR 07	1140	30.2	20 W	9418.265	9418.267		
EW	TABLE	RABBIT	1973 APR 07	1155	30.4	22 M	9418.251	9418.254		
GG	RABBIT	TABLE	1973 APR 12	1025	27.4	32 T	9418.263	9418.261		
GH	RABBIT	TABLE	1973 APR 12	1040	27.6	43 M	9418.250	9418.249		
GI	RABBIT	TABLE	1973 APR 12	1055	28.1	14 H	9418.252	9418.252		
GK	RABBIT	TABLE	1973 APR 12	1125	28.7	24 H	9418.259	9418.261	9418.256	.008
EX	TABLE	RABBIT AUX A	1973 APR 07	1215	30.3	14 W	9421.121	9421.125	9421.125	0.000
GJ	RABBIT	TABLE AUX A	1973 APR 12	1105	28.5	37 T	9417.787	9417.787	9417.787	0.000
FE	MERKO	AYGU	1973 APR 08	1615	31.8	21 W	7829.031	7829.037		
FF	MERKO	AYGU	1973 APR 08	1630	31.5	17 H	7829.002	7829.008 *		
FG	MERKO	AYGU	1973 APR 08	1645	31.1	6 W	7829.022	7829.028		
GL	MERKO	AYGU	1973 APR 12	1625	30.8	9 T	7829.020	7829.026		
GM	MERKO	AYGU	1973 APR 12	1645	30.7	23 T	7829.027	7829.033		
GN	MERKO	AYGU	1973 APR 12	1705	30.1	17 R	7829.020	7829.026	7829.026 .029	.010 005
FH	MERKO	AYGU AUX A	1973 APR 08	1705	30.6	10 W	7827.304	7827.309		
GO	MERKO	AYGU AUX A	1973 APR 12	1725	29.6	9 R	7827.303	7827.309	7827.309	0.000
GC	RABBIT	AYGU	1973 APR 12	0820	25.4	12 T	7220.467	7220.462		
GD	RABBIT	AYGU	1973 APR 12	0840	25.9	15 H	7220.462	7220.457 *		
GE	RABBIT	AYGU	1973 APR 12	0855	25.9	73 M	7220.475	7220.472	7220.460 .463	.008 .007
GF	RABBIT	AYGU AUX A	1973 APR 12	0910	26.4	24 T	7223.221	7223.217	7223.217	0.000
GP	MERKO	RABBIT	1973 APR 12	1855	26.8	12 T	13687.774	13687.779		
GQ	MERKO	RABBIT	1973 APR 12	1920	26.3	14 T	13687.773	13687.779		
GR	MERKO	RABBIT	1973 APR 12	1940	25.9	15 R	13687.766	13687.775	13687.778	.002
GS	MERKO	RABBIT AUX A	1973 APR 12	2000	25.3	23 R	13690.597	13690.609	13690.609	0.000
HX	TERMITE	HOTEL	1973 APR 18	1615	26.5	15 W	1022.572	1022.574		
HY	TERMITE	HOTEL	1973 APR 18	1630	25.0	8 H	1022.581	1022.582		
HZ	TERMITE	HOTEL	1973 APR 18	1640	25.0	9 W	1022.573	1022.575	1022.577	.004
JC	HOTEL	GALLA	1973 APR 20	1050	27.2	9 H	764.047	764.047		
JD	HOTEL	GALLA	1973 APR 20	1100	26.8	8 W	764.048	764.048		
JE	HOTEL	GALLA	1973 APR 20	1115	26.4	7 G	764.048	764.048	764.048	.001

Code	Geodimeter Sta.	Retroreflector Sta.	Date	Time	Temp.	Spread	Corrected D	Final D	Line Average	
IS	HOTEL	EUPHORBIA	1973 APR 20	0805	22.1	8 W	3517.912	3517.906		
IT	HOTEL	EUPHORBIA	1973 APR 20	0815	22.8	7 H	3517.909	3517.904		
IU	HOTEL	EUPHORBIA	1973 APR 20	0820	22.9	12 W	3517.913	3517.908	3517.906	.002
IV	HOTEL	EUPHORBIA AUX A	1973 APR 20	0840	23.0	17 H	3524.745	3524.740	3524.740	0.000
IW	HOTEL	EUPHORBIA AUX B	1973 APR 20	0850	23.3	4 W	3518.199	3518.195		
IX	HOTEL	EUPHORBIA AUX B	1973 APR 20	0900	23.4	6 H	3518.197	3518.194		
IY	HOTEL	EUPHORBIA AUX B	1973 APR 20	0915	23.4	7 W	3518.200	3518.196	3518.195	.001
IZ	HOTEL	LANGANA	1973 APR 20	0955	25.6	10 H	3394.041	3394.040		
JA	HOTEL	LANGANA	1973 APR 20	1000	26.0	5 W	3394.046	3394.045		
JB	HOTEL	LANGANA	1973 APR 20	1020	25.9	34 G	3394.049	3394.048	3394.044	.004
IE	TERMITE	GALLA	1973 APR 19	0935	21.9	24 W	746.028	746.027		
IF	TERMITE	GALLA	1973 APR 19	0950	22.7	2 T	746.027	746.027		
IG	TERMITE	GALLA	1973 APR 19	1000	23.5	4 W	746.033	746.032	746.029	.003
IH	TERMITE	EUPHORBIA	1973 APR 19	1120	25.6	14 T	3358.119	3358.120		
II	TERMITE	EUPHORBIA	1973 APR 19	1135	26.1	8 W	3358.117	3358.118		
IJ	TERMITE	EUPHORBIA	1973 APR 19	1150	26.5	17 G	3358.120	3358.122	3358.120	.002
IK	TERMITE	EUPHORBIA AUX A	1973 APR 19	1210	26.5	19 T	3372.611	3372.614	3372.614	0.000
KK	TERMITE	EUPHORBIA AUX B	1973 APR 22	0925	24.8	14 R	3358.402	3358.399		
KL	TERMITE	EUPHORBIA AUX B	1973 APR 22	0935	25.3	11 H	3358.399	3358.396		
KM	TERMITE	EUPHORBIA AUX B	1973 APR 22	0945	25.9	10 G	3358.405	3358.402	3358.399	.003
IA	TERMITE	LANGANA	1973 APR 18	1730	25.5	28 H	2434.155	2434.157		
IB	TERMITE	LANGANA	1973 APR 19	0755	18.9	4 W	2434.151	2434.147		
IC	TERMITE	LANGANA	1973 APR 19	0810	19.4	10 T	2434.153	2434.150		
ID	TERMITE	LANGANA	1973 APR 19	0835	19.6	6 G	2434.157	2434.154	2434.151	.004
LI	ARJO	TERMITE	1973 APR 27	0755	22.0	11 W	7257.933	7257.917 *		
LJ	ARJO	TERMITE	1973 APR 27	0810	22.5	10 R	7257.956	7257.942		
LK	ARJO	TERMITE	1973 APR 27	0825	22.8	6 H	7257.952	7257.939		
LL	ARJO	TERMITE	1973 APR 27	0835	23.1	22 W	7257.941	7257.928	7257.932 .937	.011 .007
IL	GALLA	EUPHORBIA	1973 APR 19	1640	25.6	21 T	2852.114	2852.117		
IM	GALLA	EUPHORBIA	1973 APR 19	1700	25.9	9 W	2852.119	2852.123		
IN	GALLA	EUPHORBIA	1973 APR 19	1715	26.8	5 G	2852.113	2852.117	2852.119	.003
IO	GALLA	EUPHORBIA AUX A	1973 APR 19	1735	26.6	13 T	2862.147	2862.150	2862.150	0.000
IP	GALLA	EUPHORBIA AUX B	1973 APR 19	1750	26.5	4 W	2852.395	2852.398		
IQ	GALLA	EUPHORBIA AUX B	1973 APR 19	1805	26.1	19 G	2852.394	2852.398		
IR	GALLA	EUPHORBIA AUX B	1973 APR 19	1820	25.5	14 T	2852.387	2852.391	2852.396	.004
JX	ARJO	GALLA	1973 APR 21	1000	26.4	38 W	7435.793	7435.788		
JY	ARJO	GALLA	1973 APR 21	1015	26.6	104 T	7435.792	7435.789		
KG	GALLA	ARJO	1973 APR 22	0730	19.2	6 H	7435.790	7435.771		
KH	GALLA	ARJO	1973 APR 22	0745	20.1	22 R	7435.778	7435.761		
KI	GALLA	ARJO	1973 APR 22	0800	21.2	18 H	7435.779	7435.763	7435.769	.013
KJ	GALLA	ARJO AUX A	1973 APR 22	0820	22.4	12 R	7439.571	7439.557	7439.557	0.000
JF	LANGANA	EUPHORBIA	1973 APR 20	1535	30.1	2 W	3232.691	3232.695		
JG	LANGANA	EUPHORBIA	1973 APR 20	1545	30.8	3 R	3232.687	3232.691		
JH	LANGANA	EUPHORBIA	1973 APR 20	1600	30.9	19 W	3232.715	3232.719*	3232.699 693	.015 .003
JI	LANGANA	EUPHORBIA AUX A	1973 APR 20	1625	29.6	28 R	3259.842	3259.846	3259.846	0.000
JJ	LANGANA	EUPHORBIA AUX B	1973 APR 20	1640	28.7	13 G	3232.885	3232.888		
JK	LANGANA	EUPHORBIA AUX B	1973 APR 20	1700	29.1	21 R	3232.884	3232.888		
JL	LANGANA	EUPHORBIA AUX B	1973 APR 20	1715	29.2	18 W	3232.884	3232.887	3232.888	.001
JQ	ARJO	EUPHORBIA	1973 APR 21	0740	20.6	7 W	6206.128	6206.113*		
JR	ARJO	EUPHORBIA	1973 APR 21	0750	21.4	17 R	6206.138	6206.124		
JS	ARJO	EUPHORBIA	1973 APR 21	0805	21.9	6 T	6206.138	6206.125	6206.120 .125	.007 .001
JT	ARJO	EUPHORBIA AUX A	1973 APR 21	0825	22.2	15 W	6229.366	6229.355	6229.355	0.000
JU	ARJO	EUPHORBIA AUX B	1973 APR 21	0840	22.9	3 T	6206.107	6206.096 *		
JV	ARJO	EUPHORBIA AUX B	1973 APR 21	0900	23.6	40 R	6206.093	6206.085		
JW	ARJO	EUPHORBIA AUX B	1973 APR 21	0910	24.3	13 W	6206.096	6206.088	6206.092 .087	.006 .002

Code	Geodimeter Sta.	Retroreflector Sta.	Date	Time	Temp.	Spread	Corrected D	Final D	Line Average	
JM	LANGANA	ARJO	1973 APR 20	1755	27.9	25 R	4851.684	4851.687		
JN	LANGANA	ARJO	1973 APR 20	1815	26.6	2 W	4851.681	4851.685		
JO	LANGANA	ARJO	1973 APR 20	1825	26.0	5 G	4851.697	4851.701*	4851.692 .685	.009 .001
JP	LANGANA	ARJO AUX A	1973 APR 20	1840	25.8	25 W	4855.270	4855.276	4855.276	0.000
KD	OITU	ALUTU	1973 APR 21	1745	27.2	13 W	4629.080	4629.083		
KE	OITU	ALUTU	1973 APR 21	1800	27.4	5 R	4629.082	4629.083		
KF	OITU	ALUTU	1973 APR 21	1810	27.1	7 T	4629.080	4629.083	4629.083	.000
JZ	OITU	OOMAY	1973 APR 21	1605	30.2	9 T	5303.627	5303.630		
KA	OITU	OOMAY	1973 APR 21	1625	29.7	2 W	5303.636	5303.637		
KB	OITU	OOMAY	1973 APR 21	1640	29.2	22 R	5303.633	5303.636	5303.634	.004
KC	OITU	OOMAY AUX A	1973 APR 21	1700	28.9	10 T	5312.157	5312.160	5312.160	0.000
KU	BMN	BMC	1973 APR 23	1050	25.9	21 R	1206.696	1206.696		
KV	BMN	BMC	1973 APR 23	1110	27.0	20 H	1206.698	1206.698		
KW	BMN	BMC	1973 APR 23	1120	27.6	15 G	1206.690	1206.691	1206.695	.004
LB	BMC	KULFO	1973 APR 23	1905	25.1	8 R	3599.156	3599.161		
LC	BMC	KULFO	1973 APR 23	1920	24.8	19 T	3599.152	3599.158		
LD	BMC	KULFO	1973 APR 23	1935	24.8	7 G	3599.148	3599.155	3599.158	.003
KX	BMC	TOSASUCHA	1973 APR 23	1635	27.7	27 T	7277.587	7277.595		
KY	BMC	TOSASUCHA	1973 APR 23	1655	26.6	17 R	7277.588	7277.596		
KZ	BMC	TOSASUCHA	1973 APR 23	1710	26.0	11 G	7277.587	7277.594	7277.595	.001
LA	BMC	TOSASUCHA AUX A	1973 APR 23	1725	26.0	19 T	7276.495	7276.502	7276.502	0.000
KN	BMP	SHECHA	1973 APR 23	0805	22.1	26 H	2331.642	2331.637		
KO	BMP	SHECHA	1973 APR 23	0815	22.1	3 R	2331.639	2331.634		
KP	BMP	SHECHA	1973 APR 23	0825	22.1	24 G	2331.639	2331.635		
KQ	BMP	SHECHA	1973 APR 23	0845	22.4	25 H	2331.633	2331.629	2331.634	.003
KR	BMN	SHECHA	1973 APR 23	0940	25.5	10 R	2937.654	2937.652		
KS	BMN	SHECHA	1973 APR 23	0955	25.4	16 G	2937.656	2937.654		
KT	BMN	SHECHA	1973 APR 23	1005	25.9	27 H	2937.657	2937.655	2937.653	.002
LE	KULFO	TOSASUCHA	1973 APR 24	1610	27.8	21 R	3772.906	3772.911		
LF	KULFO	TOSASUCHA	1973 APR 24	1625	27.1	7 H	3772.911	3772.915		
LG	KULFO	TOSASUCHA	1973 APR 24	1635	26.8	38 R	3772.910	3772.915	3772.914	.002
LH	KULFO	TOSASUCHA AUX A	1973 APR 24	1650	25.0	53 H	3772.063	3772.067	3772.067	0.000

APPENDIX G

TIKDEM 1974 GEODIMETER OBSERVATIONS

Code	Geodimeter Sta.	Retroreflector Sta.	Date	Time	Temp.	Spread	Corrected D	Final D	Line Average	
PQ	MARIAM	GITCHI	1974 NOV 22	0825	15.6	40 R	15531.209	15531.201		
PR	MARIAM	GITCHI	1974 NOV 22	0840	16.3	56 G	15531.204	15531.197		
PS	MARIAM	GITCHI	1974 NOV 22	0900	16.5	77 R	15531.209	15531.204	15531.200	.003
PX	RAILWAY	MARIAM	1974 NOV 22	1648	20.7	11 P	3929.222	3929.225		
PY	RAILWAY	MARIAM	1974 NOV 22	1658	20.3	15 M	3929.216	3929.219		
PZ	RAILWAY	MARIAM	1974 NOV 22	1710	19.9	14 P	3929.213	3929.216		
QA	RAILWAY	MARIAM	1974 NOV 22	1720	19.5	11 M	3929.215	3929.217	3929.219	.004
PT	RAILWAY	MARIAM AUX A	1974 NOV 22	1550	21.4	11 P	3937.585	3937.588		
PU	RAILWAY	MARIAM AUX A	1974 NOV 22	1603	21.3	6 M	3937.595	3937.598		
PV	RAILWAY	MARIAM AUX A	1974 NOV 22	1619	21.1	24 P	3937.597	3937.600		
PW	RAILWAY	MARIAM AUX A	1974 NOV 22	1630	21.0	19 M	3937.604	3937.607	3937.597	.008
AY	GEORGE	MARIAM	1974 OCT 24	0940	22.1	30 P	7262.585	7262.583 *		
AZ	GEORGE	MARIAM	1974 OCT 24	0950	22.2	11 R	7262.564	7262.563		
BA	GEORGE	MARIAM	1974 OCT 24	1015	22.6	13 P	7262.559	7262.558	7262.565 .561	.013 .004
AU	GEORGE AUX A	MARIAM	1974 OCT 24	0810	18.4	11 P	7259.115	7259.110		
AV	GEORGE AUX A	MARIAM	1974 OCT 24	0825	19.2	25 R	7259.114	7259.109		
AW	GEORGE AUX A	MARIAM	1974 OCT 24	0845	20.2	4 P	7259.112	7259.109	7259.109	.001
BB	GEORGE	MARIAM AUX A	1974 OCT 24	1035	23.3	6 R	7257.240	7257.240	7257.240	0.000
AX	GEORGE AUX A	MARIAM AUX A	1974 OCT 24	0900	20.9	18 R	7253.765	7253.763	7253.763	0.000
AA	RIDGE	GEORGE	1974 OCT 23	0830	20.5	14 R	2529.991	2529.989 *		
AB	RIDGE	GEORGE	1974 OCT 23	0845	21.1	25 P	2529.974	2529.972		
AC	RIDGE	GEORGE	1974 OCT 23	0907	22.0	7 R	2529.962	2529.961 *		
BC	GEORGE	RIDGE	1974 OCT 24	1545	25.7	9 M	2529.968	2529.970		
BD	GEORGE	RIDGE	1974 OCT 24	1600	25.5	19 G	2529.978	2529.980		
BE	GEORGE	RIDGE	1974 OCT 24	1615	25.4	11 M	2529.969	2529.970	2529.973 .973	.010 .004
DW	RIDGE AUX A	GEORGE	1974 OCT 29	1010	17.4	12 G	2540.203	2540.202		
DX	RIDGE AUX A	GEORGE	1974 OCT 29	1020	17.9	8 R	2540.208	2540.208	2540.205	.004
BF	GEORGE	RIDGE R.M.2	1974 OCT 24	1625	25.2	26 G	2533.934	2533.936	2533.936	0.000
AD	RIDGE	GEORGE AUX A	1974 OCT 23	0940	22.7	14 P	2530.732	2530.731	2530.731	0.000
DY	RIDGE AUX A	GEORGE AUX A	1974 OCT 29	1055	19.1	37 G	2540.862	2540.862	2540.862	0.000
BG	GEORGE	ADAMA	1974 OCT 24	1710	25.0	12 M	4461.173	4461.177		
BH	GEORGE	ADAMA	1974 OCT 24	1720	24.8	36 G	4461.173	4461.178		
BI	GEORGE	ADAMA	1974 OCT 24	1730	24.8	12 M	4461.171	4461.175	4461.176	.002
BJ	GEORGE	ADAMA AUX A	1974 OCT 24	1740	24.3	7 G	4470.819	4470.823	4470.823	0.000
EI	GEORGE	EL PASO AUX A	1974 OCT 29	1645	19.4	24 M	9160.895	9160.902		
EJ	GEORGE	EL PASO AUX A	1974 OCT 29	1655	19.1	20 P	9160.901	9160.908	9160.905 .902	.004 (½ GRC)
EF	GEORGE	GANTI	1974 OCT 29	1550	19.9	11 P	9200.898	9200.903		
EG	GEORGE	GANTI	1974 OCT 29	1600	19.7	19 M	9200.896	9200.902	9200.903 .900	.001 (½ GRC)
EH	GEORGE	GANTI AUX A	1974 OCT 29	1620	19.5	19 P	9200.350	9200.355	9200.355 .352	0.000 (½ GRC)
BK	GEORGE	FULCRUM AUX A	1974 OCT 24	1810	22.6	13 M	7281.168	7281.172		
BL	GEORGE	FULCRUM AUX A	1974 OCT 24	1820	22.2	24 G	7281.161	7281.165		
BM	GEORGE	FULCRUM AUX A	1974 OCT 24	1830	21.6	13 M	7281.165	7281.170	7281.169	.004
BN	GEORGE	FULCRUM AUX D	1974 OCT 24	1845	21.2	11 G	7257.990	7257.994	7257.994	0.000
EK	GEORGE	BOKU AUX A	1974 OCT 29	1740	17.5	9 M	9432.477	9432.482		
EL	GEORGE	BOKU AUX A	1974 OCT 29	1750	17.4	12 P	9432.480	9432.485		
EM	GEORGE	BOKU AUX A	1974 OCT 29	1800	17.4	18 M	9432.476	9432.481	9432.483 .478	.002 (no GRC)
HJ	PYLON	GEORGE	1974 NOV 03	1750	20.4	10 M	6642.838	6642.843		
HK	PYLON	GEORGE	1974 NOV 03	1805	20.1	6 P	6642.841	6642.848	6642.846	.004
HL	PYLON	GEORGE AUX A	1974 NOV 03	1815	19.7	8 M	6628.220	6628.227	6628.227	0.000
JR	WONJI	GEORGE	1974 NOV 08	1705	22.0	21 R	6566.794	6566.799		
JS	WONJI	GEORGE	1974 NOV 08	1730	21.3	16 P	6566.785	6566.789	6566.794	.007
JT	WONJI	GEORGE AUX A	1974 NOV 08	1750	20.5	14 R	6552.819	6552.823	6552.823	0.000

Code	Geodimeter Sta.	Retroreflector Sta.	Date	Time	Temp.	Spread	Corrected D	Final D	Line Average	
GQ	KOKA	GEORGE	1974 NOV 02	1135	24.5	25 R	9716.095	9716.096		
GR	KOKA	GEORGE	1974 NOV 02	1150	24.9	16 G	9716.103	9716.104		
GS	KOKA	GEORGE	1974 NOV 02	1200	25.0	26 R	9716.092	9716.094	9716.099	.005
AI	RIDGE	ADAMA	1974 OCT 23	1146	24.8	6 P	2865.572	2865.573		
AJ	RIDGE	ADAMA	1974 OCT 23	1204	25.0	15 R	2865.567	2865.568		
AK	RIDGE	ADAMA	1974 OCT 23	1215	25.2	31 P	2865.563	2865.565		
AM	ADAMA	RIDGE	1974 OCT 23	1550	26.0	84 G	2865.580	2865.582 *		
AN	ADAMA	RIDGE	1974 OCT 23	1610	25.9	21 M	2865.576	2865.578		
AO	ADAMA	RIDGE	1974 OCT 23	1625	25.6	10 M	2865.571	2865.573	2865.572 .572	.006 .005
AL	RIDGE	ADAMA AUX A	1974 OCT 23	1230	25.3	8 R	2874.400	2874.401	2874.401	0.000
DZ	RIDGE AUX A	ADAMA	1974 OCT 29	1145	19.7	27 R	2878.022	2878.023		
EA	RIDGE AUX A	ADAMA	1974 OCT 29	1205	20.0	29 G	2878.021	2878.022	2878.023 .022	.001 (nr GRC)
EB	RIDGE AUX A	ADAMA AUX A	1974 OCT 29	1215	19.9	35 R	2886.830	2886.831	2886.831 .830	0.000 (nr GRC)
AP	ADAMA	RIDGE R.M.2	1974 OCT 23	1640	25.3	9 M	2880.126	2880.129	2880.129	0.000
AE	RIDGE	FARENJI	1974 OCT 23	1030	23.4	21 P	3022.252	3022.251		
AF	RIDGE	FARENJI	1974 OCT 23	1045	23.6	15 R	3022.245	3022.245		
AG	RIDGE	FARENJI	1974 OCT 23	1055	23.6	16 P	3022.253	3022.253		
BS	FARENJI	RIDGE	1974 OCT 25	1520	25.5	25 R	3022.249	3022.252		
BT	FARENJI	RIDGE	1974 OCT 25	1535	25.5	29 G	3022.243	3022.247		
BU	FARENJI	RIDGE	1974 OCT 25	1600	25.4	38 R	3022.250	3022.254	3022.250	.004
AH	RIDGE	FARENJI AUX B	1974 OCT 23	1112	23.6	13 R	3011.195	3011.195	3011.195	0.000
BV	FARENJI	RIDGE AUX A	1974 OCT 25	1625	25.3	47 R	3026.094	3026.097		
EC	RIDGE AUX A	FARENJI	1974 OCT 29	1255	19.1	14 G	3026.073	3026.075		
ED	RIDGE AUX A	FARENJI	1974 OCT 29	1305	18.9	16 R	3026.076	3026.078	3026.079 .011	.012
EE	RIDGE AUX A	FARENJI AUX B	1974 OCT 29	1320	18.9	7 G	3014.954	3014.957	3014.957 .954	0.000 (nr GRC)
GX	RIDGE	EL PASO AUX A	1974 NOV 02	1645	23.9	22 P	6631.508	6631.512		
GY	RIDGE	EL PASO AUX A	1974 NOV 02	1700	23.8	20 G	6631.497	6631.501	6631.506	.008
GT	RIDGE	GANTI	1974 NOV 02	1545	24.2	11 P	6673.507	6673.510		
GU	RIDGE	GANTI	1974 NOV 02	1600	24.2	11 G	6673.500	6673.503		
GV	RIDGE	GANTI	1974 NOV 02	1610	24.1	6 P	6673.499	6673.502	6673.505	.004
GW	RIDGE	GANTI AUX A	1974 NOV 02	1630	23.9	29 G	6672.911	6672.914	6672.914	0.000
TQ	FULCRUM AUX A	RIDGE	1974 DEC 05	0825	14.9	30 R	5335.163	5335.160		
TR	FULCRUM AUX A	RIDGE	1974 DEC 05	0850	16.4	17 R	5335.163	5335.160		
TS	FULCRUM AUX A	RIDGE	1974 DEC 05	0905	17.7	19 R	5335.162	5335.159	5335.160	.001
TT	FULCRUM AUX A	RIDGE AUX A	1974 DEC 05	0930	19.8	23 R	5341.155	5341.153	5341.153	0.000
GZ	RIDGE	BOKU	1974 NOV 02	1740	21.9	16 P	6998.237	6998.240		
HA	RIDGE	BOKU	1974 NOV 02	1755	21.5	7 G	6998.226	6998.228		
HB	RIDGE	BOKU	1974 NOV 02	1808	21.3	17 P	6998.233	6998.236	6998.234	.006
HC	RIDGE	BOKU AUX A	1974 NOV 02	1822	20.9	21 G	6999.723	6999.727	6999.727	0.000
HG	PYLON	RIDGE	1974 NOV 03	1700	22.2	16 P	7612.220	7612.226		
HH	PYLON	RIDGE	1974 NOV 03	1705	22.0	18 M	7612.220	7612.226	7612.226	0.000
HI	PYLON	RIDGE AUX A	1974 NOV 03	1720	21.7	11 P	7602.896	7602.902	7602.902	0.000
AQ	ADAMA	FARENJI	1974 OCT 23	1740	24.4	21 P	1400.902	1400.903		
AR	ADAMA	FARENJI	1974 OCT 23	1750	24.2	5 M	1400.894	1400.896		
AS	ADAMA	FARENJI	1974 OCT 23	1800	23.8	17 P	1400.899	1400.900		
CA	FARENJI	ADAMA	1974 OCT 25	1840	23.0	19 G	1400.906	1400.908		
CB	FARENJI	ADAMA	1974 OCT 25	1900	22.7	15 R	1400.905	1400.907		
KB	FARENJI	ADAMA	1974 NOV 09	0912	19.8	19 M	1400.900	1400.899		
KC	FARENJI	ADAMA	1974 NOV 09	0920	20.2	10 P	1400.901	1400.899		
KD	FARENJI	ADAMA	1974 NOV 09	0930	20.5	37 M	1400.907	1400.905	1400.901	.004
AT	ADAMA	FARENJI AUX B	1974 OCT 23	1815	23.5	34 M	1407.480	1407.482	1407.482	0.000
CC	FARENJI	ADAMA AUX A	1974 OCT 25	1920	22.1	28 R	1398.021	1398.023		
KE	FARENJI	ADAMA AUX A	1974 NOV 09	0945	20.6	27 P	1398.023	1398.022	1398.022	.001
RW	ADAMA	EL PASO AUX A	1974 NOV 25	1015	21.6	16 R	6153.625	6153.623		
RX	ADAMA	EL PASO AUX A	1974 NOV 25	1032	22.0	18 P	6153.628	6153.627		
RY	ADAMA	EL PASO AUX A	1974 NOV 25	1045	22.5	26 R	6153.627	6153.627	6153.625	.002

Code	Geodimeter Sta.	Retroreflector Sta.	Date	Time	Temp.	Spread	Corrected D	Final D	Line Average	
RT	ADAMA	GANTI	1974 NOV 25	0928	20.8	22 P	6100.392	6100.389		
RU	ADAMA	GANTI	1974 NOV 25	0940	20.7	70 R	6100.365	6100.362*	6100.385 .389	.019
RV	ADAMA	GANTI AUX A	1974 NOV 25	0955	20.9	9 P	6101.612	6101.610	6101.610	0.000
IG	BOKU	ADAMA	1974 NOV 05	1115	21.4	33 P	7427.115	7427.115		
IH	BOKU	ADAMA	1974 NOV 05	1140	22.1	152 R	7427.083	7427.084*	7427.114 .115	.022
JY	FARENJI	EL PASO AUX A	1974 NOV 09	0820	17.0	12 P	4757.500	4757.494		
JZ	FARENJI	EL PASO AUX A	1974 NOV 09	0830	17.4	2 M	4757.497	4757.491		
KA	FARENJI	EL PASO AUX A	1974 NOV 09	0840	17.8	21 P	4757.507	4757.501	4757.494	.005
JU	FARENJI	GANTI	1974 NOV 09	0725	14.2	10 P	4709.992	4709.984		
JV	FARENJI	GANTI	1974 NOV 09	0734	14.5	10 M	4709.989	4709.982		
JW	FARENJI	GANTI	1974 NOV 09	0745	15.0	10 P	4709.991	4709.984	4709.983 .987	.001 (± GRC)
JX	FARENJI	GANTI AUX A	1974 NOV 09	0755	15.4	12 M	4711.102	4711.095	4711.095 .099	0.000 (± GRC)
BW	FARENJI	FULCRUM AUX A	1974 OCT 25	1710	25.2	15 G	2358.142	2358.144*		
BX	FARENJI	FULCRUM AUX A	1974 OCT 25	1725	24.9	4 R	2358.144	2358.145*		
KF	FARENJI	FULCRUM AUX A	1974 NOV 09	1015	21.7	20 M	2358.162	2358.162		
KG	FARENJI	FULCRUM AUX A	1974 NOV 09	1022	22.0	6 P	2358.169	2358.169	2358.155 .167	.012 .005
BY	FARENJI	FULCRUM AUX B	1974 OCT 25	1740	24.2	9 G	2359.561	2359.563*		
KH	FARENJI	FULCRUM AUX B	1974 NOV 09	1033	22.1	10 M	2359.575	2359.575		
KI	FARENJI	FULCRUM AUX B	1974 NOV 09	1042	22.2	9 P	2359.583	2359.583	2359.574 .579	.010 .006
BZ	FARENJI	FULCRUM AUX D	1974 OCT 25	1805	23.2	12 R	2372.321	2372.322	2372.322	0.000
IN	BOKU	FARENJI	1974 NOV 05	1725	20.9	34 R	6066.426	6066.430		
IO	BOKU	FARENJI	1974 NOV 05	1735	20.7	8 P	6066.437	6066.440		
IP	BOKU	FARENJI	1974 NOV 05	1750	20.5	30 R	6066.429	6066.432	6066.436 433	.005 (unweighted)
RE	EL PASO AUX A	GANTI	1974 NOV 24	1200	23.4	29 R	221.452	221.452		
RF	EL PASO AUX A	GANTI	1974 NOV 24	1210	23.5	17 P	221.463	221.463		
RG	EL PASO AUX A	GANTI	1974 NOV 24	1220	23.7	8 R	221.452	221.452	221.456	.006
RC	EL PASO AUX A	GANTI AUX A	1974 NOV 24	1130	22.7	15 R	217.517	217.517		
RD	EL PASO AUX A	GANTI AUX A	1974 NOV 24	1145	23.2	5 P	217.522	217.522	217.520	.004
RQ	FULCRUM AUX A	GANTI	1974 NOV 25	0807	17.5	6 R	4773.663	4773.661		
RR	FULCRUM AUX A	GANTI	1974 NOV 25	0820	17.9	3 P	4773.665	4773.663	4773.662	.001
RS	FULCRUM AUX A	GANTI AUX A	1974 NOV 25	0830	18.3	4 R	4776.551	4776.549	4776.549	0.000
RN	GANTI	CINDER	1974 NOV 24	1745	23.3	13 M	11447.045	11447.049		
RO	GANTI	CINDER	1974 NOV 24	1755	23.0	25 G	11447.050	11447.053		
RP	GANTI	CINDER	1974 NOV 24	1804	22.5	15 M	11447.046	11447.050	11447.050	.002
RL	GANTI	CINDER AUX A	1974 NOV 24	1720	24.0	13 M	11432.363	11432.367		
RM	GANTI	CINDER AUX A	1974 NOV 24	1733	23.6	18 G	11432.355	11432.360	11432.364	.005
II	BOKU	GANTI	1974 NOV 05	1500	21.9	12 P	2519.672	2519.673		
IJ	BOKU	GANTI	1974 NOV 05	1512	19.6	6 R	2519.659	2519.661	2519.666	.008
IK	BOKU	GANTI AUX A	1974 NOV 05	1540	21.7	18 P	2515.537	2515.538	2515.538	0.000
RB	GANTI	ROGGI	1974 NOV 24	1037	22.7	28 P	10840.841	10840.840	10840.840	0.000
QZ	GANTI	ROGGI AUX A	1974 NOV 24	1010	21.6	20 P	10858.193	10858.190		
RA	GANTI	ROGGI AUX A	1974 NOV 24	1018	22.0	22 R	10858.189	10858.186	10858.188	.003
QW	GANTI	MIETCHI	1974 NOV 24	0835	15.7	13 R	16672.522	16672.516*		
QX	GANTI	MIETCHI	1974 NOV 24	0855	16.5	8 P	16672.526	16672.521		
QY	GANTI	MIETCHI	1974 NOV 24	0907	17.2	4 R	16672.533	16672.529	16672.523 525	.007 .006
RH	GANTI	AYGU	1974 NOV 24	1525	25.5	41 M	16692.031	16692.040		
RI	GANTI	AYGU	1974 NOV 24	1535	25.6	20 G	16692.021	16692.029		
RJ	GANTI	AYGU	1974 NOV 24	1545	25.5	18 M	16692.028	16692.037	16692.034	.006
RK	GANTI	AYGU AUX A	1974 NOV 24	1556	25.5	29 G	16693.289	16693.298	16693.298	0.000

Code	Geodimeter Sta.	Retroreflector Sta.	Date	Time	Temp.	Spread	Corrected D	Final D	Line Average	
KJ	FULCRUM AUX A	GRAVES	1974 NOV 09	1530	25.4	22 R	7318.030	7318.034		
KK	FULCRUM AUX A	GRAVES	1974 NOV 09	1545	25.2	29 G	7318.010	7318.014		
KL	FULCRUM AUX A	GRAVES	1974 NOV 09	1555	25.1	41 R	7318.028	7318.032		
KM	FULCRUM AUX A	GRAVES	1974 NOV 09	1615	24.9	26 G	7318.009	7318.012		
PI	GRAVES	FULCRUM AUX A	1974 NOV 21	1610	24.3	33 P	7318.023	7318.026		
PJ	GRAVES	FULCRUM AUX A	1974 NOV 21	1620	24.1	5 M	7318.021	7318.025		
PK	GRAVES	FULCRUM AUX A	1974 NOV 21	1630	24.0	31 P	7318.021	7318.024		
PL	GRAVES	FULCRUM AUX A	1974 NOV 21	1642	23.7	48 M	7318.023	7318.026	7318.024 .025	.008 .001
KN	FULCRUM AUX A	GRAVES AUX A	1974 NOV 09	1630	24.6	32 R	7341.659	7341.662		
PF	GRAVES AUX A	FULCRUM AUX A	1974 NOV 21	1530	24.6	20 M	7341.666	7341.669		
PG	GRAVES AUX A	FULCRUM AUX A	1974 NOV 21	1540	24.4	11 P	7341.662	7341.665		
PH	GRAVES AUX A	FULCRUM AUX A	1974 NOV 21	1548	24.4	19 M	7341.663	7341.666	7341.666	.003
KO	FULCRUM AUX A	CINDER	1974 NOV 09	1730	23.1	17 G	12089.213	12089.218		
KP	FULCRUM AUX A	CINDER	1974 NOV 09	1740	22.5	17 R	12089.206	12089.210		
KQ	FULCRUM AUX A	CINDER	1974 NOV 09	1800	21.8	21 G	12089.207	12089.210	12089.213	.005
KR	FULCRUM AUX A	CINDER AUX A	1974 NOV 09	1810	21.1	20 R	12083.367	12083.372	12083.372	0.000
PM	GRAVES	CINDER	1974 NOV 21	1755	22.0	7 P	5866.834	5866.837		
PN	GRAVES	CINDER	1974 NOV 21	1801	21.4	5 M	5866.836	5866.840	5866.839	.002
PO	GRAVES	CINDER AUX A	1974 NOV 21	1813	21.1	18 P	5872.141	5872.145		
PP	GRAVES	CINDER AUX A	1974 NOV 21	1819	21.1	9 M	5872.142	5872.147	5872.146	.001
CD	BOHALLA	CINDER	1974 OCT 26	0830	21.7	31 P	7233.364	7233.358		
CE	BOHALLA	CINDER	1974 OCT 26	0840	22.4	8 M	7233.372	7233.367		
CF	BOHALLA	CINDER	1974 OCT 26	0855	23.9	11 P	7233.373	7233.368		
CG	BOHALLA	CINDER	1974 OCT 26	0910	24.5	7 M	7233.377	7233.373	7233.368	.006
CH	BOHALLA	CINDER AUX A	1974 OCT 26	0925	23.9	17 P	7223.543	7223.539		
CI	BOHALLA	CINDER AUX A	1974 OCT 26	0940	24.5	6 M	7223.543	7223.540	7223.540	.001
CS	BORI	CINDER	1974 OCT 26	1720	27.7	24 P	8886.128	8886.134		
CT	BORI	CINDER	1974 OCT 26	1730	27.4	12 R	8886.135	8886.140		
CU	BORI	CINDER	1974 OCT 26	1745	26.9	18 G	8886.138	8886.143	8886.139	.005
CP	BABOON	CINDER	1974 OCT 26	1535	29.4	13 R	8914.654	8914.662		
CQ	BABOON	CINDER	1974 OCT 26	1600	29.4	6 P	8914.648	8914.656		
CR	BABOON	CINDER	1974 OCT 26	1610	29.0	11 R	8914.644	8914.651	8914.656	.006
CM	BOHALLA	BORI	1974 OCT 26	1235	29.0	16 M	1666.382	1666.382		
CN	BOHALLA	BORI	1974 OCT 26	1250	29.4	20 P	1666.383	1666.384		
CO	BOHALLA	BORI	1974 OCT 26	1310	29.6	7 M	1666.380	1666.381	1666.382	.002
CJ	BOHALLA	BABOON	1974 OCT 26	1115	27.1	11 M	2016.917	2016.917		
CK	BOHALLA	BABOON	1974 OCT 26	1125	27.4	20 P	2016.919	2016.919		
CL	BOHALLA	BABOON	1974 OCT 26	1145	27.4	4 M	2016.922	2016.923	2016.920	.003
IM	BOKU	ROGGI	1974 NOV 05	1635	22.1	13 P	9845.340	9845.346	9845.346	0.000
IL	BOKU	ROGGI AUX A	1974 NOV 05	1615	22.5	18 R	9857.975	9857.985	9857.985	0.000
IA	BOKU	PYLON	1974 NOV 05	0820	17.2	31 P	11460.248	11460.232		
IB	BOKU	PYLON	1974 NOV 05	0835	17.5	20 R	11460.244	11460.230		
IC	BOKU	PYLON	1974 NOV 05	0845	18.1	20 P	11460.240	11460.227	11460.229	.003
ID	BOKU	WONJI	1974 NOV 05	0945	19.7	10 R	8305.184	8305.181		
IE	BOKU	WONJI	1974 NOV 05	1000	19.9	20 P	8305.180	8305.177		
IF	BOKU	WONJI	1974 NOV 05	1010	19.9	9 R	8305.170	8305.168	8305.175	.007
JF	ROGGI AUX A	MIETCHI	1974 NOV 06	1715	21.6	12 M	6236.809	6236.812		
JG	ROGGI AUX A	MIETCHI	1974 NOV 06	1730	21.3	12 G	6236.820	6236.823		
JH	ROGGI AUX A	MIETCHI	1974 NOV 06	1740	20.9	9 M	6236.811	6236.814	6236.816	.006
IZ	TOPLESS	MIETCHI	1974 NOV 06	1435	22.7	7 M	5566.650	5566.654		
JA	TOPLESS	MIETCHI	1974 NOV 06	1445	22.6	21 G	5566.648	5566.652		
JB	TOPLESS	MIETCHI	1974 NOV 06	1500	22.7	23 M	5566.650	5566.654	5566.653	.001
JC	DUST	MIETCHI	1974 NOV 06	1545	22.3	4 G	5511.385	5511.388		
JD	DUST	MIETCHI	1974 NOV 06	1555	22.2	8 M	5511.382	5511.385		
JE	DUST	MIETCHI	1974 NOV 06	1610	22.1	7 G	5511.379	5511.382	5511.385	.003

Code	Geodimeter Sta.	Retroreflector Sta.	Date	Time	Temp.	Spread	Corrected D	Final D	Line Average	
TM	QUILL	MIETCHI	1974 DEC 04	1650	24.9	26 G	7230.953	7230.957		
TN	QUILL	MIETCHI	1974 DEC 04	1705	24.4	21 G	7230.954	7230.958		
TO	QUILL	MIETCHI	1974 DEC 04	1720	24.0	21 G	7230.959	7230.962	7230.959	.003
TP	QUILL	MIETCHI AUX A	1974 DEC 04	1745	22.9	19 G	7221.234	7221.237	7221.237	0.000
QB	OOLAGA	MIETCHI	1974 NOV 23	0800	15.0	7 P	7578.953	7578.947		
QC	OOLAGA	MIETCHI	1974 NOV 23	0815	15.3	29 R	7578.963	7578.958		
QD	OOLAGA	MIETCHI	1974 NOV 23	0827	15.9	7 P	7578.954	7578.949		
QE	OOLAGA	MIETCHI	1974 NOV 23	0840	16.8	3 R	7578.959	7578.954	7578.951	.005
QF	OOLAGA	MIETCHI AUX A	1974 NOV 23	0852	17.4	18 P	7566.131	7566.127	7566.127	0.000
QS	WONJI	MIETCHI	1974 NOV 23	1715	23.2	19 M	20474.602	20474.613		
QT	WONJI	MIETCHI	1974 NOV 23	1725	22.8	17 G	20474.597	20474.607		
QU	WONJI	MIETCHI	1974 NOV 23	1735	22.3	25 M	20474.591	20474.600		
QV	WONJI	MIETCHI	1974 NOV 23	1750	21.7	21 G	20474.584	20474.592	20474.603	.009
QP	WONJI	MIETCHI AUX A	1974 NOV 23	1645	24.3	7 G	20480.199	20480.211		
QQ	WONJI	MIETCHI AUX A	1974 NOV 23	1655	23.8	16 M	20480.200	20480.212		
QR	WONJI	MIETCHI AUX A	1974 NOV 23	1705	23.5	17 G	20480.200	20480.212	20480.212	.001
IQ	SELASSIE	TOPLESS	1974 NOV 06	0920	18.3	6 M	7489.416	7489.408		
IR	SELASSIE	TOPLESS	1974 NOV 06	0930	18.5	30 M	7489.406	7489.399		
IS	SELASSIE	TOPLESS	1974 NOV 06	0945	18.9	9 M	7489.413	7489.408		
IT	SELASSIE	TOPLESS	1974 NOV 06	0957	19.6	14 M	7489.408	7489.403		
IU	SELASSIE	TOPLESS	1974 NOV 06	1010	20.1	8 M	7489.412	7489.409	7489.406	.004
IV	SELASSIE	DUST	1974 NOV 06	1050	20.9	19 M	8686.913	8686.913		
IW	SELASSIE	DUST	1974 NOV 06	1105	21.0	14 M	8686.919	8686.920		
IX	SELASSIE	DUST	1974 NOV 06	1115	21.2	37 M	8686.918	8686.919	8686.917	.004
IY	SELASSIE	DUST AUX A	1974 NOV 06	1140	21.0	19 M	8660.106	8660.108	8660.108	0.000
QN	QUILL	SODERE	1974 NOV 23	1240	26.5	3 P	3856.856	3856.859		
QO	QUILL	SODERE	1974 NOV 23	1250	26.4	11 R	3856.855	3856.858	3856.859	.001
QG	OOLAGA	QUILL	1974 NOV 23	0950	20.9	7 R	2357.714	2357.713		
QH	OOLAGA	QUILL	1974 NOV 23	1008	21.9	4 P	2357.723	2357.723		
QI	OOLAGA	QUILL	1974 NOV 23	1022	22.3	5 R	2357.715	2357.715		
QJ	OOLAGA	QUILL	1974 NOV 23	1030	22.0	21 P	2357.721	2357.721	2357.718	.005
QK	OOLAGA	SODERE	1974 NOV 23	1110	24.6	29 R	1581.717	1581.717		
QL	OOLAGA	SODERE	1974 NOV 23	1120	24.4	5 P	1581.725	1581.725		
QM	OOLAGA	SODERE	1974 NOV 23	1130	24.9	22 R	1581.723	1581.724	1581.723	.004
HD	PYLON	WONJI	1974 NOV 03	1540	24.6	8 M	3402.648	3402.652		
HE	PYLON	WONJI	1974 NOV 03	1550	24.5	5 P	3402.649	3402.654		
HF	PYLON	WONJI	1974 NOV 03	1600	24.5	10 M	3402.649	3402.653	3402.653	.001
GN	KOKA	PYLON	1974 NOV 02	1035	24.6	13 G	3080.001	3080.001		
GO	KOKA	PYLON	1974 NOV 02	1045	24.5	27 R	3079.981	3079.981		
GP	KOKA	PYLON	1974 NOV 02	1055	24.7	3 G	3079.989	3079.989	3079.991	.010
FR	THORNS	PYLON	1974 NOV 01	1015	23.9	23 P	4371.625	4371.623		
FS	THORNS	PYLON	1974 NOV 01	1030	24.2	6 M	4371.606	4371.605 ?		
FT	THORNS	PYLON	1974 NOV 01	1045	24.9	14 P	4371.630	4371.629	4371.617	.012
GK	KOKA	WONJI	1974 NOV 02	0925	23.1	22 R	5336.862	5336.860		
GL	KOKA	WONJI	1974 NOV 02	0935	23.5	10 G	5336.861	5336.858		
GM	KOKA	WONJI	1974 NOV 02	0945	23.9	16 R	5336.864	5336.862	5336.860	.002
GH	GALILA	WONJI	1974 NOV 02	0750	18.5	21 R	6263.274	6263.267		
GI	GALILA	WONJI	1974 NOV 02	0810	19.7	20 G	6263.272	6263.266		
GJ	GALILA	WONJI	1974 NOV 02	0825	20.5	14 R	6263.269	6263.263	6263.265	.002
FO	THORNS	WONJI	1974 NOV 01	0850	20.9	17 M	2804.589	2804.586		
FP	THORNS	WONJI	1974 NOV 01	0905	21.1	8 P	2804.586	2804.583		
FQ	THORNS	WONJI	1974 NOV 01	0917	21.9	2 M	2804.596	2804.593	2804.588	.005
FK	YELLEM	KOKA	1974 OCT 31	1128	25.4	19 R	2871.883	2871.883		
FL	YELLEM	KOKA	1974 OCT 31	1145	25.2	4 P	2871.887	2871.888		
FM	YELLEM	KOKA	1974 OCT 31	1200	25.5	16 R	2871.879	2871.879	2871.884	.005

Code	Geodimeter Sta.	Retroreflector Sta.	Date	Time	Temp.	Spread	Corrected D	Final D	Line Average	
FN	YELLEM	KOKA AUX A	1974 OCT 31	1220	25.9	13 P	2878.464	2878.465	2878.465	0.000
FU	THORNS	KOKA	1974 NOV 01	1125	25.7	44 M	4444.663	4444.664		
FV	THORNS	KOKA	1974 NOV 01	1140	25.7	2 P	4444.673	4444.675 *		
FW	THORNS	KOKA	1974 NOV 01	1155	25.7	24 M	4444.660	4444.662		
FX	THORNS	KOKA	1974 NOV 01	1210	25.9	15 P	4444.660	4444.662	4444.668 .663	.006 .001
FH	YELLEM	GALILA	1974 OCT 31	1015	23.6	15 P	2248.297	2248.296		
FI	YELLEM	GALILA	1974 OCT 31	1030	23.6	6 R	2248.300	2248.299		
FJ	YELLEM	GALILA	1974 OCT 31	1045	23.9	6 P	2248.295	2248.295	2248.297	.002
FY	THORNS	GALILA	1974 NOV 01	1250	27.0	17 M	4608.478	4608.481		
FZ	THORNS	GALILA	1974 NOV 01	1305	27.4	4 P	4608.480	4608.484		
GA	THORNS	GALILA	1974 NOV 01	1315	27.2	10 M	4608.479	4608.483	4608.483	.002
CY	TABLE	AYGU	1974 OCT 28	0815	21.7	15 M	7678.139	7678.128		
CZ	TABLE	AYGU	1974 OCT 28	0830	21.9	11 G	7678.137	7678.127		
DA	TABLE	AYGU	1974 OCT 28	0840	22.9	9 M	7678.141	7678.133		
DB	TABLE	AYGU	1974 OCT 28	0850	23.0	10 G	7678.142	7678.135		
FC	AYGU	TABLE	1974 OCT 30	1655	25.7	4 G	7678.140	7678.143		
FD	AYGU	TABLE	1974 OCT 30	1700	25.5	12 P	7678.134	7678.137		
FE	AYGU	TABLE	1974 OCT 30	1712	25.4	18 G	7678.134	7678.137		
FF	AYGU	TABLE	1974 OCT 30	1725	24.9	14 P	7678.131	7678.134	7678.135	.005
DC	TABLE	AYGU AUX A	1974 OCT 28	0905	23.1	11 M	7678.815	7678.807		
DD	TABLE	AYGU AUX A	1974 OCT 28	0920	23.1	15 G	7678.805	7678.800		
DE	TABLE	AYGU AUX A	1974 OCT 28	0930	23.4	7 M	7678.801	7678.796		
DF	TABLE	AYGU AUX A	1974 OCT 28	0945	23.9	8 G	7678.808	7678.804	7678.802	.005
FG	AYGU	TABLE AUX A	1974 OCT 30	1745	24.2	10 G	7679.563	7679.565	7679.565	0.000
DG	TABLE	MERKO	1974 OCT 28	1120	25.1	9 M	6858.874	6858.875		
DH	TABLE	MERKO	1974 OCT 28	1135	25.4	22 M	6858.873	6858.876		
DI	TABLE	MERKO	1974 OCT 28	1145	25.4	21 M	6858.872	6858.876		
DJ	TABLE	MERKO	1974 OCT 28	1200	25.5	17 G	6858.865	6858.869		
HQ	MERKO	TABLE	1974 NOV 04	1115	23.1	28 G	6858.871	6858.872		
HR	MERKO	TABLE	1974 NOV 04	1135	23.4	36 R	6858.881	6858.883 *		
HS	MERKO	TABLE	1974 NOV 04	1155	23.4	13 G	6858.874	6858.877	6858.875	.004 .003
DK	TABLE	MERKO AUX A	1974 OCT 28	1235	26.1	5 M	6854.807	6854.813	6854.813	0.000
ES	RABBIT	TABLE	1974 OCT 30	1050	23.2	4 R	9418.289	9418.289		
ET	RABBIT	TABLE	1974 OCT 30	1100	22.9	19 M	9418.282	9418.282		
EU	RABBIT	TABLE	1974 OCT 30	1115	23.4	21 R	9418.286	9418.287		
EV	RABBIT	TABLE	1974 OCT 30	1130	23.9	14 M	9418.285	9418.287		
HY	TABLE	RABBIT	1974 NOV 04	1835	20.9	10 P	9418.277	9418.287		
HZ	TABLE	RABBIT	1974 NOV 04	1840	20.5	3 M	9418.276	9418.286	9418.287	.002
EW	RABBIT	TABLE AUX A	1974 OCT 30	1145	23.9	21 R	9417.802	9417.805	9417.805	0.000
HT	TABLE	TCHEESA	1974 NOV 04	1615	24.7	5 M	7767.132	7767.139		
HU	TABLE	TCHEESA	1974 NOV 04	1625	24.5	56 P	7767.147	7767.154 *		
HV	TABLE	TCHEESA	1974 NOV 04	1637	24.4	7 M	7767.128	7767.135		
HW	TABLE	TCHEESA	1974 NOV 04	1650	24.2	7 P	7767.125	7767.132	7767.136	.010 .004
HX	TABLE	TCHEESA AUX A	1974 NOV 04	1700	23.9	3 M	7768.822	7768.828	7768.828	0.000
DL	MERKO	AYGU	1974 OCT 28	1530	26.4	7 P	7829.053	7829.060		
DM	MERKO	AYGU	1974 OCT 28	1555	26.0	9 R	7829.048	7829.053		
DN	MERKO	AYGU	1974 OCT 28	1615	25.6	10 P	7829.051	7829.056		
EX	AYGU	MERKO	1974 OCT 30	1450	26.9	6 P	7829.051	7829.060		
EY	AYGU	MERKO	1974 OCT 30	1510	26.6	17 G	7829.052	7829.061		
EZ	AYGU	MERKO	1974 OCT 30	1525	26.4	24 P	7829.053	7829.060		
FA	AYGU	MERKO	1974 OCT 30	1530	26.4	8 G	7829.052	7829.059	7829.058	.003
FB	AYGU	MERKO AUX A	1974 OCT 30	1550	26.3	12 P	7823.417	7823.424	7823.424	0.000
DO	MERKO	AYGU AUX A	1974 OCT 28	1640	25.0	10 R	7827.332	7827.335	7827.335	0.000
EN	RABBIT	AYGU	1974 OCT 30	0835	21.0	18 R	7220.526	7220.519		
EP	RABBIT	AYGU	1974 OCT 30	0910	21.5	5 M	7220.514	7220.510		
EQ	RABBIT	AYGU	1974 OCT 30	0920	21.9	16 R	7220.517	7220.513		
ER	RABBIT	AYGU	1974 OCT 30	0935	22.1	13 M	7220.514	7220.511	7220.513	.004
EO	RABBIT	AYGU AUX A	1974 OCT 30	0855	21.0	18 M	7223.274	7223.269	7223.269	0.000

Code	Geodimeter Sta.	Retroreflector Sta.	Date	Time	Temp.	Spread	Corrected D	Final D	Line Average	
DP	MERKO	RABBIT	1974 OCT 28	1815	22.4	6 R	13687.808	13687.821		
DQ	MERKO	RABBIT	1974 OCT 28	1835	22.2	5 P	13687.803	13687.817		
DR	MERKO	RABBIT	1974 OCT 28	1850	22.1	9 R	13687.799	13687.814		
HM	MERKO	RABBIT	1974 NOV 04	0825	18.1	24 R	13687.835	13687.816		
HN	MERKO	RABBIT	1974 NOV 04	0850	18.6	4 G	13687.834	13687.819		
HO	MERKO	RABBIT	1974 NOV 04	0910	19.0	16 R	13687.828	13687.817		
HP	MERKO	RABBIT	1974 NOV 04	0930	19.5	5 G	13687.826	13687.818	13687.818	.002
DS	MERKO	RABBIT AUX A	1974 OCT 28	1900	22.0	21 P	13690.647	13690.662	13690.662	0.000
JM	MERKO	TCHEESA	1974 NOV 08	0805	19.1	21 M	11475.937	11475.922		
JN	MERKO	TCHEESA	1974 NOV 08	0820	19.3	28 G	11475.935	11475.921		
JO	MERKO	TCHEESA	1974 NOV 08	0830	19.4	19 M	11475.936	11475.923		
JP	MERKO	TCHEESA	1974 NOV 08	0843	19.3	14 G	11475.930	11475.919	11475.921	.002
JQ	MERKO	TCHEESA AUX A	1974 NOV 08	0855	19.7	9 M	11478.379	11478.368	11478.368	0.000
LS	HOTEL	TERMITE	1974 NOV 12	1525	26.6	3 P	1022.585	1022.587		
LT	HOTEL	TERMITE	1974 NOV 12	1537	26.4	18 R	1022.583	1022.585		
LU	HOTEL	TERMITE	1974 NOV 12	1548	26.4	12 P	1022.585	1022.586	1022.586	.001
KS	GALLA	HOTEL	1974 NOV 11	0728	16.8	16 P	764.048	764.047		
KT	GALLA	HOTEL	1974 NOV 11	0741	16.6	3 R	764.048	764.046		
KU	GALLA	HOTEL	1974 NOV 11	0755	17.0	29 P	764.042	764.041		
OQ	GALLA	HOTEL	1974 NOV 17	1525	27.0	11 M	764.050	764.051		
OR	GALLA	HOTEL	1974 NOV 17	1535	27.1	11 R	764.039	764.040		
OS	GALLA	HOTEL	1974 NOV 17	1545	27.0	10 M	764.044	764.045	764.045	.004
LG	EUPHORBIA	HOTEL	1974 NOV 12	0805	16.2	15 G	3517.926	3517.920		
LH	EUPHORBIA	HOTEL	1974 NOV 12	0815	16.6	7 M	3517.927	3517.922		
LI	EUPHORBIA	HOTEL	1974 NOV 12	0825	17.2	7 G	3517.921	3517.916	3517.919	.003
LV	HOTEL	LANGANA	1974 NOV 12	1625	25.8	17 R	3394.040	3394.043		
LW	HOTEL	LANGANA	1974 NOV 12	1637	25.5	8 P	3394.046	3394.049		
LX	HOTEL	LANGANA	1974 NOV 12	1647	25.0	11 R	3394.047	3394.050		
NF	LANGANA	HOTEL	1974 NOV 14	1530	25.8	24 R	3394.040	3394.043		
NG	LANGANA	HOTEL	1974 NOV 14	1550	25.9	8 M	3394.045	3394.048		
NH	LANGANA	HOTEL	1974 NOV 14	1600	25.6	11 R	3394.042	3394.045	3394.047	.003
LY	HOTEL	ARJO	1974 NOV 12	1720	23.5	30 P	8150.994	8151.003		
LZ	HOTEL	ARJO	1974 NOV 12	1732	22.9	18 R	8150.997	8151.005		
MA	HOTEL	ARJO	1974 NOV 12	1745	22.3	27 P	8150.993	8151.000	8151.003	.003
KV	GALLA	TERMITE	1974 NOV 11	0834	18.3	18 R	746.042	746.040		
KW	GALLA	TERMITE	1974 NOV 11	0845	18.7	24 P	746.041	746.040		
KX	GALLA	TERMITE	1974 NOV 11	0905	19.5	11 R	746.037	746.036		
OT	GALLA	TERMITE	1974 NOV 17	1612	26.9	7 R	746.035	746.036		
OU	GALLA	TERMITE	1974 NOV 17	1625	26.9	29 M	746.038	746.040		
OV	GALLA	TERMITE	1974 NOV 17	1635	26.8	20 R	746.018	746.019 *	746.035 .037	.008 .002
LJ	EUPHORBIA	TERMITE	1974 NOV 12	0900	18.4	8 M	3358.129	3358.125		
LK	EUPHORBIA	TERMITE	1974 NOV 12	0910	19.6	7 G	3358.131	3358.127		
LL	EUPHORBIA	TERMITE	1974 NOV 12	0920	20.1	7 M	3358.132	3358.128	3358.127	.002
NI	LANGANA	TERMITE	1974 NOV 14	1630	25.7	12 M	2434.167	2434.171		
NJ	LANGANA	TERMITE	1974 NOV 14	1640	25.5	5 R	2434.160	2434.163		
NK	LANGANA	TERMITE	1974 NOV 14	1650	25.5	5 G	2434.158	2434.161	2434.165	.005
NC	ARJO	TERMITE	1974 NOV 14	1055	22.0	5 M	7257.981	7257.981		
ND	ARJO	TERMITE	1974 NOV 14	1105	22.9	17 P	7257.987	7257.988		
NE	ARJO	TERMITE	1974 NOV 14	1115	23.2	13 M	7257.985	7257.987	7257.985	.004
KY	GALLA	EUPHORBIA	1974 NOV 11	1005	21.3	4 P	2852.137	2852.136		
KZ	GALLA	EUPHORBIA	1974 NOV 11	1020	21.2	7 R	2852.132	2852.130		
LA	GALLA	EUPHORBIA	1974 NOV 11	1031	21.4	29 P	2852.139	2852.139		
LP	EUPHORBIA	GALLA	1974 NOV 12	1130	22.2	9 M	2852.134	2852.135		
LQ	EUPHORBIA	GALLA	1974 NOV 12	1137	22.8	23 G	2852.121	2852.122		
LR	EUPHORBIA	GALLA	1974 NOV 12	1150	23.3	5 M	2852.134	2852.136		
NU	EUPHORBIA	GALLA	1974 NOV 16	0800	18.1	11 P	2852.136	2852.130		
NV	EUPHORBIA	GALLA	1974 NOV 16	0815	18.2	8 R	2852.125	2852.120		
NW	EUPHORBIA	GALLA	1974 NOV 16	0825	18.5	8 P	2852.126	2852.121	2852.130	.007
LC	GALLA	EUPHORBIA AUX A	1974 NOV 11	1105	22.9	17 P	2862.169	2862.169	2862.169	0.000
LB	GALLA	EUPHORBIA AUX B	1974 NOV 11	1050	22.0	7 R	2852.416	2852.416	2852.416	0.000

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Code	Geodimeter Sta.	Retroreflector Sta.	Date	Time	Temp.	Spread	Corrected D	Final D	Line Average	
MZ	ARJO	GALLA	1974 NOV 14	1000	20.9	32 P	7435.820	7435.816		
NA	ARJO	GALLA	1974 NOV 14	1012	21.2	28 M	7435.824	7435.820		
NB	ARJO	GALLA	1974 NOV 14	1020	21.3	33 P	7435.820	7435.817		
OW	GALLA	ARJO	1974 NOV 17	1712	25.9	20 M	7435.804	7435.815		
OX	GALLA	ARJO	1974 NOV 17	1720	25.4	19 R	7435.801	7435.811		
OY	GALLA	ARJO	1974 NOV 17	1731	25.1	21 M	7435.801	7435.811	7435.815	.004
OZ	GALLA	ARJO AUX A	1974 NOV 17	1744	24.5	19 R	7439.584	7439.593	7439.593	0.000
MN	GALLA	OOMAY	1974 NOV 13	1710	25.2	15 G	16716.000	16716.024		
MO	GALLA	OOMAY	1974 NOV 13	1730	24.3	18 R	16715.993	16716.014		
MP	GALLA	OOMAY	1974 NOV 13	1745	23.6	22 G	16715.984	16716.004	16716.015	.010
LM	EUPHORBIA	LANGANA	1974 NOV 12	1012	21.1	10 G	3232.716	3232.715		
LN	EUPHORBIA	LANGANA	1974 NOV 12	1025	21.1	12 M	3232.720	3232.719		
LO	EUPHORBIA	LANGANA	1974 NOV 12	1033	21.1	16 G	3232.714	3232.714		
NL	LANGANA	EUPHORBIA	1974 NOV 14	1730	24.4	7 R	3232.703	3232.706		
NM	LANGANA	EUPHORBIA	1974 NOV 14	1745	23.8	13 M	3232.703	3232.706		
NN	LANGANA	EUPHORBIA	1974 NOV 14	1755	23.1	26 R	3232.698	3232.700 *		
NX	EUPHORBIA	LANGANA	1974 NOV 16	0855	19.9	4 R	3232.717	3232.714		
NY	EUPHORBIA	LANGANA	1974 NOV 16	0915	20.2	9 P	3232.719	3232.716		
NZ	EUPHORBIA	LANGANA	1974 NOV 16	0930	20.2	41 R	3232.722	3232.720	3232.712 .713	.007 .005
OA	EUPHORBIA	LANGANA AUX A	1974 NOV 16	0950	20.4	1 P	3234.444	3234.442	3234.442	0.000
NP	LANGANA	EUPHORBIA AUX A	1974 NOV 14	1820	22.6	12 G	3259.846	3259.849	3259.849	0.000
NO	LANGANA	EUPHORBIA AUX B	1974 NOV 14	1805	22.6	10 R	3232.895	3232.899	3232.899	0.000
MQ	ARJO	EUPHORBIA	1974 NOV 14	0740	15.2	20 M	6206.158	6206.143		
MR	ARJO	EUPHORBIA	1974 NOV 14	0749	15.6	12 P	6206.158	6206.143		
MS	ARJO	EUPHORBIA	1974 NOV 14	0800	16.2	3 M	6206.156	6206.143		
OB	EUPHORBIA	ARJO	1974 NOV 16	1030	22.5	41 R	6206.156	6206.155		
OC	EUPHORBIA	ARJO	1974 NOV 16	1040	22.7	5 P	6206.173	6206.172 *		
OD	EUPHORBIA	ARJO	1974 NOV 16	1050	22.6	12 R	6206.164	6206.163	6206.154 150	.012 009
OE	EUPHORBIA	ARJO AUX A	1974 NOV 16	1108	22.7	6 P	6210.055	6210.056	6210.056	0.000
MU	ARJO	EUPHORBIA AUX A	1974 NOV 14	0823	17.0	9 M	6229.387	6229.376	6229.376	0.000
MT	ARJO	EUPHORBIA AUX B	1974 NOV 14	0808	16.6	10 P	6206.134	6206.122	6206.122	0.000
MK	EUPHORBIA	OOMAY	1974 NOV 13	1520	25.5	19 R	17592.209	17592.240		
ML	EUPHORBIA	OOMAY	1974 NOV 13	1540	25.3	23 G	17592.196	17592.227		
MM	EUPHORBIA	OOMAY	1974 NOV 13	1600	25.2	16 R	17592.196	17592.227	17592.231	.008
MV	ARJO	LANGANA	1974 NOV 14	0904	18.8	14 P	4851.717	4851.713 *		
MW	ARJO	LANGANA	1974 NOV 14	0916	19.5	28 M	4851.709	4851.705		
MX	ARJO	LANGANA	1974 NOV 14	0925	19.5	19 P	4851.720	4851.716 *		
OJ	ARJO	LANGANA	1974 NOV 16	1750	24.0	10 G	4851.692	4851.697		
OK	ARJO	LANGANA	1974 NOV 16	1800	23.5	4 M	4851.691	4851.694		
OL	ARJO	LANGANA	1974 NOV 16	1809	23.3	7 G	4851.695	4851.700		
OM	ARJO	LANGANA	1974 NOV 16	1820	23.1	11 M	4851.692	4851.698	4851.702 .699	.008 .004
MY	ARJO	LANGANA AUX A	1974 NOV 14	0935	19.4	9 M	4850.052	4850.049	4850.049	0.000
OF	ARJO	SHALA	1974 NOV 16	1620	27.6	15 G	3664.321	3664.327		
OG	ARJO	SHALA	1974 NOV 16	1630	26.9	14 M	3664.320	3664.327		
OH	ARJO	SHALA	1974 NOV 16	1642	26.1	11 G	3664.313	3664.319		
OI	ARJO	SHALA	1974 NOV 16	1650	26.0	11 M	3664.318	3664.324	3664.324	.004
ON	SHALA	HARORESA	1974 NOV 17	1035	21.5	10 R	6837.889	6837.888		
OO	SHALA	HARORESA	1974 NOV 17	1050	21.6	2 G	6837.890	6837.890		
OP	SHALA	HARORESA	1974 NOV 17	1100	21.6	11 P	6837.894	6837.894	6837.891	.003
MB	OITU	ALUTU	1974 NOV 13	0912	21.0	7 P	4629.098	4629.096		
MC	OITU	ALUTU	1974 NOV 13	0923	21.2	13 M	4629.102	4629.100		
MD	OITU	ALUTU	1974 NOV 13	0930	21.2	7 P	4629.102	4629.100		
ME	OITU	ALUTU	1974 NOV 13	0943	21.6	5 M	4629.107	4629.106		
MI	OITU	ALUTU	1974 NOV 13	1200	24.8	16 P	4629.098	4629.100		
MJ	OITU	ALUTU	1974 NOV 13	1210	24.9	10 M	4629.104	4629.105	4629.101	.004
MF	OITU	OOMAY	1974 NOV 13	1049	23.6	4 M	5303.667	5303.667		
MG	OITU	OOMAY	1974 NOV 13	1100	23.8	10 P	5303.669	5303.669		
MH	OITU	OOMAY	1974 NOV 13	1115	24.2	16 M	5303.666	5303.666	5303.667	.002
SP	GUMA SE	PARADISO	1974 NOV 30	2225	24.4	11 M	3353.813	3353.817		
SQ	GUMA SE	PARADISO	1974 NOV 30	2230	24.1	4 R	3353.817	3353.821	3353.819	.003

Code	Geodimeter Sta.	Retroreflector Sta.	Date	Time	Temp.	Spread	Corrected D	Final D	Line Average	
SF	GUMA NE	PARADISO	1974 NOV 30	1820	28.5	6 M	4213.613	4213.617		
SG	GUMA NE	PARADISO	1974 NOV 30	1828	28.4	9 G	4213.608	4213.612		
SH	GUMA NE	PARADISO	1974 NOV 30	1835	28.2	9 M	4213.607	4213.611	4213.613	.003
SN	GUMA SE	GUMA W	1974 NOV 30	2130	25.4	24 G	2235.280	2235.283		
SO	GUMA SE	GUMA W	1974 NOV 30	2140	25.2	19 R	2235.277	2235.279	2235.281	.003
SD	GUMA NE	GUMA W	1974 NOV 30	0845	24.2	10 R	3581.182	3581.178		
SE	GUMA NE	GUMA W	1974 NOV 30	0905	24.4	6 G	3581.186	3581.183		
SI	GUMA NE	GUMA W	1974 NOV 30	1920	27.2	20 G	3581.174	3581.178		
SJ	GUMA NE	GUMA W	1974 NOV 30	1935	27.2	7 M	3581.180	3581.184	3581.181	.003
SK	GUMA NE	GUMA SE	1974 NOV 30	2015	26.2	16 M	2206.165	2206.168		
SL	GUMA NE	GUMA SE	1974 NOV 30	2022	26.0	14 G	2206.167	2206.170		
SM	GUMA NE	GUMA SE	1974 NOV 30	2035	25.8	9 M	2206.169	2206.172	2206.170	.002
SU	DOBI XE	DOBI IE	1974 DEC 01	0813	25.5	18 M	2583.046	2583.043		
SV	DOBI XE	DOBI IE	1974 DEC 01	0824	26.0	9 G	2583.031	2583.029		
SW	DOBI XE	DOBI IE	1974 DEC 01	0835	26.4	7 M	2583.040	2583.038	2583.036	.007
SX	DOBI XE	DOBI IW	1974 DEC 01	0906	26.7	25 G	4437.007	4437.003		
SY	DOBI XE	DOBI IW	1974 DEC 01	0916	26.6	9 M	4437.010	4437.006		
SZ	DOBI XE	DOBI IW	1974 DEC 01	0925	26.6	10 G	4437.007	4437.004	4437.005	.002
SR	DOBI XE	DOBI MW	1974 DEC 01	0710	23.0	8 G	7286.441	7286.431		
SS	DOBI XE	DOBI MW	1974 DEC 01	0725	23.2	5 M	7286.447	7286.438		
ST	DOBI XE	DOBI MW	1974 DEC 01	0735	23.6	23 G	7286.446	7286.437		
TA	DOBI XE	DOBI MW	1974 DEC 01	1805	30.7	20 M	7286.430	7286.434		
TB	DOBI XE	DOBI MW	1974 DEC 01	1815	30.4	9 R	7286.432	7286.436	7286.435	.003
TF	DOBI IE	DOBI IW	1974 DEC 01	2020	28.7	17 M	1975.865	1975.867		
TG	DOBI IE	DOBI IW	1974 DEC 01	2035	28.4	18 M	1975.860	1975.862		
TH	DOBI IE	DOBI IW	1974 DEC 01	2045	28.2	11 R	1975.864	1975.865	1975.865	.003
TC	DOBI IE	DOBI MW	1974 DEC 01	1915	29.5	16 G	4723.583	4723.586		
TD	DOBI IE	DOBI MW	1974 DEC 01	1933	29.0	11 R	4723.590	4723.593		
TE	DOBI IE	DOBI MW	1974 DEC 01	1950	28.6	4 M	4723.590	4723.593	4723.591	.004
BO	NZS BASE	NZN BASE	1974 OCT 25	0800	19.6	3 M	111.982	111.982		
BP	NZS BASE	NZN BASE	1974 OCT 25	0810	20.0	13 R	111.986	111.986		
BQ	NZS BASE	NZN BASE	1974 OCT 25	0825	20.4	14 G	111.986	111.986		
BR	NZS BASE	NZN BASE	1974 OCT 25	0835	20.8	14 P	111.979	111.979		
CV	NZS BASE	NZN BASE	1974 OCT 27	0715	18.2	4 R	111.977	111.977		
CW	NZS BASE	NZN BASE	1974 OCT 27	0730	18.6	15 G	111.976	111.976		
CX	NZS BASE	NZN BASE	1974 OCT 27	0750	19.0	13 M	111.976	111.976		
DT	NZS BASE	NZN BASE	1974 OCT 29	0805	19.4	5 G	111.983	111.982		
DU	NZS BASE	NZN BASE	1974 OCT 29	0815	19.4	9 R	111.980	111.980		
DV	NZS BASE	NZN BASE	1974 OCT 29	0820	19.5	4 P	111.984	111.984		
GB	NZS BASE	NZN BASE	1974 NOV 01	1715	24.1	5 P	111.985	111.985		
GC	NZS BASE	NZN BASE	1974 NOV 01	1725	23.9	4 P	111.982	111.982		
GD	NZS BASE	NZN BASE	1974 NOV 01	1740	23.5	11 R	111.984	111.984		
GE	NZS BASE	NZN BASE	1974 NOV 01	1750	23.2	16 R	111.977	111.977		
GF	NZS BASE	NZN BASE	1974 NOV 01	1810	22.9	4 M	111.982	111.982		
GG	NZS BASE	NZN BASE	1974 NOV 01	1820	22.6	15 M	111.974	111.975		
JI	NZS BASE	NZN BASE	1974 NOV 07	1415	24.0	8 R	111.987	111.987		
JJ	NZS BASE	NZN BASE	1974 NOV 07	1430	24.5	7 P	111.984	111.984		
JK	NZS BASE	NZN BASE	1974 NOV 07	1440	25.0	13 R	111.983	111.983		
JL	NZS BASE	NZN BASE	1974 NOV 07	1450	25.4	4 P	111.985	111.985		
PA	NZS BASE	NZN BASE	1974 NOV 18	1628	23.5	4 G	111.986	111.986		
PB	NZS BASE	NZN BASE	1974 NOV 18	1637	23.5	18 P	111.988	111.988		
PC	NZS BASE	NZN BASE	1974 NOV 18	1650	23.5	8 R	111.985	111.985		
PD	NZS BASE	NZN BASE	1974 NOV 18	1658	23.5	7 M	111.985	111.985		
PE	NZS BASE	NZN BASE	1974 NOV 18	1708	23.5	9 G	111.975	111.975		
RZ	NZS BASE	NZN BASE	1974 NOV 25	1137	25.0	3 P	111.978	111.978		
SA	NZS BASE	NZN BASE	1974 NOV 25	1145	25.0	12 R	111.981	111.981		
SB	NZS BASE	NZN BASE	1974 NOV 25	1155	25.0	8 P	111.984	111.985		
SC	NZS BASE	NZN BASE	1974 NOV 25	1205	25.0	15 R	111.981	111.981		
TI	NZS BASE	NZN BASE	1974 DEC 03	1518	23.0	11 M	111.983	111.983		
TJ	NZS BASE	NZN BASE	1974 DEC 03	1527	23.0	4 R	111.986	111.986		
TK	NZS BASE	NZN BASE	1974 DEC 03	1535	23.0	10 M	111.989	111.989		
TL	NZS BASE	NZN BASE	1974 DEC 03	1545	23.0	3 R	111.983	111.983	111.982	.004
LD	MGN BASE	MGS BASE	1974 NOV 11	1553	25.6	1 P	41.847	41.847		
LE	MGN BASE	MGS BASE	1974 NOV 11	1603	25.4	14 G	41.849	41.849		
LF	MGN BASE	MGS BASE	~~1974 NOV 11~~	1615	25.2	~~11 R~~	~~41.850~~	~~41.850~~		
NQ	MGN BASE	MGS BASE	1974 NOV 15	1740	24.9	3 M	41.852	41.852		
NR	MGN BASE	MGS BASE	1974 NOV 15	1750	24.8	3 P	41.848	41.848		
NS	MGN BASE	MGS BASE	1974 NOV 15	1800	24.8	3 G	41.848	41.848		
NT	MGN BASE	MGS BASE	1974 NOV 15	1307	24.7	18 R	41.851	41.851	41.849	.002

APPENDIX H

SHALLA 1976 GEODIMETER OBSERVATIONS

Code	Geodimeter Sta.	Retroreflector Sta.	Date	Time	Temp.	Spread	Corrected D	Final D	Line Average
AH	GEORGE	MARIAM	1976 NOV 07	0820	18.5	13 M	7262.561	7262.556	
AI	GEORGE	MARIAM	1976 NOV 07	0830	19.1	13 M	7262.565	7262.560	
AJ	GEORGE	MARIAM	1976 NOV 07	0845	19.6	9 M	7262.567	7262.563	7262.559 .003
AK	GEORGE	MARIAM AUX A	1976 NOV 07	0900	20.0	15 M	7257.244	7257.240	7257.240 0.000
AL	GEORGE	RIDGE	1976 NOV 07	0955	23.0	29 R	2529.971	2529.971	
AM	GEORGE	RIDGE	1976 NOV 07	1012	23.5	20 R	2529.955	2529.954 *	
AN	GEORGE	RIDGE	1976 NOV 07	1025	24.2	16 R	2529.982	2529.982 *	
CO	RIDGE	GEORGE	1976 NOV 13	0800	18.7	14 M	2529.973	2529.970	
CP	RIDGE	GEORGE	1976 NOV 13	0810	19.1	13 M	2529.978	2529.976	
CQ	RIDGE	GEORGE	1976 NOV 13	0820	19.2	10 M	2529.971	2529.969	2529.971 .009 .972 .003
AO	GEORGE	RIDGE AUX A	1976 NOV 07	1035	24.1	9 R	2540.170	2540.170	2540.170 0.000
CR	RIDGE	GEORGE AUX A	1976 NOV 13	0835	19.3	17 M	2530.731	2530.730	2530.730 0.000
BG	FULCRUM AUX A	RIDGE	1976 NOV 10	0750	17.1	13 M	5335.159	5335.154	
BH	FULCRUM AUX A	RIDGE	1976 NOV 10	0800	17.5	19 M	5335.157	5335.153	
BI	FULCRUM AUX A	RIDGE	1976 NOV 10	0810	17.8	18 M	5335.161	5335.157	5335.155 .002 159 (no GRC)
BJ	FULCRUM AUX A	RIDGE AUX A	1976 NOV 10	0820	18.3	28 M	5341.147	5341.143	5341.143 0.000 .147 (no GRC)
BO	FULCRUM AUX A	FARENJI	1976 NOV 10	1115	22.0	1 R	2358.156	2358.156	
BP	FULCRUM AUX A	FARENJI	1976 NOV 10	1125	22.2	22 R	2358.157	2358.157	
BQ	FULCRUM AUX A	FARENJI	1976 NOV 10	1140	22.3	15 R	2358.153	2358.153	2358.155 .002 (no GRC)
BR	FULCRUM AUX A	FARENJI AUX B	1976 NOV 10	1155	22.1	26 R	2371.718	2371.719	2371.719 0.000 .718 (no GRC)
BK	FULCRUM AUX A	GANTI	1976 NOV 10	0920	19.1	1 R	4773.662	4773.661	
BL	FULCRUM AUX A	GANTI	1976 NOV 10	0935	19.6	32 R	4773.651	4773.650	
BM	FULCRUM AUX A	GANTI	1976 NOV 10	0950	20.1	21 R	4773.660	4773.659	
BN	FULCRUM AUX A	GANTI	1976 NOV 10	1000	20.5	25 R	4773.655	4773.655	4773.658 .005
AT	FULCRUM AUX A	CINDER	1976 NOV 07	1750	23.2	25 R	12089.192	12089.197	
AU	FULCRUM AUX A	CINDER	1976 NOV 07	1805	22.7	32 R	12089.196	12089.201	
AV	FULCRUM AUX A	CINDER	1976 NOV 07	1815	22.7	12 R	12089.195	12089.201	12089.200 .002
CS	FULCRUM AUX A	BOKU	1976 NOV 13	0945	20.3	53 R	6880.096	6880.096	
CT	FULCRUM AUX A	BOKU	1976 NOV 13	1010	21.1	45 R	6880.116	6880.116 *	
CU	FULCRUM AUX A	BOKU	1976 NOV 13	1040	21.6	26 R	6880.094	6880.094	6880.100 .012 .095 .002
CV	FULCRUM AUX A	BOKU AUX A	1976 NOV 13	1120	22.4	84 R	6879.935	6879.935	6879.935 0.000
AP	BOHALLA	CINDER	1976 NOV 07	1550	27.9	1 M	7233.361	7233.366	
AQ	BOHALLA	CINDER	1976 NOV 07	1600	27.6	3 M	7233.361	7233.366	
AR	BOHALLA	CINDER	1976 NOV 07	1610	27.2	13 M	7233.361	7233.366	7233.366 .000
AS	BOHALLA	CINDER AUX A	1976 NOV 07	1625	27.0	15 M	7223.536	7223.541	7223.541 0.000
BA	QUILL	SODERE	1976 NOV 08	1635	25.8	13 R	3856.850	3856.854	
BB	QUILL	SODERE	1976 NOV 08	1650	25.6	18 R	3856.849	3856.853	
BC	QUILL	SODERE	1976 NOV 08	1705	25.5	8 R	3856.846	3856.850	3856.852 .002
AW	QUILL	OOLAGA	1976 NOV 08	1515	28.1	28 R	2357.706	2357.706	
AX	QUILL	OOLAGA	1976 NOV 08	1530	28.0	22 R	2357.709	2357.709	
AY	QUILL	OOLAGA	1976 NOV 08	1545	27.9	13 R	2357.713	2357.714	
AZ	QUILL	OOLAGA	1976 NOV 08	1605	27.1	23 R	2357.700	2357.701	2357.708 .005
BD	OOLAGA	SODERE	1976 NOV 08	1750	26.1	7 M	1581.704	1581.705	
BE	OOLAGA	SODERE	1976 NOV 08	1800	26.0	12 M	1581.705	1581.706	
BF	OOLAGA	SODERE	1976 NOV 08	1810	25.6	10 M	1581.702	1581.703	1581.705 .002
BS	TABLE	~~MENDENO~~ MERKO	1976 NOV 11	0920	18.6	7 M	6858.866	6858.858	
BT	TABLE	~~MENDENO~~ "	1976 NOV 11	0930	18.8	8 M	6858.867	6858.860	
BU	TABLE	~~MENDENO~~ "	1976 NOV 11	0940	19.0	7 M	6858.868	6858.862	6858.860 .002 .867 (no GRC)
BV	TABLE	~~MENDENO~~ AUX A	1976 NOV 11	0955	18.6	6 M	6854.802	6854.798	6854.798 0.000 .802 (no GRC)
BX	TABLE AUX A	~~MENDENO~~ "	1976 NOV 11	1030	19.8	15 M	6861.201	6861.199	6861.199 0.000 .201 (no GRC)
BW	TABLE AUX A	~~MENDENO~~ AUX A	1976 NOV 11	1010	19.4	17 M	6857.132	6857.128	6857.128 0.000 .132 (no GRC)

Code	Geodimeter Sta.	Retroreflector Sta.	Date	Time	Temp.	Spread	Corrected D	Final D	Line Average	
CA	TABLE	TCHEESA	1976 NOV 11	1215	20.1	6 R	7767.127	7767.130		
CB	TABLE	TCHEESA	1976 NOV 11	1230	20.6	15 R	7767.121	7767.125	7767.128	.004
BY	TABLE	TCHEESA AUX A	1976 NOV 11	1150	20.2	25 R	7768.827	7768.829		
BZ	TABLE	TCHEESA AUX A	1976 NOV 11	1205	20.0	11 R	7768.819	7768.822	7768.825	.005
DA	RABBIT	AYGU	1976 NOV 14	0840	19.4	21 M	7220.512	7220.506		
DB	RABBIT	AYGU	1976 NOV 14	0855	19.9	26 M	7220.511	7220.506		
DC	RABBIT	AYGU	1976 NOV 14	0900	20.6	15 M	7220.510	7220.505	7220.506	.001
DF	RABBIT AUX A	AYGU	1976 NOV 14	0945	20.8	7 M	7222.755	7222.754	7222.754	0.000
DG	RABBIT AUX B	AYGU	1976 NOV 14	1005	21.3	44 M	7207.989	7207.989	7207.989	0.000
DD	RABBIT	AYGU AUX A	1976 NOV 14	0915	21.0	9 M	7223.257	7223.255	7223.255	0.000
DE	RABBIT AUX A	AYGU AUX A	1976 NOV 14	0930	20.9	19 M	7225.504	7225.502	7225.502	0.000
DH	RABBIT AUX B	AYGU AUX A	1976 NOV 14	1020	22.1	13 M	7210.723	7210.723	7210.723	0.000
CC	SOGIDO	TCHEESA	1976 NOV 11	1630	22.4	4 M	1985.469	1985.471		
CD	SOGIDO	TCHEESA	1976 NOV 11	1640	22.2	8 M	1985.465	1985.467		
CE	SOGIDO	TCHEESA	1976 NOV 11	1650	21.8	11 M	1985.464	1985.465	1985.468	.003
CF	SOGIDO	TCHEESA AUX A	1976 NOV 11	1700	21.4	4 M	1983.174	1983.176	1983.176	0.000
CG	KUSULU	TCHEESA	1976 NOV 11	1730	20.5	5 M	4965.312	4965.315		
CH	KUSULU	TCHEESA	1976 NOV 11	1745	20.4	17 M	4965.309	4965.312	4965.314	.002
CI	KUSULU	TCHEESA AUX A	1976 NOV 11	1755	20.2	6 M	4963.028	4963.030	4963.030	0.000
CJ	SOGIDO	KUSULU	1976 NOV 12	1705	23.7	6 M	3906.287	3906.293		
CK	SOGIDO	KUSULU	1976 NOV 12	1715	23.6	9 M	3906.289	3906.295		
CL	SOGIDO	KUSULU	1976 NOV 12	1720	23.5	4 M	3906.284	3906.289	3906.292	.003
CM	SOGIDO	KUSULU AUX A	1976 NOV 12	1735	23.1	18 M	3907.409	3907.414		
CN	SOGIDO	KUSULU AUX A	1976 NOV 12	1745	22.7	9 M	3907.412	3907.416	3907.415	.001
EQ	HOTEL	TERMITE	1976 NOV 19	1715	26.2	21 R	1022.575	1022.576		
ER	HOTEL	TERMITE	1976 NOV 19	1725	25.8	5 R	1022.577	1022.577		
ES	HOTEL	TERMITE	1976 NOV 19	1735	25.5	22 R	1022.571	1022.572		
ET	HOTEL	TERMITE	1976 NOV 19	1745	25.0	11 R	1022.569	1022.570	1022.574	.003
DI	GALLA	HOTEL	1976 NOV 17	1505	26.7	6 M	764.047	764.049		
DJ	GALLA	HOTEL	1976 NOV 17	1515	26.9	9 M	764.048	764.049		
DK	GALLA	HOTEL	1976 NOV 17	1525	27.1	17 M	764.045	764.046		
DL	GALLA	HOTEL	1976 NOV 17	1535	27.1	11 M	764.044	764.045	764.047	.002
FA	EUPHORBIA	HOTEL	1976 NOV 21	1535	26.4	16 M	3517.920	3517.925		
FB	EUPHORBIA	HOTEL	1976 NOV 21	1545	26.3	4 M	3517.916	3517.921		
FC	EUPHORBIA	HOTEL	1976 NOV 21	1555	26.5	9 M	3517.919	3517.923	3517.923	.002
FD	EUPHORBIA AUX A	HOTEL	1976 NOV 21	1610	26.8	22 M	3524.757	3524.762	3524.762	0.000
ED	LANGANA	HOTEL	1976 NOV 18	1655	26.4	17 R	3394.036	3394.039		
EE	LANGANA	HOTEL	1976 NOV 18	1705	26.2	15 R	3394.029	3394.032		
EF	LANGANA	HOTEL	1976 NOV 18	1715	26.3	16 R	3394.044	3394.047		
EJ	HOTEL	LANGANA	1976 NOV 19	1520	27.6	18 M	3394.041	3394.044		
EK	HOTEL	LANGANA	1976 NOV 19	1525	27.4	13 M	3394.038	3394.041	3394.041	.006
EL	HOTEL	LANGANA AUX A	1976 NOV 19	1535	27.1	11 M	3396.094	3396.097	3396.097	0.000
EM	HOTEL	ARJO	1976 NOV 19	1605	26.8	23 M	8151.001	8151.010		
EN	HOTEL	ARJO	1976 NOV 19	1615	26.8	12 M	8151.010	8151.019		
EO	HOTEL	ARJO	1976 NOV 19	1620	26.8	11 M	8151.004	8151.014	8151.015	.005
EP	HOTEL	ARJO AUX A	1976 NOV 19	1630	26.4	6 M	8154.758	8154.767	8154.767	0.000
DM	GALLA	TERMITE	1976 NOV 17	1605	27.4	14 M	746.031	746.033		
DN	GALLA	TERMITE	1976 NOV 17	1615	27.6	7 M	746.038	746.039		
DO	GALLA	TERMITE	1976 NOV 17	1620	27.8	12 M	746.032	746.033	746.035	.003

Code	Geodimeter Sta.	Retroreflector Sta.	Date	Time	Temp.	Spread	Corrected D	Final D	Line Average	
FF	EUPHORBIA	TERMITE	1976 NOV 21	1700	26.7	16 M	3358.107	3358.112		
FG	EUPHORBIA	TERMITE	1976 NOV 21	1710	26.7	10 M	3358.105	3358.110		
FH	EUPHORBIA	TERMITE	1976 NOV 21	1715	26.4	17 M	3358.103	3358.107	3358.110	.003
FE	EUPHORBIA AUX A	TERMITE	1976 NOV 21	1645	26.9	51 M	3372.627	3372.633	3372.633	0.000
EG	LANGANA	TERMITE	1976 NOV 18	1740	25.7	5 P	2434.157	2434.159		
EH	LANGANA	TERMITE	1976 NOV 18	1755	25.0	32 R	2434.158	2434.160		
EI	LANGANA	TERMITE	1976 NOV 18	1805	24.6	17 R	2434.158	2434.161	2434.160	.001
EX	ARJO	TERMITE	1976 NOV 20	1720	26.1	9 R	7257.947	7257.957		
EY	ARJO	TERMITE	1976 NOV 20	1730	25.5	10 R	7257.943	7257.952		
EZ	ARJO	TERMITE	1976 NOV 20	1740	25.1	9 R	7257.939	7257.948	7257.952	.005
FI	EUPHORBIA	GALLA	1976 NOV 21	1750	25.1	16 M	2852.120	2852.123		
FJ	EUPHORBIA	GALLA	1976 NOV 21	1800	24.8	6 M	2852.118	2852.121		
FK	EUPHORBIA	GALLA	1976 NOV 21	1805	24.6	14 M	2852.121	2852.125	2852.123	.002
DP	GALLA	ARJO	1976 NOV 17	1705	25.9	26 R	7435.786	7435.797		
DQ	GALLA	ARJO	1976 NOV 17	1715	25.8	20 R	7435.788	7435.797		
DR	GALLA	ARJO	1976 NOV 17	1730	25.8	26 R	7435.788	7435.795		
DS	GALLA	ARJO	1976 NOV 17	1740	25.5	18 R	7435.790	7435.797	7435.797	.001
FR	EUPHORBIA	LANGANA	1976 NOV 22	1600	27.1	18 R	3232.701	3232.705		
FS	EUPHORBIA	LANGANA	1976 NOV 22	1615	27.3	7 R	3232.708	3232.713		
FT	EUPHORBIA	LANGANA	1976 NOV 22	1630	27.2	14 R	3232.703	3232.707	3232.709	.004
FU	EUPHORBIA	LANGANA AUX A	1976 NOV 22	1640	26.6	12 R	3234.425	3234.429	3234.429	0.000
EU	ARJO	EUPHORBIA	1976 NOV 20	1600	27.6	65 R	6206.147	6206.158		
EV	ARJO	EUPHORBIA	1976 NOV 20	1610	27.9	21 R	6206.155	6206.166		
EW	ARJO	EUPHORBIA	1976 NOV 20	1625	27.6	15 R	6206.151	6206.162		
FV	EUPHORBIA	ARJO	1976 NOV 22	1705	26.4	12 R	6206.148	6206.158		
FW	EUPHORBIA	ARJO	1976 NOV 22	1720	26.2	22 R	6206.139	6206.148		
FX	EUPHORBIA	ARJO	1976 NOV 22	1730	25.8	2 R	6206.144	6206.152	6206.157	.007
FY	EUPHORBIA	ARJO AUX A	1976 NOV 22	1745	24.9	6 R	6210.028	6210.035	6210.035	0.000
DZ	LANGANA	ARJO	1976 NOV 18	1545	27.9	15 M	4851.702	4851.709		
EA	LANGANA	ARJO	1976 NOV 18	1555	27.9	18 M	4851.698	4851.704		
EB	LANGANA	ARJO	1976 NOV 18	1605	27.7	17 M	4851.696	4851.703	4851.705	.003
EC	LANGANA	ARJO AUX A	1976 NOV 18	1615	27.1	9 M	4855.292	4855.298	4855.298	0.000
DY	LANGANA AUX A	ARJO	1976 NOV 18	1530	27.5	19 M	4850.033	4850.040	4850.040	0.000
DX	LANGANA AUX A	ARJO AUX A	1976 NOV 18	1520	27.3	4 M	4853.629	4853.636	4853.636	0.000
GH	OITU	ALUTU	1976 NOV 24	1715	23.8	7 M	4629.093	4629.096		
GI	OITU	ALUTU	1976 NOV 24	1720	23.9	13 M	4629.093	4629.095		
GJ	OITU	ALUTU	1976 NOV 24	1730	23.8	17 M	4629.097	4629.099		
GK	OITU	ALUTU	1976 NOV 24	1735	23.8	6 M	4629.095	4629.097	4629.097	.002
GD	OITU	OOMAY	1976 NOV 24	1545	25.7	14 M	5303.650	5303.656		
GE	OITU	OOMAY	1976 NOV 24	1555	25.6	12 M	5303.644	5303.649		
GF	OITU	OOMAY	1976 NOV 24	1605	25.2	17 M	5303.643	5303.648	5303.651	.004
GG	OITU	OOMAY AUX A	1976 NOV 24	1615	25.0	10 M	5312.166	5312.170	5312.170	0.000
GL	CHITU	SHIBIBO	1976 DEC 02	0810	18.4	35 R	5082.017	5082.013		
GM	CHITU	SHIBIBO	1976 DEC 02	0820	18.7	34 R	5082.015	5082.011		
GN	CHITU	SHIBIBO	1976 DEC 02	0840	19.0	22 R	5082.018	5082.015		
GO	CHITU	SHIBIBO	1976 DEC 02	0855	19.2	28 R	5082.020	5082.019	5082.015	.003
GP	CHITU	KORKORSA	1976 DEC 02	1605	25.6	19 M	4403.260	4403.264		
GQ	CHITU	KORKORSA	1976 DEC 02	1615	25.5	16 M	4403.264	4403.268	4403.266	.003
GR	CHITU	KORKORSA AUX A	1976 DEC 02	1630	25.4	3 M	4403.422	4403.427		
GS	CHITU	KORKORSA AUX A	1976 DEC 02	1645	25.2	20 M	4403.415	4403.419		
GT	CHITU	KORKORSA AUX A	1976 DEC 02	1655	25.1	8 M	4403.413	4403.416	4403.421	.006

Code	Geodimeter Sta.	Retroreflector Sta.	Date	Time	Temp.	Spread	Corrected D	Final D	Line Average
AA	NZN BASE	NZS BASE	1976 NOV 06	0840	20.4	33 M	25.572	25.572	
AB	NZN BASE	NZS BASE	1976 NOV 06	0900	20.8	6 R	25.567	25.567	
AC	NZN BASE	NZS BASE	1976 NOV 06	0920	21.2	20 M	25.570	25.570	
AD	NZN BASE	NZS BASE	1976 NOV 06	0936	21.8	32 M	25.558	25.558	
AE	NZN BASE	NZS BASE	1976 NOV 06	2015	19.2	28 R	25.558	25.558	
AF	NZN BASE	NZS BASE	1976 NOV 06	2030	19.2	10 M	25.556	25.557	
AG	NZN BASE	NZS BASE	1976 NOV 06	2040	19.0	18 R	25.561	25.561	
CW	NZN BASE	NZS BASE	1976 NOV 13	2045	21.0	21 M	25.556	25.556	
CX	NZN BASE	NZS BASE	1976 NOV 13	2050	20.0	34 R	25.555	25.555	
CY	NZN BASE	NZS BASE	1976 NOV 13	2100	20.0	8 M	25.566	25.566	
CZ	NZN BASE	NZS BASE	1976 NOV 13	2110	19.0	20 R	25.569	25.569	25.563 .006
DT	MGN BASE	MGS BASE	1976 NOV 18	0850	18.2	2 R	37.183	37.183	
DU	MGN BASE	MGS BASE	1976 NOV 18	0800	18.3	43 M	37.178	37.178	
DV	MGN BASE	MGS BASE	1976 NOV 18	0815	18.8	6 R	37.191	37.191	
DW	MGN BASE	MGS BASE	1976 NOV 18	0825	19.4	7 M	37.184	37.184	
FL	MGN BASE	MGS BASE	1976 NOV 22	0755	18.7	15 R	37.188	37.187	
FM	MGN BASE	MGS BASE	1976 NOV 22	0805	18.8	12 M	37.177	37.177	
FN	MGN BASE	MGS BASE	1976 NOV 22	0815	19.2	8 R	37.181	37.181	
FO	MGN BASE	MGS BASE	1976 NOV 22	0825	19.3	4 M	37.175	37.175	
FP	MGN BASE	MGS BASE	1976 NOV 22	0835	19.7	15 R	37.184	37.184	
FQ	MGN BASE	MGS BASE	1976 NOV 22	0845	20.0	7 M	37.178	37.178	
FZ	MGN BASE	MGS BASE	1976 NOV 23	0745	18.0	6 M	37.186	37.186	
GA	MGN BASE	MGS BASE	1976 NOV 23	0800	18.6	10 R	37.186	37.186	
GB	MGN BASE	MGS BASE	1976 NOV 23	0810	18.7	9 M	37.192	37.192	
GC	MGN BASE	MGS BASE	1976 NOV 23	0815	18.9	12 R	37.183	37.183	37.183 .005