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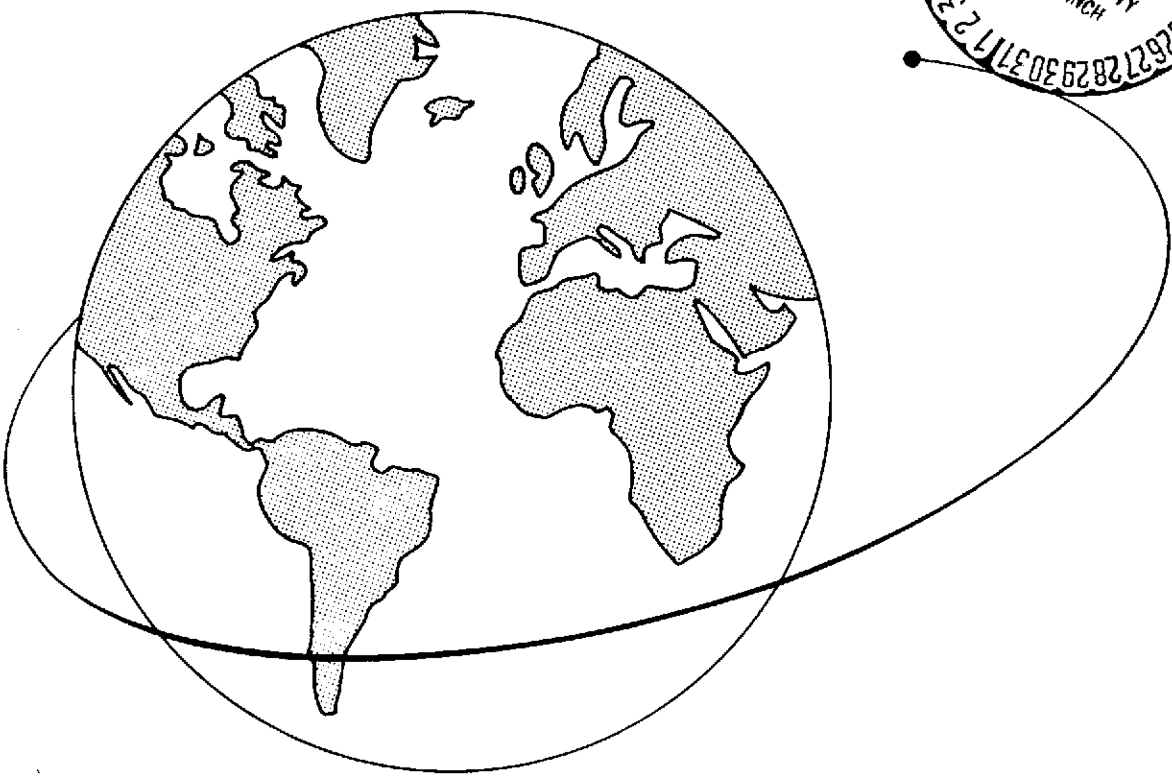
1973 ETHIOPIAN-RIFT GEODIMETER SURVEY

P. A. MOHR



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1973 ETHIOPIAN-RIFT GEODIMETER SURVEY

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ABSTRACT

Remeasurement of the Adama, Lake Langana, and Arba Minch (Lake Margherita) geodimeter networks in 1973 has enabled Mohr's interpretation concerning possible surface ground deformation in the Ethiopian rift to be considerably developed. Extension appears to have occurred across the Mojjo–Adama horst at a rate of about 1 cm yr^{-1}. The opposing rims of the Adama graben have not moved significantly relative to one another (between 1969 and 1973), but stations on the sliced graben floor show possible movement with a large rift-trend component.

In the Wolenchiti quadrilateral, significant movement of station RABBIT is confirmed, but the radical change of vector (that of 1970–1971 to that of 1971–1973) casts doubt on a tectonic cause and seems to indicate that stations on steep hillslopes are liable to be unstable. South of the quadrilateral and east of the Adama graben, alternating rift-trend zones of extension and shortening appear to coexist.

In the Lake Langana network, significant movements of the order of 0.5 cm yr^{-1} are directed perpendicular to the rift-floor faulting. No significant line-length changes have occurred in the Arba Minch network, despite an earthquake there in January 1973.

A modification of the ground-radiation correction, applied to the atmospheric-density correction, has improved the precision of the Ethiopian line-length means to the range ±4.9 to ±6.1 mm. The reference for the Ethiopian lines has been transferred from the 1970 and 1971 surveys to the 1969 survey, as the latter is now shown to be the more accurate.

RESUME

Le remesurage, en 1973, des réseaux géodimétriques d'Adama, du lac Langana et d'Arba Minch (lac Margherita), a permis de développer considérablement l'interprétation de Mohr relative à une déformation possible, en surface, du terrain du fossé éthiopien. Un allongement du horst de Mojjo-Adama semble s'être produit au rythme de 1 cm/an^{-1}. Les bords opposés du graben d'Adama ne se sont pas déplacés de manière significative l'un par rapport à l'autre (entre 1969 et 1973), mais les stations situées sur la partie inférieure fendue du graben révèlent la possibilité d'un déplacement à composante élevée de tendance à la rupture.

Dans le quadrilatère de Wolenchiti, on confirme un déplacement de la station RABBIT, mais le changement radical de vecteur (de celui de 1970-1971 à celui de 1971-1973) soulève des doutes quant à l'origine tectonique et semble indiquer que les stations situées sur des pentes raides risquent d'être instables. Au sud du quadrilatère et à l'est du graben d'Adama, une alternance de zones d'allongement et de raccourcissement à tendance à la rupture semble exister.

Dans le réseau du lac Langana, des déplacements importants de l'ordre de 0,5 cm/an^{-1} se produisent perpendiculairement aux failles de la partie inférieure du fossé. Il ne s'est produit aucun changement important de la longueur de la ligne dans le réseau d'Arba Minch, en dépit du tremblement de terre de janvier 1973.

Une modification de la correction des radiations au sol appliquée à la correction de la densité atmosphérique a amélioré la précision des moyennes de longueur de ligne de $\pm$ 4,9 à $\pm$ 6,1 mm. On a reporté la référence relative aux lignes éthiopiennes des études de 1970 et 1971 à celle de 1969, car cette dernière est maintenant tenue pour plus exacte.

КОНСПЕКТ

Переизмерения сетей геодиметра в Адана, озере Лангана, и Арба Минч (озере Маргерита) проведенные в 1973 году позволили значительно развить интерпретацию Мора касающуюся деформации поверхностного грунта в эфиопской трещине. Похоже что развитие произошло поперек гребня Можжо-Адана, со скоростью около 1 см в год. Противоположные края грабена Адана не перевинулись значительно по отношению друг к другу (между 1969 и 1973 г), но станции на срезаном полу грабена указывают на возможное движение с большим компонентом тенденции кливажа.

Подтверждается значительное движение станции РАББИТ, в четерехугольнике Уоленчити, но основное изменение (1970-1971 г по сравнению с 1971-1973 г) вызывает сомнения о тектонической причине и похоже что указывает на то что станции на крутых склонах холмов могут быть неустойчивыми. Похоже что на юге четерехугольника и на востоке грабена Адана сосуществуют перемежающиеся зоны растяжения и сжатия тенденции кливажа.

В сети озера Лангана, значительные движения порядка 0,5 см год$^{-1}$ направлены перпендикулярно к образованию разрывов пола кливажа. Не произошло значительных изменений длины линии в сети Арба Минч, несмотря на землетрясение произошедшее там в январе 1973 г.

Изменение поправки на земное излучение применяемое к поправке на атмосферную плотность улучшило точность средних измерений длин эфиопских линий в пределах от $\pm$ 4,9 до 6,1 мм. Ориентир для эфиопских линий был передвинут со съемок 1970 и 1971 г на съемки 1969 г поскольку последний показался сейчас более точным.

1973 ETHIOPIAN-RIFT GEODIMETER SURVEY

P. A. Mohr

1. INTRODUCTION

A resurvey of the Ethiopian-rift geodimeter networks (Mohr, 1973a) was undertaken during March to May 1973. Previous surveys had been made in the late months of 1969, 1970, and 1971. Although the choice of March to May was necessitated by financial considerations, it was also of interest to see how the instrumental distance values would be affected by the higher ambient temperatures in the rift valley during the latter part of the dry season.

Particular attention was appropriate for the Wolenchiti quadrilateral, the site of significant movements between 1970 and 1971, and for the Arba Minch (Lake Margherita) network, where an earthquake was felt on 7 January 1973. (The epicentral determination by the National Oceanic and Atmospheric Administration places the origin of this 4.9-magnitude earthquake at 5.3° N, 36.8° E, 110 km southwest of Arba Minch.)

Participants in the 1973 survey were J. Wohn, who led the second half of the survey, J. Rolff, C. Heindel, R. Thrall, Ato Girum Mikru, and the author. The instruments used were Smithsonian Astrophysical Observatory's (SAO) Mk8 geodimeter (no. 81006) and a Ranger III (no. 07B 3042) loaned from Laser Systems & Electronics Inc., Tullahoma, Tennessee. It was originally intended to work the two instruments together, but problems with both made this impossible.

The survey has been designated Project AWARRA, after the Amharic word for dust. During the project, unseemly quantities of this substance were in motion between the surface of the lithosphere and the lower levels of the troposphere, with finite residence time on the project participants.

This work was supported in part by grant NGR 09-015-002 from the National Aeronautics and Space Administration.

2. PROGRAM

In the unplanned absence of the geodimeter, which was undergoing major overhaul at the AGA Corp., Secaucus, New Jersey, the survey was begun with the Ranger. The Ranger proved to have a maximum operating range of about 7.5 km in good atmospheric conditions: Unfortunately, the exceptional amount of wind-blown dust in the rift valley during early 1973 rendered these conditions generally mediocre. Later seasons of the year, following the "kremt" big rains, provide superior weather, at least in the northern part of the rift adjacent to Afar.

The Ranger was first used on the shorter lines of the Adama (Nazret) network, east of Addis Ababa. During the first week, 85 line measurements were made. Each measurement was the average of about 20 digital-output repeats and took only a few minutes. Work was thus much faster with the Ranger than with the geodimeter, and the limiting time factor proved to be the equilibration time for the thermometers and barometers. However, the automatic readout of the Ranger makes the analysis of any aberrant reading more difficult, so the gain in speed is not without cost for extremely precise work. At the beginning of the eighth day, the laser plasma tube failed and the Ranger had to be returned to the suppliers.

Fortunately, the geodimeter arrived in Addis Ababa a few days later. Although the repairs effected on this instrument left something to be desired, resulting in operating difficulties and poorer internal consistency, 194 line measurements, covering the Wolenchiti quadrilateral and the Lakes Langana and Margherita networks, were made during the remainder of the Project. Measuring conditions were good at Lake Margherita but were impaired at Lake Langana by lake-level cloud.

Owing to the instrumental problems and the resulting loss of time, fewer lines were repeat-measured on different days than had originally been planned. Repeat measurement of Ranger lines by the geodimeter was restricted to four lines. Only three new stations were established (Figure 1): BORI and BABOON, on the fresh fault

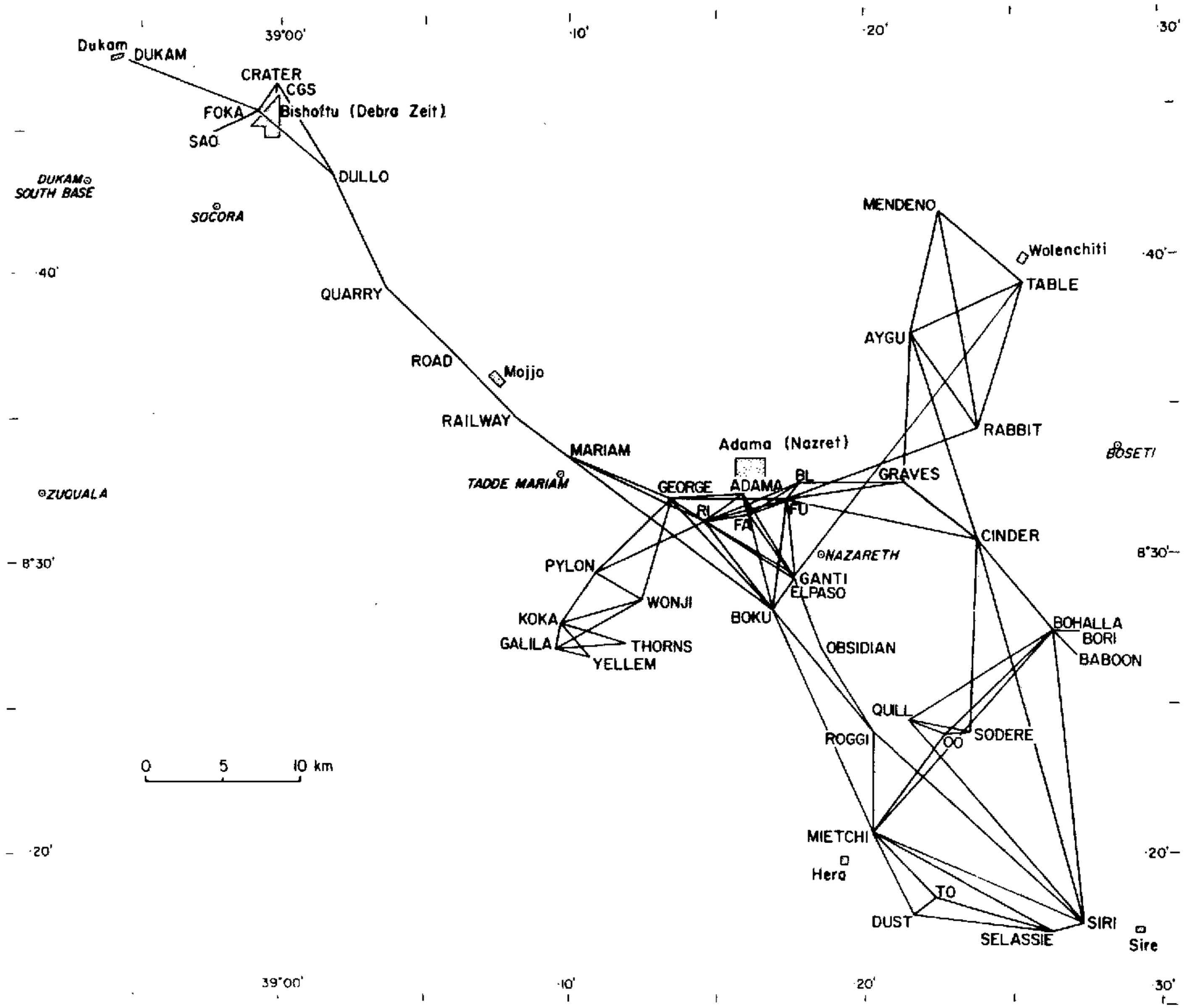

Figure 1. The 1973 Ethiopian geodimeter network at 8° to 9° N.

scarp south of Bofa (Mohr, 1973a, Figure 22) and east of station BOHALLA; and BLOSSOM, established 1.5 km north of FULCRUM owing to the impending destruction of the latter by building operations. Additional auxiliary points were installed at a number of stations because of attempted defacing of station markers.

By the end of the survey, oven cycling interfered with the nulling of the geodimeter to such an extent that the instrument was sent to AGA in Lidingö, Sweden, for repairs; in addition, the instrument required recalibration owing to discrepancies in measured distances between it and the Ranger (see Section 3.2).

Specimens of volcanic rocks from the Addis Ababa–Adama–Sire rift traverse were collected, and a selected suite was subjected to radiometric dating by the potassium-argon method. The results, and interpretation of these new ages, are presented in Appendix A.

3. REDUCTION OF DATA

Analysis of the Ethiopian geodetic data by Rolff has revealed that an incomplete tripod-height correction had been applied by Mohr (1973a). Furthermore, application of the 1969 triangulation data of M. Kazakopoulos (supplied through the courtesy of Professor G. Veis) has led to the revision of station elevations (Appendix B), which also affects the tripod-height correction. This revision, together with a reevaluation of the ground-radiation correction (GRC) discussed below and with the revision of some line mean temperatures, has necessitated the recomputation of all the Ethiopian-rift geodetic data, presented in Appendices C through G.

3.1 Ground-Radiation Correction, and Precision

3.1.1 Introduction

Replicate line measurements for 78 geodimeter lines yielded a precision of ±4.8 mm. For 73 Ranger lines, each measured 20 times, the precision was ±6.8 mm, but this value is improved to ±5.7 mm when the two most aberrant of the 20 readings are omitted.

The rapidly produced Ranger measurements enabled phenomena to be observed that warrant further investigation. Steady drift in the apparent distances can be related either to passage through the line of atmospheric "blobs" or to instrumental drift; the drift was usually unidirectional but was sometimes observed to reverse. Single erratic readings, differing from the preceding and following ones by as much as 20 mm, can be related only to instrumental quirks. Thus, two distances are presented for each Ranger line in Appendix F, the second ones omitting the two most aberrant readings. Because of the large number of readings (about 20), the line mean is rarely changed by more than 1 mm as a result of this omission.

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Aberrant distances resulted with both the geodimeter and the Ranger if insufficient warm-up time was allowed: This problem was particularly evident during 1970 Project LASER8 (Mohr, 1973a). Hofmann (1968) allowed a warm-up time of 60 min during his California surveys, but 10 min has usually had to suffice in Ethiopia.

During the initial computation of the 1973 distances, it was found that application of the GRC derived by Mohr (1973a) worsened the majority of line standard deviations. This was emphasized in situations where the only lines considered were those that had been repeat-measured on more than 1 day and at different times of the day. This led to a reevaluation of the GRC.

The GRC is intended to correct for differences between the mean air temperature along a line path and the mean air temperature measured 2 m above the ground at the two ends of a line. The first is the quantity desired; the second is the one obtained in practice. Mohr (1973a) derived a GRC, based on work in the Santa Rita Mountains of Arizona (Project APACHE), whereby a cubic best-fit correction was directly related to the time of day of measurement. He noted that the APACHE GRC applied with varying degrees of success to the previous Ethiopian surveys – excellently for 1970 LASER8, fairly well for 1969 GEODIS (after modification of the nighttime section of the GRC curve), and without significant improvement for 1971 PAPAYA. Now, for 1973 AWARRA, the precision is worsened.

For all the 1973 geodimeter lines, the average precision deteriorated from ±4.4 to ±4.8 mm when the GRC was applied. For the nine 1973 Ranger lines measured twice or more on different days, five main–main lines were less precise on application of the GRC, while four main–auxiliary lines showed improved precisions! Unless this is an undesirable coincidence, not unknown to Ethiopian survey work, the fact that a main–auxiliary line is measured immediately after the corresponding main–main line makes it more likely to be free from any thermometer/barometer lag in adjusting to ambient conditions. The speed of Ranger measurements requires a wait for the atmospheric readings to equilibrate after the distance measuring is completed.

Whereas the Arizona-derived GRC applies fairly well in cool-season Ethiopian-rift conditions, it is evident that it is not valid in March to May, when the air is hotter and the diurnal temperature variation is reduced. For lines TABLE–MENDENO, TERMITE–LANGANA, and ARJO–GALLA in particular, the 1973 distances are subject to a radical worsening of precision when the GRC is applied, indicating that the vertical air-temperature gradient is being exaggerated. Stronger winds during the hotter part of the dry season undoubtedly contribute to better mixing of the atmosphere and thus to a reduction of the air-temperature gradient. In the cool season, flowage of cold air from the plateau into the rift valley may steepen air-temperature gradients for certain lines during the early morning and late evening, and then the APACHE GRC is appropriate.

3.1.2 The Wolenchiti quadrilateral

As an example of the importance of the correct application of the GRC to crustal-deformation studies, examination is made of the data for the Wolenchiti quadrilateral. Significant crustal extension during 1970 and 1971 was suggested for this region by Mohr (1973a).

The effect of the GRC is proportional to the length of the line, and in the Wolenchiti quadrilateral, these lengths range between 6.9 and 13.7 km. A comparison of the Wolenchiti line lengths for the years 1970, 1971, and 1973 is presented in Table 1. Data are given first with the APACHE GRC applied and then without this correction. The 1973 data all bear a best-fit increment of +28 mm, as discussed in Section 3.2. (Note: For the Wolenchiti quadrilateral considered alone, an increment of +32 mm is required to produce a best fit for the 1971 and 1973 values without GRC.)

The data of Table 1 show that interpretation of line-length changes must be significantly governed by GRC considerations. Note, for example, the opposing behavior between 1970 and 1971 of line AYGU–MENDENO according to whether the GRC is applied or not. Between 1970 and 1971, line lengths increase, with or without GRC, for lines TABLE–RABBIT and MENDENO–RABBIT, but the magnitude of the latter is doubled on application of the GRC.

Table 1. Wolenchiti quadrilateral: Effect of APACHE GRC on apparent line-length means, in meters; standard deviations, in millimeters, are given in parentheses. Station abbreviations are listed in Appendix B. The suffixed letters refer to the time of measurements: a, morning; m, midday; p, afternoon and evening.

Line	1970	1971	1973 (+28 mm)
		With GRC	
TA–AY	7678.141 (7) a, m	.141 (4) a, m	.146 (9) p
TA–ME	6858.862 (5) a, m	.868 (6) a, p	.866 (11) a, p
TA–RA	9418.265 (5) a, a	.284 (1) a	.285 (8) a, m
AY–ME	7829.049 (8) a, a	.061 (3) p	.063 (5) p
AY–RA	7220.497 (8) a, m	.515 (7) p	.481 (7) a
ME–RA	13687.803 (0) m	.828 (5) p	.824 (3) p
		Without GRC	
TA–AY	7678.150 (17)	.141 (6)	.134 (9)
TA–ME	6858.864 (12)	.858 (11)	.865 (5)
TA–RA	9418.267 (7)	.287 (1)	.283 (8)
AY–ME	7829.057 (10)	.049 (2)	.048 (9)
AY–RA	7220.500 (10)	.502 (7)	.494 (6)
ME–RA	13687.791 (0)	.803 (5)	.799 (4)

Since the GRC depends on the time of day, the data of Table 1 can be examined to see how the apparent line-length changes relate to the time of measurement. Line AYGU–RABBIT shows a dramatic apparent reversal, from extension to contraction, through 1970, 1971, and 1973 according to the values derived with GRC, but no significant length changes occur according to those without GRC. The 1971 measurements of this line were made during the evening, while those in 1970 and 1973 were conducted during the morning and at midday. Assuming no ground deformation, the GRC seems to be overcompensating: The morning lines are shortened too much, and the evening lines lengthened too much. Again, if it is assumed that no ground deformation occurs, GRC overcompensation is indicated for lines AYGU–MENDENO 1970 and TABLE–AYGU 1973 – in both cases, precisely in accordance with the time of day. Furthermore, in both these cases, line-length constancy is obtained by a partial application of GRC, not by its elimination.

No manipulating of the GRC can eliminate apparent line-length changes for two of the three lines involving station RABBIT; for the third line, elimination can be performed only by the complete omission of the GRC. However, for the lines connecting the other three stations of the Wolenchiti quadrilateral, where there is no field evidence for significant ground deformation (Mohr and Rolff, 1971), the opportunity is offered for modifying the GRC application.

3.1.3 Modification of the GRC

It is evident that what is required for increasing line-length precision in Ethiopian-rift geodetic surveys is a more sensitive application of the GRC. To abolish it altogether would be quite unrealistic in view of the improvement of the 1969 and 1970 (Table 1) line-mean standard deviations effected by it. As will be shown below, the 1971 and 1973 standard deviations also can be improved by application of a modified GRC.

Mohr (1973a, p. 41) suspected that lines involving stations (such as FULCRUM) exposed to the prevailing northeasterly winds bear the APACHE GRC less well than do lines involving more sheltered stations. This is clearly revealed in the results of 1971 Project PAPAYA, where the standard deviations for FULCRUM lines are greatly increased by application of the GRC. It therefore seems that two additional factors need to be incorporated into the GRC: 1) a station factor that distinguishes exposed from less exposed stations, and 2) a wind-speed factor based on a reduction of the vertical air-temperature gradient with increasing wind. The requirement of a station factor in addition to a wind-speed factor is indicated by the results for lines involving hilltop stations, such as FULCRUM, measured in calm weather.

Station factors have been ascribed according to the topographical situation of each station and to the observed effect of the GRC for lines involving that station. As yet, not every station has a sufficient number of morning, midday, and afternoon/evening line measurements for a factor to be properly evaluated, and the evolving of a fine spectrum of station factors must await further fieldwork. For the present, stations are placed in one of three empirically derived categories to which factors of 1.0, 0.5, or 0.25 are currently ascribed (Appendix B). Thus, for any given line, the appropriate APACHE GRC is multiplied by the mean of the factors of the two stations involved.

A wind-speed factor has been devised, largely from the observations of Mohr (1973a, Figure 11) on the variation of air temperature with wind speed for a relatively sheltered and well-insolated site. The factor varies from 1.0 at a wind speed of 0 kph to 0.0 at a wind speed of 60 kph, according to the following empirically derived curve:

$$WF = 0.000013w^3 - 0.00114w^2 + 0.005w + 1.0 \quad ,$$

where WF is the wind-speed factor, and w is the wind speed in kph. The wind-speed factor is applied directly to the APACHE GRC.

Application of the station factor and the wind-speed factor is seen to reduce the APACHE GRC. Unfortunately, wind speeds were not recorded during the 1969 and 1970 seasons, and a general correction for 15-kph wind (WF = 0.87) has been made. The writer's diaries suggest that, except for notoriously wind-buffeted stations such as MARIAM, BOKU, and FULCRUM, winds were lighter during 1969 and 1970 than in 1971 and 1973, and thus, in general, a larger GRC is appropriate.

The effect of a modified GRC on the standard deviation about line means is compared in Table 2 with standard deviations from application of APACHE GRC and no GRC. For 1969 Project GEODIS, the improvement in the standard deviations resulting from the modification is gratifying. The application of the full APACHE GRC for 1970 Project LASER8 is such a radical improvement that any mitigation of this correction can only be expected to worsen the standard deviations, but in this case, the worsening is acceptably small. For 1971 Project PAPAYA, the modified GRC again improves the standard deviations, dramatically so for some longer lines such as those involving station FULCRUM. Finally, for 1973 Project AWARRA, modification improves the standard deviations for the Ranger lines, but for the geodimeter lines, the best application remains no correction.

Overall, the modified GRC successfully improves the standard deviations for lines repeat-measured during different times of the day (Table 2). The problem now arises of whether to treat each project on its own merits, accepting whatever method will reduce the average standard deviation for the whole project to the lowest possible

Table 2. Line-mean standard deviations: Effect of applying station factor and wind-speed factor to APACHE GRC for lines repeat-measured on different days at different times of the day.

Project	Number of lines	Line-mean standard deviations: Modified GRC (mm)	APACHE GRC (mm)	No GRC (mm)
1969 GEODIS	40	±4.9	±5.2	± 5.8
1970 LASER8	24	±6.0	±5.5	±10.5
1971 PAPAYA	18	±5.0	±7.2	± 7.3
1973 AWARRA geodimeter	6	±5.8	±7.0	± 4.5
1973 AWARRA Ranger	10	±6.1	±6.5	± 6.5

value, or whether to hold fast to a scheme giving the best results for all the projects considered together. The distinction is important, for not only are standard deviations involved, but also line-length means. Admittedly, the influence of the GRC on the latter is significant only for the longer lines, but the nature of the Ethiopian work demands the highest possible precision and consistency.*

Despite the fact that the 1973 survey was made at a different time of year from previous ones, thus warranting different treatment, the writer retains a prejudice for equal treatment. Otherwise, the ultimate result, as moral theologians would immediately recognize, would be the manipulation of each line in each project to suit the "desired" answer. It now seems to the writer that, with the modified GRC, he has gone as far as possible with a general formula to approach the real mean air temperatures of the lines, short of flying monitoring equipment along the lines at the time of measurement.

*The accuracy of the Ethiopian geodimeter lines is not known. Consistency here is taken to mean hitting the same distance values from one year to the next (on a line subject to no crustal movement), regardless of any difference from the accurate values.

Perhaps a mark of the success of the modified GRC has been the identification, in the line-length list, of measurements subject to various factors – such as instrumental vibration in violent winds, sluggish nulling of the geodimeter, operator nulling at incorrect signal strength, hurried measuring (at the approach of storms or the police), suspect errors in the recording of field data, and erroneous temperature or pressure readings. Such factors, noted at the time (except for data-recording errors), can almost all be identified as "sore thumb" distances in the new data lists, while only a few can be recognized from the lists of Mohr (1973a). These distances have accordingly been omitted in obtaining line averages for interproject comparisons. It should be pointed out that the Mk8 geodimeter retains a distinct advantage over direct-readout instruments, such as the Ranger III, in that nulling behavior reveals something of the quality of a measurement, as do the subsequently computed D spreads.

3.2 Instrumental Calibration

Previous work (Mohr, 1973a) showed that the Mk6 geodimeter line measurements in 1969 averaged 16 mm less than the Mk8 geodimeter remeasurements in 1970 and 1971 (there was no measurable discrepancy between the 1970 and the 1971 values). This is very similar to the 18-mm discrepancy reported by Decker, Einarsson, and Mohr (1971) between Mk6 geodimeter (1967) and Mk8 geodimeter (1970) measurements of Icelandic rift-zone lines.

At the start of Project AWARRA, it was expected that no such discrepancy would be observed between the 1973 geodimeter results and those of 1970 and 1971, since the same type of instrument was being employed and the same agents (AGA, New Jersey) were doing the calibration. This expectation proved unfounded to a surprising degree.

Table 3 lists the comparative distance differences for lines measured in 1971 and 1973 (Δd_{71-73}) with the geodimeter. For the 11 lines remeasured in the Adama region, Δd_{71-73} averages 20 mm, but if we exclude those lines with a comment in the Remarks column, the value is actually 28 mm. For the Wolenchiti region, four lines give an average Δd_{71-73} of 28.5 mm; the other two lines are omitted for the reason given in the Remarks column. Thus, an overall distance difference with the geodimeter (Δd_G) of +28 mm can be applied.

Table 3. Comparative distance differences, 1971 to 1973 (geodimeter).

Region	Line	Δd_{71-73} (mm)	Remarks
Adama	RI–AD	17	possible extension
	RI–FA	21	
	BO–AD	32	
	BO–FA	-1	erroneous?
	BO–FUA	6	erroneous?
	OL–MI	20	
	PY–GE	19	possible extension
	PY–RI	-3	possible extension
	PY–WO	34	
	PY–KO	30	
	KO–WO	29	
Wolenchiti	TA–AY	27	
	TA–ME	31	
	TA–RA	28	
	AY–ME	28	
	AY–RA	52	possible shortening
	ME–RA	45	possible shortening
Lake Langana	HO–TE	19	
	HO–GL	6	
	HO–EU	20	
	HO–EUA	29	
	HO–LA	11	
	TE–GL	16	
	TE–EU	7	
	TE–EUA	14	
	TE–LA	25	
	GL–EU	23	
	GL–EUA	21	
	GL–AR	10	
	LA–EU	8	
	LA–EUA	8	
	LA–AR	14	
	AR–EU	17	
	AR–EUA	18	
	OI–AL	6	
	OI–OY	25	
Lake Margherita	BN–BC	13	
	BC–KU	14	
	BC–TS	13	
	BC–TSA	9	
	BP–SH	17	
	BN–SH	19	
	KU–TS	8	

The Δd_{71-73} values for the Lakes Langana and Margherita lines are much lower than they are for the Adama region. For 7 lines in the Lake Margherita network, Δd_G averages 13.3 ± 4 mm, and for 19 in the Lake Langana network, the average is 15.6 ± 6 mm. An average Δd_G for both networks can be taken as +14 mm, notably close to the correction required to bring the 1969 distances into conformity with those of 1970 and 1971.

Two points arise from the 1971 and 1973 comparison. First, the geodimeter constant for instrument 81006 apparently suffered an abrupt change of about 14 mm halfway through Project AWARRA. The change occurred before 18 April, when the survey party had moved to the Lake Langana region. The Adama survey ended on 15 April, but since only new lines were measured on the last 2 days, any change at that time in the geodimeter constant cannot be identified. On 13 April, the following lines were measured in the order given:

Line	Δd_{71-73} (mm)	Δd_{70-73} (mm)	Δd_{69-73} (mm)
ROA–MI		23	25
OL–MI	20		
KO–PY	30		
KO–WO	29		

The indication is that Δd_{71-73} was still +28 mm on 13 April. If the change to a value of 14 mm had occurred between the 13 April and the 14 April measurements, this would reduce but not eradicate the GRAVES–BLOSSOM AUX. A line anomaly resulting from the comparison between geodimeter and Ranger distances in 1973 (see below, Table 5). Only a resurvey of the new lines measured on 14 and 15 April, including the GRAVES–BLOSSOM AUX. A line, can ascertain whether the Δd_G change occurred in the interval 13 to 14 April or 15 to 18 April.

The implied cause for the abrupt Δd_G change from +28 to +14 mm is a frequency change in one or more of the crystals, although the D spreads do not seem to be correspondingly affected (see Mohr, 1973a, p. 16). But the geodimeter was not subject to any exceptional physical treatment that might account for a frequency change. Nor is there evidence of any other implied frequency change, in excess of 3 mm, during Project AWARRA.

Second, the geodimeter constant for instrument 81006 obviously must be in error unless the constants for the instruments used in 1970 and 1971 were each in error by that same amount. The constant for geodimeter 81006 was determined (9 December 1971) by AGA (New Jersey) to be +0.205 m. Since the instrument had undergone several repairs between the original determination and its shipment to Ethiopia in March 1973, the writer requested AGA (Lidingö) to redetermine the constant after the termination of Project AWARRA. The redetermined value (May 1973) was +0.202 m, in agreement for present purposes with the initial value.

The vagaries of the AWARRA geodimeter constant are underlined by the disagreement between the geodimeter and the Ranger distances. Table 4 lists the comparative distance differences for 1971 to 1973 (Ranger); for 36 lines, the average Δd_{71-73} is 9.2 ± 7 mm. The omission of the lines listed in the Remarks column fails to change this figure significantly (owing to a counterbalancing effect between abnormally high and abnormally low values), and thus a Ranger distance-difference correction (Δd_R) of +9 mm is accepted.

The discrepancy of 19 mm between geodimeter and Ranger distances during the first half of Project AWARRA ($\Delta d_G - \Delta d_R = 28 - 9 = 19$ mm) suggests that the geodimeter constant must have jumped by this amount at some time before that period, and then reverted to a more normal value ($\Delta d_G - \Delta d_R = 14 - 9 = 5$ mm) at Lake Langana. This is also indicated from a comparison with previous Ethiopian surveys, where the Ranger results conform better with earlier values from the Adama network.

Four lines were measured with both the geodimeter and the Ranger during Project AWARRA (Table 5). As mentioned above, the original intention was to measure as many lines as possible with both instruments at the same setup, but this was vitiated by malfunctioning. Of the four common lines, line RIDGE–ADAMA shows excellent agreement between the Δd-corrected 1973 geodimeter and Ranger values. These values, however, are significantly greater than a likewise excellent agreement among the 1969, 1970, and 1971 values, and crustal extension of the order of 1 cm may have affected this line during 1972 (see also Tables 3 and 4, lines RIDGE–ADAMA and RIDGE–ADAMA AUX. Á). For line RIDGE–FARENJI, there is fair agreement between the 1973 Δd-corrected geodimeter and Ranger values, and excellent agreement with the three preceding surveys.

Table 4. Comparative distance differences, 1971 to 1973 (Ranger).

Line	1971-1973 (mm)	Remarks
MA–GE	7	
MA–GEA	1	
GE–RI	9	
GEA–RI	5	
GE–AD	6	
RI–AD	-5	possible extension
RI–ADA	-6	possible extension
RI–FA	9	
RI–FAB	20	
RI–EPA	22	
RI–GN	8	
RI–FUA	-3	
RI–FUB	7	
RI–BO	18	possible contraction?
RIA–BO	31	possible contraction?
AD–FA	6	
ADA–FA	-6	
AD–FAB	11	
AD–EPA	18	
AD–GN	7	
FA–EPA	15	
FA–GN	-3	
FA–FUA	-1	dubious 1971 value
FA–BO	9	
BO–EPA	22	dubious 1971 value
BO–GN	6	
FUA–GN	11	
FUA–GR	8	
FUA–GRA	14	
GR–CI	20	possible contraction
GR–CIA	38	possible contraction
BH–CI	4	
BH–CIA	2	
QL–SO	12	
QL–OL	0	
OL–SO	11	

The two remaining lines, both about twice the length of the first two, yield excessively large 1973 geodimeter distances. Line BOKU–FARENJI finds the Ranger value in excellent agreement with the 1970 and 1971 surveys, but the 1973 geodimeter value exceeds them by about 15 mm. Lines involving hilltop station BOKU are relatively steep and subject to correspondingly greater uncertainties in the atmospheric-refraction

Table 5. AWARRA lines common to both geodimeter and Ranger, in meters. The numbers in parentheses are standard deviations about the line means, in millimeters. Suffixed letters indicate the time of measurements: a, morning; m, midday; p, afternoon and evening; n, night.

	AWARRA 1973				
Line	Geodimeter	Ranger	PAPAYA 1971	LASER8 1970	GEODIS 1969
			Before Δd application		
RI–AD	2865.551 (3)	.573 (4)	.568 (5)	.569	.559 (3)
RI–FA	3022.238 (3)	.250 (2)	.259 (4)	.261 (4)	.247 (3)
BO–FA	6066.396 (4)	.393 (9)	.402 (1)	.407 (4)	–
GR–BLA	6514.626 (6)	.615 (4)	–	–	–
			After Δd application		
RI–AD	2865.579 a	.582 a, m, p	.568 a, m, p	.569 m	.572 n
RI–FA	3022.266 a	.259 m, p	.259 a, m, p	.261 p	.260 n
BO–FA	6066.418 p	.402 a	.402 m	.407 a	–
GR–BLA	6514.654 m	.624 p	–	–	–

Note: The applied Δd factors are AWARRA geodimeter = +28 mm, AWARRA Ranger = +9 mm, GEODIS = +13 mm. (The GEODIS factor has been revised; see text.) Here, the mutually consistent PAPAYA and LASER8 surveys are used as reference (Mohr, 1973a), but the validity of this reference is critically examined later.

correction (Mohr, 1973a). Lines BOKU–FULCRUM AUX. A and BOKU–ADAMA were measured with the geodimeter on the same afternoon as BOKU–FARENJI (7 April 1973): BOKU–FULCRUM AUX. A is in excess of previous surveys of this line by 10 to 20 mm; BOKU–ADAMA is more difficult to interpret because of a large difference between the 1970 and 1971 distances. The 1973 geodimeter distance for BOKU–ADAMA approaches the lower limit of significance for that obtained in 1971, but exceeds the well-determined 1970 value by about 40 mm. It could be postulated, therefore, that the atmospheric conditions on 7 April 1973 led to excessive geodimeter distances, an excess that could be accounted for if the line mean temperatures were 3 to 6°C lower than those actually recorded. The writer considers such a temperature error to be unlikely, both because of the strong winds experienced that afternoon and because of its singularity – no such error was encountered during the Ranger or previous geodimeter surveys. It is interesting to note that if a Δd_G value of 14 mm is adopted, instead of 28 mm, then the agreement with all other BOKU–FARENJI determinations becomes good.

GRAVES–BLOSSOM AUX. A is a new line established in 1973, so no comparison can be made with previous years. The geodimeter distance exceeds that of the Ranger by 30 mm if $\Delta d_G = 28$ mm is accepted; as discussed above, however, the change from $\Delta d_G = 28$ mm to $\Delta d_G = 14$ mm could have occurred before this line was measured, in which case the geodimeter distance would exceed that of the Ranger by only about 15 mm. It must be emphasized that no manipulation nor even total omission of the GRC according to the time of day can significantly reduce the differences between geodimeter and Ranger distances for lines BOKU–FARENJI and GRAVES–BLOSSOM AUX. A, let alone bring them into conformity.

It is concluded that the 1973 geodimeter values for lines BOKU–FARENJI and GRAVES–BLOSSOM AUX. A have suffered instrumental quirks and that these do not detract from the general applicability of the Δd_{71-73} average values from both the geodimeter and the Ranger. This is confirmed when average Δd values are obtained from comparison with the 1969 GEODIS distances. Values of Δd are given in Table 6, for the number of common lines stated, for each of the surveys subsequent to 1969 GEODIS. An agreement close to $\Delta d_{7X-69} = 14$ mm is obtained, in which $\Delta d_{73G-71} = 28$ mm and $\Delta d_{73R-71} = 9$ mm fit nicely.

Table 6. Average line-length differences for 1970 and later surveys relative to 1969 GEODIS distances (Adama network) (197X-1969 values in millimeters).

	1970	1971	1973 geodimeter	1973 Ranger
Number of lines	18	21	7	16*
Δd_{7X-69}	13	13	14	15

*Excludes lines involving station MARIAM, where crustal extension has been operative.

Note: 28 mm has been added to the 1973 geodimeter line distances and 9 mm to the 1973 Ranger distances. These increments have, of course, been obtained from comparison with 1971 values, and because Δd_{73-71} and Δd_{73-69} are derived from different sets of remeasured lines, the 2-mm difference revealed in the table is permissible.

Mohr (1973a) obtained Δd_{71-69} and Δd_{70-69} values of +16 mm, and the revision here to +13 mm is due almost entirely to the modification of the GRC. For the 37 common lines, excluding the Wolenchiti quadrilateral where possible extension has occurred, Δd_{71-70} averages +1.6 ± 14 mm, a difference that is not considered significant.

Finally, we can return to the question of which of the Ethiopian surveys is most accurate and should be taken as the reference. Mohr (1973a) preferred, in lieu of additional data, to take the agreement between the 1970 and the 1971 surveys as evidence that the 1969 survey gave distances 16 mm (now, 13 mm) too short. However, the resulting upward revision of the 1969 GEODIS distances exacerbated the differences between the geodimeter-measured and the taped distances of the 1969 baselines (Mohr, 1973a, p. 12). The results of the 1973 survey, both for the second half of the geodimeter work and for the whole of the Ranger work, indicate that indeed the 1969 GEODIS rather than the 1970 and 1971 distances were the more accurate and that the initial survey should be reverted to as the reference for all ensuing surveys. A comparison using geodimeters 81006 and 80058, the latter loaned by the U.S. Geological Survey to Professor R. W. Decker, was conducted in Iceland in July 1973; it confirms the geodimeter constant obtained by AGA (Lidingö) for 81006. The distances given by this geodimeter during the Lake Langana and Lake Margherita surveys of Project AWARRA are offset only 1 mm from the 1969 GEODIS reference, whose validity is thus underlined.

The final distances in this work are obtained as follows: The 1969 line-length means (Appendix C) remain as given. The 1970 and 1971 line-length means (Appendices D and E) require reduction by 13 mm. The 1973 Ranger line-length means (Appendix F) need to be reduced by 4 mm (13 - 9 mm), and the 1973 geodimeter means (Appendix G) increased by 15 mm (28 - 13 mm) for the Adama sector and 1 mm (14 - 13 mm) for the Lakes networks. These final distances are presented in Table 7 for all remeasured lines. It should be noted that although the corrected Δd_{73-69} is 14 and 15 mm for geodimeter and Ranger, respectively (Table 6), Δd_{70-69} and $\Delta d_{71-69} = 13$ mm is retained (and not the average $\Delta d_{7X-69} = 14$ mm). This is because the 1973 distances have been adjusted through a Δd_{73-71} increment, in which there are 22 geodimeter lines common to 1973 and 1971, as against only 7 lines common to 1973 and 1969.

Table 7. Final line-length means, in meters, for all remeasured lines of 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
RY–MA	3929.189 (9)			.217 (15) R
RY–MAA	3937.581 (16)			.599 (6) R
MA–GE	7262.526 (8)		.537 (1)	.539 (3) R
MA–GEA	7259.073 (8)		.082 (2)	.090 (3) R
MAA–GE	7257.195 (7)			.216 (10) R
MAA–GEA	7253.734			.751 (9) R
MA–RI	9759.	.373 (1)	.361 (0)	
GE–RI	2529.956 (13)	.938	.957 (1)	.957 (10) R
GE–RIA	2540.192 (9)		.174	
GEA–RI	2530.718		.723	.727 (4) R
GE–AD	4461.172 (4)	.163	.173 (1)	.176 (4) R
GE–ADA	4470.815		.817 (0)	
GE–FUA	7281.	.176 (1)	.164 (2)	
GE–BO	9430.	.837 (1)	.825 (2)	
RI–AD	2865.559 (3)	.556	.555 (5)	.569 (4) R .566 (3) G
RI–ADA	2874.388		.389 (2)	.404 (2) R
RIA–AD	2878.000			.012 (4) R
RI–FA	3022.247 (3)	.248 (4)	.246 (4)	.246 (2) R .253 (3) G
RIA–FA	3026.071		.074 (2)	
RI–FAB	3011.		.189 (1)	.178 (6) R
RI–EPA	6631.484 (4)	.478	.493 (2)	.480 (5) R
RI–GN	6673.		.484 (3)	.485 (10) R
RI–FU	5339.754 (3)	.754 (5)		
RI–FUA	5335.149	.175 (2)	.151 (5)	.163 (2) R
RI–FUB	5337.		.052 (8)	.054 (2) R
RI–BO	6998.	.198 (11)	.225 (12)	.216 (7) R
RIA–BO	6983.		.083 (3)	.061 (7) R
AD–FA	1400.884 (3)	.881 (2)	.888 (0)	.891 (9) R
ADA–FA	1398.016		.019 (2)	.034 (2) R
AD–FAB	1407.		.481 (4)	.479 (7) R
AD–EPA	6153.615	.598	.610 (4)	.600 (8) R
AD–GN	6100.		.365 (3)	.367 (8) R
AD–BO	7427.	.055 (5)	.107 (6)	.092 (4) G
FA–EPA	4757.483	.489 (2)	.479 (3)	.473 (8) R
FA–GN	4709.		.976 (2)	.979 (3) R
FA–FU	2365.982 (3)	.992 (6)		
FA–FUA	2358.158	.167 (7)	.157	.167 (13) R
FA–BO	6066.	.394 (4)	.389 (1)	.389 (9) R .405 (4) G
BO–EPA	2361.	.066 (6)	.086	.073 (5) R
BO–GN	2519.		.656 (5)	.659 (6) R
BO–FUA	6880.	.071	.082 (8)	.091 (1) G
FUA–GN	4773.		.638 (3)	.636 (4) R

Table 7 (Cont.)

Line	1969	1970	1971	1973	
RO–MI	6260.904 (0)	.894 (5)		.913	G
ROA–MI	6236.801	.799 (4)		.804 (4)	G
ROA–BO	9857.	.954 (10)	.954 (1)		
TO–MI	5566.625 (4)			.617 (9)	G
TO–DU	1709.692 (4)			.690 (3)	G
TO–DUA	1684.644			.640	G
GR–FU	7315.763 (1)	.776 (18)			
GR–FUA	7318.006	.029	.001 (8)	.002 (2)	R
GR–FUB	7315.		.542 (1)	.783 (3)	R(!)
GRA–FU	7339.301 (5)	.311 (4)			
GRA–FUA	7341.		.656 (1)	.651 (3)	R
GRA–FUB	7340.		.038 (2)	39.429 (5)	R(!)
FUA–CI	12089.	.216 (4)	.202 (5)		
GR–CI	5866.824 (2)		.817 (3)	.806 (7)	R
GR–CIA	5872.		.127 (7)	.098 (6)	R
GRA–CI	5876.678 (2)	.666 (1)	.684 (5)		
BH–CI	7233.	.345 (3)	.339 (3)	.344 (8)	R
BH–CIA	7223.	.512 (3)	.512 (7)	.519 (6)	R
QL–SO	3856.		.827 (2)	.824 (6)	R
QL–OL	2357.		.701 (3)	.709 (9)	R
OL–SO	1581.		.700 (3)	.698 (5)	R
OL–MI	7578.		.939 (2)	.947 (2)	G
PY–GE	6642.		.838 (0)	.847 (2)	G
PY–RI	7612.		.207 (2)	.238 (8)	G
PY–WO	3402.		.640 (1)	.634 (4)	G
PY–KO	3079.		.975 (5)	.973 (4)	G
KO–WO	5336.		.854 (4)	.853 (5)	G
GA–YE	2248.	.280 (0)	.285 (1)		
GA–TH	4608.	.467 (1)	.469 (3)		
KO–YE	2871.	.862 (2)	.880 (2)		
KO–TH	4444.	.643 (1)	.653 (2)		
TA–AY	7678.	.127 (8)	.126 (3)	.127 (8)	G
TA–ME	6858.	.849 (6)	.855 (6)	.852 (10)	G
TA–RA	9418.	.252 (5)	.272 (1)	.271 (8)	G
AY–ME	7829.	.039 (9)	.043 (3)	.043 (4)	G
AY–RA	7220.	.486 (9)	.494 (6)	.476 (2)	G
ME–RA	13687.	.786 (0)	.806 (5)	.793 (2)	G
BN–BC	1206.		.695 (5)	.696 (3)	G
BC–KU	3599.		.159 (6)	.159 (2)	G
BC–TS	7277.		.595 (1)	.596 (1)	G
BC–TSA	7276.		.498 (2)	.503	G
BP–SH	2331.		.638 (2)	.635 (3)	G
BN–SH	2937.		.659 (2)	.654 (1)	G
KU–TS	3772.		.913 (5)	.915 (2)	G

Table 7 (Cont.)

Line	1969	1970	1971	1973
HO-TE	1022.	.584 (6)	.584 (1)	.579 (4) G
HO-GL	764.	.051 (7)	.039 (3)	.047 (0) G
HO-EU	3517.	.923 (4)	.913 (3)	.907 (2) G
HO-EUA	3524.	.748	.756 (4)	.741 G
HO-LA	3394.		.042 (0)	.045 (3) G
TE-GL	746.	.038 (1)	.032 (3)	.030 (2) G
TE-EU	3358.	.109 (4)	.114 (1)	.121 (1) G
TE-EUA	3372.	.611	.614 (0)	.614 G
TE-LA	2434.		.164 (2)	.153 (3) G
GL-EU	2852.	.119 (5)	.129 (2)	.120 (2) G
GL-EUA	2862.	.153 (2)	.158 (3)	.151 G
GL-AR	7435.		.772 (3)	.776 (12) G
LA-EU	3232.		.687 (1)	.693 (2) G
LA-EUA	3259.		.841 (0)	.847 G
LA-AR	4851.		.687 (1)	.687 (1) G
AR-EU	6206.		.129 (0)	.126 (0) G
AR-EUA	6229.		.360	.356 G
OI-AL	4629.	.068 (0)	.066 (3)	.084 (0) G
OI-OY	5303.		.646 (2)	.635 (4) G

4. RESULTS

All final distances for the remeasured Ethiopian-rift lines are given, with standard deviations about the mean, in Table 7. Line-length changes between one survey and the next, and also cumulative line-length changes throughout 1969 to 1973, are listed in Table 8; a minimum significant change of 6 mm is imposed, on the basis of the data of Table 2.

4.1 The Adama Region

Statistically significant line-length changes are discussed first for the Adama network. Particular attention is given to those station–station links* that contain main-auxiliary or even auxiliary–auxiliary lines in addition to the main–main line.

Link RAILWAY–MARIAM comprises two remeasured lines that agree to the extent of yielding 23 ± 5-mm extension for the period 1969 to 1973, although Table 8 exposes the poor precisions on which this figure is based. Nevertheless, the tensional ground cracks that occurred on 24 May 1971 in the Mojjo region (Gouin, 1971), some 2 km northwest of station RAILWAY, are temptingly close and provide a stimulus to further remeasurements of this link and also of ROAD–RAILWAY, which has not been remeasured since its inception in 1969.

Link MARIAM–GEORGE consists of four remeasured lines in good agreement with one another, yielding 17 ± 3 mm of apparent extension during the course of the four surveys. Furthermore, measurements of two of the four lines in 1971 give intermediate values, suggestive of regular rather than single-episode extension. The

*For discussion purposes, a station encompasses a group of points, usually all within about 25 m of one another, from which distance measurements are made – e.g., main point, auxiliary point. A link is the general connection between two such stations, and lines connect specific points of different stations.

Table 8. Line-length changes for all remeasured Ethiopian rift lines, in millimeters. The initial measurement of each line is indicated by a zero. Standard deviations for interseason changes are given in parentheses, and where these changes are nonsignificant, a zero value is again given. For cumulative changes, values are given to the nearest millimeter and the statistically significant ones are underlined. R and G represent Ranger and geodimeter results, respectively.

Line	Interseason changes				Cumulative changes			
	1969	1970	1971	1973	1969	1970	1971	1973
RY−MA	0			28 (17)	0			28
RY−MAA	0			18 (16)	0			18
MA−GE	0		11 (6)	0	0		11	13
MA−GEA	0		9 (7)	8 (4)	0		9	17
MAA−GE	0			21 (12)	0			21
MAA−GEA	0			17 (?)	0			17
MA−RI		0	-14 (1)			0	-14	
GE−RI	0	-18 (?)	19 (?)	0	0	-18	1	1
GE−RIA	0		-18 (?)		0		-18	
GEA−RI	0		0	0	0		5	9
GE−AD	0	-9 (?)	10 (?)	0	0	-9	1	4
GE−ADA	0		0		0		2	
GE−FUA		0	-12 (2)		0	0	-12	
GE−BO	0	0	-12 (2)			0	-12	
RI−AD	0	0	0	14 (6) R	0	-3	-4	10 R
				11 (6) G	0			7 G
RI−ADA	0		0	15 (3)	0		1	16
RIA−AD	0			12 (?)	0			12
RI−FA	0	0	0	0 R	0	1	-1	-1 R
				6 (5) G				6 G
RIA−FA	0		0		0		3	
RI−FAB			0	-11 (5)			0	-11
RI−EPA	0	0	15 (?)	-13 (5)	0	-6	9	-4
RI−GN			0	0			0	1
RI−FU	0	0			0	0		
RI−FUA	0	26 (?)	-22 (5)	13 (5)	0	26	2	14
RI−FUB			0	0			0	2
RI−BO		0	27 (16)	0		0	27	18
RIA−BO			0	-22 (7)			0	-22

Table 8 (Cont.)

Line	Interseason changes				Cumulative changes			
	1969	1970	1971	1973	1969	1970	1971	1973
AD–FA	0	0	7 (2)	0	0	-3	4	7
ADA–FA	0		0	15 (3)	0		3	18
AD–FAB			0	0			0	-2
AD–EPA	0	-17 (?)	12 (?)	-16 (8)	0	-17	-5	-21
AD–GN			0	0			0	2
AD–BO		0	52 (8)	-10 (7)		0	52	43
FA–EPA	0	0	-10 (4)	0	0	6	-4	-10
FA–GN			0	12 (4)			0	12
FA–FU	0	10 (6)			0	10		
FA–FUA	0	9 (?)	-10 (?)	0	0	9	-1	9
FA–BO		0	0	0 R		0	-5	-5 R
				21 (4) G				17 G
BO–EPA		0	20 (?)	-13 (?)		0	20	7
BO–GN			0	0			0	3
BO–FUA		0	11 (?)	15 (7)		0	11	27
FUA–GN			0	0			0	-2
RO–MI	0	-10 (4)		18 (?)	0	-10		9
ROA–MI	0	0		0	0	-2		3
ROA–BO		0	0			0	0	
TO–MI	0			0	0			-8
TO–DU	0			0	0			-2
TO–DUA	0			0	0			-4
QL–SO			0	0			0	-3
QL–OL			0	0			0	-3
OL–SO			0	0			0	-2
OL–MI			0	8 (3)				8
GR–FU	0	0			0	13		
GR–FUA	0	23 (?)	-28 (?)	0	0	23	-5	-4
GR–FUB			0	[?]			0	[?]
GRA–FU	0	10 (6)			0	10		
GRA–FUA			0	0			0	-5

Table 8 (Cont.)

Line	Interseason changes 1969	1970	1971	1973	Cumulative changes 1969	1970	1971	1973
GRA–FUB			0	[?]			0	[?]
FUA–CI		0	-14 (6)			0	-14	
GR–CI	0		-7 (4)	-11 (7)	0		-7	-18
GR–CIA			0	-29 (9)			0	-29
GRA–CI	0	-12 (2)	18 (4)		0	-12	6	
BH–CI		0	0	0		0	-6	-1
BH–CIA		0	0	0		0	0	7
PY–GE			0	9 (2)			0	9
PY–RI			0	31 (7)			0	31
PY–WO			0	-6 (4)			0	-6
PY–KO			0	0			0	-2
KO–WO			0	0			0	-1
GA–YE		0	0			0	5	
GA–TH		0	0			0	2	
KO–YE		0	18 (3)			0	18	
KO–TH		0	10 (2)			0	10	
TA–AY		0	0	0		0	-1	0
TA–ME		0	0	0		0	6	3
TA–RA		0	20 (4)	0		0	20	19
AY–ME		0	0	0		0	4	4
AY–RA		0	0	-18 (6)		0	8	-10
ME–RA		0	20 (4)	-13 (5)		0	20	7
HO–TE		0	0	0		0	0	-5
HO–GL		0	-12 (7)	8 (2)		0	-12	-4
HO–EU		0	-10 (5)	-6 (4)		0	-10	-16
HO–EUA		0	8 (?)	-15 (?)		0	8	-7
HO–LA			0	0			0	3
TE–GL		0	-6 (3)	0		0	-6	-8
TE–EU		0	5 (4)	7 (1)		0	5	12
TE–EUA		0	0	0		0	3	3

Table 8 (Cont.)

Line	Interseason changes				Cumulative changes			
	1969	1970	1971	1973	1969	1970	1971	1973
TE–LA			0	-11 (4)			0	-11
GL–EU		0	10 (5)	-9 (3)		0	10	1
GL–EUA		0	0	-7 (?)		0	5	-2
GL–AR			0	0			0	4
LA–EU			0	6 (2)			0	6
LA–EUA			0	6 (?)			0	6
LA–AR			0	0			0	0
AR–EU			0	0			0	-3
AR–EUA			0	0			0	-4
OI–AL		0	8 (2)	8 (2)		0	8	16
OI–OY			0	-11 (4)			0	-11
BN–BC			0	0			0	1
BC–KU			0	0			0	0
BC–TS			0	0			0	1
BC–TSA			0	0			0	5
BP–SH			0	0			0	-3
BN–SH			0	0			0	-5
KU–TS			0	0			0	2

agreement among the four lines is reassuring in showing no significant movements between main and auxiliary points at either of the two stations, a happy state of affairs not apparently obtaining at some other stations. The similar orientations (325^g and 341^g) of the two links suggest a large component of extension perpendicular to the rift normal faulting on the Mojjo–Adama horst (Mohr, 1973b), at a rate of about 1 cm yr^{-1}. This is equivalent to a strain rate of $10^{-5.5}$ yr^{-1}, but a uniform strain field is most unlikely to exist in fault-sliced terrain.

Results are less consistent for the relatively short links in the Adama graben. GEORGE–RIDGE, comprising three lines, indicates an extension of 5 ± 3 mm from 1969 to 1973 for two of the lines. The third, GEORGE–RIDGE AUX. A, shows an apparent shortening of nearly 2 cm from 1969 to 1971, but the 1971 value could be suspect. No other link involving station RIDGE gives evidence that points RIDGE and RIDGE AUX. A have moved relative to one another: RIDGE AUX. A lies 25 m south-southwest of RIDGE, and both points are sited on large outcrops forming a flat "plaza" on the crest of an otherwise knife-edged tectonic ridge.

The two lines of link GEORGE–ADAMA show no significant length changes during the four surveys. Similarly, the three lines of link RIDGE–ADAMA are consistent in showing no length changes during 1969 and 1971, but from 1971 to 1973, there is an apparent extension of 12 ± 3 mm. Link RIDGE–FARENJI comprises two lines yielding no significant length changes during all four surveys, but a third, new line (RIDGE–FARENJI AUX. B) has apparently shortened by about 1 cm between 1971 and 1973. No relative movement of points FARENJI and FARENJI AUX. B seems likely on geological grounds.

Link RIDGE–FULCRUM consists of three lines (one extinct after 1970) that reveal no apparent length changes, although an aberrant value was obtained in 1970 for line RIDGE–FULCRUM AUX. A. Link FARENJI–FULCRUM presents a paradox in that its two lines concur in an apparent extension of 10 ± 1 mm during 1969 and 1970: One line then became extinct, and the other (FARENJI–FULCRUM AUX. A) apparently shortened to its 1969 length in 1971, only to extend back to its 1970 length in 1973! The reality of these oscillatory goings-on can be checked only by future resurveys.

The three lines of link ADAMA–FARENJI suggest no significant length changes during the four surveys, except that line ADAMA AUX. A–FARENJI apparently extended about 1.5 cm between 1971 and 1973. Point ADAMA AUX. A lies 23 m east of ADAMA, and both are situated in an unusually massive, solid outcrop forming the top of a basalt lava flow sliced upward by a young rift fault. The stability of line ADAMA–FARENJI AUX. B contrasts with that of RIDGE–FARENJI AUX. B, where measuring errors are thus indicated.

Link ROGGI–MIETCHI shows an apparent extension of 6 ± 3 mm during 1969 to 1973; the intervening 1970 values are erratic and are not regarded as significant. Link TOPLESS–DUST, comprising two short lines parallel to the rift structures, reveals a statistically nonsignificant, though consistent, shortening of 3 ± 1 mm over the 4 years.

Links involving stations BOKU, ELPASO, and GANTI are mostly single lines. BOKU is a windswept, summit station uncongenial to the geodimeter (Mohr, 1973a). This is reflected in some erratic results for BOKU links: In particular, BOKU–RIDGE, BOKU–ADAMA, and BOKU–ELPASO all show apparently reversed movement from 1970–1971 (extension) to 1971–1973 (contraction). Aberrant 1971 values could be claimed, except that link BOKU–FARENJI, which was measured on the same occasion as the three supposedly aberrant links, shows no significant line-length changes between 1970 and 1973. Link BOKU–ROGGI, like BOKU–FARENJI, has also remained unchanged in length in the 1970 and 1971 surveys. In the case of line BOKU–ADAMA, an apparent extension of over 5 cm is indicated for 1970 to 1971, the largest line-length change thus far obtained in the Ethiopian work. But when the line-length changes are examined in relation to the geometry of the Adama network (see below), the reality of changes of this magnitude immediately becomes dubious, and the poorer precision for lines in BOKU links is underlined.

Hilltop station GANTI is linked to five other stations, and for all five links, no significant line-length changes have occurred between 1971 and 1973. Gara Ganti lies immediately northeast of Gara Boku, but its 100-m lower elevation perhaps explains the much better stability of the GANTI links. Station ELPASO lies on the southeastern shoulder of Gara Ganti, about halfway up the hillside. It has been involved in some significant line-length changes that are apparently oscillatory: shortening during 1969–1970 and 1971–1973 and extending during 1970–1971 (synchronous with three

BOKU links, but out of phase with FARENJI–FULCRUM – see above). Again, is this the result of instrumental factors or of real tectonic or station movement? The stability of the GANTI links rules out tectonic movements; but instrumental factors can also be ruled out since GANTI and ELPASO AUX. A lines have been measured on the same occasions. The apparent movement of station ELPASO may therefore reflect local ground consolidation.

The links of the Adama region, and their significant line-length changes (if any), can be considered in the context of the network geometry (Figure 2). Since precise elevations are lacking, it is not yet possible to obtain a least-squares best fit for each survey and then make comparisons between successive surveys. Furthermore, it has not been possible to remeasure every line of the network during each survey, and the resulting gaps in our knowledge complicate interpretation of possible ground strain. Third, the duration of the Ethiopian observations, with a maximum of only 3 1/2 years, is a very short one for this type of study (cf. Savage and Burford, 1973), and instrumental errors and quirks tend to obliterate any regular accumulation of strain. The survey precisions in Table 2 are average values, and as soon as a particular line is examined, the possibility of a worse real precision must be borne in mind, especially where line inconsistencies exist within a given link.

Thus, Figure 2 must be interpreted with caution. The writer currently declines to speculate further than the presentation in Figure 3, where triangular vectors of other stations are drawn relative to an arbitrarily fixed station RIDGE.* The average vectors are as follows:

RIDGE	reference	FULCRUM	uncertain (stationary, or 11 mm at 385^g?)
GEORGE	10 mm at 000^g		
ADAMA	13 mm at 030^g	GANTI	stationary
FARENJI	5 mm at 275^g	ELPASO	7 mm at 395^g
		BOKU	10 mm at 145^g

These vectors are all for the period 1969 to 1973, except for BOKU, 1970 to 1973.

*The method of strain analysis used by Raleigh and Burford (1969) is not applied here, because it involves the assumption – of unlikely validity for the floor of the Ethiopian rift valley – that strain accumulation is uniformly distributed regardless of intervening faults. Furthermore, refined methods of analysis such as that of Frank (1966) will not be applied here until enough resurveys enable incontestable line-length changes to be extracted.

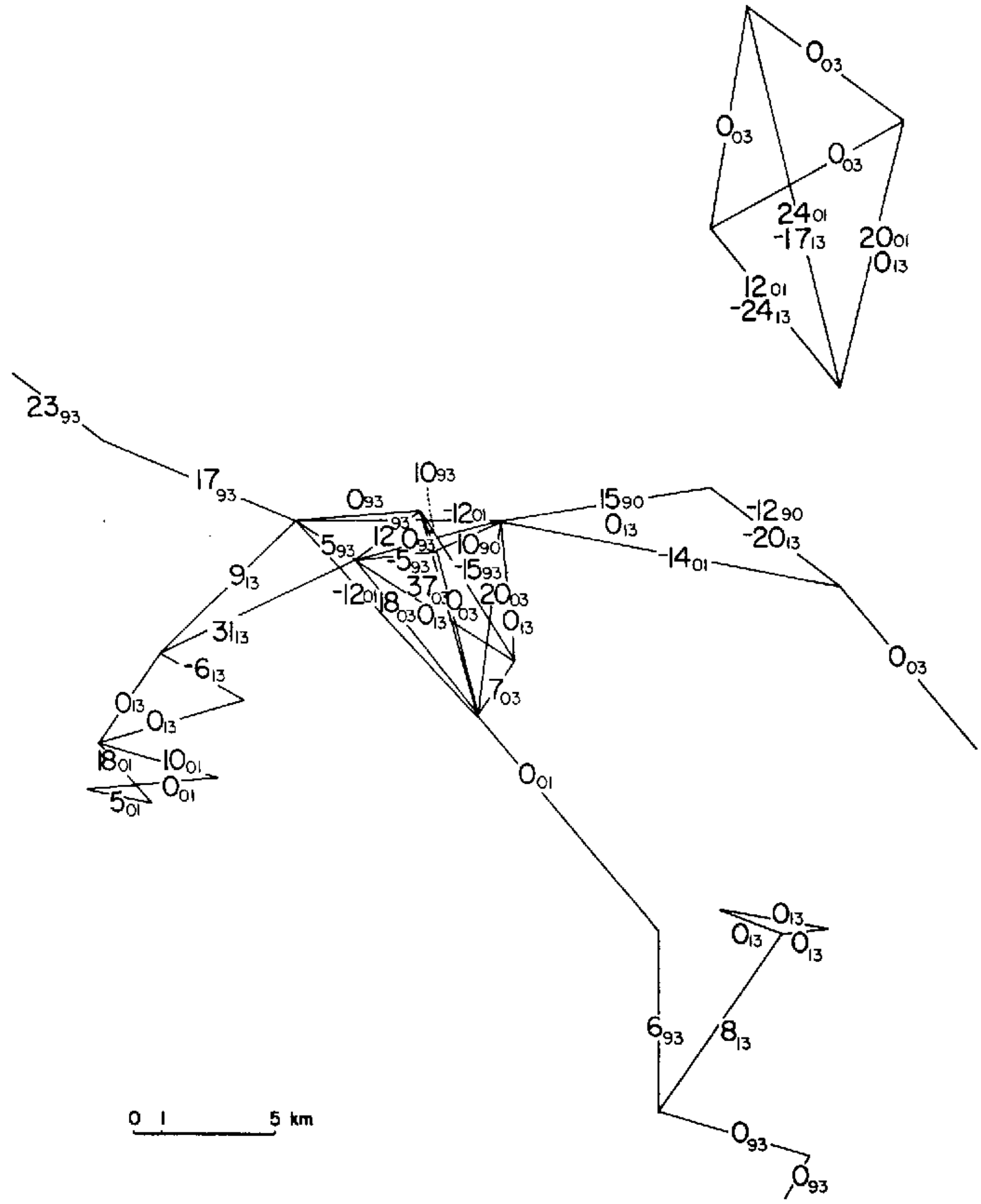

Figure 2. Significant line-length changes in the Adama network, in millimeters. Suffixed two-digit numbers indicate the period of observation (e.g., -5_{93} denotes 5 mm of shortening between 196<u>9</u> and 197<u>3</u>).

<u>If</u> these vectors are the result of tectonic strain accumulation, then we can first note the absence of a regional homogeneous strain. This is not surprising, considering the slicing of the rift floor into parallel faulted blocks in this region. As argued above, the movement of station ELPASO relative to GANTI is attributed to ground

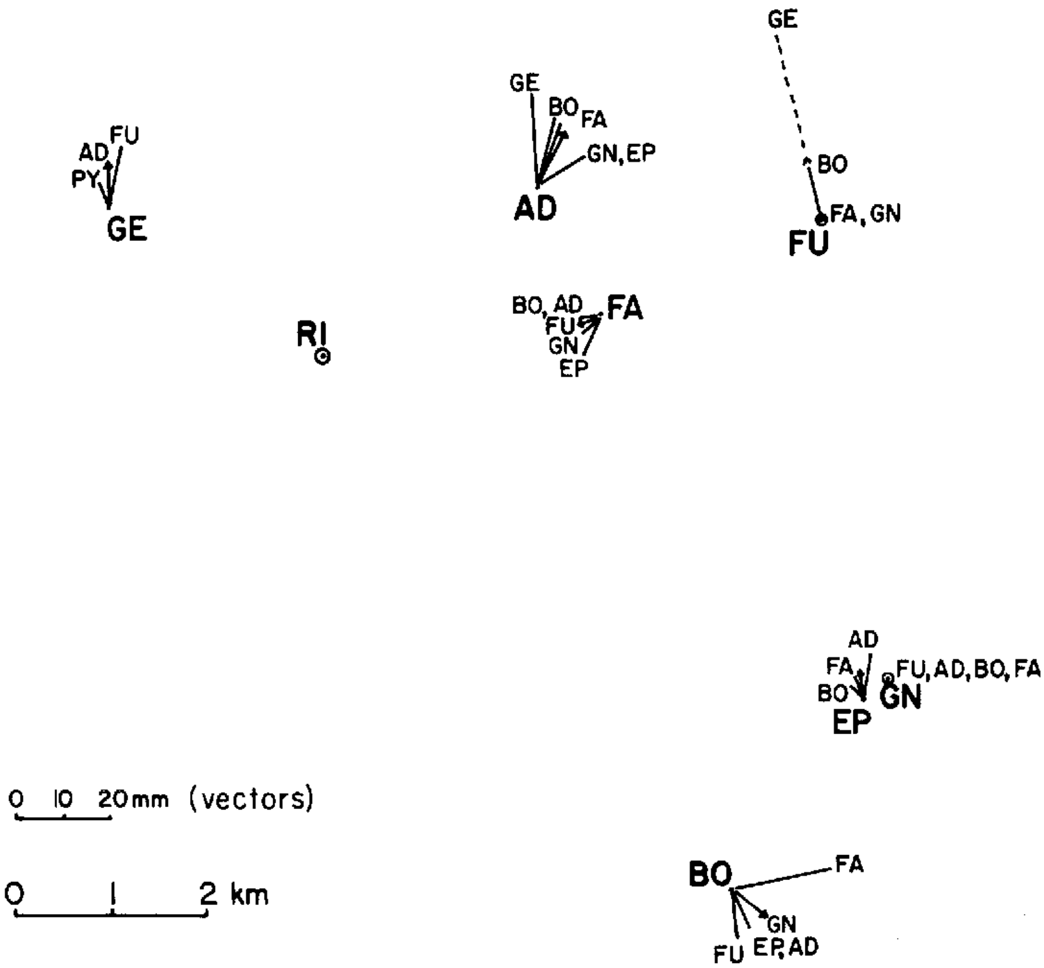

Figure 3. Station displacement vectors for 1969 to 1973 (a 1970 to 1973 interval is used for station BOKU) relative to station RIDGE held fixed. Station abbreviations affixed to individual vectors indicate the third station of the triangle analyzed in the derivation of that vector.

consolidation, and Figure 3 suggests an uphill movement, which has important consequences for the interpretation of the Wolenchiti quadrilateral (see Section 4.2).

Station RIDGE and stations GANTI, ELPASO, and FULCRUM are on opposing rims of the Adama graben, and in revealing no significant relative movement, they show that this graben is currently "quiet" compared with the adjacent Mojjo–Adama horst to the west. However, when graben-floor stations are examined, the situation is more complex. Station FARENJI has undergone a small southeasterly movement that is probably not significant, but ADAMA has made a more definite excursion of 13 mm in 3 years, north-northeastward along the structural trend of the rift. If real, this would mean sinistral shear relative to the western margin of the Adama graben and dextral shear relative to the eastern margin. The apparent movement of station GEORGE relative to RIDGE is likewise almost along the rift trend, with a large component of dextral shear. Geological evidence exists of transcurrent displacements along young faults of the rift floor – for example, those affecting recent basaltic cinder cones in Gadamsa caldera (Thrall, 1973; DiPaola, 1973), some 30 km southeast of Adama.

4.2 The Wolenchiti Quadrilateral

The Wolenchiti quadrilateral was considered by Mohr (1973a) to be the site of significant crustal extension between 1970 and 1971, involving ~2.5-cm movement of station RABBIT along an azimuth of 190^g. The revised line lengths now show an even greater consistency in confirming a movement of RABBIT relative to an undeformed triangle comprising the other three stations: 24 ± 2 mm at 196^g from 1970 to 1971 (Figure 4). The excellent mutual consistency of the three lines involving station RABBIT is witnessed to in the small standard deviation, which is also improved by the elimination of significant extension for line AYGU–MENDENO (cf. Mohr, 1973a, pp. 48-49).

The results of 1971 to 1973 give a completely different vector for station RABBIT, again relative to unchanged lengths of the triangle comprising the other three stations of the quadrilateral. The best-fit vector is 23 ± 2 mm at 318^g (Figure 4). This vector is sensitive to any length change of line TABLE–RABBIT and is almost perpendicular to it (cf. the configuration of the 1970 to 1971 vector, which is insensitive to the behavior of any one line). The 1971 to 1973 result must therefore be accepted with corresponding caution; nevertheless, it would be impossible to reverse the 1970 to 1971 vector with a feasible 1971 to 1973 vector* and so hint that the 1971 measurements involving RABBIT were erroneous. The tentative conclusion is that station RABBIT, in accordance with its name, has dodged west perpendicular to the rift faulting, and it is of interest that 2 months after the 1973 measurements were made, ground cracks

*Changing the station factor for RABBIT from 0.5 to 1.0 changes the 1970 to 1971 vector to 28 ± 2 mm at 191^g and the 1971 to 1973 vector to 31 ± 2 mm at 318^g.

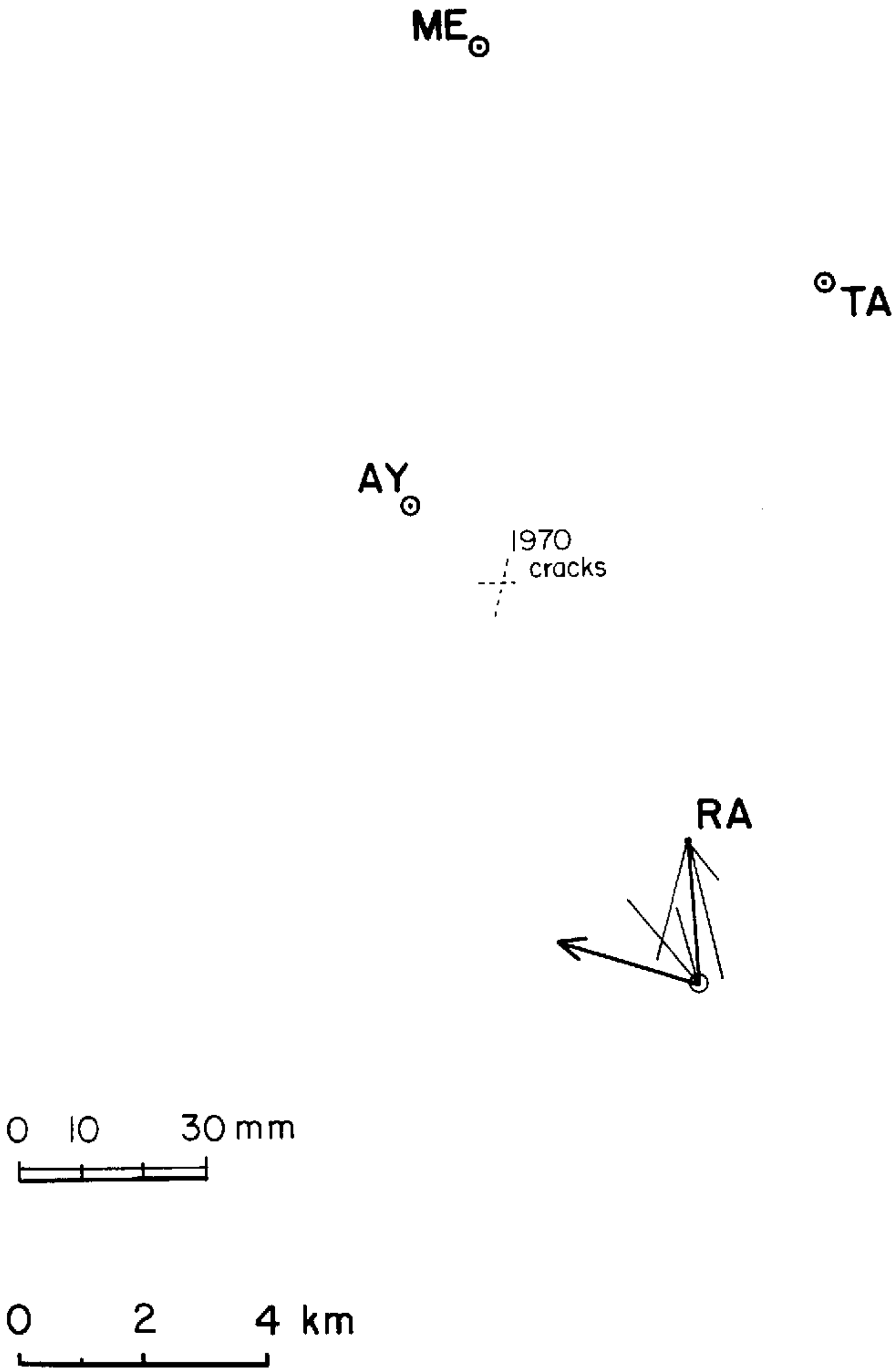

Figure 4. Apparent motions of station RABBIT relative to the stable triangle formed by the other three stations of the Wolenchiti quadrilateral.

once more appeared in the quadrilateral (Prof. P. Gouin, 1973, personal communication). Point RABBIT and the 1973-established RABBIT AUX. A will bear watching to see whether the apparent movements of this station are caused by crustal strain, or merely by creep of the steep surface of the rhyolitic lava flow on which RABBIT is situated. The apparent uphill creep of station ELPASO has already been remarked: Can this be a general feature of hill-slope stations? If so, such sites are best avoided for this type of work (but the alternative to RABBIT is the top of Boseti Guda volcano, a mere 800 m higher for the foot-bound).

Mohr (1973a) concluded that the August 1970 ground cracking in the region of the subsequently established Wolenchiti quadrilateral had failed to cause significant extension of the nearest 1969 GEODIS lines (link GRAVES–FULCRUM). The revised line lengths presented here indicate, to the contrary, that the three lines of the GRAVES–FULCRUM link are consistent in showing an apparent 15 ± 6-mm extension between 1969 and 1970. Unfortunately, only one line (GRAVES–FULCRUM AUX. A) was extant to be remeasured in 1971, and it indicated reversion back to the 1969 length! Two lines show no significant length changes from 1971 to 1973 (two further lines measured with the Ranger gave crazy 1973 results – see Table 7). There is, then, some grounds for considering that link GRAVES–FULCRUM <u>was</u> affected by the 1970 surface cracks 10 km to the north.

Link GRAVES–CINDER comprises three mutually inconsistent lines: GRAVES–CINDER and GRAVES–CINDER AUX. A both indicate progressive shortening during 1969, 1971, and 1973, but GRAVES AUX. A–CINDER indicates a shortening from 1969 to 1970 and then compensating extension between 1970 and 1971. However, point GRAVES AUX. A was damaged at some time between the 1970 and 1971 surveys; unfortunately, no GRAVES AUX. A–FULCRUM lines were measured in both 1970 and 1971, so no check for an expected corresponding 1970 to 1971 shortening west of GRAVES AUX. A can be made. Therefore, the writer currently considers that link GRAVES–CINDER has indeed shortened, possibly by 7 mm from 1969 to 1971 and by 20 ± 9 mm from 1971 to 1973. On-going shortening of this link will be sought in future resurveys. Link BOHALLA–CINDER comprises two lines that agree in showing no significant length changes from 1970 to 1973. The traverse of the Wolenchiti valley south of the quadrilateral and immediately east of the Adama graben therefore seems to identify discrete ?rift-trending zones of extension, shortening, and no movement.

4.3 The Lake Langana Network

In the Lake Langana network (Figure 5), all links involving station EUPHORBIA are composed of two lines and can be subjected to a mutual-consistency test. Link HOTEL–EUPHORBIA shows 12 ± 5 mm of progressive shortening from 1970 to 1973, with only one erratic reading – for line HOTEL–EUPHORBIA AUX. A in 1971. Link TERMITE–EUPHORBIA is inconsistent, one line showing more than 1 cm of gradual extension from 1970 to 1973, and the other, no significant change. Link GALLA–EUPHORBIA displays an extension of 8 ± 3 mm between 1970 and 1971, but the 1973 length values revert back to those of 1970. Once again the problem arises: Are these oscillatory length changes real, or are they due to measurement errors? The latter is more likely but has not yet been conclusively established. Links LANGANA–EUPHORBIA (6 ± 0-mm extension between 1971 and 1973) and ARJO–EUPHORBIA (4 ± 1-mm apparent shortening between 1971 and 1973) are each consistent within their line pairs.

At the northern end of Lake Langana, the two lines crossing the O'itu caldera show opposing changes. Line O'ITU–ALUTU, unchanged during 1970 and 1971, has apparently extended by nearly 2 cm between 1971 and 1973. Line O'ITU–OOMAY has apparently shortened by about 1 cm from 1971 to 1973. The orientations of these two transcaldera lines are 285^g and 269^g, respectively, and if the line-length changes are real, then an anticlockwise rotation of the peninsula (9.4×10^{-4} rad or 1.5×10^{-5} grad about a fulcrum 500 m north-northeast of station OOMAY) on the western side of the O'itu caldera is indicated. Obviously, this has to be checked in future resurveys.

Figure 6 shows the apparent movement vectors for the Lake Langana stations, relative to EUPHORBIA held fixed. As was done for Figure 3, the vectors are derived from best-fit adjustments of all the triangles with EUPHORBIA as an apex. Station HOTEL has continued the southeasterly movement described by Mohr (1973a), and the vector for 1970 to 1973 is 13 mm at 135^g. The vector for station GALLA (2 mm at

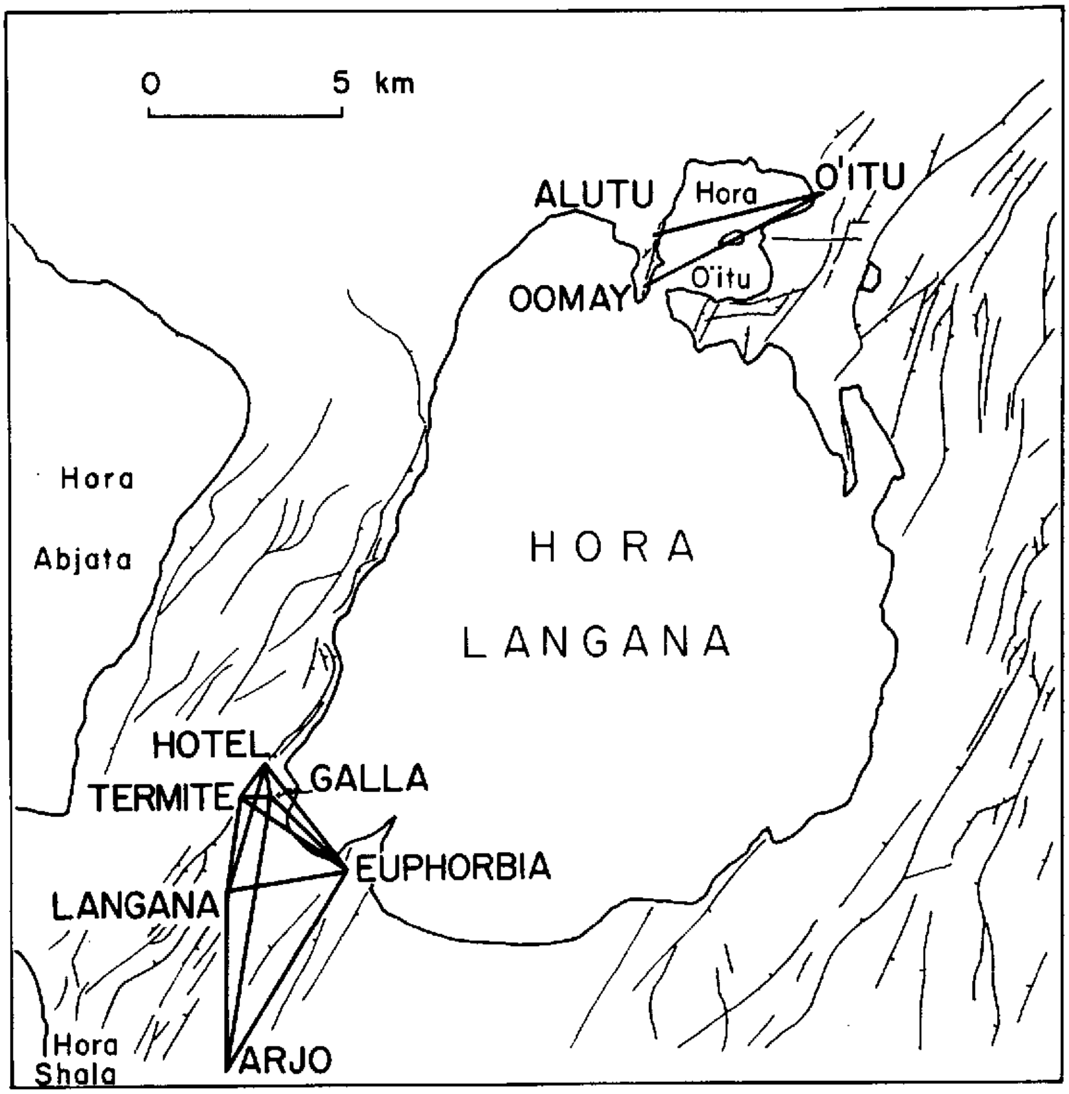

Figure 5. The Lake Langana network, showing preserved fault scarps (from Mohr, 1966, 1973a).

250^g) is probably not significant; the data for station TERMITE are not consistent, so a vector is not derived. Station LANGANA has apparently moved 6 mm at 310^g, and station ARJO, 9 mm at 105^g.

The movements of stations HOTEL, LANGANA, and ARJO are all notably perpendicular to the local rift faulting, which is strong confirmation of the reality of the movements. Strangely, however, in all three cases, the direction of movement is opposite

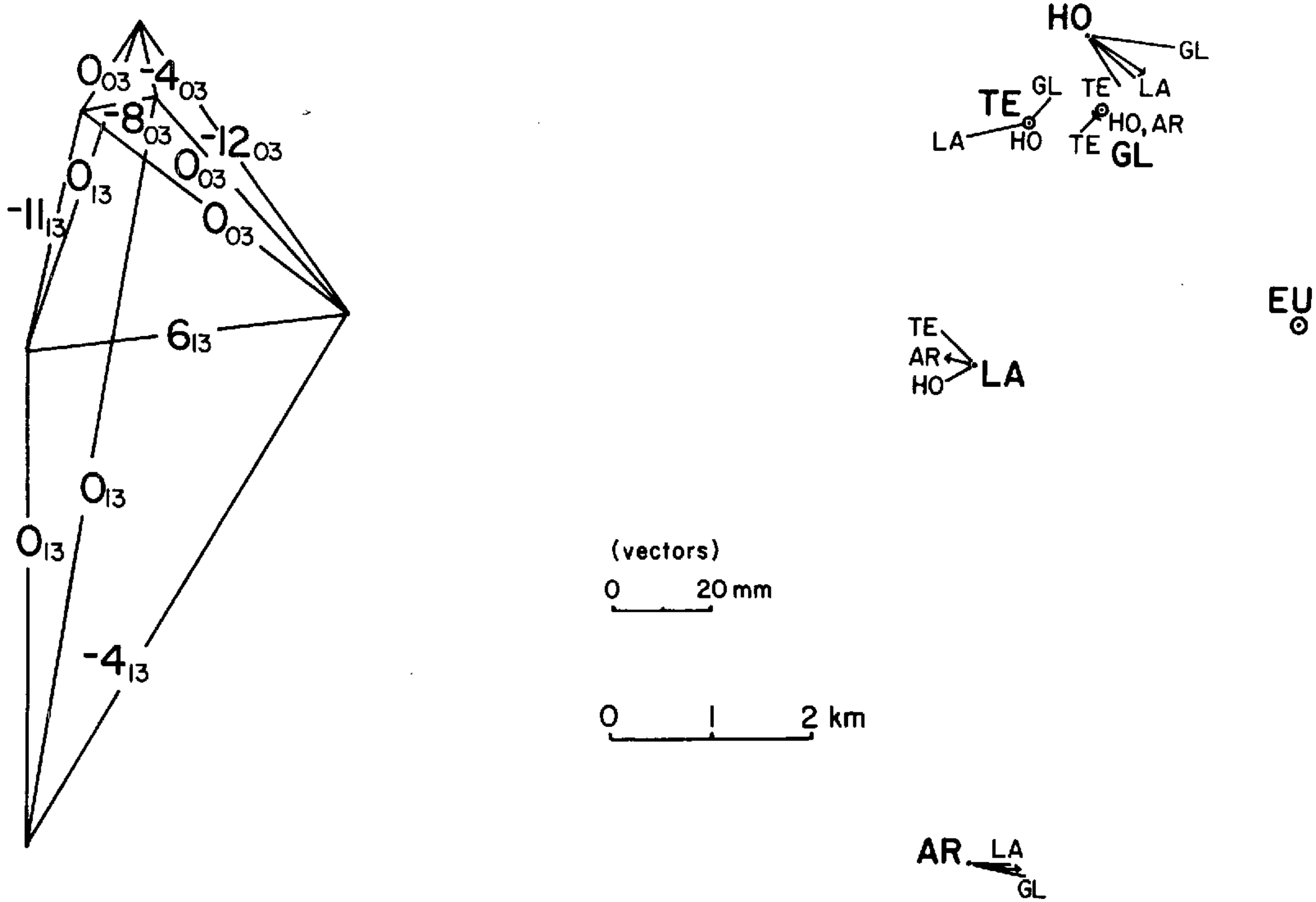

Figure 6. Left: Significant line-length changes in the Langana network, in millimeters. Right: Station displacement vectors for 1970 to 1973 (except a 1971 to 1973 interval for links involving stations LANGANA and ARJO) relative to station EUPHORBIA held fixed. Station abbreviations affixed to individual vectors indicate the third station of the triangle analyzed in the derivation of the vector.

what would be expected from the configuration of the proximate normal faults: The movement is toward the fault. Slow reversal of crustal displacements effected by faulting has been detected by precise leveling in Israel, west of the Dead Sea rift (Karcz and Kafri, 1973).

4.4 The Arba Minch Network

After all the honest doubts and shifty equivocations concerning the real precision obtainable in the Ethiopian work, the results of the 1973 remeasurement of the Arba Minch network (Figure 7) come like a breath of fresh air. For seven lines, the average line-length change is 0 ± 3 mm. This remarkable agreement between the 1971 and the 1973 values indicates 1) the precision obtainable with a well-functioning geodimeter, 2) the success of the modified GRC applied to the atmospheric-density correction, and 3) the absence of any effect on line lengths from the January 1973 earthquake felt in Arba Minch.

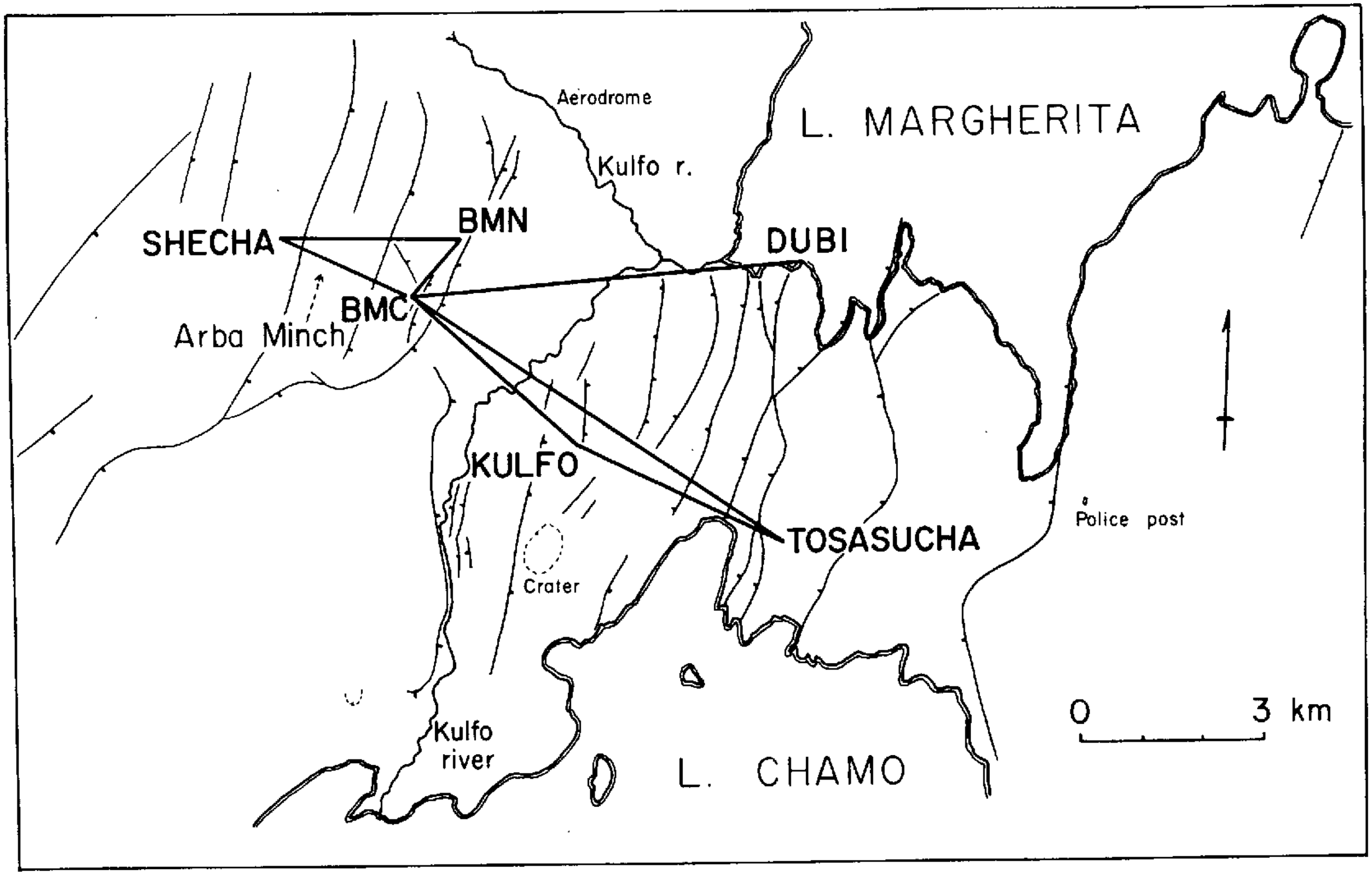

Figure 7. The Lake Margherita network, showing preserved fault scarps (from Mohr, 1973a; Levitte, Columba, and Mohr, 1974).

5. CONCLUSIONS

Taking the gloomy side of things first, there is no doubt that the employment of a different geodimeter instrument for each of the Ethiopian surveys has complicated interpretation of the results and has reduced the certainty with which line-length changes can be identified. All future surveys will use the SAO geodimeter 81006. In addition, the writer thinks it true to say that the Ethiopian work has thus far suffered from more than its fair share of instrumental gremlins. All possible precautions will be taken to ensure that in future resurveys the geodimeter shall be functioning as it should, although even then existing technology is being stretched to its limit to detect real line-length changes in the African rift system during the span of a human lifetime.

Although the correct evaluation of atmospheric density is generally regarded as the limiting factor of precision in geodimeter surveys, it is the small percentage of instrumentally aberrant measurements that can be the chief obstruction to placing full confidence in the final data. Fortunately, as the volume of Ethiopian data increases and the networks become tighter, these aberrant values can be more easily identified. Further assistance in this regard is to come from the setting-up of a network in central Afar, where the rate of strain accumulation is expected to be of the order of centimeters, rather than millimeters, per year.

All things considered, the precision of the Ethiopian rift geodetic surveys is now sufficient to identify significant relative movements within some station pairs. Confirmation of this comes from the mutual consistency of length changes for the lines comprising a given link.

Significant extension of the order of 1 cm yr^{-1} has occurred progressively from 1969 to 1973 across the Mojjo–Adama horst. The extension appears to be widely distributed, perhaps at the 10 large faults on the horst (Mohr, 1973a, b), in which case, a movement of 1 mm yr^{-1} on each fault might be predicted.

The Adama graben has been stable since 1969, except for some graben-floor stations situated near faults; these stations have rift-trend movements of 0.2 to 0.5 cm yr^{-1} relative to the graben rims. East of the graben, the link FULCRUM–GRAVES has apparently extended in association with the August 1970 ground cracks, 10 km to the north, but the next link farther east (GRAVES–CINDER) has shown progressive shortening during the 4 years. Side-by-side zones of rift extension and shortening are tentatively indicated.

In the Wolenchiti quadrilateral, station RABBIT is shown to have moved 24 ± 2 mm at 197^g from 1970 to 1971, but 23 ± 2 mm at 318^g since then. Like station ELPASO, RABBIT is on a steep hill slope and the station appears to be possibly unstable, although this is not the case with slope stations GEORGE, MIETCHI, and SHECHA. Caution must be used in detracting from a tectonic cause for the movement of station RABBIT, however, as further ground cracks appeared 2 months after the 1973 survey.

In the Langana networks, significant, consistent, and progressive movement of stations HOTEL, LANGANA, and ARJO has occurred relative to station EUPHORBIA. The movements are all perpendicular to the fresh rift-floor faults and have proceeded at rates of ~0.5 cm yr^{-1}. In each case, the movement has been toward the proximate fault – the opposite of what would be expected from normal faulting. Possible rotation of a faulted block west of the O'itu caldera has been detected. In the Arba Minch network, exquisitely precise measurements reveal no significant changes (±3 mm) of any line lengths since 1971.

An improved ground-radiation correction scheme leaves the writer confident that progressive extensions and shortenings as small as 0.5 cm yr^{-1} can be reliably extracted from the Ethiopian surveys, especially where network geometry imposes more stringent analysis. A bigger problem is the preservation of the existing stations, owing to the almost explosive development of towns and villages in the survey region.

Ad multos millimetros!

6. ACKNOWLEDGMENTS

Particular appreciation and gratitude is expressed to Mr. B. Cutshaw (Laser Systems & Electronics, Inc.), who loaned the Ranger III free of charge to the survey team for evaluation under Ethiopian field conditions. That the laser unit failed is regarded as pure ill fortune. Similarly, much assistance has been rendered by AGA (Lidingö) in identifying and curing the troubles of the SAO geodimeter.

The success of the survey rested to a very large extent on help extended by Professor P. Gouin (Haile Selassie I University), most especially in his loan of two Landrovers. Mr. J. Rolff, of 1970 survey fame, ably assisted the 1973 survey in his efficient and immediate reduction of distances in the field. Mr. J. Wohn was responsible for the second half of the survey, when the writer went gallivanting off to the Arussi Mountains (4000 m) to supervise a geology student. Miss F. Dakin very kindly identified and obtained the aerial photographs used in all this work.

Reduction of the data in their final form has been accomplished with the enthusiastic help of Mr. A. Girnius, who also revised the station elevations by using the triangulation data of M. Kazakopoulos.

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APPENDIX A

SOME NEW RADIOMETRIC AGES BEARING ON THE EVOLUTION OF THE MAIN ETHIOPIAN RIFT, EAST OF ADDIS ABABA

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SOME NEW RADIOMETRIC AGES BEARING ON THE EVOLUTION OF THE MAIN ETHIOPIAN RIFT, EAST OF ADDIS ABABA

The structural evolution of the main Ethiopian rift in quantitative terms has been briefly addressed by the writer (Mohr, 1973a), who commented on the absence of radiometric-age data for the rocks involved. By measuring the throw and hade of faults crossing the Addis Ababa–Sire rift traverse (see Figure A-1), and by using broad stratigraphic ages (Taieb, 1974, and personal communications), minimum extension rates of 0.3 mm yr^{-1} were obtained for the rift during the Quaternary and 5 mm yr^{-1} for the Wonji fault belt during the last 100,000 yr.

The geodimeter surveys described in this paper are, of course, monitoring present accumulations of strain in the rift. The results of such strain accumulation in the past, and its release as crustal faulting (Mohr, 1973a), have an evident bearing on the interpretation of the geodetic work, providing as they do another dimension to the problem. Now, the first radiometric ages for rift volcanic rocks are presented (Table A-1), restricted here to samples from the Addis Ababa–Sire sector of the main Ethiopian rift. These ages will be discussed in terms of their stratigraphic significance, deferring mention of the mineralogy and chemistry of the rocks.

First, to review very briefly the volcanic history of the rift and its margins: Basaltic extrusions and sills along the margins of the proto-rift trough in Ethiopia were produced for the first time, and in relatively small quantities, during the Cretaceous (Canuti, Gregnanin, Piccirillo, Sagri, and Tacconi, 1972; Mohr, 1967, 1971). In the Palaeocene, there began a dispersal of eruption sites over the greater part of the present Ethiopian highland region, and an enormous increase in the rate of magmatic ascent (Mohr, 1963; Grasty, Miller, and Mohr, 1963; Megrue, Norton, and Strangway, 1972). Fissure-basalt eruptions along the warped trough margins continued throughout the Tertiary and, from the Miocene on, were accompanied by the buildup of shields on the intermittently uplifted plateaus (Baker, Mohr, and Williams, 1972).

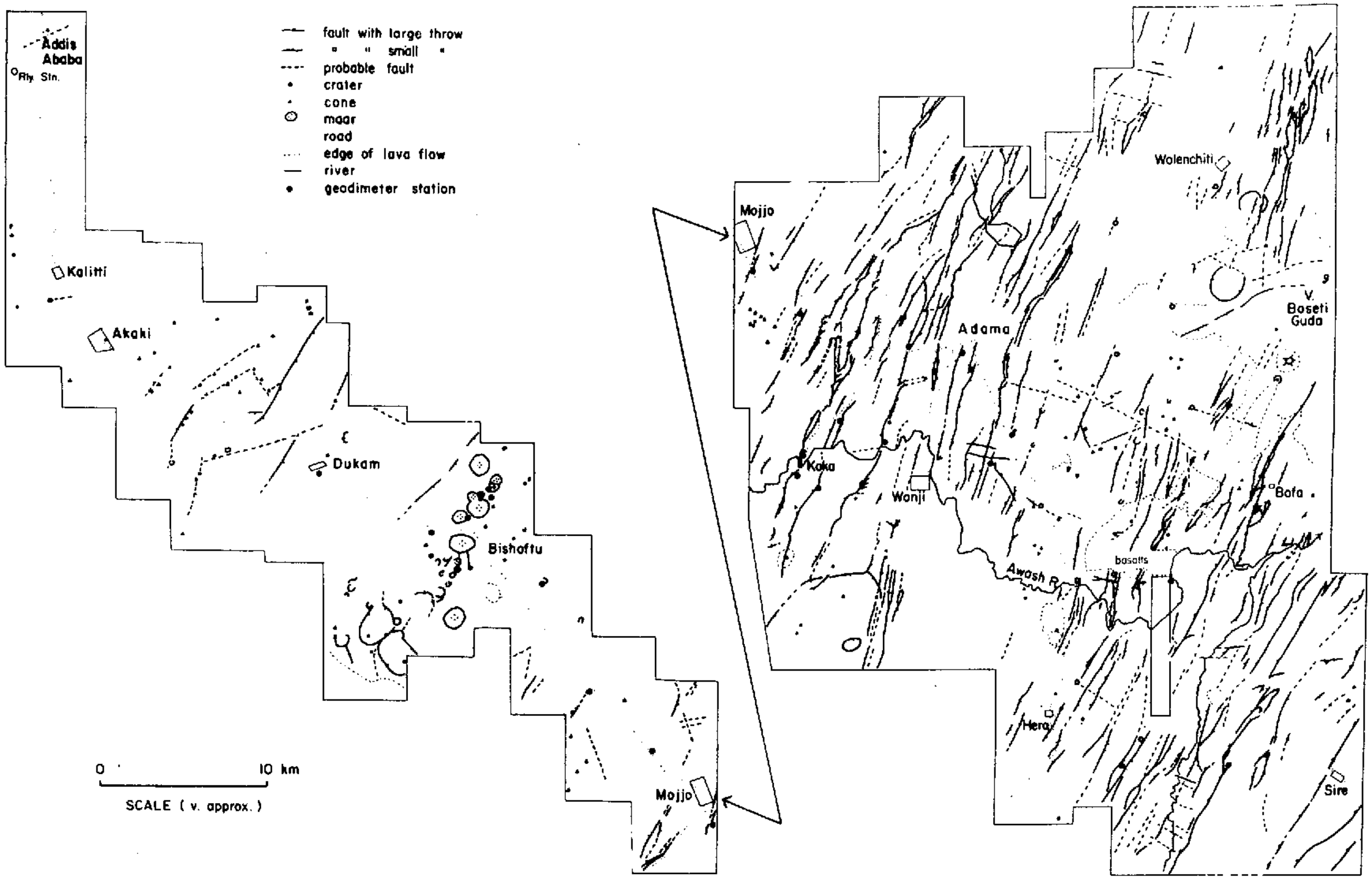

Figure A-1. Fault map of the rift valley east of Addis Ababa.

Table A-1. Potassium-argon analyses of some volcanic rocks from the northern geodimeter network, main Ethiopian rift.

Sample*	K_2O (%)	Atmospheric contamination (%)	Volume of Ar/g sample (mm^3)	Age (m.y.)
1	0.923	72.5	4.55×10^{-4}	6.9 ± 0.8
2	1.598	85.5	3.18×10^{-4}	2.8 ± 0.7
3	6.574	73.2	2.43×10^{-3}	5.2 ± 0.2
4	0.813	91.7	2.04×10^{-4}	3.5 ± 0.9
5	0.743	89.3	3.29×10^{-4}	6.2 ± 1.4

$$\lambda_\beta = 4.72 \times 10^{-10}\ yr^{-1}$$
$$\lambda_e = 0.585 \times 10^{-10}\ yr^{-1}$$

*Sample 1: Olivine basalt, Geophysical Observatory, Haile Selassie I University, Addis Ababa (whole rock).
Sample 2: Hawaiite dyke, Gara Bushu, 7 km northwest of Dukam (whole rock).
Sample 3: Porphyritic pantellerite obsidian, MARIAM geodimeter station, 4 km southeast of Mojjo (feldspar phenocrysts).
Sample 4: Scoriaceous olivine basalt, fissure at western foot of Gara Bolalo (CINDER geodimeter station), 13 km east-southeast of Adama (whole rock).
Sample 5: Tholeiitic olivine basalt, SELASSIE geodimeter station, 6 km west of Sire (whole rock).

Note: Analyzed by Geochron Laboratories. (Two argon analyses were made on samples 2, 3, and 4; four on sample 1; and three on sample 5.)

Silicic rocks interbedded in the basalts became more common toward the end of the Miocene (Rex, Gibson, and Dakin, 1971); and in the Pliocene, they became dominant in the form of voluminous ash-flow tuffs, which filled the now rapidly subsiding rift trough, until the major graben-faulting occurred in the late Pliocene–early Pleistocene (Mohr, 1967; Baker et al., 1972). Since that event, volcanism and tectonism have been largely restricted to the graben floor, and most recently (Holocene), to discrete, narrow zones trending along the axis or margins of the rift.

It is noted that the long period of fissure-basaltic volcanism in Ethiopia is distinctive compared with the brief history of other basaltic piles of similar volume – for example, the Deccan Traps (Kaneoka and Haramura, 1973) and the Columbia River Basalts (Snavely, MacLeod, and Wagner, 1973). This is because of the long-standing existence and slow evolution of the Ethiopian rift system, the latter being expressed in the alkaline chemistry and mineralogy of the lavas, unusual for a thick basaltic pile.

Two of the radiometric ages given in Table A-1 refer to the basalts found capping the eastern and western margins of the rift, respectively, at Sire on the Somalian plateau and at Addis Ababa on the Ethiopian plateau. The ages indicate that these youngest basalts on each side of the rift could be coeval at ~6.5 m.y. In both instances, the basalts have tholeiitic tendencies, and total only some tens of meters in thickness as a thin capping to a massive succession of pantelleritic ash-flow tuffs. These tuffs are especially well exposed by the eastern-margin faulting of the rift, at Sire (E. C. Potter, in preparation); here, the capping basalt is observed to be displaced down to the rift floor by the faulting (DiPaola, 1973), which must therefore be younger than 6.5 m.y. – the faults are, in fact, tentatively ascribed an early Pleistocene age.

Rex et al. (1971) have shown that major basaltic volcanism on the rift margin, northeast of Addis Ababa, terminated close to 10 m.y. ago and was superseded by ash-flow tuffs. Therefore, the succession of thick ash-flow tuff exposed in the Addis Ababa–Sire sector would seem to have been largely formed during the 10- to 6.5-m.y. interval, filling the proto-rift trough between the warping margins. Isolated silicic centers continued their activity beyond this interval – for example, at Wachacha and Yerer on the western margin of the rift, for which potassium-argon ages of 4.6 m.y. have been obtained (Miller and Mohr, 1966). From the central sector of the rift floor, near Mojjo, a new radiometric age is available that dates the termination of major silicic volcanism there: An end-phase, fault-controlled extrusion of porphyritic obsidian through ash-flow tuffs of the southern flank of Mt. Bokkam yields an age of 5.2 m.y.

If lithospheric separation analogous to sea-floor spreading is to be postulated for the main Ethiopian rift, it must have occurred before the regional ash-flow-tuff eruptions ended. These late Miocene–early Pliocene ash-flow tuffs blanket the whole width of the rift, where exposure is deep enough to provide this test; even where the Wonji fault belt crosses the Adama–Kaletta sector of the rift (Mohr, 1973a), Pliocene tuffs are suspected at the base of the exposed succession, although radiometric ages are not yet available. If (and this is a very debatable "if") the rigid, uppermost crust of the rift floor remains competent on the underlying, more plastic material, then the amount of lithospheric extension at this plate boundary is represented solely by surficial faulting (Mohr, 1973a), and not by a single transcrustal zone of lithospheric accretion.

Radiometric ages have been obtained for two lines of basaltic volcanism superimposed on the ash-flow tuffs of the rift floor. The line of denuded cones passing between Akaki and Dukam, on the western side of the rift, is the site at Gara Bushu of a scoriaceous hawaiite dyke cutting dense, black, olivine basalt lavas (Mohr, 1971, p. 37). Mohr (1973a) attributed a possible mid-Quaternary age to the faulting associated with the denuded cones; the early Quaternary age (2.8 m.y.) given by radiometric analysis of the dyke now favors an early Quaternary age for the initiation of faulting.

The most recently active sector of the rift floor, the Wonji fault belt, passes northward from the eastern shores of Lake Zway, via Gadamsa caldera to the Mojjo–Adama horst (Mohr, 1967; DiPaola, 1973; Thrall, 1974). Here, the active zone is transposed eastward to the Kaletta–Boseti Guda alignment, which continues strongly northward to the Kassam valley (Mohr, 1974). It is on this latter alignment that a basaltic fissure line is well exposed at Gara Bolalo (geodimeter station CINDER). The fissure feeder is 1 to 2 m wide, trends north-northeast, and is marked by excellently preserved cinder cones and, to the south, masking basalt lavas. The obtained radiometric age of 3.5 m.y. is difficult to reconcile with the youthful profile of the apparently associated cinder cones: Either the cones are unsuspectedly younger than the fissure basalts, or inherited ^{40}Ar is present in the analyzed rock. A comparison needs to be made between fissure and central basalts to see if potassium-argon ages for the former can be more affected by inherited ^{40}Ar, and also to see if certain parameters of fissure basalts and dykes can be related to this problem (Megrue et al., 1972; Mohr, 1973b).

The geological significance of the radiometric ages presented here has an implication for the geodimeter surveys that was already suspected: that the zone of strain accumulation in the rift floor has become narrowed into discrete belts where faulting has become correspondingly more concentrated; but as yet, no single line of transcrustal injection and plate accretion has been produced (although in geological terms, the time for this may not now be far off).

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APPENDIX B

STATION ABBREVIATIONS, REVISED ELEVATIONS, AND ASSIGNED STATION FACTORS

APPENDIX B

STATION ABBREVIATIONS, REVISED ELEVATIONS, AND ASSIGNED STATION FACTORS

The elevations of all stations established in 1969 are now quoted to the nearest meter, with the U. S. Coast & Geodetic Survey triangulation base at DUKAM used as reference. All other stations are quoted to the nearest 5 m, as their elevations are currently known only from altimeter observations.

The elevations in the Lakes Langana and Margherita networks are given relative to the lake elevations of 1582 and 1175 m, respectively, determined from U.S. Army leveling.

No consistent altimeter elevation can be derived from existing data for station AYGU; this will be a subject of investigation on the next resurvey.

Station	Abbreviation	Elevation (m)	Station factor
DUKAM	DU	1937.4	1.0
FOKA	FO	2014	0.25
DULLO	DL	1927	0.5
SAO	SA	1924	1.0
CRATER	CR	1920	0.5
CGS	CG	1886	1.0
QUARRY	QY	1885	0.5
ROAD	RD	1810	1.0
RAILWAY	RY	1807	1.0
MARIAM	MA	1949	0.25
GEORGE	GE	1781	0.5
RIDGE	RI	1731	0.5
ADAMA	AD	1637	1.0
FARENJI	FA	1638	1.0
ELPASO	EP	1741	0.5
GANTI	GN	1785	0.25
FULCRUM	FU	1649	0.25
BLOSSOM	BL	1665	0.5
GRAVES	GR	1477	0.5
CINDER	CI	1563	0.5

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Station	Abbreviation	Elevation (m)	Station factor
BOHALLA	BH	1405	0.5
BORI	BR	1425	0.5
BABOON	BB	1385	0.5
BOKU	BO	1885	0.5
OBSIDIAN	OB	1632	1.0
ROGGI	RO	1560	1.0
MIETCHI	MI	1839	0.25
TOPLESS	TO	1714	1.0
DUST	DU	1722	1.0
SELASSIE	SE	1854	1.0
SIRI	SI	1920	0.5
QUILL	QL	1560	0.25
SODERE	SO	1385	0.5
OOLAGA	OL	1430	1.0
PYLON	PY	1700	1.0
WONJI	WO	1625	0.5
KOKA	KO	1660	0.5
GALILA	GA	1615	0.5
YELLEM	YE	1625	1.0
THORNS	TH	1640	1.0
TABLE	TA	1525	1.0
AYGU	AY	1560?	0.5
MENDENO	ME	1620	1.0
RABBIT	RA	1605	0.5
HOTEL	HO	1655	0.5
TERMITE	TE	1645	1.0
GALLA	GL	1600	1.0
EUPHORBIA	EU	1625	1.0
LANGANA	LA	1665	0.5
ARJO	AR	1760	1.0
O'ITU	OI	1585	0.5
ALUTU	AL	1590	0.25
OOMAY	OY	1650	1.0
BMC	BC	1345	1.0
BMP	BP	1345	1.0
BMN	BN	1285	1.0
SHECHA	SH	1440	1.0
DUBI	DB	1175	0.5
KULFO	KU	1150	1.0
TOSASUCHA	TS	1260	0.5

APPENDIX C

GEODIS 1969 GEODIMETER DATA

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Code	Geodimeter station	Retroreflector station	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 .010
									.790 .005
AD	DUKAM AUX A	FOKA	1969 OCT 11	2325	12.8	40 23	9396.471	9396.486*	
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 .007
									.500 .002
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	6400.714	6400.719	
GF	DULLO	FOKA	1969 NOV 26	1930	17.2	22 23	6400.714	6400.718	6400.707 .012
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	6372.963	6372.963 0.000
AF	SAO	FOKA	1969 OCT 13	2340	15.6	19 17	3237.860	3237.866	
AG	FOKA	SAO	1969 OCT 13	2220	16.1	39 34	3237.870	3237.875	3237.869 .005
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 .001
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 .003
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	
FO	QUARRY	DULLO	1969 NOV 22	2045	17.1	33 31	7888.305	7888.313	7888.300 .008
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	513.439	513.440	
FY	CRATER	CGS	1969 NOV 24	2245	15.3	12 21	513.439	513.440	
GI	CGS	CRATER	1969 NOV 27	0030	13.7	36 15	513.431	513.432	
GI	CGS	CRATER	1969 NOV 27	0030	13.7	83 28	513.430	513.431	
GI	CGS	CRATER	1969 NOV 27	0030	13.7	83 22	513.430	513.431	
GI	CGS	CRATER	1969 NOV 27	0030	13.7	13 21	513.430	513.431	513.435 .004
GB	CRATER AUX A	CGS	1969 NOV 24	2215	15.3	34 13	505.960	505.961	

*Anomalous measurements.

Code	Geodimeter station	Retroreflector station	Date	Time	Temp.	Spread		Corrected D	Final D	Line Average	
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	.000
AY	QUARRY	ROAD AUX A	1969 OCT 22	0130	13.3	6	11	5907.212	5907.226		
AY	QUARRY	ROAD AUX A	1969 OCT 22	0130	13.3	18	24	5907.214	5907.228		
AZ	ROAD AUX A	QUARRY	1969 OCT 21	2345	13.9	14	13	5907.210	5907.222		
AZ	ROAD AUX A	QUARRY	1969 OCT 21	2345	13.9	17	22	5907.208	5907.220	5907.224	.003
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	5774.447		
BD	ROAD	RAILWAY	1969 OCT 23	0015	16.7	28	18	5774.435	5774.451		
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	5774.455	.009
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	5774.373		
BC	RAILWAY AUX A	ROAD	1969 OCT 22	2315	17.2	37	24	5774.356	5774.371	5774.378	.012
										.373	.003
BA	ROAD AUX A	RAILWAY	1969 OCT 21	2300	16.1	28	28	5734.986	5735.001		
BB	RAILWAY	ROAD AUX A	1969 OCT 22	0045	12.8	16	6	5734.982	5734.999		
BB	RAILWAY	ROAD AUX A	1969 OCT 22	0045	12.8	38	18	5734.984	5735.001		
BB	RAILWAY	ROAD AUX A	1969 OCT 22	0045	12.8	23	24	5734.982	5734.999		
BB	RAILWAY	ROAD AUX A	1969 OCT 22	0045	12.8	38	24	5734.983	5735.000	5735.000	.001
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	3929.200		
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	3937.597	3937.581	.016
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	.008
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	7259.067		
BZ	GEORGE AUX A	MARIAM	1969 OCT 29	2330	17.9	22	5	7259.063	7259.070		
BZ	GEORGE AUX A	MARIAM	1969 OCT 29	2330	17.9	16	14	7259.062	7259.069		
BZ	GEORGE AUX A	MARIAM	1969 OCT 29	2330	17.9	20	20	7259.061	7259.068		

Code	Geodimeter station	Retroreflector station	Date	Time	Temp.	Spread	Corrected D	Final D	Line average
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	7259.069	
BZ	GEORGE AUX A	MARIAM	1969 OCT 29	2330	17.9	14 38	7259.060	7259.068	7259.074 .008
BJ	MARIAM AUX A	GEORGE	1969 OCT 23	2300	19.1	10 17	7257.179	7257.186	
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 .007
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	2529.965	2529.968	
EB	RIDGE	GEORGE	1969 NOV 14	0015	17.2	12 13	2529.968	2529.972	
EC	RIDGE	GEORGE	1969 NOV 13	2315	17.3	31 21	2529.937	2529.941	
EC	RIDGE	GEORGE	1969 NOV 13	2315	17.3	25 21	2529.940	2529.943	2529.956 .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 .009
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 .000
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 .001
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 .003
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	2878.000	2878.000 .001
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	6625.359	
CZ	(EL PASO)	RIDGE	1969 NOV 4	0100	17.5	17 12	6625.353	6625.363	6625.356 .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	6631.488	6631.484 .004
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 .003
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	

Code	Geodimeter station	Retroreflector station	Date	Time	Temp.	Spread	Corrected D	Final D	Line Average
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 .008 (.247 .003)
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	5339.747	5339.750	
DX	(FULCRUM)	RIDGE	1969 NOV 10	2000	18.7	18 20	5339.750	5339.753	
EA	RIDGE	(FULCRUM)	1969 NOV 14	0115	15.0	36 19	5339.751	5339.757	
EA	RIDGE	(FULCRUM)	1969 NOV 14	0115	15.0	27 19	5339.751	5339.757	5339.754 .003
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 .008
DA	EL PASO AUX A	ADAMA	1969 NOV 3	2330	18.2	24 29	6153.603	6153.615	6153.615 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 .003
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 .003
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 .001
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 .009 (.025 .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 .001
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 .003
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 .002

Code	Geodimeter station	Retroreflector station	Date	Time	Temp.	Spread	Corrected D	Final D	Line Average
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 .003
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
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 .001
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	5866.821	
FI	GRAVES	CINDER	1969 NOV 22	0100	16.8	27 22	5866.814	5866.823	
FK	GRAVES	CINDER	1969 NOV 21	2400	16.5	21 15	5866.816	5866.824	
FK	GRAVES	CINDER	1969 NOV 21	2400	16.5	21 17	5866.819	5866.827	5866.824 .002
FJ	GRAVES AUX A	CINDER	1969 NOV 22	0030	16.8	37 28	5876.669	5876.678	
FJ	GRAVES AUX A	CINDER	1969 NOV 22	0030	16.8	37 28	5876.672	5876.680	
FL	GRAVES AUX A	CINDER	1969 NOV 21	2330	16.8	27 22	5876.668	5876.675	
FL	GRAVES AUX A	CINDER	1969 NOV 21	2330	16.8	27 19	5876.671	5876.678	5876.678 .002
DI	OBSIDIAN	ROGGI	1969 NOV 5	2400	17.6	47 30	6074.160	6074.177	
DI	OBSIDIAN	ROGGI	1969 NOV 5	2400	17.6	30 17	6074.170	6074.186	
DI	OBSIDIAN	ROGGI	1969 NOV 5	2400	17.6	35 29	6074.170	6074.186	
DI	OBSIDIAN	ROGGI	1969 NOV 5	2400	17.6	43 17	6074.163	6074.180	
DR	ROGGI	OBSIDIAN	1969 NOV 07	2315	16.7	21 15	6074.162	6074.178	
DR	ROGGI	OBSIDIAN	1969 NOV 07	2315	16.7	3 12	6074.158	6074.174	
DR	ROGGI	OBSIDIAN	1969 NOV 07	2315	16.7	22 25	6074.163	6074.179	
DR	ROGGI	OBSIDIAN	1969 NOV 07	2315	16.7	3 25	6074.161	6074.176	6074.179 .004
DH	OBSIDIAN	ROGGI AUX A	1969 NOV 5	2230	18.6	7 14	6089.912	6089.927	
DH	OBSIDIAN	ROGGI AUX A	1969 NOV 5	2230	18.6	26 5	6089.912	6089.926	
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	6089.924 .002
DG	OBSIDIAN R.M.	ROGGI	1969 NOV 06	0045	17.2	35 24	6081.086	6081.104	6081.104 0.000

Code	Geodimeter station	Retroreflector station	Date	Time	Temp.	Spread		Corrected D	Final D	Line average
DU	ROGGI	MIETCHI	1969 NOV 07	1930	19.2	14	19	6260.898	6260.904	
EE	ROGGI	MIETCHI	1969 NOV 13	2015	17.7	20	18	6260.897	6260.904	6260.904 0.000
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	6236.791	6236.798	
DT	ROGGI AUX A	MIETCHI	1969 NOV 07	2015	18.6	11	16	6236.794	6236.801	
DT	ROGGI AUX A	MIETCHI	1969 NOV 07	2015	18.6	14	22	6236.793	6236.800	
DT	ROGGI AUX A	MIETCHI	1969 NOV 07	2015	18.6	14	12	6236.797	6236.805	6236.801 .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	5566.621	5566.628	
EH	TOPLESS	MIETCHI	1969 NOV 14	2045	17.9	14	16	5566.623	5566.630	
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 .004
EG	TOPLESS AUX A	MIETCHI	1969 NOV 24	2130	17.3	23	12	5576.982	5576.990	
EG	TOPLESS AUX A	MIETCHI	1969 NOV 24	2130	17.3	29	16	5576.987	5576.994	
EI	TOPLESS AUX A	MIETCHI	1969 NOV 14	1945	18.9	15	4	5576.990	5576.996	
EI	TOPLESS AUX A	MIETCHI	1969 NOV 14	1945	18.9	30	17	5576.992	5576.998	5576.994 .003
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	5511.373	
FX	DUST	MIETCHI	1969 NOV 14	2345	13.7	22	25	5511.365	5511.375	5511.373 .001
FW	DUST AUX A	MIETCHI	1969 NOV 15	0030	13.6	9	23	5521.134	5521.144	5521.144 0.000
EP	DUST	TOPLESS	1969 NOV 16	0120	13.6	32	29	1709.682	1709.688	
EP	DUST	TOPLESS	1969 NOV 16	0120	13.6	19	12	1709.684	1709.689	
EV	TOPLESS	DUST	1969 NOV 16	2315	15.4	36	33	1709.692	1709.697	
EV	TOPLESS	DUST	1969 NOV 16	2315	15.4	13	7	1709.690	1709.695	1709.692 .004
EO	DUST AUX A	TOPLESS	1969 NOV 16	0150	12.4	34	26	1684.639	1684.645	
EO	DUST AUX A	TOPLESS	1969 NOV 16	0150	12.4	16	2	1684.639	1684.644	
EO	DUST AUX A	TOPLESS	1969 NOV 16	0150	12.4	34	13	1684.637	1684.642	
EO	DUST AUX A	TOPLESS	1969 NOV 16	0150	12.4	29	26	1684.642	1684.648	1684.644 .002
EU	TOPLESS AUX A	DUST	1969 NOV 16	2345	15.8	47	36	1739.338	1739.343	
EU	TOPLESS AUX A	DUST	1969 NOV 16	2345	15.8	43	41	1739.343	1739.348	
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	7489.387	7489.398	
ET	SELASSIE	TOPLESS	1969 NOV 16	1900	18.9	20	12	7489.389	7489.401	7489.399 .001
ES	SELASSIE AUX A	TOPLESS	1969 NOV 16	1940	18.6	17	11	7469.983	7469.995	7469.995 0.000
EK	TOPLESS AUX A	SELASSIE	1969 NOV 15	2015	17.9	33	16	7466.236	7466.249	
EK	TOPLESS AUX A	SELASSIE	1969 NOV 15	2015	17.9	13	15	7466.235	7466.248	
EK	TOPLESS AUX A	SELASSIE	1969 NOV 15	2015	17.9	33	7	7466.234	7466.248	
EK	TOPLESS AUX A	SELASSIE	1969 NOV 15	2015	17.9	22	28	7466.235	7466.249	7466.248 .001
EN	DUST	SELASSIE	1969 NOV 15	2220	16.0	17	27	8686.855	8686.876	

Code	Geodimeter station	Retroreflector station	Date	Time	Temp.	Spread		Corrected D	Final D	Line average
EN	DUST	SELASSIE	1969 NOV 15	2220	16.0	16	18	8686.857	8686.877	
EQ	SELASSIE	DUST	1969 NOV 16	2100	17.8	31	29	8686.870	8686.887	
EQ	SELASSIE	DUST	1969 NOV 16	2100	17.6	24	29	8686.874	8686.891	8686.882 .006
ER	SELASSIE AUX A	DUST	1969 NOV 16	2020	18.2	28	32	8662.804	8662.820	
ER	SELASSIE AUX A	DUST	1969 NOV 16	2020	18.2	11	12	8662.804	8662.820	8662.820 0.000
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	198.526	
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	198.525	
FS	NORTHWEST(X)	SOUTHEAST(0)	1969 NOV 23	2400	16.1	13	28	198.525	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	198.523	198.524	
FT	NORTHWEST(X)	SOUTHEAST(0)	1969 NOV 23	2330	16.1	31	22	198.527	198.527	
FT	NORTHWEST(X)	SOUTHEAST(0)	1969 NOV 23	2330	16.1	28	17	198.524	198.524	
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	297.833	
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 D

LASER8 GEODIMETER DATA

Code	Geodimeter station	Retroreflector station	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	.001
KY	BOKU	MARIAM	1970 NOV 14	1530	22.9	31 M	16322.444	16322.454		
KZ	BOKU	MARIAM	1970 NOV 14	1540	22.7	22 M	16322.428	16322.438	16322.445	.008
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	.003
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	9430.843	9430.850	9430.860	.011
									.850	.001
HZ	RIDGE	ADAMA	1970 NOV 03	1150	24.7	9 M	2865.567	2865.569	2865.569	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	2866.135	2866.133		
HP	ADAMA	RIDGE R.M.	1970 NOV 02	1640	24.8	26 R	2866.101	2866.104	2866.123	.013
HY	RIDGE	EL PASO AUX A	1970 NOV 03	1105	23.1	20 M	6631.490	6631.491	6631.491	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	.011
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	.004
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	.005
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	.005
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

*Anomalous measurements; they include first-of-the-day measurements JG, IW, and KQ, suggesting insufficient warm-up time for the geodimeter.

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Code	Geodimeter station	Retroreflector station	Date	Time	Temp.	Spread	Corrected D	Final D	Line average
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 .011
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 .002
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 .005
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 .002
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 .006
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 .005
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 .007
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 .004
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 .018
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 .004
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 .004
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 .021 .410 .006
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	12578.463	12578.457	12578.449 .013
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	

Code	Geodimeter station	Retroreflector station	Date	Time	Temp.	Spread	Corrected D	Final D	Line average	
KV	BOKU	(FULCRUM)	1970 NOV 14	1020	21.4	33 R	6902.417	6902.416	6902.404	.007
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	13466.913	13466.923 .913	.009
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	.003
KM	BOHALLA	CINDER AUX A	1970 NOV 13	1110	24.3	29 M	7223.521	7223.522		
KN	BOHALLA	CINDER AUX A	1970 NOV 13	1118	24.4	11 M	7223.526	7223.527	7223.525	.003
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	.005
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	.004
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	.021 .004
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	.010
HC	TABLE	AYGU	1970 OCT 30	1112	25.2	9 M	7678.141	7678.142		
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	7678.178	7678.177 *		
KD	AYGU	TABLE	1970 NOV 12	1030	25.1	21 M	7678.173	7678.171 *		
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	7678.153	7678.151	7678.150 .140	.015 .008
HA	TABLE	MENDENO	1970 OCT 30	0915	23.0	4 M	6858.870	6858.862		
HB	TABLE	MENDENO	1970 OCT 30	0920	23.5	3 M	6858.876	6858.870		
IM	MENDENO	TABLE	1970 NOV 05	1325	27.7	8 M	6858.850	6858.858		
JA	TABLE	MENDENO	1970 NOV 08	1240	26.1	15 R	6858.849	6858.855	6858.862	.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	.005
II	MENDENO	AYGU	1970 NOV 05	0950	24.8	14 M	7829.049	7829.045		
IJ	MENDENO	AYGU	1970 NOV 05	1000	24.8	22 M	7829.045	7829.042		
KA	AYGU	MENDENO	1970 NOV 12	0858	21.0	25 M	7829.069	7829.062		
KB	AYGU	MENDENO	1970 NOV 12	0906	21.4	18 M	7829.067	7829.060	7829.052	.009

Code	Geodimeter station	Retroreflector station	Date	Time	Temp.	Spread	Corrected D	Final D	Line average	
JW	AYGU	RABBIT	1970 NOV 11	0955	21.4	9 R	7220.501	7220.499		
JX	AYGU	RABBIT	1970 NOV 11	1020	22.0	25 R	7220.483	7220.482		
KE	AYGU	RABBIT	1970 NOV 12	1155	23.0	19 M	7220.497	7220.499		
KF	AYGU	RABBIT	1970 NOV 12	1220	23.4	35 M	7220.496	7220.499		
MH	AYGU	RABBIT	1970 NOV 21	0835	19.0	17 M	7220.516	7220.511		
MI	AYGU	RABBIT	1970 NOV 21	0847	19.4	20 M	7220.506	7220.501	7220.499	.009
IK	MENDENO	RABBIT	1970 NOV 05	1205	26.1	13 M	13687.791	13687.798		
IL	MENDENO	RABBIT	1970 NOV 05	1220	26.4	11 M	13687.791	13687.799	13687.799	.000
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	764.071	764.070		
LS	HOTEL	GALLA	1970 NOV 18	0910	19.4	8 M	764.063	764.062		
LT	HOTEL	GALLA	1970 NOV 18	0920	19.3	13 M	764.056	764.055	764.064	.007
LE	GALLA	TERMITE	1970 NOV 17	0835	18.2	3 R	746.051	746.049		
LF	GALLA	TERMITE	1970 NOV 17	0850	18.6	26 R	746.051	746.050		
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	746.051	.001
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	2852.132	2852.130		
LO	EUPHORBIA	GALLA	1970 NOV 17	1815	22.2	17 M	2852.135	2852.139		
LP	EUPHORBIA	GALLA	1970 NOV 17	1822	22.0	13 M	2852.130	2852.134		
MC	EUPHORBIA	GALLA	1970 NOV 19	0945	19.7	13 R	2852.133	2852.131	2852.132	.005
MD	EUPHORBIA AUX A	GALLA	1970 NOV 19	1010	20.9	16 R	2862.169	2862.168		
ME	EUPHORBIA AUX A	GALLA	1970 NOV 19	1022	21.1	6 R	2862.165	2862.164	2862.166	.002
LQ	HOTEL	TERMITE	1970 NOV 18	0830	18.6	15 M	1022.598	1022.597		
LR	HOTEL	TERMITE	1970 NOV 18	0845	19.1	4 M	1022.602	1022.601		
LU	TERMITE	HOTEL	1970 NOV 18	1630	24.7	18 M	1022.595	1022.596		
LV	TERMITE	HOTEL	1970 NOV 18	1645	24.5	38 M	1022.584	1022.585	1022.597	.006
LI	EUPHORBIA	HOTEL	1970 NOV 17	1627	25.4	27 M	3517.927	3517.931		
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	3517.938		
LZ	EUPHORBIA	HOTEL	1970 NOV 19	0826	18.1	15 R	3517.946	3517.942	3517.936	.004
LK	EUPHORBIA AUX A	HOTEL	1970 NOV 17	1645	24.8	14 M	3524.757	3524.761	3524.761	0.000
LM	EUPHORBIA	TERMITE	1970 NOV 17	1735	23.3	20 M	3358.113	3358.117		
LN	EUPHORBIA	TERMITE	1970 NOV 17	1742	23.0	13 M	3358.116	3358.119		
MA	EUPHORBIA	TERMITE	1970 NOV 19	0900	18.9	10 R	3358.131	3358.127		
MB	EUPHORBIA	TERMITE	1970 NOV 19	0912	19.3	18 R	3358.129	3358.125	3358.122	.004
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	.000
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

Code	Geodimeter station	Retroreflector station	Date	Time	Temp.	Spread	Corrected D	Final D	Line average	
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	.005
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	.002
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	.001

APPENDIX E

PAPAYA 1971 GEODIMETER DATA

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Code	Geodimeter station	Retroreflector station	Date	Time	Temp.	Spread	Corrected D	Final D	Line average	
DG	MARIAM	GEORGE	1971 NOV 07	1710	24.2	4 M	7262.547	7262.551		
DH	MARIAM	GEORGE	1971 NOV 07	1720	23.9	1 W	7262.545	7262.548		
DI	MARIAM	GEORGE	1971 NOV 07	1730	23.5	2 M	7262.550	7262.552	7262.550	.001
DJ	MARIAM	GEORGE AUX A	1971 NOV 07	1745	22.9	3 W	7259.094	7259.097		
DK	MARIAM	GEORGE AUX A	1971 NOV 07	1800	22.4	6 M	7259.091	7259.093	7259.095	.002
DL	MARIAM	RIDGE	1971 NOV 07	1830	21.3	18 M	9759.372	9759.374		
DM	MARIAM	RIDGE	1971 NOV 07	1840	20.7	24 W	9759.372	9759.374	9759.374	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	.001
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 H	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 H	4470.825	4470.829	4470.830	.000
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	.002
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	6642.844	6642.852	6642.851	.000
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 H	9430.861	9430.854*		
AJ	BOKU	GEORGE	1971 NOV 01	0825	19.7	9 M	9430.843	9430.836	9430.844	.008
									.838	.002
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	2865.565	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	2865.568	2865.573		

*Anomalous measurements; they include measurements made at the wrong signal strength: WX, AI, AL, AN, AP, AU, AW, AY, BA, BR, BS, and BW.

Code	Geodimeter station	Retroreflector station	Date	Time	Temp.	Spread	Corrected D	Final D	Line average	
WZ	RIDGE	ADAMA	1971 OCT 20	2115	19.0	7 M	2865.567	2865.572	2865.568	.005
VG	RIDGE	ADAMA AUX A	1971 OCT 17	1800	23.6	4 M	2874.391	2874.394		
VO	RIDGE	ADAMA AUX A	1971 OCT 18	1000	25.4	5 M	2874.411	2874.410	2874.402	.008
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	.002
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	3022.253	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 H	3022.252	3022.258		
XB	RIDGE	FARENJI	1971 OCT 20	2245	16.3	8 M	3022.252	3022.258	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	.001
WE	FARENJI	RIDGE AUX A	1971 OCT 19	1620	25.6	12 M	3026.087	3026.089		
WF	FARENJI	RIDGE AUX A	1971 OCT 19	1630	25.4	6 M	3026.084	3026.086	3026.087	.002
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	5335.171	5335.173	5335.164	.006
XC	RIDGE	FULCRUM AUX B	1971 OCT 21	0000	16.1	12 M	5337.053	5337.059		
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	.008
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	.004
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	.002
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	.003
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 .239	.020 .012
AM	BOKU	RIDGE AUX A	1971 NOV 01	0925	21.9	42 M	6983.095	6983.093		

Code	Geodimeter station	Retroreflector station	Date	Time	Temp.	Spread	Corrected D	Final D	Line average	
AN	BOKU	RIDGE AUX A	1971 NOV 01	0935	22.4	36 M	6983.099	6983.098	6983.096	.003
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	.004
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 M	1407.500	1407.498		
WP	FARENJI AUX B	ADAMA	1971 OCT 20	0935	23.1	6 M	1407.491	1407.490	1407.494	.004
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	.002
WU	ADAMA	GANTI	1971 OCT 20	1545	25.8	26 M	6100.377	6100.382		
WV	ADAMA	GANTI	1971 OCT 20	1605	25.4	5 M	6100.372	6100.376	6100.378	.003
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 M	7427.132	7427.132*	7427.126 .120	.006
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	.003
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 M	2307.111	2307.112*	2307.106 .099	.006
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	.014
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	.002
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	.001
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 M	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 M	7318.009	7318.015		
ZO	GRAVES	FULCRUM AUX A	1971 OCT 28	2120	15.4	13 M	7317.992	7317.998	7318.014	.008
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 M	7341.668	7341.670	7341.669	.001
XR	GRAVES	FULCRUM AUX B	1971 OCT 22	1555	26.9	26 M	7316.550	7316.553		
XS	GRAVES	FULCRUM AUX B	1971 OCT 22	1610	26.8	22 M	7316.553	7316.556	7316.555	.001

Code	Geodimeter station	Retroreflector station	Date	Time	Temp.	Spread	Corrected D	Final D	Line average	
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	.002
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	.006
WW	FULCRUM AUX A	GANTI	1971 OCT 20	1640	24.5	19 M	4773.654	4773.655		
WX	FULCRUM AUX A	GANTI	1971 OCT 20	1655	24.2	14 H	4773.670	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	4773.648	4773.647	4773.656 .651	.011 .003
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 .095	.008
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	.003
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	.005
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	9216.859	9216.857	9216.857	0.000
DA	SODERE	CINDER	1971 NOV 06	1655	26.2	11 M	11778.552	11778.560		
DB	SODERE	CINDER	1971 NOV 06	1710	25.9	12 T	11778.556	11778.564		
DC	SODERE	CINDER	1971 NOV 06	1720	25.7	3 M	11778.557	11778.564	11778.563	.002
DD	SODERE	CINDER AUX A	1971 NOV 06	1735	25.3	13 T	11756.222	11756.228		
DE	SODERE	CINDER AUX A	1971 NOV 06	1745	24.9	8 M	11756.221	11756.227		
DF	SODERE	CINDER AUX A	1971 NOV 06	1800	24.4	6 T	11756.224	11756.229	11756.228	.001
EX	SIRI	CINDER	1971 NOV 10	1110	24.2	21 H	24358.244	24358.246		
EY	SIRI	CINDER	1971 NOV 10	1120	24.2	36 T	24358.241	24358.244		
EZ	SIRI	CINDER	1971 NOV 10	1135	24.7	34 H	24358.237	24358.242	24358.244	.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		

Code	Geodimeter station	Retroreflector station	Date	Time	Temp.	Spread	Corrected D	Final D	Line average	
YI	BOHALLA	CINDER AUX A	1971 OCT 23	1230	26.3	19 M	7223.522	7223.524	7223.525	.007
CU	SIRI	ROGGI AUX A	1971 NOV 06	1000	22.7	8 M	17400.551	17400.543		
CV	SIRI	ROGGI AUX A	1971 NOV 06	1010	22.8	41 H	17400.548	17400.541		
CW	SIRI	ROGGI AUX A	1971 NOV 06	1020	23.0	16 M	17400.549	17400.544	17400.543	.001
BG	BOKU	ROGGI AUX A	1971 NOV 02	1030	23.1	10 T	9857.970	9857.968		
BH	BOKU	ROGGI AUX A	1971 NOV 02	1040	23.2	34 W	9857.967	9857.966	9857.967	.001
BE	BOKU AUX A	ROGGI AUX A	1971 NOV 02	0945	22.9	11 W	9856.443	9856.437		
BF	BOKU AUX A	ROGGI AUX A	1971 NOV 02	1005	22.9	42 T	9856.448	9856.444	9856.439	.004
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	.003
BQ	OOLAGA	MIETCHI	1971 NOV 03	0820	18.7	12 M	7578.954	7578.949		
BR	OOLAGA	MIETCHI	1971 NOV 03	0830	18.6	18 H	7578.933	7578.928 *		
BS	OOLAGA	MIETCHI	1971 NOV 03	0840	18.7	27 H	7578.932	7578.928 *		
BT	OOLAGA	MIETCHI	1971 NOV 03	0850	18.9	1 M	7578.957	7578.953		
BU	OOLAGA	MIETCHI	1971 NOV 03	0900	18.8	18 M	7578.957	7578.953	7578.945	.012
									.952	.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	14052.186		
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	14052.182	.003
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	.004
BI	BOHALLA	MIETCHI	1971 NOV 02	1645	24.2	10 M	16768.249	16768.257		
BJ	BOHALLA	MIETCHI	1971 NOV 02	1700	23.9	13 T	16768.246	16768.252		
BK	BOHALLA	MIETCHI	1971 NOV 02	1715	23.6	24 T	16768.223	16768.228 *		
BL	BOHALLA	MIETCHI	1971 NOV 02	1725	23.4	18 M	16768.254	16768.259	16768.251	.012
									.256	.003
FE	SIRI	SELASSIE	1971 NOV 11	0910	18.3	8 T	1951.106	1951.104		
FF	SIRI	SELASSIE	1971 NOV 11	0920	18.2	10 M	1951.109	1951.107		
FG	SIRI	SELASSIE	1971 NOV 11	0930	18.4	1 M	1951.106	1951.105		
FH	SIRI	SELASSIE	1971 NOV 11	0940	18.5	4 T	1951.105	1951.103	1951.105	.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	1980.151		
FK	SIRI	SELASSIE AUX A	1971 NOV 11	1030	20.1	5 H	1980.147	1980.147	1980.150	.002
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	.001
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		

Code	Geodimeter station	Retroreflector station	Date	Time	Temp.	Spread	Corrected D	Final D	Line average	
DW	KOKA	PYLON	1971 NOV 08	1220	26.5	14 T	3079.992	3079.994	3079.988	.005
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	.002
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	.004
ZE	TABLE	GANTI	1971 OCT 28	0745	18.4	8 M	22963.108	22963.074		
ZF	TABLE	GANTI	1971 OCT 28	0800	18.6	23 M	22963.110	22963.079	22963.076	.003
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	.005
CC	QUILL	SODERE	1971 NOV 04	1720	24.5	2 W	3856.840	3856.842		
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	3856.837	3856.839	3856.840	.002
BV	OOLAGA	QUILL	1971 NOV 03	0955	22.9	6 M	2357.716	2357.716		
BW	OOLAGA	QUILL	1971 NOV 03	1005	23.3	14 H	2357.704	2357.704 *		
BX	OOLAGA	QUILL	1971 NOV 03	1020	23.3	21 H	2357.712	2357.712		
BY	OOLAGA	QUILL	1971 NOV 03	1035	23.3	17 M	2357.721	2357.721		
CF	QUILL	OOLAGA	1971 NOV 04	1830	22.1	3 T	2357.710	2357.712		
CG	QUILL	OOLAGA	1971 NOV 04	1840	21.5	2 T	2357.711	2357.714		
CH	QUILL	OOLAGA	1971 NOV 04	1850	21.0	5 H	2357.709	2357.711	2357.713	.005
									.714	.003
CX	SIRI	QUILL	1971 NOV 06	1050	23.1	9 M	16380.134	16380.133		
CY	SIRI	QUILL	1971 NOV 06	1100	23.3	11 H	16380.131	16380.132		
CZ	SIRI	QUILL	1971 NOV 06	1110	23.5	11 M	16380.134	16380.135	16380.133	.001
BM	BOHALLA	QUILL	1971 NOV 02	1825	23.3	10 M	10605.554	10605.559		
BN	BOHALLA	QUILL	1971 NOV 02	1835	23.2	14 T	10605.554	10605.560		
BO	BOHALLA	QUILL	1971 NOV 02	1845	23.0	15 M	10605.557	10605.563		
BP	BOHALLA	QUILL	1971 NOV 02	1850	22.9	6 T	10605.555	10605.562		
CI	BOHALLA	QUILL	1971 NOV 05	1655	25.7	7 M	10605.568	10605.573		
CJ	BOHALLA	QUILL	1971 NOV 05	1705	25.4	9 W	10605.568	10605.573	10605.565	.006
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	9274.222	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	.006
ES	SIRI	BOHALLA	1971 NOV 10	0900	22.3	14 T	18019.115	18019.103		

Code	Geodimeter station	Retroreflector station	Date	Time	Temp.	Spread	Corrected D	Final D	Line average	
ET	SIRI	BOHALLA	1971 NOV 10	0920	22.6	23 H	18019.121	18019.111		
EU	SIRI	BOHALLA	1971 NOV 10	0930	22.7	10 T	18019.127	18019.118		
EV	SIRI	BOHALLA	1971 NOV 10	0945	22.9	7 H	18019.124	18019.117		
EW	SIRI	BOHALLA	1971 NOV 10	0955	23.5	13 T	18019.133	18019.127	18019.116	.008
ZB	TABLE	AYGU	1971 OCT 27	1000	23.3	5 M	7678.143	7678.139		
ZC	TABLE	AYGU	1971 OCT 27	1005	23.5	27 H	7678.144	7678.140		
ZD	TABLE	AYGU	1971 OCT 27	1015	23.3	13 M	7678.145	7678.142		
ZJ	TABLE	AYGU	1971 OCT 28	1200	26.3	16 W	7678.133	7678.135		
ZK	TABLE	AYGU	1971 OCT 28	1215	26.4	12 T	7678.141	7678.144		
ZL	TABLE	AYGU	1971 OCT 28	1225	26.1	10 W	7678.136	7678.137	7678.139	.003
AF	MENDENO	TABLE	1971 OCT 31	1810	23.7	1 T	6858.855	6858.865		
AG	MENDENO	TABLE	1971 OCT 31	1820	23.4	1 M	6858.858	6858.868		
YW	TABLE	MENDENO	1971 OCT 26	1650	25.9	6 T	6858.866	6858.876		
YX	TABLE	MENDENO	1971 OCT 26	1705	25.5	7 W	6858.876	6858.884 *		
YY	TABLE	MENDENO	1971 OCT 26	1725	25.1	17 T	6858.861	6858.869		
YZ	TABLE	MENDENO	1971 OCT 27	0815	21.4	10 M	6858.870	6858.857		
ZA	TABLE	MENDENO	1971 OCT 27	0825	21.6	10 T	6858.881	6858.869	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	9418.284		
ZI	TABLE	RABBIT	1971 OCT 28	1040	24.2	10 T	9418.286	9418.286	9418.285	.001
AB	MENDENO	AYGU	1971 OCT 31	1650	25.5	6 M	7829.052	7829.060		
AC	MENDENO	AYGU	1971 OCT 31	1700	25.3	23 T	7829.049	7829.057		
AD	MENDENO	AYGU	1971 OCT 31	1710	25.1	4 M	7829.049	7829.056		
AE	MENDENO	AYGU	1971 OCT 31	1715	24.9	11 T	7829.045	7829.052	7829.056	.003
ZT	RABBIT	AYGU	1971 OCT 29	1545	26.7	45 M	7220.493	7220.498		
ZT	RABBIT	AYGU	1971 OCT 29	1545	26.7	47 M	7220.495	7220.500		
ZU	RABBIT	AYGU	1971 OCT 29	1605	26.4	21 W	7220.470	7220.475 *		
ZV	RABBIT	AYGU	1971 OCT 29	1630	26.0	15 W	7220.499	7220.502		
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	7220.510	7220.512	7220.502	.012
									.508	.006
AA	MENDENO	RABBIT	1971 OCT 31	1530	26.5	16 T	13687.810	13687.826		
ZY	MENDENO	RABBIT	1971 OCT 31	1505	26.5	16 T	13687.796	13687.813		
ZZ	MENDENO	RABBIT	1971 OCT 31	1520	26.5	19 M	13687.803	13687.819	13687.819	.005
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	746.042	746.042		
HE	GALLA	TERMITE	1971 NOV 18	1810	24.9	13 T	746.048	746.049		
HF	GALLA	TERMITE	1971 NOV 18	1820	24.7	7 W	746.043	746.045	746.045	.003
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	2852.145	2852.144	2852.142	.002
GI	EUPHORBIA AUX A	GALLA	1971 NOV 17	1745	25.1	5 W	2862.169	2862.172		

Code	Geodimeter station	Retroreflector station	Date	Time	Temp.	Spread	Corrected D	Final D	Line average	
GJ	EUPHORBIA AUX A	GALLA	1971 NOV 17	1800	24.5	5 T	2862.172	2862.175		
GK	EUPHORBIA AUX A	GALLA	1971 NOV 17	1815	24.3	3 W	2862.163	2862.167	2862.171	.003
HG	ARJO	GALLA	1971 NOV 19	0745	18.1	5 M	7435.801	7435.784		
HH	ARJO	GALLA	1971 NOV 19	0800	18.6	5 H	7435.798	7435.782		
HI	ARJO	GALLA	1971 NOV 19	0810	19.0	4 M	7435.804	7435.789	7435.785	.003
GW	HOTEL	TERMITE	1971 NOV 18	1535	25.7	7 T	1022.596	1022.597		
GX	HOTEL	TERMITE	1971 NOV 18	1545	25.6	4 W	1022.596	1022.597		
GY	HOTEL	TERMITE	1971 NOV 18	1600	25.5	8 T	1022.596	1022.598		
GZ	HOTEL	TERMITE	1971 NOV 18	1610	25.5	7 W	1022.594	1022.596	1022.597	.001
FS	EUPHORBIA	HOTEL	1971 NOV 17	0755	17.8	4 M	3517.929	3517.923		
FT	EUPHORBIA	HOTEL	1971 NOV 17	0805	18.3	7 H	3517.928	3517.923		
FU	EUPHORBIA	HOTEL	1971 NOV 17	0815	18.6	5 M	3517.932	3517.927		
FV	EUPHORBIA	HOTEL	1971 NOV 17	0825	18.5	7 H	3517.935	3517.930	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	.004
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	.000
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	.001
GF	EUPHORBIA AUX A	TERMITE	1971 NOV 17	1645	25.2	1 T	3372.622	3372.627		
GG	EUPHORBIA AUX A	TERMITE	1971 NOV 17	1700	24.4	12 T	3372.622	3372.627		
GH	EUPHORBIA AUX A	TERMITE	1971 NOV 17	1710	25.4	6 W	3372.622	3372.627	3372.627	.000
GT	LANGANA	TERMITE	1971 NOV 18	1000	21.6	10 M	2434.181	2434.180		
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	2434.177	2434.176	2434.177	.002
GL	LANGANA	EUPHORBIA	1971 NOV 18	0745	17.6	4 M	3232.706	3232.700		
GM	LANGANA	EUPHORBIA	1971 NOV 18	0755	17.9	8 H	3232.707	3232.701		
GN	LANGANA	EUPHORBIA	1971 NOV 18	0805	18.0	4 M	3232.704	3232.699	3232.700	.001
GO	LANGANA	EUPHORBIA AUX A	1971 NOV 18	0815	18.4	11 H	3259.859	3259.855		
GP	LANGANA	EUPHORBIA AUX A	1971 NOV 18	0825	19.1	11 M	3259.858	3259.854	3259.854	.000
HM	ARJO	EUPHORBIA	1971 NOV 19	0935	20.6	8 H	6206.148	6206.142		
HN	ARJO	EUPHORBIA	1971 NOV 19	0945	20.8	6 M	6206.146	6206.141		
HO	ARJO	EUPHORBIA	1971 NOV 19	0955	21.0	8 H	6206.146	6206.142	6206.142	.000
HP	ARJO	EUPHORBIA AUX A	1971 NOV 19	1010	21.4	3 M	6229.375	6229.373	6229.373	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	.002

Code	Geodimeter station	Retroreflector station	Date	Time	Temp.	Spread	Corrected D	Final D	Line average	
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	.002
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	.001
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	4851.706	4851.700		
HK	ARJO	LANGANA	1971 NOV 19	0845	19.8	6 H	4851.704	4851.699		
HL	ARJO	LANGANA	1971 NOV 19	0855	20.1	7 M	4851.707	4851.701	4851.700	.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	.002
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	.005
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	.001
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	.006

Code	Geodimeter station	Retroreflector station	Date	Time	Temp.	Spread	Corrected D	Final D	Line average	
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 M	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	.002
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 F

AWARRA 1973 RANGER DATA

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Code	Ranger III station	Retroreflector station	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 .015	H (30)
CR	MARIAM AUX A	RAILWAY	1973 MAR 30	1645	29.5	3937.603	3937.605 3937.606	.008 .006	W (20)
CV	MARIAM	GEORGE	1973 MAR 30	1820	27.9	7262.541	7262.543 7262.543	.004 .003	W (21)
CU	MARIAM	GEORGE AUX A	1973 MAR 30	1810	28.2	7259.091	7259.094 7259.094	.004 .003	M (20)
CS	MARIAM AUX A	GEORGE	1973 MAR 30	1750	28.9	7257.219	7257.221 7257.220	.010 .010	W (20)
CT	MARIAM AUX A	GEORGE AUX A	1973 MAR 30	1755	28.6	7253.754	7253.756 7253.755	.010 .009	M (20)
AA	RIDGE	GEORGE	1973 MAR 25	1545	29.9	2529.970	2529.971 2529.971	.016 .013	R (20)
AR	RIDGE	GEORGE	1973 MAR 27	0815	22.3	2529.954	2529.952 2529.952	.007 .006	W (20)
AB	RIDGE	GEORGE AUX A	1973 MAR 25	1610	30.1	2530.727	2530.728 2530.728	.010 .008	H (20)
AS	RIDGE	GEORGE AUX A	1973 MAR 27	0830	22.6	2530.736	2530.734 2530.735	.010 .009	M (20)
BG	ADAMA	GEORGE	1973 MAR 28	0850	23.8	4461.185	4461.180 4461.180	.005 .004	H (20)
AC	RIDGE	ADAMA	1973 MAR 25	1635	30.1	2865.574	2865.576 2865.576	.004 .003	W (20)
AT	RIDGE	ADAMA	1973 MAR 27	1000	26.8	2865.575	2865.574 2865.574	.007 .005	G (20)
BE	ADAMA	RIDGE	1973 MAR 28	0800	21.4	2865.571	2865.567 2865.567	.004 .003	H (20)
AD	RIDGE	ADAMA AUX A	1973 MAR 25	1700	29.9	2874.405	2874.408 2874.407	.004 .004	R (20)
AU	RIDGE	ADAMA AUX A	1973 MAR 27	1009	27.3	2874.411	2874.410 2874.409	.012 .008	M (20)
BF	ADAMA	RIDGE AUX A	1973 MAR 28	0810	22.3	2878.020	2878.016 2878.016	.004 .004	M (21)
AE	RIDGE	FARENJI	1973 MAR 25	1725	29.6	3022.251	3022.253 3022.252	.002 .001	H (20)
AV	RIDGE	FARENJI	1973 MAR 27	1030	26.4	3022.247	3022.246 3022.247	.005 .004	W (20)
AW	RIDGE	FARENJI AUX B	1973 MAR 27	1045	26.5	3011.182	3011.182	.007	W (20)

Code	Ranger III station	Retroreflector station	Date	Time	Temp.	Corrected D	Final D	S.D.	No.
							3011.182	.006	
AF	RIDGE	FARENJI AUX C	1973 MAR 25	1725	29.3	3012.008	3012.010	.003	W (20)
							3012.010	.002	
AZ	RIDGE	EL PASO AUX A	1973 MAR 27	1155	27.7	6631.483	6631.484	.006	W (20)
							6631.484	.005	
AX	RIDGE	GANTI	1973 MAR 27	1120	27.5	6673.488	6673.489	.012	M (20)
							6673.489	.010	
AY	RIDGE	GANTI AUX A	1973 MAR 27	1135	27.5	6672.896	6672.897	.006	G (20)
							6672.897	.005	
AG	RIDGE	FULCRUM AUX A	1973 MAR 25	1805	28.6	5335.165	5335.167	.002	W (20)
							5335.167	.002	
AH	RIDGE	FULCRUM AUX B	1973 MAR 25	1820	28.3	5337.056	5337.059	.002	G (20)
							5337.059	.002	
BC	RIDGE	FULCRUM AUX C	1973 MAR 27	1650	29.3	5334.033	5334.034	.012	R (20)
							5334.033	.008	
BD	RIDGE	FULCRUM AUX D	1973 MAR 27	1715	29.2	5335.403	5335.404	.012	W (20)
							5335.403	.011	
BA	RIDGE	BLOSSOM	1973 MAR 27	1605	29.9	6366.118	6366.121	.008	W (20)
							6366.120	.006	
BB	RIDGE	BLOSSOM AUX A	1973 MAR 27	1620	29.8	6367.697	6367.700	.008	W (20)
							6367.700	.007	
BY	BOKU	RIDGE	1973 MAR 29	1030	28.1	6998.221	6998.220	.008	M (20)
							6998.220	.007	
BZ	BOKU	RIDGE AUX A	1973 MAR 29	1040	28.4	6983.066	6983.065	.007	R (14)
							6983.065	.007	
AN	FARENJI	ADAMA	1973 MAR 26	1745	30.3	1400.903	1400.904	.004	H (20)
							1400.904	.004	
BH	ADAMA	FARENJI	1973 MAR 28	0922	25.8	1400.886	1400.885	.008	M (20)
							1400.885	.007	
BI	ADAMA	FARENJI AUX B	1973 MAR 28	0930	26.0	1407.485	1407.483	.009	H (22)
							1407.483	.007	
AO	FARENJI	ADAMA AUX A	1973 MAR 26	1755	29.7	1398.037	1398.038	.003	G (20)
							1398.038	.002	
BL	ADAMA	EL PASO AUX A	1973 MAR 28	1045	28.1	6153.593	6153.592	.003	M (3)
							(6153.595	.007)	
DC	ADAMA	EL PASO AUX A	1973 APR 01	0940	27.4	6153.609	6153.605	.010	M (20)
							6153.605	.008	
DD	ADAMA AUX A	EL PASO AUX A	1973 APR 01	0955	28.1	6150.073	6150.071	.008	R (20)

Code	Ranger III station	Retroreflector station	Date	Time	Temp.	Corrected D	Final D	S.D.	No.
							6150.070	.007	
BJ	ADAMA	GANTI	1973 MAR 28	1004	26.9	6100.373	6100.371	.009	M (23)
							6100.371	.008	
BK	ADAMA	GANTI AUX A	1973 MAR 28	1015	27.0	6101.593	6101.591	.009	H (20)
							6101.591	.008	
DA	FARENJI	EL PASO AUX A	1973 APR 01	0855	25.1	4757.483	4757.477	.009	M (20)
							4757.477	.008	
DB	FARENJI AUX B	EL PASO AUX A	1973 APR 01	0907	25.3	4752.318	4752.314	.008	R (20)
							4752.314	.007	
AP	FARENJI	GANTI	1973 MAR 26	1830	27.7	4709.990	4709.992	.003	R (20)
							4709.992	.003	
AQ	FARENJI	GANTI AUX A	1973 MAR 26	1840	27.4	4711.092	4711.095	.003	R (20)
							4711.095	.003	
AI	FARENJI	FULCRUM AUX A	1973 MAR 26	1540	31.1	2358.169	2358.170	.014	R (13)
							2358.171	.013	
AJ	FARENJI	FULCRUM AUX B	1973 MAR 26	1600	30.9	2359.590	2359.591	.006	R (10)
							2359.591	.005	
AK	FARENJI	FULCRUM AUX C	1973 MAR 26	1615	31.1	2370.993	2370.994	.007	H (20)
							2370.994	.006	
AL	FARENJI	FULCRUM AUX D	1973 MAR 26	1625	30.9	2372.330	2372.331	.005	G (20)
							2372.331	.004	
AM	FARENJI	BLOSSOM	1973 MAR 26	1710	30.8	3520.609	3520.612	.005	R (20)
							3520.612	.004	
BW	BOKU	FARENJI	1973 MAR 29	0935	26.3	6066.396	6066.392	.009	M (20)
							6066.393	.009	
BX	BOKU	FARENJI AUX B	1973 MAR 29	0950	27.0	6056.446	6056.443	.010	R (10)
							6056.442	.008	
BV	BOKU	EL PASO AUX A	1973 MAR 29	0825	22.2	2307.080	2307.078	.006	G (20)
							2307.077	.005	
CW	FULCRUM AUX A	GANTI	1973 APR 01	0745	21.2	4773.642	4773.639	.004	R (20)
							4773.640	.004	
CZ	FULCRUM AUX B	GANTI	1973 APR 01	0815	23.0	4770.751	4770.748	.005	R (20)
							4770.748	.004	
CX	FULCRUM AUX A	GANTI AUX A	1973 APR 01	0750	22.2	4776.547	4776.544	.005	G (20)
							4776.544	.005	
CY	FULCRUM AUX B	GANTI AUX A	1973 APR 01	0808	22.5	4773.628	4773.626	.006	M (20)

Code	Ranger III station	Retroreflector station	Date	Time	Temp.	Corrected D	Final D	S.D.	No.
							4773.626	.005	
BT	BOKU	GANTI	1973 MAR 29	0800	22.0	2519.664	2519.662 2519.662	.007 M .006	(21)
BU	BOKU	GANTI AUX A	1973 MAR 29	0810	22.0	2515.532	2515.531 2515.531	.004 R .003	(20)
CB	BLOSSOM	FULCRUM AUX A	1973 MAR 29	1605	31.4	1305.173	1305.173 1305.174	.008 H .006	(20)
CH	BLOSSOM AUX A	FULCRUM AUX A	1973 MAR 29	1650	30.5	1310.227	1310.227 1310.227	.004 H .003	(20)
CA	BLOSSOM	FULCRUM AUX B	1973 MAR 29	1555	30.8	1306.172	1306.172 1306.173	.011 W .009	(20)
CG	BLOSSOM AUX A	FULCRUM AUX B	1973 MAR 29	1645	30.7	1311.274	1311.274 1311.274	.006 W .004	(20)
CC	BLOSSOM	FULCRUM AUX C	1973 MAR 29	1615	30.9	1248.498	1248.498 1248.498	.007 W .005	(20)
CF	BLOSSOM AUX A	FULCRUM AUX C	1973 MAR 29	1635	30.8	1253.168	1253.169 1253.169	.003 H .003	(20)
CD	BLOSSOM	FULCRUM AUX D	1973 MAR 29	1625	30.7	1247.403	1247.403 1247.403	.006 G .005	(20)
CE	BLOSSOM AUX A	FULCRUM AUX D	1973 MAR 29	1630	30.7	1252.164	1252.164 1252.164	.003 W .003	(20)
CL	FULCRUM AUX A	GRAVES	1973 MAR 29	1820	29.1	7318.004	7318.006 7318.006	.003 H .002	(20)
CK	FULCRUM AUX A	GRAVES AUX A	1973 MAR 29	1815	29.1	7341.653	7341.655 7341.655	.004 W .003	(20)
CM	FULCRUM AUX B	GRAVES	1973 MAR 29	1830	28.4	7315.785	7315.788 7315.788	.004 W .003	(20)
CN	FULCRUM AUX B	GRAVES AUX A	1973 MAR 29	1838	27.8	7339.431	7339.433 7339.433	.006 W .005	(20)
CI	BLOSSOM AUX A	GRAVES	1973 MAR 29	1735	30.7	6514.614	6514.615 6514.615	.004 H .004	(20)
CJ	BLOSSOM AUX A	GRAVES AUX A	1973 MAR 29	1745	30.3	6532.816	6532.818 6532.818	.002 H .002	(20)
DE	GRAVES	CINDER	1973 APR 01	1605	33.0	5866.806	5866.810 5866.810	.009 W .007	(20)
DF	GRAVES	CINDER AUX A	1973 APR 01	1620	32.6	5872.099	5872.102 5872.102	.007 R .006	(12)

Code	Ranger III station	Retroreflector station	Date	Time	Temp.	Corrected D	Final D	S. D.	No.
CO	BOHALLA	CINDER	1973 MAR 30	0945	28.9	7233.350	7233.347	.010 R	(20)
							7233.348	.008	
CP	BOHALLA	CINDER AUX A	1973 MAR 30	1010	29.3	7223.525	7223.523	.008 W	(19)
							7223.523	.006	
BO	QUILL	SODERE	1973 MAR 28	1625	33.1	3856.824	3856.828	.007 W	(20)
							3856.828	.006	
BM	QUILL	OOLAGA	1973 MAR 28	1545	32.7	2357.701	2357.702	.010 R	(30)
							2357.702	.008	
BS	OOLAGA	QUILL	1973 MAR 28	1755	31.0	2357.720	2357.721	.004 R	(20)
							2357.721	.004	
BN	QUILL	OOLAGA AUX A	1973 MAR 28	1600	32.5	2359.107	2359.108	.006 R	(20)
							2359.108	.005	
BR	OOLAGA AUX A	QUILL	1973 MAR 28	1745	31.4	2359.129	2359.130	.005 W	(20)
							2359.130	.004	
BP	OOLAGA	SODERE	1973 MAR 28	1655	33.1	1581.700	1581.702	.007 W	(20)
							1581.702	.005	

APPENDIX G

AWARRA 1973 GEODIMETER DATA

C-2

Code	Geodimeter station	Retroreflector station	Date	Time	Temp.	Spread	Corrected D	Final D	Line average
FU	PYLON	GEORGE	1973 APR 10	1045	27.5	5 T	6642.832	6642.831	
FV	PYLON	GEORGE	1973 APR 10	1105	27.8	18 T	6642.830	6642.831	
FW	PYLON	GEORGE	1973 APR 10	1120	28.3	9 R	6642.835	6642.836	6642.832 .002
FX	PYLON	GEORGE AUX A	1973 APR 10	1140	28.9	6 R	6628.225	6628.227	6628.227 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	2865.546	
EC	RIDGE	ADAMA	1973 APR 06	0815	23.8	4 M	2865.558	2865.554	2865.551 .003
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 .003
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 .002
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 .003
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	7612.206	7612.211	
GA	PYLON	RIDGE	1973 APR 10	1255	29.2	102 R	7612.218	7612.224	7612.223 .008
GB	PYLON	RIDGE AUX A	1973 APR 10	1315	29.3	3 R	7602.869	7602.874	7602.874 0.000
EY	BOKU	ADAMA	1973 APR 07	1605	30.2	46 M	7427.062	7427.070	
EZ	BOKU	ADAMA	1973 APR 07	1620	30.1	18 R	7427.071	7427.079	7427.077 .004
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 .004
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	6880.078	
FD	BOKU	FULCRUM AUX A	1973 APR 07	1745	27.9	30 R	6880.074	6880.074	6880.076 .002
HO	GRAVES	BLOSSOM AUX A	1973 APR 14	1020	27.7	23 T	6514.626	6514.624	
HP	GRAVES	BLOSSOM AUX A	1973 APR 14	1040	28.0	26 R	6514.620	6514.619	
HQ	GRAVES	BLOSSOM AUX A	1973 APR 14	1055	28.2	18 T	6514.633	6514.633	6514.626 .006
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	

*Anomalous measurements.

Code	Geodimeter station	Retroreflector station	Date	Time	Temp.	Spread	Corrected D	Final D	Line average	
HT	BOHALLA	BORI	1973 APR 15	1100	30.8	18 H	1666.372	1666.372	1666.362	.009
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	.003
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	6236.792	6236.785		
GU	ROGGI AUX A	MIETCHI	1973 APR 13	0855	18.8	12 W	6236.794	6236.788		
GV	ROGGI AUX A	MIETCHI	1973 APR 13	0910	19.3	10 R	6236.800	6236.795	6236.789	.004
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	5566.590	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	.009
FP	TOPLESS	MIETCHI R.M.	1973 APR 09	1305	28.0	23 W	5566.228	5566.228	5566.228	0.000
GY	OOLAGA	MIETCHI	1973 APR 13	1052	21.0	14 W	7578.930	7578.930		
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 .932	.018 .002
HB	OOLAGA	MIETCHI R.M.	1973 APR 13	1150	24.5	5 R	7575.709	7575.711	7575.711	0.000
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	.003
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	.004
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	.004
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	.005
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	7678.100	7678.106		
EO	TABLE	AYGU	1973 APR 06	1825	29.8	44 R	7678.121	7678.126		

Code	Geodimeter station	Retroreflector station	Date	Time	Temp.	Spread	Corrected D	Final D	Line average	
EP	TABLE	AYGU	1973 APR 06	1840	29.7	28 W	7678.108	7678.114	7678.112	.008
EK	TABLE	MENDENO	1973 APR 06	1600	32.1	25 W	6858.832	6858.842		
EL	TABLE	MENDENO	1973 APR 06	1615	31.6	10 R	6858.842	6858.852		
EM	TABLE	MENDENO	1973 APR 06	1645	31.5	19 R	6858.830	6858.838		
EQ	TABLE	MENDENO	1973 APR 07	0835	26.8	21 W	6858.838	6858.827		
ER	TABLE	MENDENO	1973 APR 07	0850	27.2	22 M	6858.834	6858.824		
ES	TABLE	MENDENO	1973 APR 07	0905	27.7	17 W	6858.839	6858.830	6858.837	.010
ET	TABLE	MENDENO 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	9418.264	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	9421.126	9421.126	0.000
GJ	RABBIT	TABLE AUX A	1973 APR 12	1105	28.5	37 T	9417.787	9417.787	9417.787	0.000
FE	MENDENO	AYGU	1973 APR 08	1615	31.8	21 W	7829.031	7829.037		
FF	MENDENO	AYGU	1973 APR 08	1630	31.5	17 H	7829.002	7829.008 *		
FG	MENDENO	AYGU	1973 APR 08	1645	31.1	6 W	7829.022	7829.028		
GL	MENDENO	AYGU	1973 APR 12	1625	30.8	9 T	7829.020	7829.026		
GM	MENDENO	AYGU	1973 APR 12	1645	30.7	23 T	7829.027	7829.033		
GN	MENDENO	AYGU	1973 APR 12	1705	30.1	17 R	7829.020	7829.027	7829.026	.009
									.028	.004
FH	MENDENO	AYGU AUX A	1973 APR 08	1705	30.6	10 W	7827.304	7827.309		
GO	MENDENO	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	7220.468	7220.462		
GD	RABBIT	AYGU	1973 APR 12	0840	25.9	15 H	7220.462	7220.458		
GE	RABBIT	AYGU	1973 APR 12	0855	25.9	73 M	7220.476	7220.472 *	7220.461	.006
										.002
GF	RABBIT	AYGU AUX A	1973 APR 12	0910	26.4	24 T	7223.221	7223.217	7223.217	0.000
GP	MENDENO	RABBIT	1973 APR 12	1855	26.8	12 T	13687.774	13687.779		
GQ	MENDENO	RABBIT	1973 APR 12	1920	26.3	14 T	13687.773	13687.779		
GR	MENDENO	RABBIT	1973 APR 12	1940	25.9	15 R	13687.766	13687.775	13687.778	.002
GS	MENDENO	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	1022.573	1022.575		
HY	TERMITE	HOTEL	1973 APR 18	1630	25.0	8 H	1022.582	1022.583		
HZ	TERMITE	HOTEL	1973 APR 18	1640	25.0	9 W	1022.574	1022.575	1022.578	.004
JC	HOTEL	GALLA	1973 APR 20	1050	27.2	9 H	764.046	764.046		
JD	HOTEL	GALLA	1973 APR 20	1100	26.8	8 W	764.047	764.047		
JE	HOTEL	GALLA	1973 APR 20	1115	26.4	7 G	764.046	764.046	764.046	.000
IS	HOTEL	EUPHORBIA	1973 APR 20	0805	22.1	8 W	3517.912	3517.907		
IT	HOTEL	EUPHORBIA	1973 APR 20	0815	22.8	7 H	3517.909	3517.904		

Code	Geodimeter station	Retroreflector station	Date	Time	Temp.	Spread	Corrected D	Final D	Line average	
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	3524.744	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	3518.198	3518.194		
IY	HOTEL	EUPHORBIA AUX B	1973 APR 20	0915	23.4	7 W	3518.200	3518.197	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	.003
IE	TERMITE	GALLA	1973 APR 19	0935	21.9	24 W	746.028	746.028		
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	.002
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	3358.116	3358.118		
IJ	TERMITE	EUPHORBIA	1973 APR 19	1150	26.5	17 G	3358.119	3358.121	3358.120	.001
IK	TERMITE	EUPHORBIA AUX A	1973 APR 19	1210	26.5	19 T	3372.610	3372.613	3372.613	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	.002
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	2434.152	2434.148		
IC	TERMITE	LANGANA	1973 APR 19	0810	19.4	10 T	2434.154	2434.150		
ID	TERMITE	LANGANA	1973 APR 19	0835	19.6	6 G	2434.158	2434.154	2434.152	.003
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	7257.957	7257.942		
LK	ARJO	TERMITE	1973 APR 27	0825	22.8	6 H	7257.953	7257.939		
LL	ARJO	TERMITE	1973 APR 27	0835	23.1	22 W	7257.941	7257.929	7257.932 .937	.010 .005
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	2852.122		
IN	GALLA	EUPHORBIA	1973 APR 19	1715	26.8	5 G	2852.113	2852.117	2852.119	.002
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	2852.394	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	.003
JX	ARJO	GALLA	1973 APR 21	1000	26.4	38 W	7435.793	7435.789		
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	7435.775	.012
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	3232.690	3232.694		
JG	LANGANA	EUPHORBIA	1973 APR 20	1545	30.8	3 R	3232.686	3232.690		
JH	LANGANA	EUPHORBIA	1973 APR 20	1600	30.9	19 W	3232.714	3232.718 *	3232.698 .692	.012 .002

Code	Geodimeter station	Retroreflector station	Date	Time	Temp.	Spread	Corrected D	Final D	Line average	
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	3232.884	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	3232.883	3232.887	3232.888	.000
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	.005 .000
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	6206.097 *		
JV	ARJO	EUPHORBIA AUX B	1973 APR 21	0900	23.6	40 R	6206.094	6206.085		
JW	ARJO	EUPHORBIA AUX B	1973 APR 21	0910	24.3	13 W	6206.097	6206.089	6206.092 .089	.005 .002
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	4851.682	4851.685		
JO	LANGANA	ARJO	1973 APR 20	1825	26.0	5 G	4851.696	4851.700 *	4851.691 .686	.007 .001
JP	LANGANA	ARJO AUX A	1973 APR 20	1840	25.8	25 W	4855.271	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	.003
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 W	1206.698	1206.698		
KW	BMN	BMC	1973 APR 23	1120	27.6	15 G	1206.690	1206.691	1206.695	.003
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	.002
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 W	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 W	2331.633	2331.629	2331.634	.003
KR	BMN	SHECHA	1973 APR 23	0940	25.5	10 R	2937.654	2937.652		

Code	Geodimeter station	Retroreflector station	Date	Time	Temp.	Spread	Corrected D	Final D	Line average
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 .001
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

BIOGRAPHICAL NOTE

PAUL A. MOHR received his B. Sc. in 1952 and Ph. D. in 1955 in geochemistry from Manchester University, under Professor W. A. Deer.

Before joining Smithsonian Astrophysical Observatory in 1967, he spent 10 years at Haile Selassie I University (formerly University College, Addis Ababa), with intervening 1-year research fellowships at Sheffield University and Cambridge University.

Since joining the Smithsonian Astrophysical Observatory, he has retained his interest in Ethiopian rift valley studies: in particular, in the relationships between tectonism and volcanism, and in establishing precise geodetic nets to detect crustal deformation in the rift.