Report on Topographic Mapping Project for Musoma Area, Republic of Tanzania

(First Year)

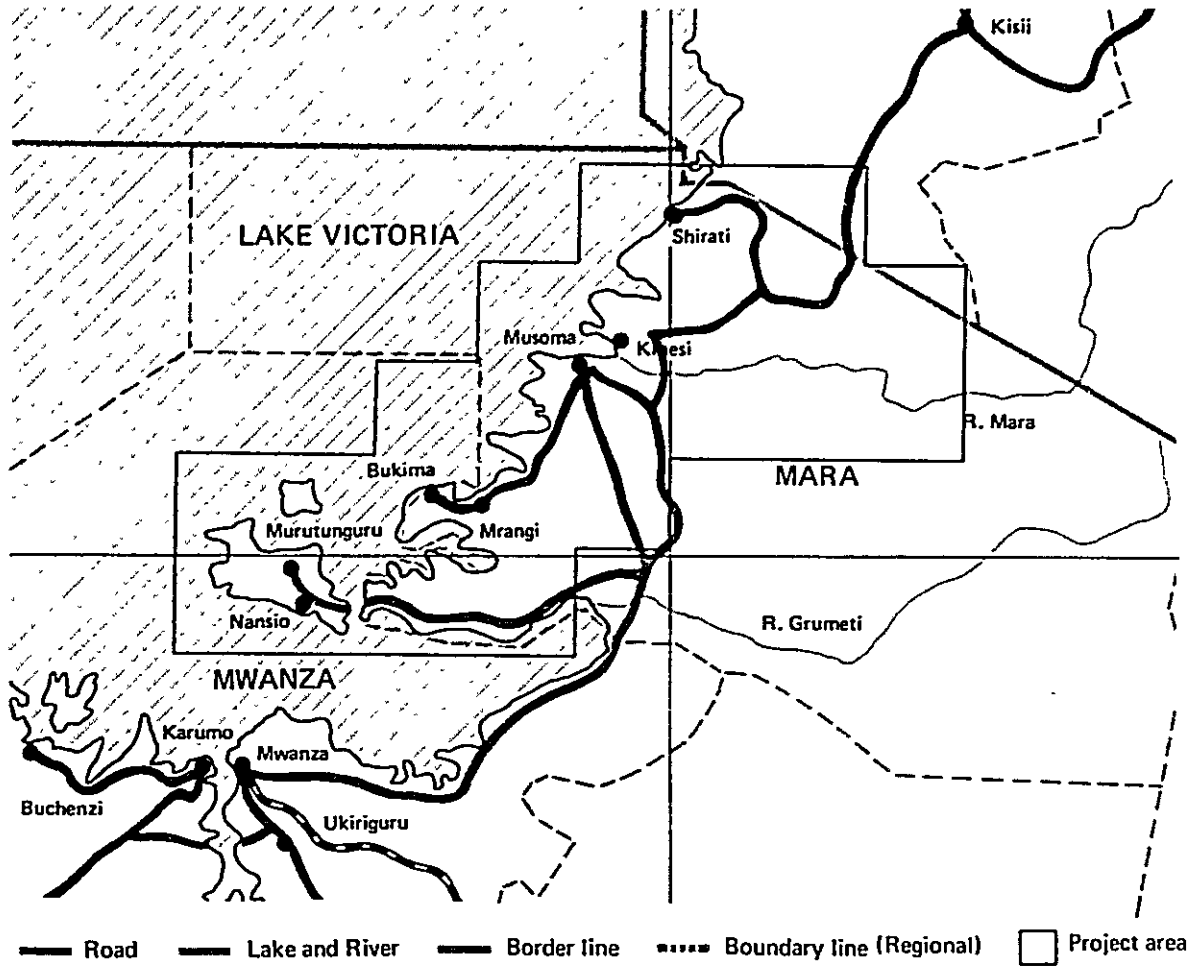
(Part I) Control Point Survey

(Part II) Aerial Photography

March 1974

Overseas Technical Cooperation Agency

Location Map of Project Area



PREFACE

In compliance with a request from the Government of the Republic of Tanzania, the Government of Japan decided to carry out a map preparation project for the Musoma Area of Tanzania lying along the east bank of Lake Victoria. Execution of the project was entrusted to the Overseas Technical Cooperation Agency.

The map preparation project for the Musoma Area (Area: approx. 12,730km^2, scale: 1/50,000) requires continuous surveying over approximately three years, including aerial photography, ground survey, aerial triangulation survey, compilation, printing, and so on. During F.Y. 1973 (the First Year), control point survey and aerial photography were conducted.

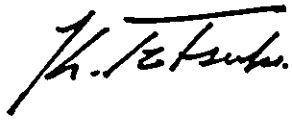
In consideration of the character and scope of the topographic mapping project estimated to require a period of several years, our Agency entrusted the actual work to the International Engineering Consultants Association, and for proper and effective management of the project, obtained cooperation of the Topographic Mapping Work Supervisory Comittee.

From early July to late December 1973, actual field survey work was conducted by a Survey Group with approximately 20 members organised by the International Engineering Consultants Association (headed by Juhei Kobayashi, Assistant Chief of Production Division of the Pacific Aero Survey Co., Ltd.), under close co-operation rendered by the Survey & Mapping Division, Ministry of Land, Housing & Urban Development, of the Government of Tanzania and its counterpart. To supervise this work, Mr. Arao Yoshida, Chief of the Control Section, Mapping Division, Geographic Survey Institute, Ministry of Construction, and Mr. Masanobu Hirobe, Chief of the Second Land Survey Section, Land Survey Division of the same were dispatched from Japan as supervisory officials.

The fact that the various types of field survey work mentioned above have been conducted superlatively and smoothly is largely attributable to the energetic efforts rendered by the members who were directly engaged in this work and the earnest cooperation offered by all related authorities organization.

Upon completion of the First Year Survey Work, I express my deep gratitude to the Government of the Republic of Tanzania, its ministries concerned, the Japanese Embassy in Tanzania, the Japanese Government and its ministries concerned, the Geographic Survey Institute, the aerial surveying firms under the International Engineering Consultants Association, and all other related authorities organization who willingly rendered great support and cooperation regarding this project.

March 1974



Keiichi Tatsuke
Director General
Overseas Technical Cooperation Agency

LETTER OF TRANSMITTAL

Mr. Keiichi Tatsuke, Director-General,
Overseas Technical Cooperation Agency

The Report on the First Year Survey Work of the Musoma Area of Tanzania Topographic Mapping Project, carried out from early July to mid-December 1973 in compliance with your request, is herein submitted to you.

In this report are clarified the contents of the First Year Survey Works (Control Point Survey and Aerial Photography). I feel confident that the results of the survey techniques conducted by the despatched survey group during the said period will largely contribute to future development plans for the Musoma Area and to improvement of the Tanzania survey techniques.

I hereby express my heartfelt gratitude to Mr. J. Daniel, Commissioner of the Survey & Mapping Division, Ministry of Land, Housing & Urban Development of the Republic of Tanzania, the Division personnel, the officials of the Japanese Embassy in Tanzania, and the Japan Overseas Cooperation Volunteers who cooperated with us during the field survey period and in drawing up this report. At the same time, I hope that the second and subsequent year survey projects will be conducted without delay.

March 1974

Juhei Kobayashi

Juhei Kobayashi
Leader, Topographical Mapping Group of the Musoma Area, TANZANIA
International Engineering Consultants Association

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(Part I)

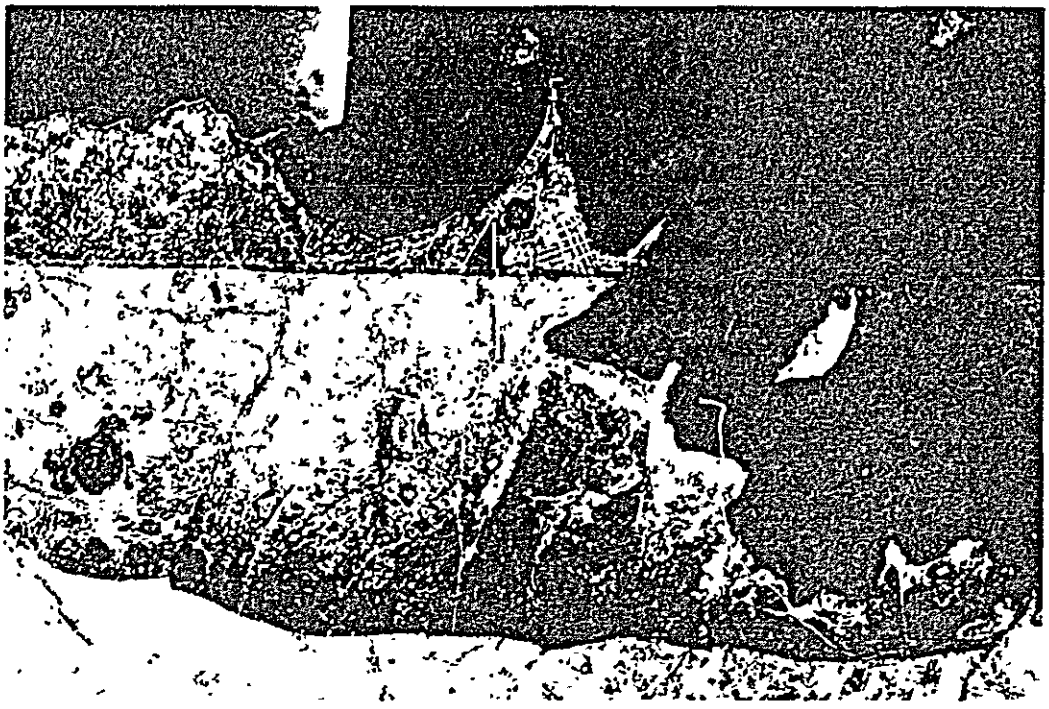
Report on Control Point Survey for the

Tanzania Musoma Area Topographic Mapping Project

1. ARRIVAL AT SURVEY FIELD

1.1 First Start Group

On July 7th, the Advanced Group consisting of Masaichi Sakaguchi (in charge of general affairs), Kunio Kobayashi (Chief Surveyor), and Junichi Koyama (in charge of liaison) departed on the mission of purchasing the survey equipment and materials, negotiating with the Surveys & Mapping Division authorities, receiving and effecting customs clearance procedures for the equipment having been transported from Japan, acquiring vehicles, making preparations for receiving the main survey group, and arranging for the photography. The Group passed through Nairobi on July 8th, and arrived at Dar-es-salaam (hereinafter abbreviated to D.S.M.), the Tanzanian capital, on July 10th and began assuming their duties.



Musoma and its environs located in the project area

1.2 Main Survey Group

On July 21st, the 12-member Main Survey Group consisting of Juhei Kobayashi (Group Leader), Kan Funazu (in charge of Co-ordination), Kiyoshi Yoshioka (Surveyor), Fumio Ohdaira (Surveyor), Etsuro Ono (Asst. Surveyor), Seiki Oyama (Asst. Surveyor), Ryoichi Kawakami (Asst. Surveyor), Takashi Aoki (Asst. Mechanist), Hiroshi Haga (Asst. Surveyor), Jun Nakamura (Asst. Surveyor), Tsutomu Mizuguchi (Asst. Surveyor), and Kichitaro Kano (Asst. Surveyor), accompanied by Supervisor Hiroshi Kimura of OTCA Supervisory Committee of Topographic Mapping Work, departed from Haneda International Airport and arrived at Nairobi the following day (July 22nd).

the sightseeing season, all hotels in D.S.M. and other principal cities, as well as the

transportation facilities leading there, were filled with visitors. Especially in D.S.M., reception of the Main Survey Group was impossible. Accordingly, to pay respect to the Japanese Embassy in Tanzania and the Tanzanian Surveys and Mapping Division, and to effect documentary procedures for launching the survey work, the Main Survey Group members Juhei Kobayashi, Kan Funazu, and Survey Work Supervisor Kimura promptly proceeded to D.S.M. on the same day. On the following day (July 23rd), the Main Survey Group joined the Advanced Group and they departed from Nairobi, and by way of Kisii and crossing the border line, they arrived at the survey area of Musoma on July 24th.

1.3 Transportation of Vehicles and Equipment

For the reasons mentioned above, transportation of the eight jeeps purchased by the OTCA Group members was rendered infeasible. Conseauently, these jeeps were transported by drivers of the Surveys & Mapping Division. They departed from D.S.M. on July 20th, and by way of Arusha, arrived at Musoma on July 23rd. On July 22nd, while enroute, one of the vehicles overturned; however, no casualties resulted, the vehicle was normalised, and all arrived safe at Musoma.

The two trucks required for the survey work were not available on the spot. Accordingly, by changing the type of trucks, an order was issued from D.S.M. and the two trucks were obtained on August 11th.

The surveying equipment and materials sent from Japan were transported by the Tanzania Transporters Association after customs clearance. They departed from D.S.M. on July 21st, and by way of Dodoma, arrived at Musoma on the 23rd.

The equipment, materials, and camping goods ordered at Nairobi were transported by Group member Sakaguchi (in charge of general affairs) and arrived at Musoma on July 27th.

2. PREPARATIONS FOR SURVEY WORK

2.1 Encampment

Immediately after arrival of the equipment and materials, the Base Camp was set up in a park located at the northwestern end of Musoma City. The camping site was leased by Mr. Sikukuu, Chief of the Musoma Branch Survey Division, and camping life there started from July 29th.

For receiving mail arriving from Japan, P.O. Box 399 Musoma was rented from July 25th.

For smoothing operations and life at the Base Camp, teams in charge of respective jobs were organised. The teams and members were as follows:

- Camp Management Team ..... Seiki Oyama and Hiroshi Haga
- Equipment and Fittings Team ..... Fumio Ohdaira and Tsutomu Mizuguchi
- Personnel Team ..... Kiyoshi Yoshioka and Kichitaro Kano
- Food Team ..... Etsuro Ono, Ryoichi Kawakami, and Jun Nakamura
- Accountant Team ..... Junichi Koyama
- Vehicle and Electricity Team ..... Takashi Aoki
- Medical Supplies Team ..... Ryoichi Kawakami

2.2 Hiring of Field Assistants

Eight workers of the D.S.M. Survey Division and 27 Musoma inhabitants, totaling 35 (including three drivers) were hired as Field Assistants. On August 1st, at the Base Camp, labor contract deeds were exchanged in the presence of the Chief of Musoma Branch of Survey Division.

2.3 Organisation of Survey Teams

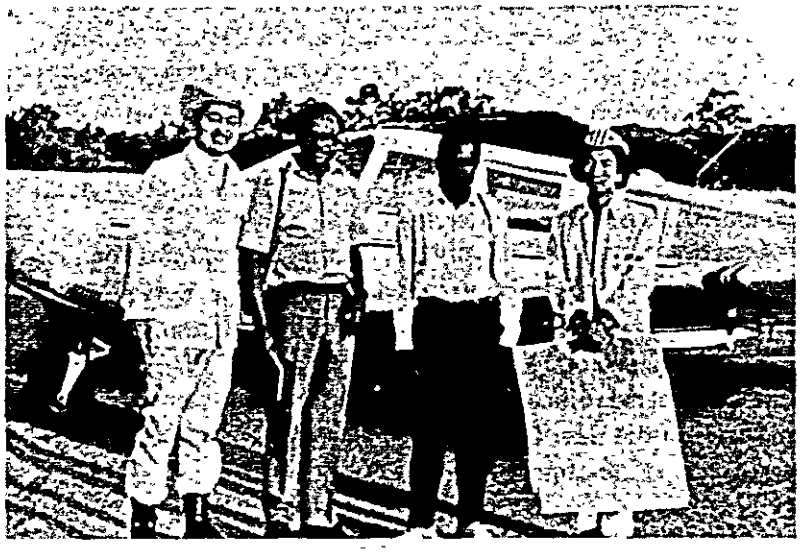
In view of the rainy seasons, it was estimated that the field survey work would range over a long period of time. Consequently, it was decided to initially conduct traverse survey. After organising the five teams listed below, field survey work was started.

Team 1: Kiyoshi Yoshioka and Takashi Aoki ..... Traverse survey
Team 2: Etsuro Ono and Hiroshi Haga ..... Traverse survey
Team 3: Seiki Oyama and Jun Nakamura ..... Traverse survey
Team 4: Fumio Ohira and Tsutomu Mizuguchi ..... Levelling
Team 5: Ryoichi Kawakami and Kitsutaro Kano ... Traverse survey and levelling

3. RECONNAISSANCE OF SURVEY FIELDS

3.1 Survey Flight

On July 28th and 29th, by employing a Cessna plane of Tim Air, which flew the Main Group members from D.S.M., a preliminary aerial reconnaissance survey of the surveying region was conducted. The preliminary survey flight each day was conducted for approximately three hours, the flight altitude ranging from 300 to 400 meters. The results largely contributed to clarifying the topography, roads, state of vegetation and positions of the given points.



Survey flight members

3.2 Reconnaissance of Traverse Routes

Starting on August 1st, by employing jeeps and by dividing the entire region into southern and northern sections, road networks were surveyed first of all by Teams 1 and 2 (southern), and Teams 3 and 5 (northern).

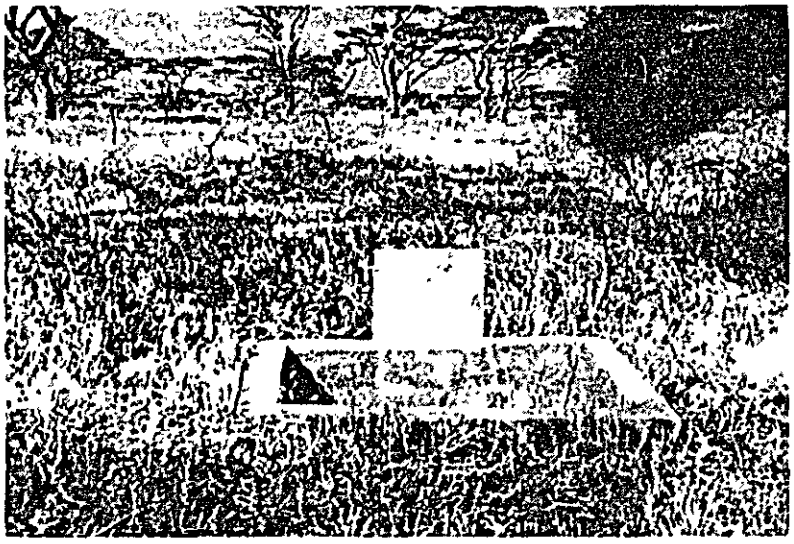
Six of the existing points were surveyed. The Survey Branch Division officials and game scouts accompanied the teams.

When surveying the islands in Lake Victoria, a government-affiliated motorboat was borrowed to reach each island, and surveying on each island was conducted on foot.

Reconnaissance of traverse points

3.3 Reconnaissance of Levelling Routes

The survey of the first order levelling route of Seronera-Bunda was conducted from July 31st by mainly tracing back monuments buried by the Survey Division in 1972, referring to the description sheets prepared by them. As a result, four dubious points, two fluctuating points, and one lost point were discovered, for which monuments were newly established later on. Since the vicinity of Seronera was haunted by wild beasts and was remote from the Base Camp, the survey was conducted in concert with game scouts by establishing a sub-camp.



First Order Bench Mark FBM Seronera

4. SELECTION OF SURVEY POINTS

4.1 Selection of Traverse Points

Before starting the survey, the schematic drawings drawn up in Japan were referred to, and by employing a heliotrope at each survey point, the positions of survey points were determined one after another by confirming the intervisibility between two survey points. The newly established survey points throughout the whole survey area (including additional survey) totaled 29, the survey sides numbered 41, the minimum side length reached 9.6 km, the maximum side length reached 33.3 km, and the average side length became 19.5 km.

The system of the Tanzanian Government Survey Division was followed in naming the survey points. These terms included the Sheet No. of each map divided into 30' x 30' sections (determined by the Survey Division), the order of each survey point, the number of the survey point (a serial number in case of the same sheet), and the place name.

Example: 5 – ST – 2 SHIRATI

where

5: Sheet No.

ST: 2nd order

2: the 2nd in Sheet No. 5

SHIRATI: Name of hamlet

From the date of completing reconnaissance on August 27th to September 1st, Masanobu Hirobe, Chief of the Second Land Survey Section, Land Survey Division of Geographic Survey Institute of Japan, inspected the reconnaissance results as the Land Survey Work Superintendent. (He was accompanied by Group member Hiroshi Shibata, in charge of co-ordination.)

4.2 Selection of Bench Mark Sites

As already mentioned, the leveling routes had been monumented by the Survey Division. Accordingly, only dubious points and lost points were restored to their original positions by newly establishing the monuments.

5. MONUMENTATION AND SIGNALISATION

5.1 Monumentation

The monuments were established based on specifications prescribed by the Survey Division. Monuments in normal terrain were established at 14 points, and monuments in rocky terrain were established at 15 points.

A concrete beacon containing a cartridge case was employed as a monument in normal terrain, for which concrete was placed on the spot. For a monument in rocky terrain, a hole was chiseled in the rock, into which a cartridge case was directly cemented. A total of four witness marks were set up around the survey point.

Figs. 1, 2, and 3 in Appended Diagram 1 are sectional drawings with plans of the monument and the witness mark.

5.2 Signalisation

Because of the weather fluctuations considered possible, a system was adopted to conduct the main photography (scale: 1:50,000) prior to the signalisation, to set up signals later on at already established points and the second order traverse points, and to take strip photography of each of those points, and finally to combine the two photographs. For the original program (excluding additional work), signals composed of three 100 x 200cm blades were installed. Fig. 4 in Appended Diagram 1 illustrates the shape of the signal.

A scene of signalization

Since the photographic scale in the additional survey area was 1:50,000, larger signals with 200 x 500cm blades were installed. (Positioning of the signals is shown in Appended Diagram 10.)
The signals were installed on the same day as the monuments were established, or on the soonest day thereafter. However, since strip photography and additional photography were scheduled for December, signals were reinforced to safeguard against possible damage anticipated by rainfall, animals, and other causes.

6. OBSERVATIONS

6.1 Traverse Observations

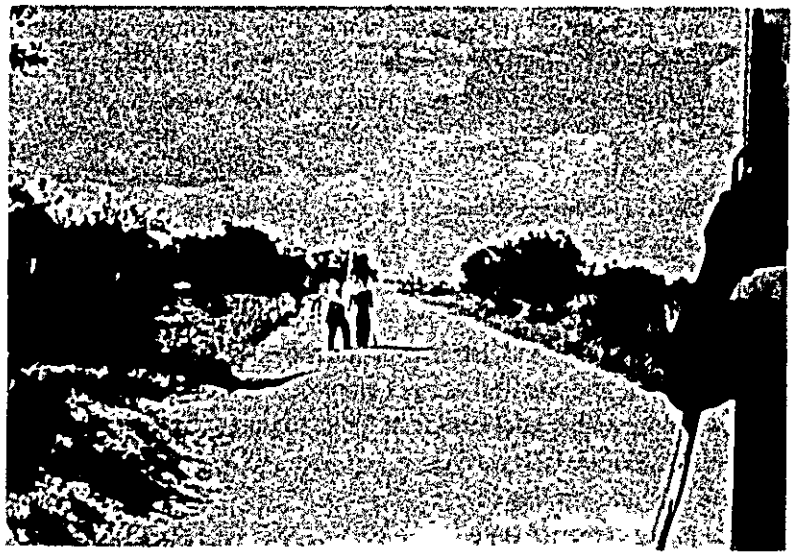
The traverse observations included angle measurement and distance measurement. A WILD T3 or Kern DKM 3A was used for angle measurements. Horizontal directions were observed in six sets and vertical angles were observed simultaneously from both directions at three times, with signal lamps or heliotropes as the target.
A Tellurometer MRA Model 101 was employed for the distance measurement. The distance measurements were made in two sets both backwards and forwards (one set consists of two coarse readings and ten fine readings). An aneroid barometer (BAROMEC, made in England) and an air psychrometer were employed for meteorological observations, and observations were conducted four times in one set.
The results of observations were entered in the designated field notebook, and field inspection of the entries was conducted twice by the observer and supervisor. Appended Diagrams 2 - 4 show these field notebooks.
The abstracts of field observations were compiled at the Base Camp, and as in the case of the field notebook, they were also inspected twice. These abstracts were forwarded to Japan. Appended Diagrams 5 - 7 show the abstracts of field observations.

A scene of traverse observation

6.2 Levelling Observations

A WILD N3 and its accessory rods were employed for levelling observations, and double-run observations to read the left- and right-side scales were conducted. Atmospheric temperature observations were conducted when necessary. The results of observations were entered in the field notebook by the recorder or by the observer. The Tabulation of Benchmarks was compiled at the Base Camp. As in the case of

traverse survey, inspection was conducted twice. Examples of the entries are shown in Appended Diagrams 8 and 9.



Levelling observation in progress

7. PHOTO POINT SURVEY

Second order traverse survey under this project represents control point survey for the succeeding map compilation. Since the islands in Lake Victoria are included in the mapping area, surveying only the existing points and the second order points is insufficient. Accordingly, photo points are necessary as auxiliary points, and these were established mostly on the islands in Lake Victoria.

Photo point survey of the original project (excluding additional work) was started from October 8th after completing observation of second order traverse survey, and a total of 11 points was established.

As a means of transportation to the islands, a boat was leased from the Musoma Regional Commissioner.

On the advice of Mr. Daniel, Chief of the Survey Division, monuments were not established on those points. Aerial signals were also not set up because pricking was scheduled for the next year. At the two points located in the northern part (in the vicinity of the border line), however, signals were established under instructions issued by Mr. Hirobe, a deputy of the Survey Work Superintendent, as in the case of the second order traverse points.

Observations were conducted in a manner similar to the case of second order traverse survey, and the horizontal angles were observed in four sets, the vertical angles were simultaneously observed twice, and distance observations were made in one set.

8. ADDITIONAL SURVEY

Observation activities for the second order traverse survey (for 25 new points), having been planned prior to the start of the project, were completed on October 5th. Since additional survey for the two islands of Ukurewe and Ukara was requested by the Tanzanian Survey Division, the possibility was studied from the viewpoint of the work period and appropriations. Since the work was determined as possible to perform, reconnaissance activities were launched on October 30th in accordance with instructions provided by the OTCA.

Since the additional survey area was located a long distance from the Musoma Base Camp, a sub-camp was organized at Nansio on Ukurewe Island. Activities were promoted by leasing a boat from the Mwanza Regional Commissioner (because the additional survey area was located in the Mwanza Region), and 4 second order traverse points and 10 photo points were established.

By conducting additional survey, total numbers of second order traverse points and photo points were increased to 29 and 21 respectively. A net map of those points is shown in Appended Diagram 10.

9. PROGRESS OF SURVEY ACTIVITIES

9.1 Maintenance of Vehicles

All of the eight jeeps and two trucks purchased by the OTCA were brand-new vehicles. Since they were to endure rugged use over bad roads day after day, we wanted to hire a professional mechanic for their maintenance. Hiring a local national mechanic was hampered by technical and language barriers. Accordingly, we decided to request assistance from the Japan Overseas Cooperation Volunteers (J.O.C.V). The request was submitted through the Japanese Embassy in Tanzania and the Survey Division to the Game Office, and we finally succeeded in obtaining assistance from Akito Tobo, who was working with the Game Scout Training Center in Mwanza.

Although some of the vehicular parts were procured in the city of Musoma, most of them were procured in Mwanza.

Fuel was procured from the Survey Division at the start of the survey activities and thereafter from petrol stations in the city. The quality of petrol was generally poor, as evidenced by the fact that the petrol filters frequently became clogged.

Vehicle maintenance upon completion of work was conducted in D.S.M. by Mr. Tobo.

9.2 Procurement of Materials

The survey work materials were mostly procured in Musoma, but procuring cement was very difficult. In mid-August when monumentation work was busily in progress, we were compelled to go to Mwanza on four occasions to obtain cement through desperate efforts. However, most other materials and daily expendables were obtained in Musoma.

9.3 Communications and Liaison

Liaison between Musoma and other regions was difficult; particularly, liaison with Japan through telephone was totally impossible. Consequently, we were compelled

to go to Nairobi (about 600km away) to effect liaison with Japan through telephone or telex.
Even for effecting domestic liaison within Tanzania, telegraph and mail were the only available means, and telephone calls were almost impossible. As a result, we were occasionally compelled to travel to where the other party was living.

9.4 Vehicular Overturn Accident

A jeep overturned on August 25t ı at the road fork leading to Ikoma Fort Lodge, on our way back from the Ikoma sub-camp to the Base Camp. Despite the fact that the vehicle was badly damaged, no serious results were sustained by the driver and the four Survey Group member passengers. Those injured were promptly treated at the Musoma National Hospital. Since the driver, Tsutomu Mizuguchi, was suffering from abdominal bruises, on September 1st he proceeded after treatment in Musoma, together with Junichi Koyama (in charge of liaison) to Nairobi, and received a detailed medical inspection conducted by a Japanese physician at the Kenyatta National Hospital. Since no abnormalities were observed, he returned to the Base Camp on September 8th and resumed leveling work from September 12th.
The vehicle was repaired with insurance money at the Musoma Mara Pannel Beeting, with repairs completed on November 14th.

9.5 Reconnaissance of Levelling Routes Scheduled for Next Fiscal Year

For approximately two weeks, starting from November 12th, following the completion of observation activities for first order leveling, reconnaissance of the second order levelling routes scheduled for next fiscal year (extending approximately 680km) was conducted by a 4-man team comprising Kunio Kobayashi, Fumio Ohdaira, Ryoichi Kawakami, and Takashi Aoki.
In addition to the originally scheduled routes, the reconnaissance was conducted for those which were requested by the Survey Work Supervisory Committee and the Chief, Survey Division.

9.6 Visit by Ambassador

On November 5th, after completion of the originally scheduled survey activities (excluding additional survey activities), Ambassador Nobuyuki Nakashima, accompanied by his aide Mr. Suzuki, travelled from the Japanese Embassy in Tanzania to the Base Camp. The Ambassador, together with Mr. Daniel, Chief of Survey Division, and Mr. Sikukuu, Chief of Musoma Branch, inspected the progress of our observation activities on traverse survey and levelling.

Mr. Nakashima, the Japanese Ambassador to Tanzania, and the project staff

On November 7th, the Ambassador called on the Mwanza Regional Commissioner and requested him to render local co-operation on additional survey activities, and then returned to D.S.M.

10. DEMOBILISATION

10.1 Breaking up Camp and Preparations for Returning to Japan

Since all of the scheduled field survey activities were completed, reconditioning of the survey equipment and materials was started from December 1st, and preparations were made for shipping the main equipment and instrument back to Japan. Other miscellaneous equipment and tools were stored in warehouses leased from the Musoma Branch of Survey Division.

On December 3rd, the field assistants were discharged, with a few reserved, and we visited the related offices in Mwanza to bid farewell.

On December 4th, we visited the Musoma Survey Branch Division and related offices to bid farewell. The 1st Departing Party left the Base Camp.

On December 5th, the 1st Departing Team comprising Juhei Kobayashi, Seiki Oyama, Etsuro Ono, Jun Nakamura, Takashi Aoki, Kichitaro Kano, Tsutomu Mizuguchi, and Hiroshi Haga departed from Musoma and proceeded to D.S.M.

The 2nd Departing Party comprising Kunio Kobayashi, Kiyoshi Yoshioka, Fumio Ohdaira, and Ryoichi Kawakami accompanied Arao Yoshida, Chief of the Control Section, Mapping Division, Geographic Survey Institute, and the Survey Work Superintendent, who came to the survey field on December 8th for his patrolling inspection of the surveyed areas. On December 12th, the Team departed from Musoma and proceeded to D.S.M.

On December 1st, Hideyuki Sanagi (in charge of co-ordination), who was responsible

for customs clearance, arrived at the Base Camp; on the following day, together with Junichi Koyama, he proceeded to D.S.M. by way of Nairobi.

10.2 Return to Japan

On December 8th, the 1st Departing Team arrived in D.S.M. and engaged in customs clearance procedures. On December 11th, they departed from D.S.M. and returned to Tokyo by way of Nairobi on December 17th. Members of the 1st Departing Team were as listed below:

Junichi Koyama, Seiki Oyama, Etsuro Ono, Jun Nakamura, Kichitaro Kano, Tsutomu Mizuguchi, and Hiroshi Haga (total seven).

On December 14th, the 2nd Departing Team arrived in D.S.M. and settled remaining business matters. On December 18th, they proceeded to Nairobi, and confirmed the signals shown on the strip photographs. On December 21st, they departed from Nairobi, arriving at Tokyo on the 24th. Members of the 2nd Departing Team were as listed below:

Kunio Kobayashi, Kiyoshi Yoshioka, Fumio Ohdaira, and Ryoichi Kawakami.

On December 8th, Takashi Aoki, who accompanied the 1st Departing Team and arrived in D.S.M., engaged in vehicle maintenance in co-operation with Akito Tobo, the JOCV vehicle mechanic. On the other hand, Juhei Kobayashi and Mr. Yoshida, the Survey Work Superintendent, engaged in negotiations with the Survey Division and in settling other business matters.

On December 24th, in co-operation with Mr. Matsuoka, an OTCA official and member of the Trans-African Highway Survey Team, they conducted vehicle return procedures for the ten vehicles. On December 25th, they departed from D.S.M., arriving at Tokyo on the 27th.

11. CALCULATIONS AND ARRANGEMENT

11.1 Traverse Survey

Since the final adjustment computation should be made by using the elevation results of the traverse points which will be derived from the second order levelling scheduled for the next fiscal year (by means of differential levelling), computation of the second order traverse survey was made only for the checking of loop closures and comparison of the survey results of the side length between the given points with the final results of previous survey.

Appended Diagrams 12 and 13 show the results of such computations.

Descriptions of the new traverse points were prepared by field investigation using 1/250,000 topographic map series.

11.2 Levelling Survey

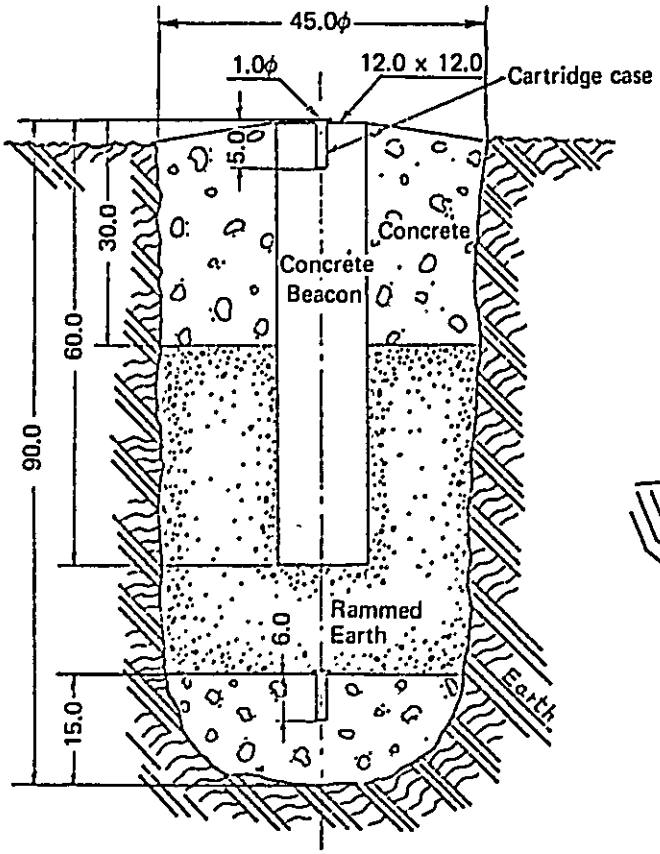
The first order levelling was conducted from FBM Seronera to FBM Bunda.

When the observation results were compared with the final results of FBM Bunda received from the Survey Division, we found a discrepancy of 195.0cm.

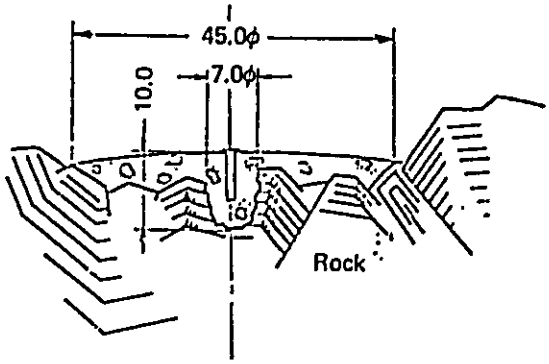
This might have been caused by the fact that the final results of the two FBM were calculated from the observations at different tide observation stations.

The mean square error per km for the entire routes observed are shown in Appended Diagram 14.

Diagram 1



MONUMENT IN
Normal Terrain : figure 1
Rocky Terrain : figure 2



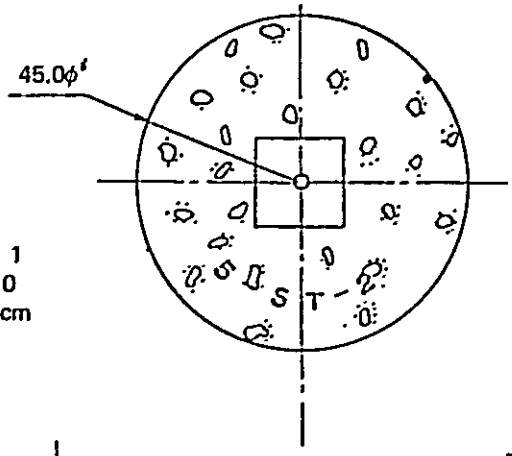


figure 1
S=1:10
unit: cm

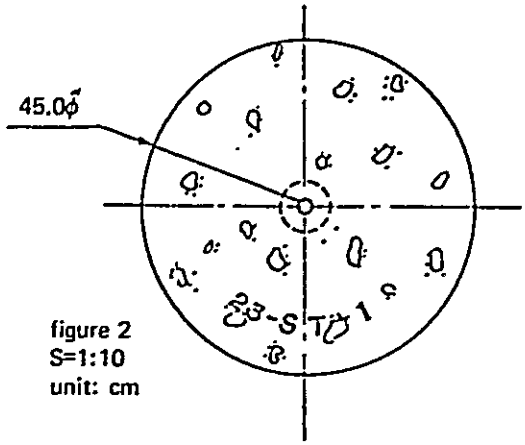


figure 2
S=1:10
unit: cm

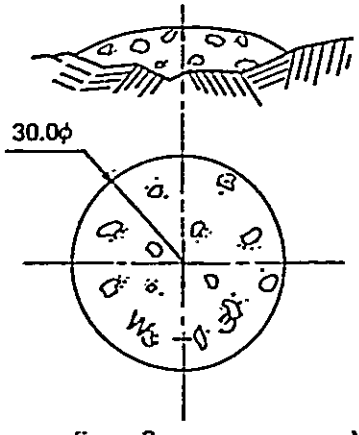


figure 3
S=1:10
unit: cm

Witness Mark : figure 3
Signalization: figure 4

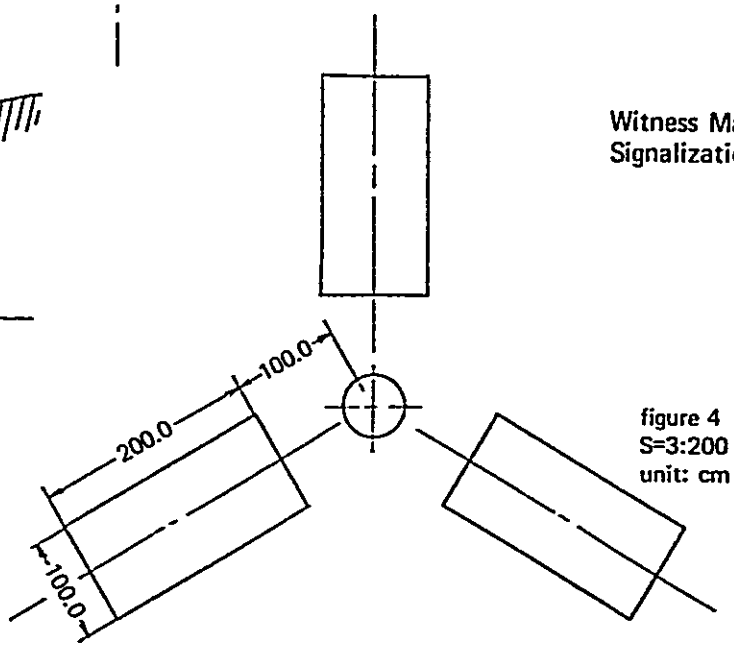


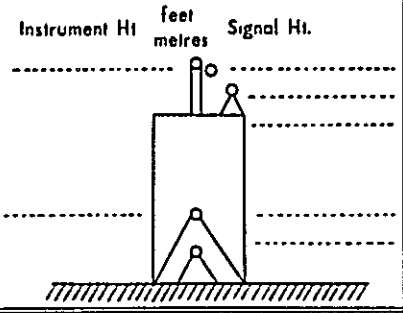
figure 4
S=3:200
unit: cm

Diagram 2

HORIZONTAL ~~& VERTICAL~~ ANGLE OBSERVATIONS.

Station : *JAN 317*

Date : *27-9-'73*



Notes on observing

Conditions:

Observer: *K.Y.*

Booker: *T.A.*

Reduced: *T.A.*

Checked: *K.Y.*

Ins. No. *T3-83067*

Weather: *Fine*

Visibility. *Good*

Stn Page *3* of *3*

3

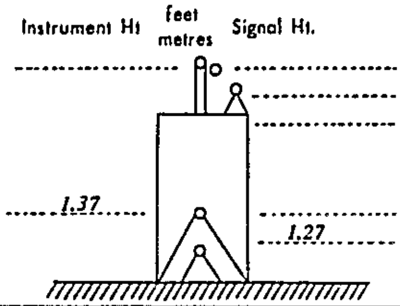
Station	Face	Signal		Reading		A	B	Mean	Reduced. Read'g			Remarks
				°	'	"	"	"	°	'	"	
5-ST-3	*R*	*Hello*	*16:10*	*0*	*0*	*32 , 8*	*33 , 0*	*65 , 8*	*0*	*0*	*0 , 0*	
4-ST-3	*L*	*Lamp*		*184*	*52*	*52 , 0*	*52 , 2*	*104 , 2*	*184*	*52*	*38 , 4*	*39.8*
				4	*52*	*50 , 0*	*50 , 0*	*100 , 0*	*184*	*52*	*41 , 3*	
				180	*0*	*29 , 4*	*29 , 3*	*58 , 7*	*0*	*0*	*0 , 0*	
						,	,	,			,	
	L			*210*	*12*	*15 , 6*	*15 , 6*	*31 , 2*	*0*	*0*	*0 , 0*	
				35	*04*	*34 , 2*	*33 , 7*	*67 , 9*	*184*	*52*	*36 , 7*	*37.6*
	R			*215*	*04*	*37 , 9*	*37 , 9*	*75 , 8*	*184*	*52*	*38 , 5*	
				30	*12*	*18 , 5*	*18 , 8*	*37 , 3*	*0*	*0*	*0 , 0*	
						,	,	,			,	
	R			*60*	*18*	*02 , 7*	*02 , 9*	*05 , 7*	*0*	*0*	*0 , 0*	
				245	*10*	*23 , 4*	*23 , 4*	*46 , 8*	*184*	*52*	*41 , 1*	*39.8*
	L			*65*	*10*	*19 , 7*	*19 , 8*	*39 , 5*	*184*	*52*	*38 , 5*	
				240	*18*	*0 , 5*	*0 , 5*	*01 , 0*	*0*	*0*	*0 , 0*	
						,	,	,			,	
	L			*270*	*30*	*16 , 5*	*16 , 6*	*33 , 1*	*0*	*0*	*0 , 0*	
				95	*22*	*35 , 4*	*35 , 6*	*71 , 0*	*184*	*52*	*37 , 9*	*36.6*
	R			*275*	*22*	*38 , 0*	*38 , 4*	*76 , 4*	*184*	*52*	*35 , 4*	
				90	*30*	*20 , 7*	*20 , 6*	*41 , 0*	*0*	*0*	*0 , 0*	
						,	,	,			,	
	R			*120*	*10*	*58 , 9*	*59 , 1*	*118 , 0*	*0*	*0*	*0 , 0*	
				305	*04*	*17 , 2*	*17 , 2*	*34 , 4*	*184*	*52*	*36 , 4*	*36.9*
	L			*125*	*04*	*15 , 7*	*15 , 7*	*31 , 4*	*184*	*52*	*37 , 4*	
				300	*10*	*57 , 0*	*57 , 0*	*114 , 0*	*0*	*0*	*0 , 0*	
						,	,	,			,	
	L			*330*	*22*	*46 , 8*	*47 , 0*	*93 , 8*	*0*	*0*	*0 , 0*	
				155	*16*	*04 , 2*	*04 , 5*	*08 , 7*	*184*	*52*	*34 , 9*	*35.0*
	R			*335*	*16*	*07 , 9*	*08 , 1*	*16 , 0*	*184*	*52*	*35 , 1*	
				150	*22*	*50 , 4*	*50 , 5*	*100 , 9*	*0*	*0*	*0 , 0*	
						,	,	,			,	
						,	*5-ST-3*	,	*0*	*0*	*0 , 0*	
						,	*51-ST-3*	,	*184*	*52*	*37 , 6*	
						,	,	,			,	

Diagram 3

~~HORIZONTAL &~~ VERTICAL ANGLE OBSERVATIONS.

Station: *5-ST-4 SIRARI*

Date: *6-9-'73*



Notes on observing	
Conditions:	
Observer:	*E.O.*
Booker:	*H.H.*
Reduced:	*H.H.*
Checked:	*E.O.*
Ins. No.	*T3-91186*
Weather:	*Fine*
Visibility:	*Good*

Stn Page *2* of *2*

8

Station	Face	Signal	Time	Reading °	′	″ A	″ B	Mean ″	Reduced. Read'g °	′	″	Remarks
5-ST-3	*R*	*Helio*	*12.10*	*89*	*40*	*10.2*	*10.4*	*10.3*				
	L			*90*	*19*	*30.6*	*30.4*	*30.5*	*0*	*39*	*20.2*	
				179	*59*			*40.8*				
	R			*89*	*40*	*07.6*	*07.6*	*07.6*				
	L			*90*	*19*	*31.6*	*31.4*	*31.5*	*0*	*39*	*23.9*	
				179	*59*			*39.1*				
	L			*90*	*19*	*32.2*	*32.2*	*32.2*				
	R			*80*	*40*	*09.8*	*09.8*	*09.8*	*0*	*39*	*22.4*	
				179	*59*			*42.0*				
								MEAN	*0*	*39*	*22.2*	
								Z	*90*	*39*	*22.2*	

Diagram 4

Survey _____ Job No. _____

TELLUROMETER LINE MEASUREMENT (BY MRA101)

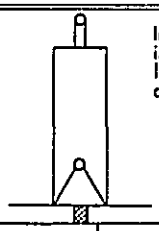
Master at: *TAN 317*

Remote at: *5-ST-3*

Date: *27-9-'73*

Measure No: *1*

File Page No. *1*



Eccentricity Diagram

Time: *10:00*

Weather *Fine*

Visibility: *Good*

Booker. *T.A.*

Checked *K.Y.*

Master Inst.	No: *773*	Ht: *0.33*	Operator: *K.Y.*	Calc'n: *T.A.*
Remote Inst.	No. *772*	Ht: *1.30*	Operator: *R.K.*	Checked *K.Y.*

Carrier	F	R	Mean	Graph
1.0	*392*	*392*	*392*	
2.0	*392*	*391*	*392*	
3.0	*409*	*406*	*408*	
4.0	*383*	*383*	*383*	
5.0	*375*	*379*	*377*	
6.0	*383*	*380*	*382*	
7.0	*385*	*380*	*382*	
0.0	*403*	*390*	*396*	
1.0	*389*	*385*	*387*	
2.0	*394*	*392*	*393*	

COARSE READINGS

Initial

A				3	9	0	
E			5	3			
D			4	5			
C			9	4			
B		2	9				

Carrier Tune *1.0* .. 2 9 4 5 3 9 0

Final

A				3	9	4	
E			5	3			
D			4	5			
C			9	5			
B		2	9				

Carrier Tune *2.0* .. 2 9 4 5 3 9 4

CALCULATION

Met correctn factor $O = 1{,}000325/n - 1$

$(n-1) \times 10^6 = A + B(P-1000)$;

A and B obtained from table under t and t–t'

P= *848* P-1000= *-152*

t= *20.0* B= *0.257*

t'= *12.3* B(P-1000) = *39.06*

t–t'= *2.7* A= *341.45*

$(n-1) \times 10^6$ = *302.39*

O= *+0.000023*

Sum			*3,892*	Pressure Mbs			Temp °C	
Mean			*389*	Read'g	Corr	Press	Dry	Wet
No of Rdgs	M. Baro	Start				*846*	*19.6*	*17.3*
10	No *982*	Finish				*846*	*20.4*	*18.0*
Swing	R. Baro	Start				*849*	*21.2*	*17.2*
31	No*1027*	Finish				*849*	*18.6*	*16.6*
		Sum				*3390*	*79.8*	*69.1*
		Mean				P. *848*	t. *20.0*	t' *17.3*

29,453.89 D=Ind. Dist.

+0.68 D·O

29,454.57 L=Sum

-0.35 Zero Corrn

29,454.22 Field Length

Diagrams remarks etc

Obs Sheet No.	Set 1 of 3			Set 3 of 3			Set 1 of 3			Set of			Set of			Set of			Diagram & Remarks.
Date/Time	27-9-'73 / 15 h 40 m			27-9-'73 / 16 h 10 m			27-9-'73 / 15 h 40 m			/ h m			/ h m			/ h m			
Type of Target	Helio Lamp			Lamp Helio			Helio Lamp												
Theodolite No.	T3 83067			T3 83067			T3 83067												
Observer	K. Yoshioka			K. Yoshioka			K. Yoshioka												
Conditions	Good			Good			Good												
From R O	5-ST-3			5-ST-3			5-ST-3												
To Stn	5-ST-5			4-ST-3			5-ST-1												
	"	Reobs	vv	"	Reobs	vv	"	Reobs	vv	"	Reobs	vv	"	Reobs	vv	"	Reobs	vv	
Rounds 1	40 , 1	0 , 5	0,25	38 , 4	0 , 8	0 , 64	27 , 1	0 , 7	0, 49	,	,	,	,	,	,	,	,	,	
2	43 , 4	2 , 8	7,84	41 , 3	3 , 7	3 , 69	30 , 0	2 , 2	4, 84	,	,	,	,	,	,	,	,	,	
3	38 , 0	2 , 6	6,76	36 , 7	0 , 9	0 , 81	27 , 7	0 , 1	0, 01	,	,	,	,	,	,	,	,	,	
4	39 , 4	1 , 2	1,44	38 , 5	0 , 9	0 , 81	23 , 9	3 , 9	5, 21	,	,	,	,	,	,	,	,	,	
5	40 , 3	0 , 3	0,09	41 , 1	3 , 5	2 , 25	28 , 6	0 , 8	0, 64	,	,	,	,	,	,	,	,	,	
6	42 , 0	1 , 4	1,96	38 , 5	0 , 9	0 , 81	26 , 6	1 , 2	1, 44	,	,	,	,	,	,	,	,	,	
7	41 , 6	1 , 0	1,00	37 , 9	0 , 3	0 , 09	29 , 2	1 , 4	1, 96	,	,	,	,	,	,	,	,	,	
8	41 , 8	1 , 2	1,44	35 , 4	2 , 2	4 , 84	27 , 5	0 , 3	0, 09	,	,	,	,	,	,	,	,	,	
9	41 , 0	0 , 4	0,16	36 , 4	1 , 2	1 , 44	30 , 1	2 , 3	5, 29	,	,	,	,	,	,	,	,	,	
10	38 , 9	1 , 7	2,89	37 , 4	0 , 2	0 , 04	26 , 4	1 , 4	1, 96	,	,	,	,	,	,	,	,	,	
11	40 , 5	0 , 1	0,01	34 , 9	2 , 7	7 , 29	25 , 9	1 , 9	3, 61	,	,	,	,	,	,	,	,	,	
12	39 , 6	1 , 0	1,00	35 , 1	2 , 5	6 , 25	30 , 7	2 , 9	8, 41	,	,	,	,	,	,	,	,	,	
Sum εvv	486 , 6		4 , 8	451 , 6		48, 96	333 , 7		43, 95	,		,	,		,	,		,	
Mean, $\varepsilon^{vv}/n(n-1)$	40 , 6		0 , 19	37 , 6		0, 37	27 , 8		0, 33	,		,	,		,	,		,	
Set Angle	°	'	"	°	'	"	°	'	"	°	'	"	°	'	"	°	'	"	File Page No.
σm Set	0.4			0.6			0.6												
Diff Sets	3.1			4.8			2.8												
Accepted Angle	° 57	' 48	" 40.6	° 184	' 52	" 37.6	° 260	' 24.	" 27.8	°	'	"	°	'	"	°	'	"	

ABSTRACT OF HORIZONTAL ANGLES.

Date 1-10-'73
Abstracted by K. Yoshioka
Checked by K. Kobayashi

Stn page of

Station. TAN 317
RORIA

Diagram 5

From "A"	TO "B"	MEAN OBSERVED ANGLE			HEIGHTS Inst "A"	HEIGHTS Target "B"	No. of Rounds	Spread	Instrument Type.	Instrument No.	Date	Time	Obs. Sheet No.	Distance	Diff. Observed Calculated	Corrected Zenith Distance		Remarks
		°	′	″	m	m								km	″	°	′	″	
13-ST-2	TAN316	88	36	35 ,8	1 ,48	0 ,25	4	3.0	T3	83067	24-9-73	13 ,00	3 of 3	15 ,2	-16 ,7	88	36	19 ,1	
TAN316	13-ST-2	91	30	57 ,6	0 ,34	1 ,18	4	3.1	T3	91186	24-9-73	13 ,00	2 of 2	15 ,2	+11 ,4	91	31	09 ,0	
TAN316	13-ST-3	90	35	36 ,7	0 ,34	1 ,17	5	4.4	T3	91186	24-9-73	12 ,30	1 of 2	23 ,6	+ 7 ,3	90	35	44 ,0	
13-ST-3	TAN316	89	35	42 ,0	1 ,66	0 ,18	4	1.2	DKM3A	134825	24-9-73	12 ,30	3 of 3	23 ,6	-12 ,9	89	35	29 ,1	
13-ST-3	13-ST-4	91	22	15 ,4	1 ,49	1 ,27	4	1.9	T3	91186	4-9-73	13 ,50	1 of 3	18 ,3	- 2 ,5	91	22	12 ,9	
13-ST-4	13-ST-3	88	46	48 ,9	1 ,50	1 ,24	4	3.3	DKM3A	134825	4-9-73	13 ,50	2 of 2	18 ,3	- 2 ,9	88	46	46 ,0	
13-ST-4	12-ST-5	89	26	34 ,5	1 ,50	0 ,24	4	4.2	DKM3A	134825	4-9-73	13 ,40	1 of 2	12 ,0	-21 ,7	89	26	12 ,8	
12-ST-5	13-ST-4	90	39	36 ,0	1 ,08	1 ,27	4	4.8	T3	83067	4-9-73	13 ,40	2 of 2	12 ,0	+ 3 ,3	90	39	39 ,3	
12-ST-5	12-ST-6	90	00	28 ,2	1 ,08	1 ,26	4	2.6	T3	83067	4-9-73	11 ,30	1 of 2	28 ,2	+ 1 ,3	90	00	29 ,5	
12-ST-6	12-ST-5	90	13	01 ,9	1 ,40	1 ,38	3	4.7	T3	91186	4-9-73	11 ,30	2 of 3	28 ,2	- 0 ,1	90	13	01 ,8	

LINES :

File Page No.

ABSTRACT OF VERTICAL ANGLES

Survey _____

Job No. _____

Abstracted by

Checked by

Remarks

$$\text{Diff} = -\frac{A-B}{D}\rho''$$

MASTER AT	REMOTE AT	MEAN MET. P mds.	MEAN MET. t°c	MEAN MET. t°c	INDICATED SLOPE DISTANCE	No. of FR	Swing CMS	MASTER No.	MASTER Ht.	REMOTE No.	REMOTE Ht.	Date	Time	REDUCED SLOPE DISTANCE	Obs. Sheet No.	Remarks
TAN 317	5-ST-3	848	20.0	17.3	29 453.89	10	31	773	0.33	772	1.30	27-9-73	10:00	29 454.22	1	
TAN 317	5-ST-3	844	25.9	19.0	3.78	10	19	773	0.33	772	1.30	27-9-73	13:00	4.37	3	
5-ST-3	TAN 317	847	20.2	17.4	3.90	10	25	772	1.30	773	0.33	27-9-73	10:15	4.23	2	
5-ST-3	TAN 317	844	25.6	19.0	3.75	10	31	772	1.30	773	0.33	27-9-73	13:20	4.31	4	
													MEAN	29 454.28		
														0		
														29 454.28		
									+6	36						
									-9	81						
									+5	25						
									-3	9						
									-1	151 ÷ 12				M.S.E. ±4cm		
														diff. of set 12cm		

LINES :

TAN 317
5-ST-3

File Page No.

ABSTRACT OF TELLUROMETER MEASURES

Survey _____

Job No. _____

Abstracted by
R. Kawakami
Checked by
E. Ono

Zero Correction

-0.35^m

Remarks

FILD SHEETS OF FIRST ORDER LEVELING.

ROUTE ( ) FROM $H/60^A/13$ TO $H/60^A/14$ (*I*)

Date: *29/8/'73* | Weather: *FINE* | File page No. *35*

Instrument: | Rods:

Observer: | Checked:

PT.	DIST.	b or f	LEFT BACKSIGT / ×COMPLE	SCALE ×COMPLE / FORESIGT	RIGHT BACKSIGT / ×COMPLE	SCALE ×COMPLE / FORESIGT	REMARKS
	m		,	,	,	,	
I	15	b	2,12477	×7,87533	5,13999	×4,86011	$H/60^A/13$
		f	×9,13691	0,86311	×6,12113	3,87877	15^h10^m
			1,26116	×8,73884	1,26112	×8,73888	35°C
II	18	b	2,14999	×7,85011	5,16558	×4,83422	WIND/E/I
		f	×9,43191	0,56881	×6,41653	3,58335	
			2,84334	×7,15666	2,84335	×7,15655	
III	24	b	2,21577	×7,78433	5,23112	×4,76888	
		f	×9,78933	0,21077	×6,77337	3,22663	
			4,84884	×5,15116	4,84884	×5,15116	
IV	26	b	2,53900	×7,46100	5,55445	×4,44555	
		f	×9,59411	0,40589	×6,57844	3,42156	
			6,98135	×3,01885	6,98133	×3,01887	
V	26	b	2,45077	×7,54933	5,46633	×4,53377	
		f	×9,63544	0,36446	×6,61998	3,38021	
			9,06776	×0,93244	9,06774	×0,93266	
VI	30	b	2,57955	×7,42045	5,59533	×4,40477	
		f	×9,64744	0,35326	×6,63117	3,36833	
			11,29445	×88,70555	11,29444	×88,70566	
VII	26	b	2,42899	×7,57111	5,44422	×4,55578	
		f	×9,34532	0,45548	×6,52966	3,47044	
			13,26886	×86,73114	13,26882	×86,73188	
VIII	32	b	2,56588	×7,43412	5,58113	×4,41887	
		f	×9,46666	0,53334	×6,45088	3,54922	
			15,30100	×84,69900	15,30083	×84,69917	
IX	31	b	2,27088	×7,72992	5,28655	×4,71345	
		f	×8,80677	1,19333	×5,79099	4,20911	
			16,37885	×83,62115	16,37777	×83,62223	
X	39	b	1,06422	×8,93578	4,07944	×5,92056	
		f	×8,16770	1,83330	×5,15117	4,84833	
			15,60997	×84,39003	15,60888	×84,39112	
XI	40	b	1,07966	×8,92034	4,09555	×5,90445	
		f	×8,39775	1,60225	×5,38117	4,61883	+14,4903
			15,08688	×84,91312	15,08600	×84,91400	
XII	43	b	1,18677	×8,81333	4,20223	×5,79777	34°C
III	350	f	×8,21771	1,78229	×5,20117	4,79883	... A
			14,49006	×85,50994	14,49000	×85,51000	
TOTAL		b	24,65555		60,84233		
		f	10,16499	−14,49006	46,35223	−14,49000	

T_1 = , °C

T_2 = ,

T = , °C

FROM TO ( )=− , ( ): S.P.

13 · $\begin{matrix}+14.4903\\-14.4912\end{matrix}$ (A) $\begin{matrix}+1.9838^{(-16)}\\-1.9854\end{matrix}$ · 14

TABULATION

OF BENCH-MARK

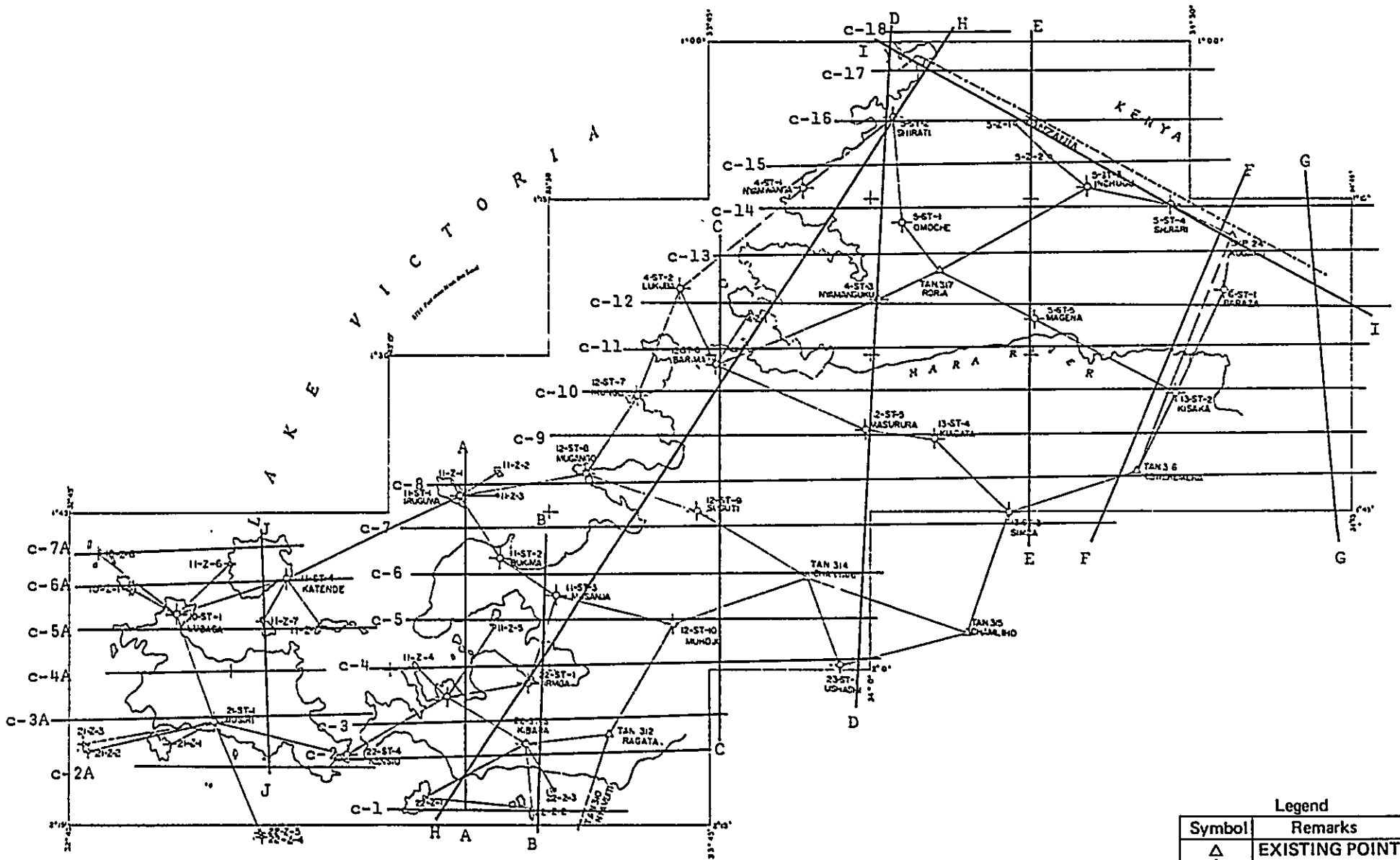
FROM *Seronera F.B.M.* COMPUTED BY _____

TO *Bunda F.B.M.* CHECKED BY _____

POINT	DIST.	DIFFERENCE I	DIFFERENCE II	CORR FOR STAFF	OBSERVED ELEVATION	CORR FOR ORTHO-METRIC	CORR FOR CLOSURE	ADJUSTED ELEVATION	REMARKS
	km	m		26°C	m			m	
Seronera F.B.M.					1509 , 5800	–	–	1509 , 5800	*staff No.*
H.60A	0 , 986	– 4 , 1850	1838	– 1	– 4 , 1845				*1045-A*
1				28	1505 , 3955	– 0	–	1505 , 3955	*1045-B*
	1 , 471	– 11 , 0739	0772	– 3	– 11 , 0759				
2				24	1494 , 3196	– 1	–	1494 , 3197	
	1 , 539	– 3 , 5264	5263	– 1	– 3 , 5265				
3				28	1490 , 7931	– 2	–	1490 , 7933	
	1 , 567	– 17 , 8868	8885	– 4	– 17 , 8880				
4				25	1472 , 9051	– 2	–	1472 , 9053	
	1 , 522	– 32 , 7152	7177	– 7	– 32 , 7171				
5				24	1440 , 1880	– 2	–	1440 , 1882	
	1 , 611	– 10 , 5603	5594	– 2	– 10 , 5600				
6				22	1450 , 7480	– 3	–	1450 , 7483	
	1 , 498	– 9 , 3006	2998	– 2	– 9 , 3004				
7				26	1460 , 0484	– 4	–	1460 , 0488	
	1 , 895	– 10 , 5974	5952	– 2	– 10 , 5965				
8				24	1449 , 4519	– 4	–	1449 , 4523	
	1 , 878	– 21 , 8992	9024	– 4	– 21 , 9012				
9				26	1427 , 5507	– 4	–	1427 , 5511	
	1 , 535	– 35 , 2366	2388	– 7	– 35 , 2384				
10				27	1392 , 3123	– 5	–	1392 , 3128	
	1 , 480	– 8 , 9570	9563	– 2	– 8 , 9568				
11				28	1401 , 2691	– 6	–	1401 , 2697	
	1 , 545	– 16 , 0898	0880	– 4	– 16 , 0893				
12				30	1385 , 1798	– 7	–	1385 , 1805	
	1 , 500	– 16 , 0796	0782	– 4	– 16 , 0793				
13				31	1401 , 2591	– 7	–	1401 , 2598	
	1 , 532	– 16 , 4741	4766	– 4	– 16 , 4758				
14				26	1417 , 7349	– 8	–	1417 , 7357	
	1 , 490	– 5 , 6432	6431	– 1	– 5 , 6433				*15~17*
15				27	1423 , 3782	– 9	–	1423 , 3791	*staff No.*
	1 , 537	– 15 , 5038	5028	– 6	– 15 , 5039				*1455-A*
16				27	1407 , 8743	– 10	–	1407 , 8753	*1455-B*
	1 , 512	– 3 , 7800	7822	– 1	– 3 , 7812				*17~19*
17				29	1404 , 0931	– 10	–	1404 , 0941	*staff No.*
	1 , 556	– 24 , 7093	7100	– 12	– 24 , 7108				*1432-A*
18				28	1379 , 3823	– 11	–	1379 , 3834	*1432-B*
	1 , 979	– 2 , 6334	6322	– 1	– 2 , 6329				
19				26	1382 , 0152	– 12	–	1382 , 0164	*19~*
	1 , 610	– 2 , 0964	0952	– 0	– 2 , 0958				*staff No.*
20				27	1379 , 9194	– 13	–	1379 , 9207	*1045-A*
	1 , 888	– 6 , 5006	5017	– 1	– 6 , 5013				*1045-B*
21				27	1386 , 4207	– 14	–	1386 , 4221	
	1 , 868	– 5 , 4982	4996	– 1	– 5 , 4990				
22				22	1391 , 9197	– 14	–	1391 , 9211	
	1 , 957	– 16 , 1898	1894	– 3	– 16 , 1899				
23				28	1375 , 7298	– 15	–	1375 , 7313	
	1 , 853	– 5 , 4752	4750	– 1	– 5 , 4752				
24				27	1381 , 2050	– 16	–	1381 , 2066	
	1 , 528	– 6 , 3154	3162	– 1	– 6 , 3159				
25				28	1387 , 5209	– 17	–	1387 , 5226	
	1 , 517	– 6 , 5824	5848	– 2	– 6 , 5838				
26					1394 , 1040	– 17	–	1394 , 1064	
	41.794				*–215 4990*				
					+100 0237				
					–115 4753				

Diagram 10 MUSOMA AREA

1:750,000



Legend

Symbol	Remarks
△	EXISTING POINT
-⊙-	new point
o	*PHOTO POINT*

Diagram 11 MUSOMA AREA
OBSERVATION MAP
1:1,000,000

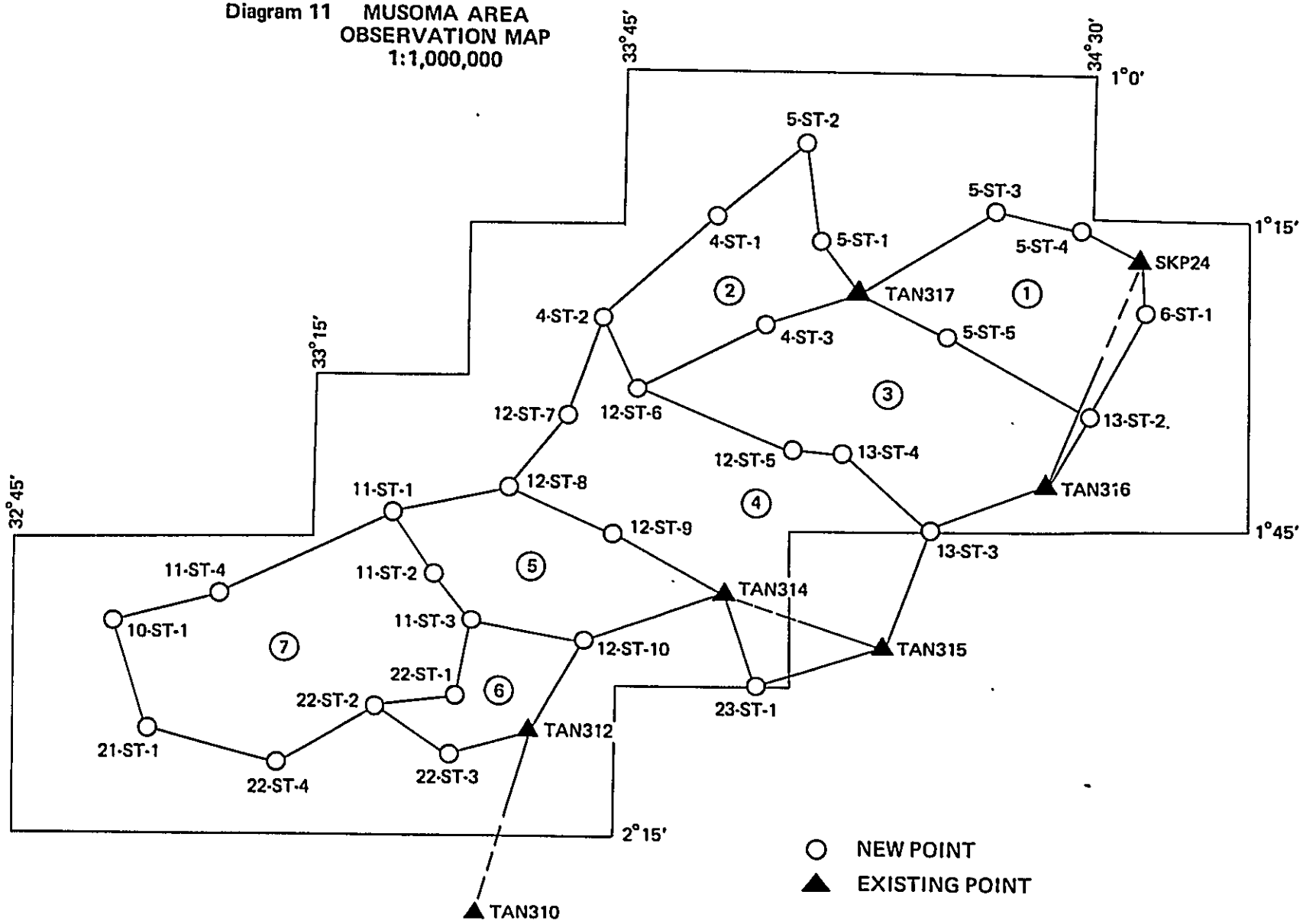


Diagram 12

Closure error and accuracy in Traverse Survey

(Performed in 1973)

Loop No.	Angle (ΔA) m	Position (ΔS) m	Accuracy ΔS/ΣS	Height Difference (Δh) m
(1)	+0.02	0.16	1 : 808,263	+1.01
(2)	+2.48	0.23	1 : 584,158	+0.46
(3)	−1.59	1.02	1 : 182,020	−1.62
(4)	−4.90	0.68	1 : 314,270	−0.23
(5)	+2.15	0.22	1 : 628,773	−0.81
(6)	−3.06	0.04	1 : 2,050,520	+0.14
(7)	−2.82	0.60	1 : 287,732	+0.23

(Note) For loop Nos., refer to Diagram 11, net map (1/1,000,000).

Diagram 13

Checking results of side length between given points

(Performed in 1973)

Section between two given points	Survey results	Known value	ΔS
	km m	km m	cm
SKP24 – TAN316	44,558.79	44,558.73	+6
TAN314 – TAN315	29,265.30	29,265.27	+23
TAN312 – TAN310	43,319.37	43,318.87	+50

Diagram 14

Accuracy of leveling

First order levelling between Seronera and Bunda, performed in 1973

1. Working period: August 15 to November 28, 1973
2. No. of intervals between two bench marks: 93
   - Frequency of positive numbers: 37 — *Total of positive results:* 51.1^{mm}
   - Frequency of negative numbers: 55 — Total of negative results: 78.0
   - Frequency of zero: 1 — −26.9
3. *Mean square error per kilometer* (Total length: 161.5km)

$$m = \pm 0.65^{mm}$$

(Part II)

Report on Aerial Photography for Topographic Mapping Project for Musoma Area, Republic of Tanzania

1 OBJECTIVE OF AERIAL PHOTOGRAPHY

The objective of aerial photography was to effect vertical stereophotography necessary for preparing the National Basic Map of the project area. According to the scheduled work flow, aerial photography was conducted in fiscal year 1973.

2 OUTLINE OF AERIAL PHOTOGRAPHY

A. 1 : 50,000 vertical stereophotography
Work amount : Area approx. 12,730 km²
No. of photographs : Approx. 710 sheets

The project area was situated on the east bank of Lake Victoria, Republic of Tanzania. In view of the meteorological environment peculiar to the Continental Savannah Zone, a period extending from late June through July was selected for the photographic work, because that period was considered the best for taking aerial photography. Accordingly, the Survey Team and equipment were immediately mobilised to the project area. The elevation of the project area, situated in the highlands, averaged 1,200 meters above sea level. Therefore, with due consideration given to this elevation and economical flight performance of the photographing aircraft, a superwide-angle lens cone was employed to lower the flight altitude as far as possible. Wilson Airport in Kenya and Mwanza Airport in Tanzania were primarily used as bases of operation for photography. For those sections that were decided to be re-photographed because of such problems as difficulty in maintaining a planned photographic course owing to featureless terrains and unfavorable weather conditions, and also for those sections which had not yet been photographed, photography was conducted during the minor dry spell in December. All photographic activities were thus completed on January 2, 1974. (See Appended Diagram 10.)

B. 1 : 10,000 strip photography
Workload: 32 points

Strip photography, restrained by weather and time because 1:50,000 vertical stereophotography had to be conducted prior to signalisation at the control points, was conducted after signalisation for the purpose of transferring the control points onto the original photographs. Nevertheless, all activities were completed during the minor dry spell in December. For precisely leading the camera to the target positions, a mosaic photograph on which all signalised points were marked was employed as a guide map.

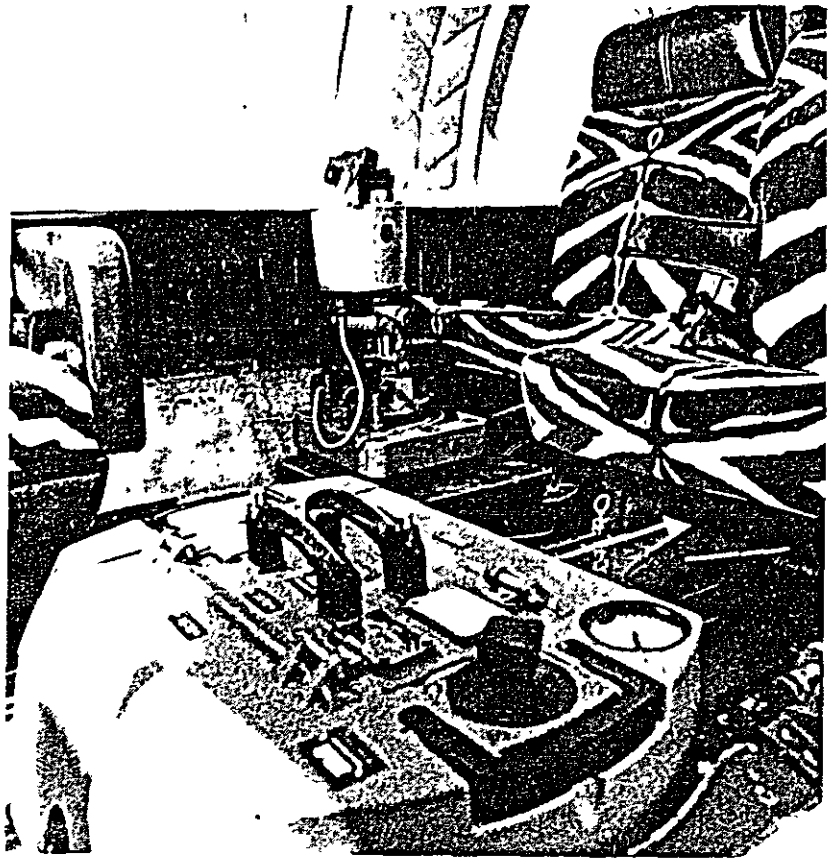
3 EQUIPMENT & MATERIAL USED FOR THIS WORK:

3.1 Aircraft

A turbocharged twin-engined Cessna 402 A aircraft, Reg. No. 5Y-AMS, with long-range ferry tanks giving it 8 hours endurance. The aircraft can reach an altitude of 9,000 meters and has a speed of 260 km/hour. It has been specially modified to accommodate all modern aerial cameras and navigation sights.

3.2 *Camera & Lens-cone*

A Wild RC. 10 camera with a Wild Super Aviogon lens cone was used for 1:50,000 scale photography and a Universal Lens Cone for photographing the "Signalised Points." The Navigator remote-controlled the camera by the aid of the Wild Navigation Telescope NF-2.



Aerial survey camera and finder mounted on the plane

Technical details of the camera were as follows:

1.	Serial No. of Camera	:	1267
2.	Serial No. of lens cone	:	SAG 2009
3.	Calibrated focal length of SAG lens	:	87.94 mm
4.	Serial No. of UAG lens cone	:	1015
5.	Calibrated focal length of UAG lens	:	151.75 mm
6.	No. of Film cassettes used	:	3
7.	Serial No. of cassettes	:	1252, 1253 and 1254

3.3 Film Used

Kodak Double X aerial film, Specification 957 (9½ in. 500 ft.) Expiration date September 1975.

3.4 Chemicals

1. Developer : Kodak DK. 50
2. Stop bath : Glacial Acetic Acid
3. Fixer : Kodak RT-Fixer
4. Wetting Agents : Kodak Foto Flo.

Average developing time of a full roll film (1,500m) was 28 minutes at 20°C; fixing time was 25 minutes.

3.5 Developing Machine

Zeiss FE-120, Serial No. 120-730

3.6 Drying Machine

Zeiss TB-24, Serial No. 116-945

3.7 Printing Process

A Milligan Electronic Printer, Mod. CP 10 A, Serial No. 517 was used throughout the contract for contact printing. Prints were made on Kodak WSG Paper which was developed in Kodak DA-163 and fixed in Kodak Unifix solution. Drying was effected on a Kodak Drum Dryer, Serial No. T 24 R/1407.

4 AIRCREW

1. Pilot in Command:
   Captain R. J. Dance, 48 years old
   Licence: ALTP, J.R.,
   Flying Hrs.: 3200 in Africa, Asia, and Europe.

2. Navigator:
   Konrad Meyer-Buenau, 61 years old
   Total of 5000 flying hours.
   Experience in aerial photography: 25 years in Europe, Asia, and Africa.

5 GENERAL CONDITIONS OF AERIAL PHOTOGRAPHY

1:50,000 scale photography of the Musoma Area was started on 9th July, 1973 and completed on 27th July, 1973. 1:50,000 scale photography of the Musoma Extension Area, 1:10,000 signal photography, and re-flights of Musoma was started on 5th December, 1973 and completed on 2nd January, 1974.

The clearance and permission for photography for the area which is a restricted area had to be approved by the Government of Tanzania at D.S.M. (Army Headquarters). The flight permission was granted by Major Yakanda, Army Headquarters and the crew passed through D.S.M. on the way to the target to get this clearance. Weather conditions during the entire photography period were poor. Dense haze causing very poor visibility obstructed navigation and photgraphy.

On several days the visibility was so bad that the crew was unable to see the ground

from an altitude of 10,000 ft. A.M.S.L. High clouds in the mornings and quickly ascending cumulus clouds made photography impossible on several days. The crew flew every day across the entire target to take photographs, except for a few days when the aircraft could not even take off because of bad weather.
Maps used for the photography were very old with insufficient topographical details. Used for the northern part of the project area were 1:250,000 scaled maps; used for the southern part and the Musoma Extension Area were 1:500,000 scaled maps compiled in 1949. Due to the inferior quality maps and the poor visibility, navigation was extremely difficult. Several lines had to be re-flown because of clouds.

Summary of the Actual Photography

9.7.1973 ATD Wilson 06.55 (ATA D.S.M. 09.35 = 2^h30^m. All indicated times are local times.)
Flying to D.S.M. to clear flight permission. ATD D.S.M. 12.30. ATA Mwanza 16.00 = 3^h20^m. The aircraft climbed up to photographing height, but haze was so dense that the crew could not see the ground. Also clouds obstructed photography.

10.7.1973 ATD Mwanza 08.05. ATA Mwanza 09.05 = 1^h00^m. No photography due to dense haze and clouds.

11.7.1973 ATD Mwanza 11.00. ATA Mwanza 12.40 = 1^h40^m. Photography runs 4 and 3. Work suspended due to dense haze.

12.7.1973 ATD Mwanza 08.30. ATA Wilson 11.05 = 2^h35^m. Photography of run 10. Work suspended due to bad forward visibility; impossible to remain on the line.

13.7.1973 ATD Wilson 08.00. ATA Wilson 11.05 = 3^h05^m. Photography of run 6. Work suspended due to dense haze and clouds.

14.7.1973 ATD Wilson 07.55. ATA Wilson 10.05 = 2^h20^m. Photography of runs 11, 10, 9, 8, and 6. Work suspended due to haze and cumulus clouds.

15.7.1973 ATD Wilson 09.45. ATA Wilson 10.20 = 0^h35^m. No photography due to stratocumulus and altocumulus clouds.
ATD Wilson 14.00. ATA Wilson 16.40 = 2^h40^m. Clouds completely blanketed the target.

16.7.1973 ATD Wilson 07.50. ATA Wilson 12.40 = 4^h50^m. Photography of runs 12, 10, D, 18, 17, 16, and 14. Work suspended due to haze and quick-appearing cumulus clouds.

17.7.1973 ATD Wilson 09.05. ATA Wilson 13.25 = 4^h20^m. Photography of runs 10, 11, 12, 13, 15, and 16. Work suspended due to clouds. Developing of film.

18.7.1973 ATD Wilson 07.55. ATA Wilson 11.15 = 3^h20^m .Photography of runs 8, 7, and 9. Work suspended due to haze and cumulus clouds. Navigation very difficult due to old, inferior quality maps.

19.7.1973 ATD Wilson 07.50. ATA Wilson 14.20 = 6^h30^m . Photography of runs 13, 14, J, E, 3, and 8; re-flights of eastern part of runs 7 and 8; new photography of runs 6, 5, and 9. Work suspended due to clouds in other part of the target.

20.7.1973 ATD Wilson 07:55. ATA Wilson 10.00 = 2^h15^m . Crew flew over the whole target but was unable to take photographs due to high and low clouds.

21.7.1973 No flight and no photography due to clouds.

22.7.1973 ATD Wilson 08.00. ATA Wilson 13.40 = 5^h40^m .Photography of runs 9, F, and 4; re-flights of runs 4 and 3 (off line due to inferior quality maps). New photography of runs I, H, A, and B. Work suspended due to clouds.

23.7.1973 ATD Wilson 08.00. ATA Mwanza 10.50 = 2^h50^m .Photography of runs 1 and D. Work suspended due to clouds. Standby at Mwanza.
ATD Mwanza 14.25. ATA Wilson 16.05 = 1^h40^m . No photography due to clouds.

24.7.1973 ATD Wilson 07.55. ATA Wilson 10.00 = 2^h05^m . No photography due to clouds.
Developing of film.

25.7.1973 ATD Wilson 08.00. ATA Wilson 12.35 = 4^h35^m .Photography of runs 9 and 10. Re-flights of areas with clouds on the first flights on runs 13 and 12 with 90% length overlap. New photography of runs 1, 17, 14, and continuing No. 10. Work suspended; clouds appeared very quickly.

26.7.1973 ATD Wilson 07.50. ATA Wilson 09.50 = 2^h00^m . No photography due to high and low clouds.

27.7.1973 ATD Wilson 08.00. ATA Wilson 11.50 = 3^h50^m . Re-flights of runs 1, 2, and 3. Photography finished.
Developing of film.

5.12.1973 ATD Wilson 11.00. ATA Mwanza 13.29 = 2^h30^m .. Photography 1:10,000 scale of Signalized Points 4 ST 2, 4 ST 1, 5 ST 2, 12 ST 6, 12 ST 7, 12 ST 8, 11 ST 2, and 11 ST 1; Work suspended due to cumulus clouds; no 1:50,000 scale photography.
Crew Captain Dance and Navigator Meyer-Buenau with 5Y-AMS based at Mwanza to be closer to the target.

6.12.1973 ATD Mwanza 08.20. ATA Mwanza 12.05 = 3^h45^m. Photography of "Signalised Points" 1:10,000 scale 22 ST 3, TAN 312, 23 ST 1, TAN 314, 12 ST 5, 13 ST 4, 13 ST 3, TAN 316, 13 ST 2, 6 ST 1, SKP 24, 5 ST 4, 5 ST 3, 5 Z 2, 5 Z 1, 5 ST 1, TAN 317, and 11 ST 3.
Work suspended due to quick-appearing cumulus clouds.

7.12.1973 ATD Mwanza 07.50. ATA Mwanza 12.20 = 4^h35^m. Photography of "Signalised Points" 22 ST 2, 22 ST 1, 13 ST 3, 12 ST 10, 12 ST 9, 5 ST 5, and 4 ST 3.
After finishing photography, 1:10,000 scale lens was changed to effect 1:50,000 scale photography of runs H and G "Musoma Re-flights."
Work temporarily suspended due to clouds; photography of runs C 7 A, C 5 A, C 4 A, C 3 A, and C 6 A. Some runs not finished due to clouds.

8.12.1973 ATD Mwanza 09.30. ATA Wilson 12.50 = 3^h20^m. Photography of run C2A. "Musoma Extension"; work temporarily suspended due to clouds; later on photography of run H (Musoma Re-flights) and runs 17, 16, and 14. Work suspended due to clouds.
Developing of film.

9, 10 &
11.7.1973 No flights due to bad weather with rain in the area.

12.12.1973 ATD Nairobi/Embakasi 09.05. ATA Mwanza 11.30 = 2^h25^m. Photography of run D "Musoma Re-flights." Run not finished due to clouds.

13.12.1973 ATD Mwanza 08.00. ATA Mwanza 11.30 = 3^h30^m. Photography of "Musoma Extension" run C6A, J, C3A, and C2A. Then photography of "Musoma Re-flights" Run 8, G, and E. Runs not flown to the end due to clouds.

14.12.1973 ATD Mwanza 08.05. ATA Mwanza 08.35 = 0^h30^m. No photography due to thunderstorms with rain in the target area.

15.12.1973 ATD Mwanza 08.05. ATA Mwanza 12.15 = 4^h10^m. Photography of "Musoma Re-flights" runs D, 13, 6, 8, and E. Work suspended due to clouds.
ATD Mwanza 15.00. ATA Wilson 16.50 = 1^h50^m.

17.12.1973 & 18.12.1973 Developing film and checking photos with Mr. Yoshida; checked runs H, 17, 16, 14, and 8 of "Musoma Re-flights."

19.12.1973 Checking photography of "Signalised Points" with D.T.C.A. surveyors.

20.12.1973 ATD Wilson 09.20. ATD Mwanza 10.25=2^h05^m. Re-flight of Signalised Point SKP 24, which the surveyors were unable to find on photos of the first flight.

1:50,000 scale photography impossible due to cumulus clouds.

21.12.1973 ATD Mwanza 08.10. ATA Mwanza 11.30 = 3^h20^m. Re-flights of areas covered by clouds; Musoma Extension on runs C3A and J; also re-flight of "Musoma Re-flights" runs 14 and 8.
Work suspended due to clouds.

22.12.1973 ATD Mwanza 08.10. ATA Mwanza 08.40 = 0^h30^m. No photography due to thunderstorms and rain in the area.

23.12.1973 No flight due to thunderstorms and rain in the area.

24.12.1973 ATD Mwanza 08.35. ATA Wilson 10.20 = 1^h45^m. No photography due to clouds and rain in the area.
Developing of film.

25.12.1973 Checking photography; no flight because of bad weather conditions.

26.12.1973 ATD Wilson 07.20. ATA Wilson 13.20 = 5^h00^m. Some photography, although cloudy.

27.12.1973 Poor weather, no photography.
Developing of film and checking photography.

28.12.1973 Musoma = 2^h15^m. Extension. No photography because too cloudy.

29.12.1973 Musoma = 2^h30^m. Extension. Some photography.

30.12.1973 Musoma = 1^h10^m. Extension. No photography.

31.12.1973 Musoma = 3^h40^m. Extension. Developing of film.

1.1.1974 Musoma = 4^h10^m. Extension. Some photography.

2.1.1974 Musoma = 4^h15^m. Extension. Completed photography.