REPORT ON PRELIMINARY SURVEY

FOR

MICROWAVE NETWORK PROJECT IN ETHIOPIA

ADDIS ABABA : ASMARA ROUTE

JUNE 1969

OVERSEAS TECHNICAL COOPERATION AGENCY

GOVERNMENT OF JAPAN

Preface

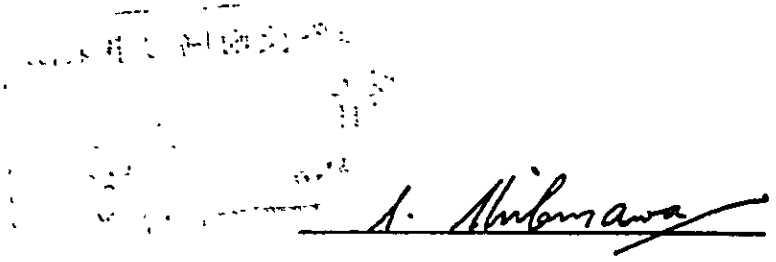
The Government of Japan, at the request of the Imperial Government of Ethiopia, decided to undertake a preliminary survey for the Microwave Network Construction Project which is presently envisaged for the route between Asmara and Addis Ababa, the capital city of Ethiopia, and entrusted this task to the Overseas Technical Cooperation Agency (OTCA), an institution for implementing technical cooperation activities on government basis.

The OTCA, in the light of great importance of developing telecommunication in Ethiopia, immediately organized a survey team for the above project, consisting of five members headed by Mr. Seishi Nakamura, Technical Officer of the Ministry of Posts and Telecommunications, and despatched it to Ethiopia for a period of forty-five days, from February 15 to March 31, 1969.

The report hereby presented is based on the outcome of the preliminary survey carried out during the above period. I sincerely hope that this report will play its part in the Microwave Network Construction Project in Ethiopia and at the same time contribute to the economic development of Ethiopia and furthering friendship between our two countries.

Finally, I take this opportunity to express my hearty gratitude to the Imperial Government of Ethiopia, particularly to the Imperial Board of Telecommunications of Ethiopia, for their generous support and cooperation extended to the team.

June, 1969



Shinichi Shibusawa
Director General
Overseas Technical Cooperation Agency
Japan

C O N T E N T S

I. INTRODUCTION

1. Objective

The team, in compliance with the request of the Government of the Empire of Ethiopia, conducted a preliminary survey for the microwave networks construction project covering a distance of about 800 Km between Addis Ababa and Asmara, which was planned as a part of the 4th 5 year Investment Program in Ethiopia.

2. Organization of the Preliminary Survey Team

The organization of the preliminary survey team is as follows.

Head	Seishi Nakamura;	Chief, International Cooperation Affairs, Radio Regulatory Bureau, Ministry of Post and Telecommunications of Japan
Member	Katsusaburo Suzuki;	Staff, Legal Division, Radio Regulatory Bureau, Ministry of Post and Telecommunications of Japan
Member	Teruaki Sato;	Chief Engineer, International Affairs Office, Nippon Telegraph and Telephone Public Corporation
Member	Kichiro Kimura;	Staff engineer, International Affairs Office, Nippon Telegraph and Telephone Public Corporation
Member	Chizuo Abe;	Chief of the Programming Section, Overseas Technical Cooperation Agency of Japan

The survey team started from Addis Ababa on February 24th, 1969 and carried out the field survey for the site selection along the proposed microwave routes until March 21st.

An interim report was prepared on the result of the field survey and submitted to I.B.T.E. on March 29th, and discussions were held with I.B.T.E. on the results of the survey and future problems.

Team member Chizuo Abe remained in Addis Ababa from the beginning of this survey until March 5th for coordination with Ethiopian authorities.

Throughout the survey period, full cooperation and assistance were extended to the team by the staff of I.B.T.E. to enable it to accomplish this mission.

3. Acknowledgements

All the member of the team would like to express their sincere gratitude for generous supports extended by the staff of I.B.T.E., which enable the team to carry out the work smoothly throughout the survey period.

It is the sincere desire of the team members that those microwave networks will be successfully completed at the earliest opportunity.

II. SITE SELECTION

A field survey in the area between ADDIS ABABA and ASMARA was carried out with the cooperation of engineers of I.B.T.E., during a period of 26 days from February 24th to March 21st.

It should be noted that Mr. Beyene Desta (Manager of Radio Division of I.B.T.E.) and Mr. Seyoum G. Kristos (Chief of Radio Communication Branch) joined the field survey for the section between ASMARA and DESSIE and that between DESSIE and ANCOBER NORTH, respectively to review site selection and confirm the results of the survey.

1. Basic Conditions to be Considered for Site Selection

In the work of selecting the site for a microwave route, the following basis conditions should be taken into consideration.

(a) The Line-of-Sight for the direct wave should be insured so that the 1st Fresnel Zone will not be shielded by obstacles between the proposed adjacent sites. "The Line-of-Sight" referred herein is the term with the consideration of refraction of microwave in the atmosphere.

On the other hand, the refraction index of light in the atmosphere has the values of 1.1-1.2. Therefore, if the optical Line-of-Sight is confirmed by a mirror test, the Line-of-Sight for the microwave under the atmospheric condition at K=4/3, the standard coefficient of equivalent earth' radius, may be secured with some margin.

(b) The microwave propagation is affected by the Duct-type fading as a result of irregular variation of refraction index of the atmospher and by the K-type fading caused by reflected wave. Therefore, when it is unavoidable to establish a microwave route in a region subject to the fading, the selection of station sites should be made in a manner so as not to result in a long propagation path. At the same time it will be necessary to examine the feature of anticipated fading and to consider adopting necessary space diversity reception system, etc.

(c) When the phase difference between reflected and direct waves, due to the path difference, is relatively large, the reflected wave causes the propagation distortion noise. In the selection of site, therefore, it is essential to select such a propagation path which has a shielding, ridge for the reflected wave would be set up on its route.

The effective reflection coefficient for the reflected wave is pricipally

governed by the reflection coefficient which is determined by the condition of reflection point and by the ridge loss.

Therefore, when there is no shielding ridge on the propagation path, it is necessary to give much attention that the water surface, swamp, etc., whose reflection coefficient is fairly large, do not become reflection point as much as it can be avoided.

It is also possible to substantially reduce the influence of the reflected wave either by using a highly directive antenna or by selecting such a propagation path as High-Low type, which provide a greater difference in elevation between the adjacent sites, to avoid Low Layer type propagation.

(d) The hop distance should be made as close to the standard distance as possible and extremely long or short hop must be avoided.

In addition, attention must be paid in the selection of site so that the over all performance of the circuits should not be affected with the interference by the Over-Reach propagation, Front-to-Side coupling, etc., though the effect varies depending on whether the two frequency system or the four frequency system is used.

2. Map Study

A map study was made prior to the start of the field survey. The most suitable maps for preparing a profile map, indispensable to the site selection, are those on a scale of 1:50,000. However, the only maps availabe in Ethiopia are on a scale of 1:500,000 and not suitable for the preparation of the profile map. The survey team, therefore, began its field survey after studying only a draft of proposed microwave route.

3. Outline of the Field Survey

The field survey was performed principally by means of the mirror test to confirm the Line-of-Sight between the adjacent sites and the measurement of angle of adjoining paths using a transit located at the sites.

The altitude of the ridge on the propagation path is usually measured by the triangulation based on the triangulation point where a altitude, latitude and longitude are known. In the area where field survey was made, however, there was no such triangulation point and therefore the measurement could not be performed.

Moreover, the angle of each adjoining paths, which was obtained from plotting the proposed sites on the map, differed by about 5 degrees on an average

from that measured in the field survey. Accordingly, altitudes, latitudes and longitudes of the sites, profile maps, hop distances, etc., which are shown in this report, were presumed on the basis of the results of the field survey and from available maps.

Besides, the Line-of-Sight of SHANO SOUTH-ANCOBER NORTH and ANCOBER NORTH-KARRAKORRE sections has not been confirmed due to the mist haunting around ANCOBER NORTH with an altitude of 3600 m.

In addition, the selection of the propagation path with a shielding ridge for the reflected wave from the swamp in the KARRAKORRE-KORKE section, the reaffirmation of the clearance between MACLLE NORTH and ADIGRAT WEST, the confirmation of an altitude of the ridge between DIGSA and BETE GIORGIS, etc., as well as the review of the site selection, are the tasks left to the second survey.

3.1 ADDIS ABABA - DESSIE

As shown in Fig. II-1, this route is composed of six sections, including the reflector relay section between KORKE and DESSIE, with a total distance of about 250 Km.

Both terminal stations, ADDIS ABABA and DESSIE, are scheduled to make use of the existing stations at respective locations, and other six repeater sites will have new stations.

These sites have been selected as near as possible to All Weather Road between Addis Ababa and Asmara in order to reduce the length of access roads to be constructed.

Since it was intended, at the request of I.B.T.E., to make the hop distances rather long and also because it was difficult to select the propagation path through the narrow space restricted by the mountains near to KARRAKORRE, four sections except both ending sections, namely, ADDIS ABAB - MT. FURI and KORKE - DESSIE, have become, as the result, the long propagation paths with an average distance of about 80 Km, fairly exceeding the standard of 50 Km.

Particularly, regarding KARRAKORRE - KORKE section, as it is presumed that the reflection point will be on the water surface, it is desirable to investigate as to whether the propagation path with a shielding ridge for the reflected wave could be selected or not. Moreover, as to other long propagation paths it is also recommended that a study be made on the possibility of the site selection of the alternative route for the selected one, because it can be expected that better performance of circuits would be obtained by locating an intermediate repeater station in this section.

3.2 DESSIE - MACALLE

As shown in Fig. II-1, this route is composed of six sections including two sections using the reflector relay system, DESSIE - KORKE and MAI CEU NORTH - AMBA ALAGI, and extends over about 280 Km in a total distance.

DESSIE terminal station is intended to use an existing station building and other sites will have new stations. At the request of I.B.T.E., MACALLE NORTH station is scheduled to be set up as a terminal station and to be connected with Macalle telephone office by a cable system.

All of the sites except UALDIA, which requires a new acess road of about 5 Km in distance, have been selected close to the All Weather Road, and no difficulty is foreseen in the construction of the stations.

In the vicinity of the section between MAI CEU NORTH and AMBA ALAGI, which is situated at about the center of this route, there are several steep mountains with a height of about 3,000m on both sides of the road. Because of this geographical condition, it is inevitable to divide this section into two hops with an extremely short distance of 8 Km and 7 Km, respectively. Accordingly, it will be unavoidable to adopt a passive relay system with a reflector in this section. COBBO EAST site has been selected in the farmland near the road. As both sites adjoining COBBO EAST are about 1,000 m higher than COBBO EAST which has an altitude of about 1,470 m, the reflection point goes right into the farmland near the site and no ridge to shield the reflected wave can be found there. This is not considered to create any problem, however.

3.3 MACALLE - BETE GIORGIS

As shown in Fig. II-1, this route consists of four sections with over all distance of about 210 Km.

BETE GIORGIS site has been selected for the same place as the terminal station of existing microwave route by 2GHz band, extending from Bete Giorgis to Massaua. As both the building and antenna tower do not have room in reserve to accommodate facilities of new microwave route, it will be necessary to build a new station at this site also, similar to the other four sites.

Cable system is expected to be used for the section between BETE GIORGIS and ASMARA Telecommunication Office in compliance with the request of I.B.T.E.

Not all the sites are always close to the All Weather Road, running between Addis Ababa and Asmara. However, as the existing roads are available as an acess road, the length of access road to be newly constructed at each site will be 1 Km at the longest.

The path length of each section is almost equal to the standard of 50 Km

with the exception of 78 Km between MACALLE NORTH and ADIGRAT WEST. No influence of the reflected wave is anticipated.

4. Proposed Sites

Approximate latitude and longitude as well as altitude of each site and hop distance are shown in Table II-1. In addition, guide maps for the sites and topographic sketches of the sites and the neighbourhood area are shown in Fig. II-2 - Fig. II-34.

4.1 ADDIS ABABA - DESSIE

4.1.1 ADDIS ABABA

This site is proposed to be located at Filwoha in the center of Addis Ababa City and the facilities are to be housed in the existing building currently been used as I.B.T.E. office and telephone exchange. An antenna tower for this station should be installed with a sufficient height to clear tall buildings expected to be built around the site in the future.

4.1.2 MT. FURI

This site is proposed to be located at the summit of Mt. Furi with an altitude of about 2,800m, in the southeast of Addis Ababa City.

This site provides an unobstructed visibility in the direction of Shashamene, Dire Daua and Gimma, where a microwave route is scheduled to be located in the future.

In the direction of the proposed SULULTA earth station of communication satellite systems, which I.B.T.E. plans to construct following the 4th Five-Year Investment Program, there lies a mountain chain leading to Mt. Entotto. It will be necessary, therefore, to give a special study on the problem of interference between the earth station and the microwave routes.

It will be necessary to build an access road of about 5 Km long for this site and to repair some of the existing roads. However, considering the future plan for the networks for each direction, selection of the site may be justified.

The summit of the mountain provides sufficient space for the construction of a repeater station, and land preparation is considered to be accomplished relatively easily because of no tall vegetation. But there are several huge exposed rocks on the edge of the summit, which should be avoided in locating an antenna tower.

As this site is expected to be used as a repeater station for not only ADDIS ABABA route but the projected microwave routes for Shashamene,

Dire Daua and Gimma, determination of the type of this station should be made depending on the following proposals for these microwave routes.

(Proposal 1): It is proposed that MT. FURI is to be set up as a terminal station, and that a large microwave system is to be set up in the section between ADDIS ABABA and MT. MURI, with the capacity of each radio channel and sufficient number of radio channels in parallel capable to accomodate all the telephone and television transmission circuits required for Asmara, Shashamene, Dire Daua, Gimma and all others conceivable in the future. It will be necessary, therefore, to install the carrier terminal equipments and the supervisory equipments for each route at MT. FURI for the translation of Groups and Supergroups, etc. of telephone circuits in conformance with the number of telephone channels of each route and to switch television broadcasting.

(Proposal 2): It is proposed that the MT. FURI is to be set up as an unattended branching station and that all carrier equipment are to be installed at ADDIS ABABA. Accordingly, several individual microwave systems for each route, such as ADDIS ABABA - ASMARA, ADDIS ABABA - DIRE DAUA, etc., are to be accommodated by MT. FURI - ADDIS ABABA section.

Besides, it is also planned on ADDIS ABABA - MT. FURI section to adopt one microwave systems regardless of the capacity of each radio channel for each route. In this case, each bearer of this microwave system should be connected with that of the most appropriate microwave systems for each route by IF band at MT. FURI station.

Though several different types may be conceivable as to the type of MT. FURI station, the final type of this station should determined by considering long-term traffic requirement forecast for each route, requirement for relaying television broadcasting, the plan of frequency usage, the economic aspect of the system and the type of maintenance perforemed.

4.1.3 SHANO SOUTH

This site has been proposed to be located on the hill about 10 Km south-west of Shano Town and about 4 Km east of the All Weather Road between Addis Ababa and Asmara.

The east and south sides of the hill are cut by the cliffs with a height of more than 200m. The east end of the hill is a small waste land with a lot of small rocks. But the grassland, close to the waste land, has few rocks and

provides sufficient area to construct a repeater station. Construction of an access road to this site will be easily accomplished.

On the other hand, the mirror test was not performed between this site and ANCOBER NORTH. The final decision on the location of the station, therefore, should be made after confirming the Line-of-Sight by a mirror test.

4.1.4 ANCOBER NORTH

This site has been proposed to be located at the summit of a mountain with an altitude of about 3,600 m, in the east of Debra Berhan Town and in the north of Ancober Town. A road leading from Debra Berhan Town to Ancober Town passes by the south side of the mountain foot. The difference in altitude between the road and the site is about 200 m. The access road to this site may be constructed by making use of the gently sloping side of the mountain.

The mountain summit with huge exposed rocks is so narrow that the sufficient area to construct a repeater station is not available. But the wide grassland about 15 m below the mountain summit is suitable for the construction of a repeater station. Because of its high altitude of about 3,600 m, this mountain is always covered by a mist. In this field survey, therefore, the Line-of-Sight between this site and both adjacent sites, SHANO SOUTH and KARRAKORRE, could not be confirmed by mirror test. It is recommended therefore that in the second survey the confirmation be made on the Line-of-Sight by all means and then final decision on the location of the site be made thereafter.

4.1.5 KARRAKORRE

This site has been proposed to be located halfway up a mountain standing east of the All Weather Road between Addis Ababa and Asmara. The vicinity of the site is a farmland and there runs a footpath through almost the center of the site. The site is sufficiently wide enough for the construction of a repeater station.

On the other hand, the proposed route of a new access road should be studied upon determination of the site location, which will be discussed below, but it would be more advantageous to utilize the north slant.

Since the mirror test was not performed for the section between this site and ANCOBER NORTH due to the mist and also because it is necessary to investigate the influence of the reflected wave on the propagation path between

KARRAKORRE and KORKE, it is suggested that the final decision on the location of the site be made in the second survey.

4.1.6 KORKE

This site has been proposed to be located at the summit of a mountain which lies approximately 10 Km in a crow line north east of Dessie City and east of the point situated about 13 Km distant from the city on All Weather Road leading to Asmara City. The site is within about 45 minutes' walk from the road. The mountain summit is a grassland with many exposed small rocks and provide a space large enough for the construction of a repeater station.

This site is proposed for not only a repeater station of ADDIS ABABA-ASMARA route but an unattended branching station to branch off the main route to Dessie City. The branching angle (an angle between path of main route and that of a branching one) is about 75 degrees.

The radio frequency channels to be used for the main and branching routes should be determined by taking into consideration the interference noise power, final plan of frequency allocation and economic aspect.

4.1.7 DESSIE

(a) Reflector Site

This site has been proposed to be located a mountain which stands east of Dessie City, and sufficient area to construct a reflector is available.

(b) Terminal station

This site is proposed for the existing telephone office of I.B.T.E. located in the centre of Dessie City. As the structure of this building is not suitable for the construction of an antenna tower on it's roof, there is no alternative other than constructing a small antenna tower in the back yard of this telephone office.

The location and the required floor space of the equipment room should be decided by considering the future requirements of this telephone office as well.

4.2 DESSIE - MACALLE

4.2.1 DESSIE, KORKE

These sites are proposed to be located at the same place as those for ADDIS ABABA - DESSIE route, which were mentioned previously.

4.2.2 UALDIA

This site has been proposed to be located near the summit of a mountain which is situated northeast of Ualdia Town. On the mountain summit there stands St. Gabriel Church. The site is proposed to be located in a wide and gently sloping grassland. The difference in altitude between the site and the All Weather Road is about 500 m, and the access road to be constructed will be about 6 Km long.

4.2.3 COBBO EAST

This site has been proposed to be located in a farmland about 2.5 Km northeast of Cobbo Village. Existing road provides an easy access close to the site by jeep. However, the condition of the road is not satisfactory for the traffic necessary for the construction and maintenance of the repeater station and requires some repair works such as graveling, etc.

4.2.4 MAI CEU NORTH

This site has been proposed to be located at the summit of a mountain which stands about 16 Km north of Mai Ceu Town and within a 30 minutes' walk from the All Weather Road. The summit is not wide compared with other sites, but the land space large enough for the construction of a repeater station is available. The difference in altitude between the site and All Weather Road is about 100 m, and the access road to be constructed will be about 1 Km long.

4.2.5 ADI SHAHU

This site has been proposed to be located 6 Km southeast of Adi Shahu Village and 600 m west of All Weather Road, and is within a 15 minutes' walk from the road. The site is situated at the foot of a steep mountain, and the vicinity of the site is a gently sloped land which is being used as a farmland. In the site there are many small rocks and the west side ends with a cliff, but the land space sufficiently large enough for a repeater station is available.

The difference in altitude between the site and All Weather Road is about 40 m, and the existing footpath may be used to transport materials for construction work.

4.2.6 AMBA ALAGI

This site is proposed to be located halfway up Mt. Amba Alagi which stands southeast of Amba Alagi Village. The Newly constructed road of about 1 Km long connects All Weather Road to the site and is accessible by jeep. However, some repair works will be required for the transportation

of heavy materials for construction work.

4.2.7 MACALLE NORTH

This site is proposed to be located on the tableland which lies northeast of Macalle City and stretches from east to west. All Weather Road runs close to the east side of the site, which is about 13 km from the telephone office in the central part of Macalle City.

This extensive tableland consists of a farmland and a waste land with many small rocks and pebbles and the vicinity of the site slightly slants south ward.

This proposed site, located close to Macalle City, is also convenient from the standpoint of construction work, for power supply and water supply may be readily available.

A plan has been worked out to construct a terminal station at this site and to lay a cable transmission line between this site and the telephone office in Macalle City. Therefore, no survey was made on this section by the team.

4.3. MACALLE NORTH - BETE GIORGIS

4.3.1 MACALLE NORTH

This site is proposed for the same location as that of DESSIE - MACALLE NORTH route mentioned previously.

However, since there is a ridge about 30 km distant from this site on the propagation path between MACALLE NORTH and ADIGRAT WEST, it will be necessary to construct an antenna tower sufficiently high enough to clear this ridge.

4.3.2 ADIGRAT WEST

This site is proposed to be located about 20 km west of Adigrat Town. The road, branched off from All Weather Road and extended in the direction of Axum, is running by the north side of the site. The difference in altitude between the site and this road is about 70 m. An access road of about 1 km long will have to be constructed between All Weather Road and the site. The portion of the proposed route for access road is covered by the base rocks, but it does not seem to create any problem in the road construction.

In and around the site there are many rocks of various sizes, and the east of the site is a farmland. A land space sufficiently large enough to construct a repeater station is available.

The height of the antenna tower should be determined so as to provide

sufficient clearance by considering the height of the ridge between this site and MACALLE NORTH.

A Sign reading "I.B.T.E.'JAPAN" was painted and guide marks were also painted in red at the entrance to the site and on the footpath from All Weather Road to the site.

4.3.3 MESHAL EAST

This site is proposed to be located on the tableland which lines about 10 Km southeast of Senafe Town and extends toward the east from All Weather Road.

A comparatively new road of about 2 Km long runs from All Weather Road to this site and is accessible by Jeep. At the entrance of the site, there stands St. Gabriel Church.

Guide mark signs were painted in red at the entrance to the site and at the branching point on the All Weather Road. The final location of the site was not marked but the point about 100 m east of this position has a sign of "I.B.T.E. JAPAN" in red paint, marked at time of the previous site selection survey.

No particular problems are foreseen for the propagation path between this site and ADIGRAT WEST. However, as a small rocky mountain lies at the point about 10 Km from the site on the propagation path between this site and the adjoining DIGSA in the north, it will be necessary to install an antenna tower sufficiently high enough to clear this rocky mountain.

4.3.4 DIGSA

This site is located at a point about 15 Km southeast of Saganeiti Town and is at the entrance of Digsa Village which is about 2 Km eastward from All Weather Road. The existing road from All Weather Road to Digsa Village is accessible by jeep, but the condition of the road surface is not satisfactory and some repair works may be required.

The site is proposed to be located on the hill top and is within a 10 minutes' walk from the road. The difference in altitude between the existing road and the site is about 50 m and the construction of an access road seems to be relatively easy.

The top of the hill is free of vegetation and the whole area is covered by rocks of petrified huge trees. Necessary land space is available for the construction of a repeater station.

A sign in red paint reading "I.B.T.E. JAPAN" was marked at the site and guide marks were also painted at the branching point on All Weather Road

and at several points on the way to the site.

4.3.5 BETE GIORGIS

This site is proposed to be located at the same site as the existing repeater station of the microwave route of 2 GHz between Bete Giorgis and Massaua. There also is a church at the proposed site.

Since both the existing building and antenna tower have no room to accommodate the new microwave route between ADDIS ABABA and ASMARA, it will be necessary to construct a new station in the vacant lot in the south part of the site.

It has been proposed to connect this station with the telephone office of Asmara City by coaxial cable system.

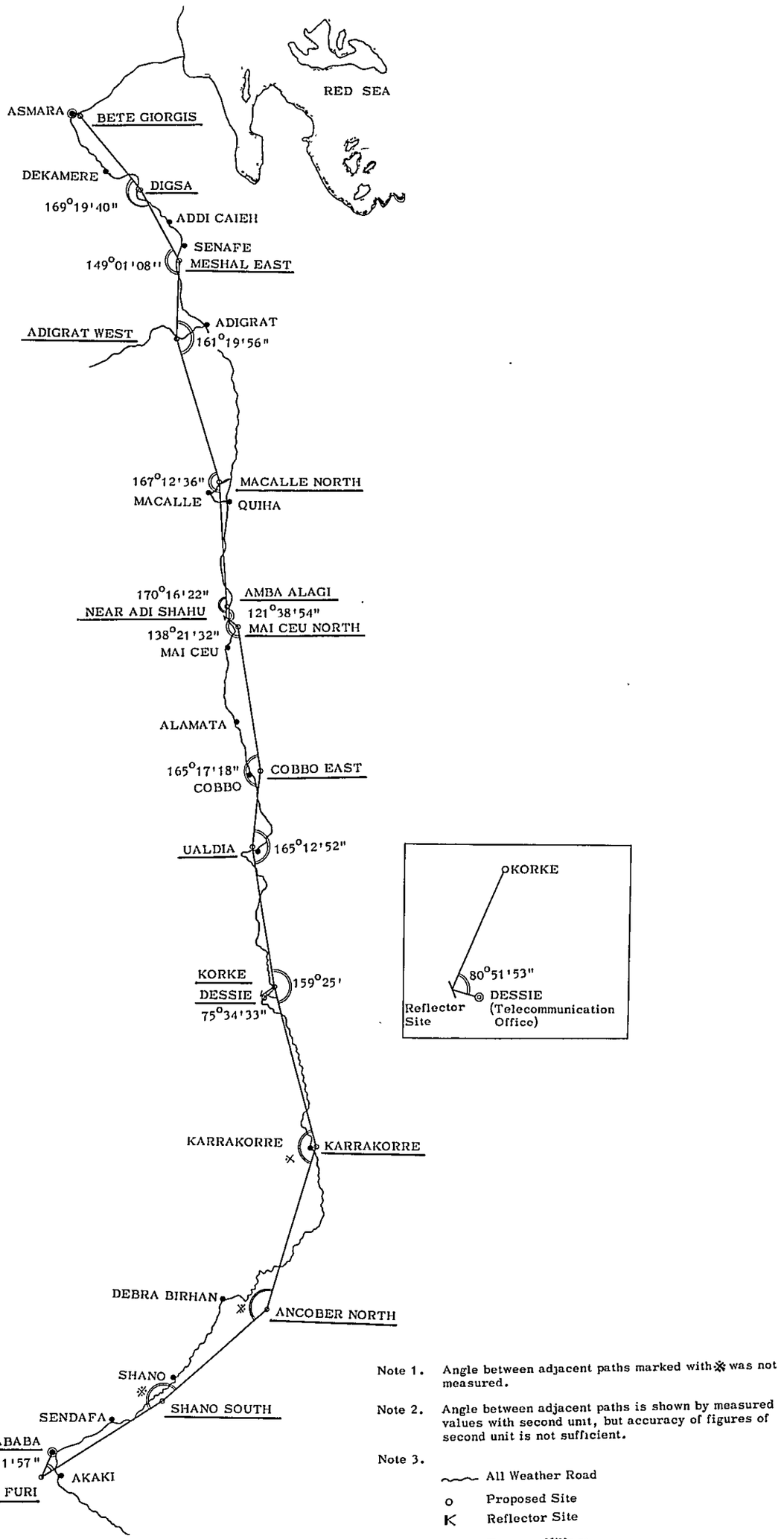
No final confirmation was made as yet on the height of the ridge between this site and DIGSA due to bad weather condition. The attached profile map of this section was prepared by estimation based on the results obtained by the eye measurement of the assumed propagation parth, taken from All Weather Road.

1. Microwave Route Map

2. Location and Altitude of the Site and Hop Distance

3. Guide Map of the Site and Topographic Sketch of the Site and Neighbourhood

Fig II - 1 Map of Microwave Route between ADDIS ABABA and ASMARA



Note 1. Angle between adjacent paths marked with ※ was not measured.

Note 2. Angle between adjacent paths is shown by measured values with second unit, but accuracy of figures of second unit is not sufficient.

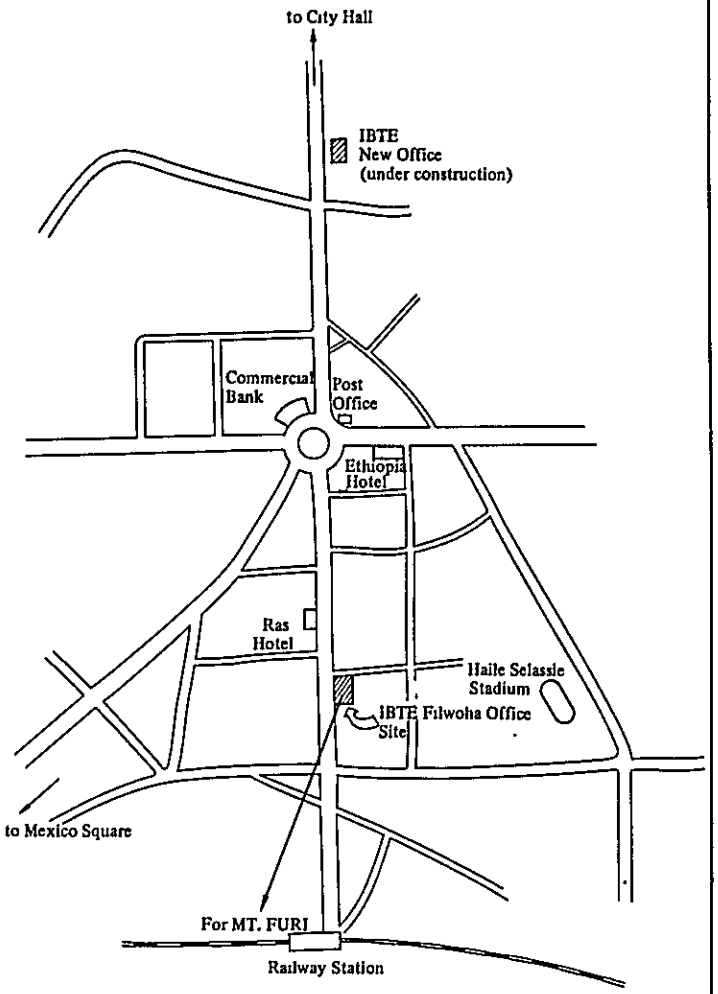
Note 3.

- All Weather Road
- o Proposed Site
- K Reflector Site
- • Town or Village
- ◉ City

Table II-1 Location and Altitude of the Site and Hop Distance

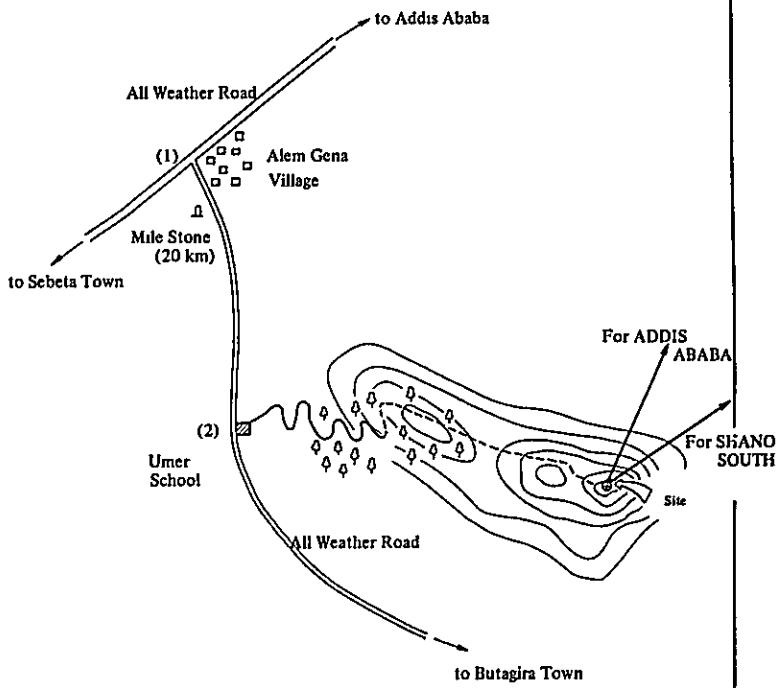
Site	Latitude (° ' ")	Longitude (° ' ")	Altitude (m)	Hop Distance(km)
ADDIS ABABA (Filwoha Office)	9.00.20 N	38.45.50 E	2390	16
MT. FURI	8.52.30 N	38.42.10 E	2820	74
SHANO SOUTH	9.14.30 N	39.15.50 E	2800	72
ANCOBER NORTH	9.40.30 N	39.44.30 E	3580	89
KARRAKORRE	10.26.50 N	39.57.30 E	1890	87
KORKE	11.11.20 N	39.42.00 E	2600	73
UALDIA	11.50.30 N	39.36.40 E	2430	38
COBBO EAST	12.10.40 N	39.40.50 E	1470	77
MAI CEU NORTH	12.52.00 N	39.35.40 E	2910	8
NEAR ADI SHAHU (Reflector Site)	12.54.20 N	39.31.50 E	2750	7
AMBA ALAGI	12.58.10 N	39.32.40 E	3100	66
MACALLE NORTH	13.34.30 N	39.32.20 E	2360	78
ADIGRAT WEST	14.15.10 N	39.20 00 E	2770	41
MESHAL EAST	14.37.10 N	39.24.30 E	2500	43
DIGSA	14.58.10 N	39.14.10 E	2180	49
BETE GIORGIS	15.20.30 N	38.58.10 E	2460	
KORKE	11.11.20 N	39.42.00 E	2600	9
DESSIE (Reflector Site)	11.07. N	39.37. E	2700	1.5
DESSIE (Telecommunication Office)	11.07.30 N	39.37.10 E	2470	

Note: Figures of latitude, longitude and hop distance were presumed by the maps on scale 1 to 500,000.

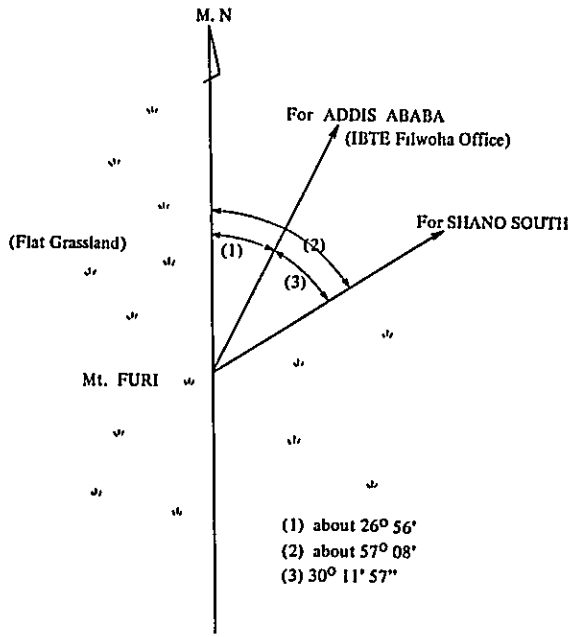


Guide Map of the Site	ADDIS ABABA
	Fig. II-2

(1) - Addis Ababa City (IBTE Filwoha Office) : about 20 km
(1) - (2) : about 3 km, All Weather Road
(2) - (3) : about 3 km, open to jeep
(3) - Site : about 3 km, about 1.5 hr. on foot

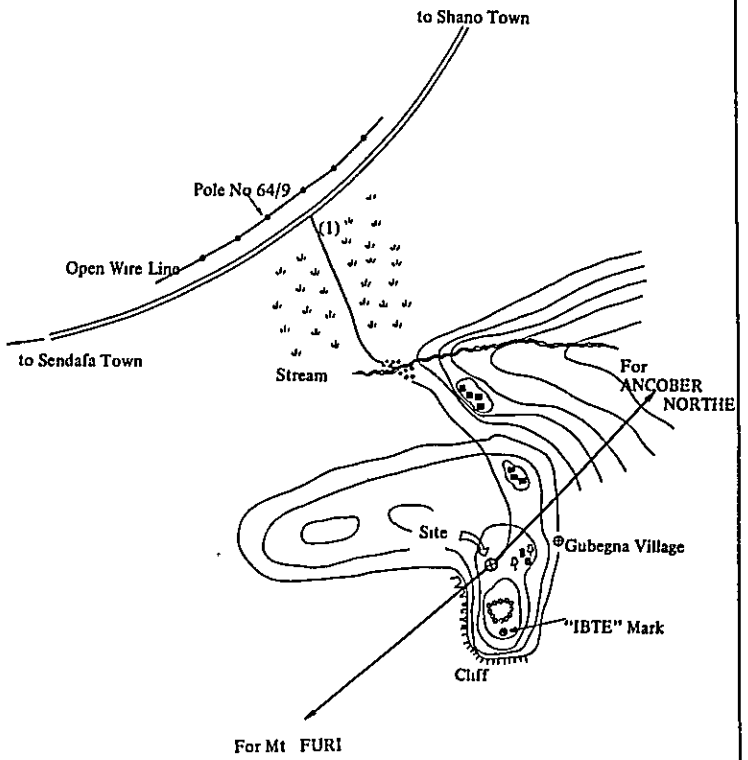


Guide Map of the Site	Mt. FURI
	Fig. II - 3

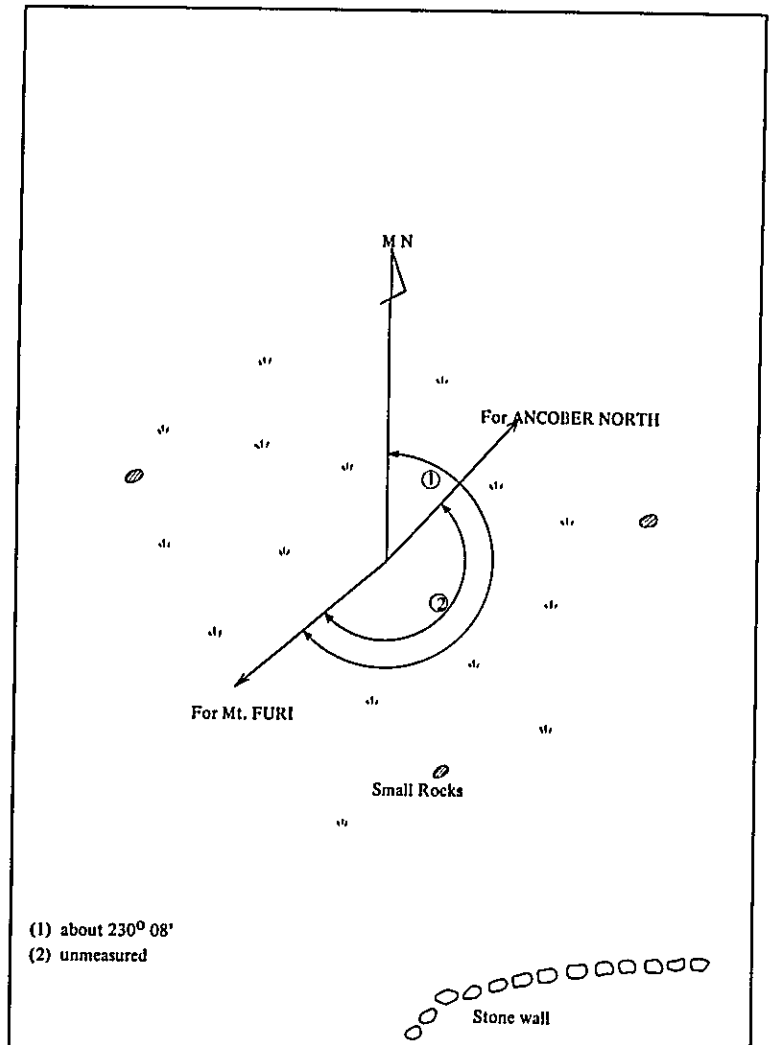


Topographic Sketch of the Site and Neighbourhood	Mt. FURI
	Fig II - 4

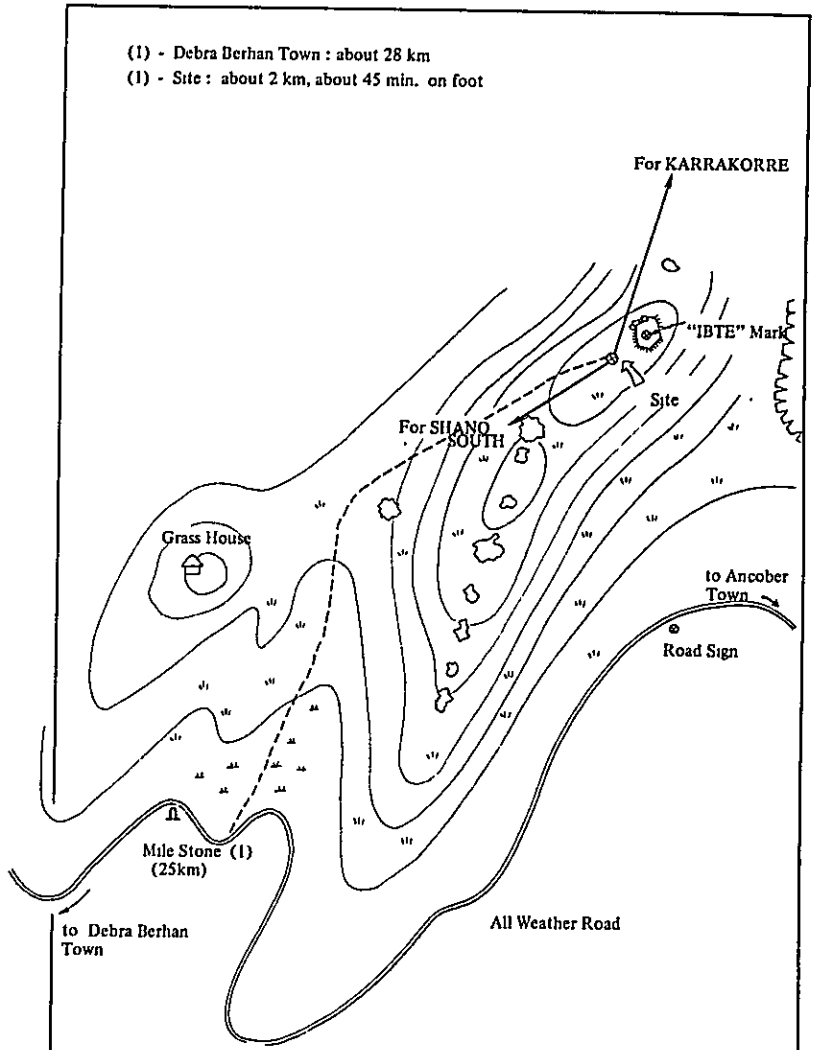
(1) - Shano Town : about 10 km
(1) - Sendafa Town : about 30 km
(1) - Site : about 4 km, open to Jeep



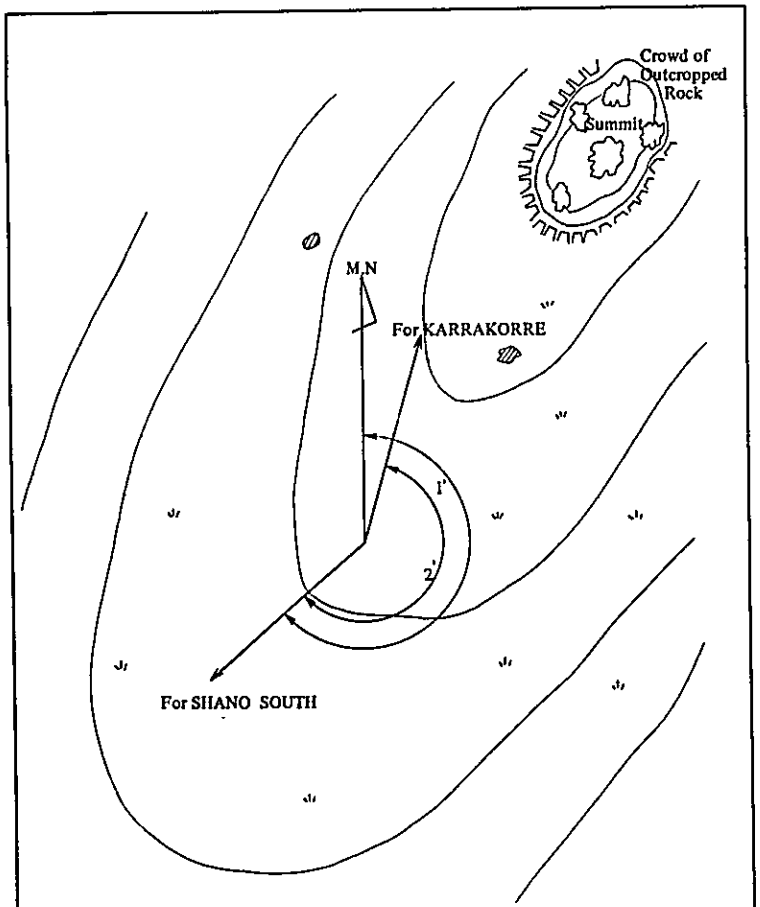
Guide Map of the Site	SHANO SOUTH
	Fig. II - 5



Topographic Sketch of the Site and Neighbourhood	SHANO SOUTH
	Fig II - 6

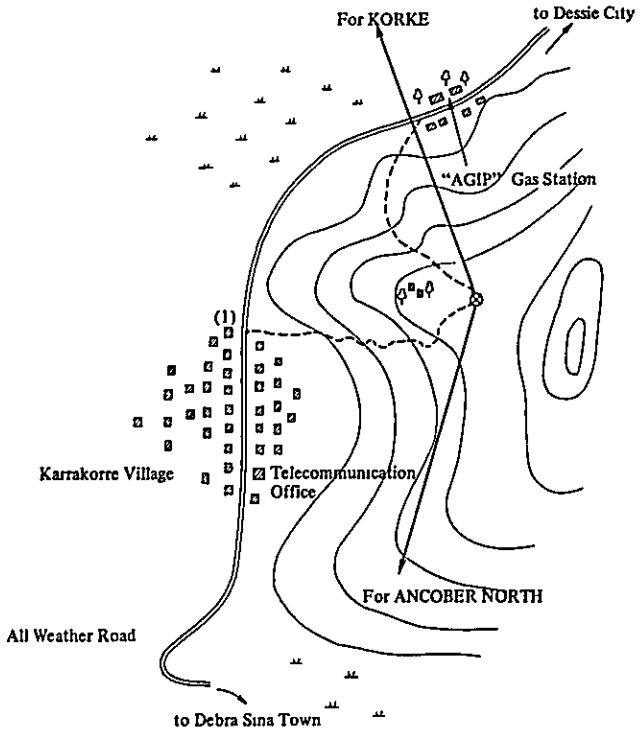


Guide Map of the Site	ANCOBER NORTH
	Fig. II - 7

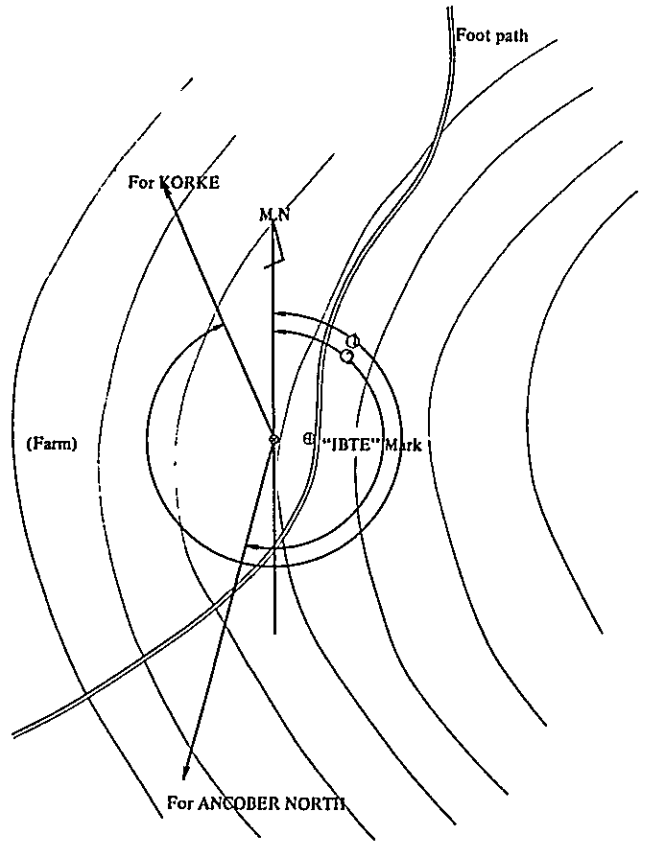


Topographic Sketch of the Site and Neighbourhood	ANCOBER NORTH
	Fig. II - 8

(1) - Dessie City : about 115km
(1) - Debra Sina Town : about 100km
(1) - Site : about 1.5km, about 30 min. on foot
(2) - Site : about 2km



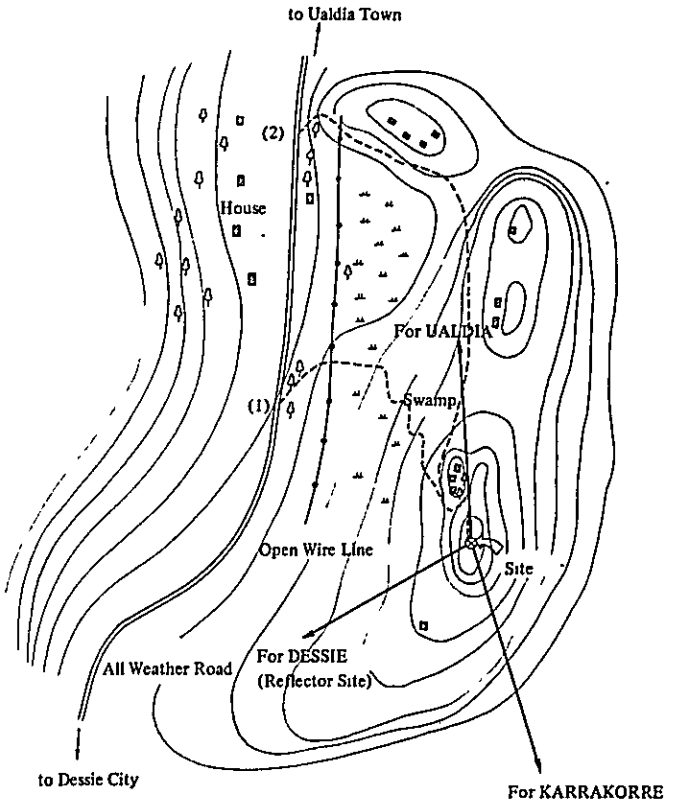
Guide Map of the Site	KARRAKORRE
	Fig. II - 9



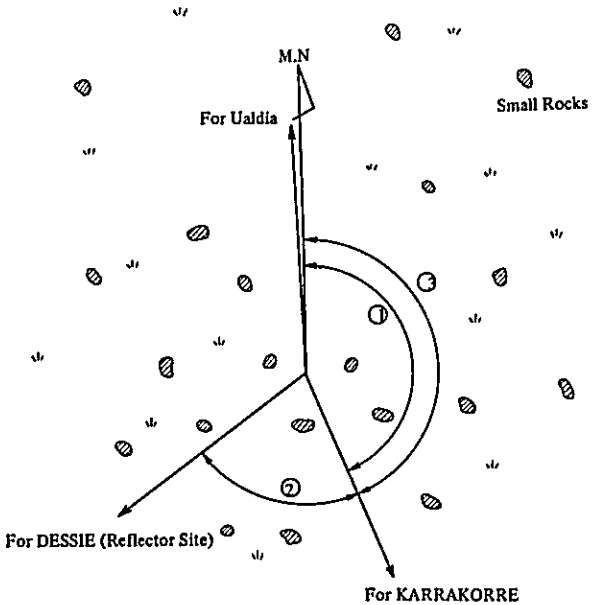
(1) unmeasured
(2) unmeasured

Topographic Sketch of the Site and Neighbourhood	KARRAKORRE
	Fig. II - 10

(1) - Ualdia Town : about 110 km
(1) - Dessie City (Telecommunication Office): about 13 km
(1) - Site : about 2.5 km, about 45 min. on foot
(2) - Site : about 3.5 km



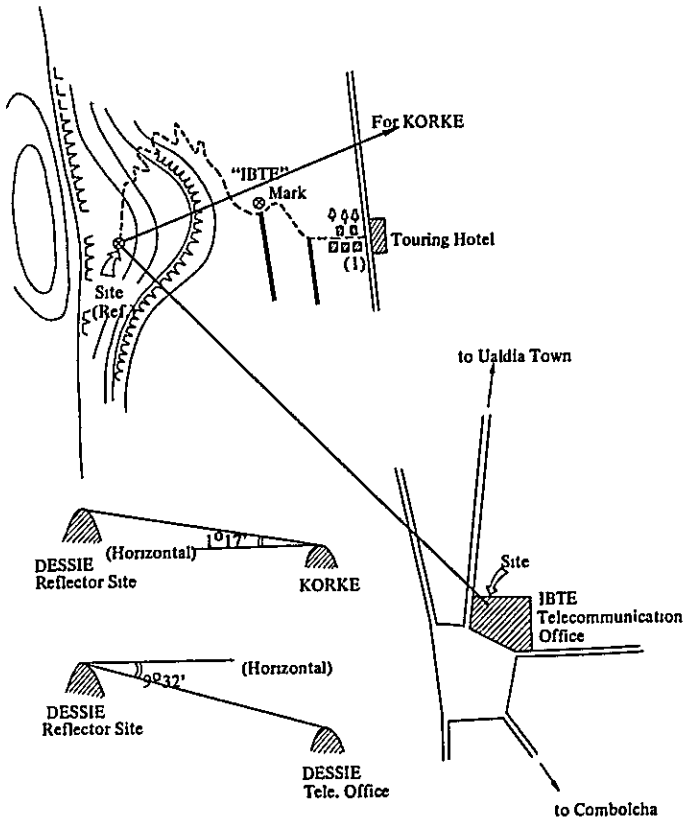
Guide Map of the Site	KORKE
	Fig. II - 11



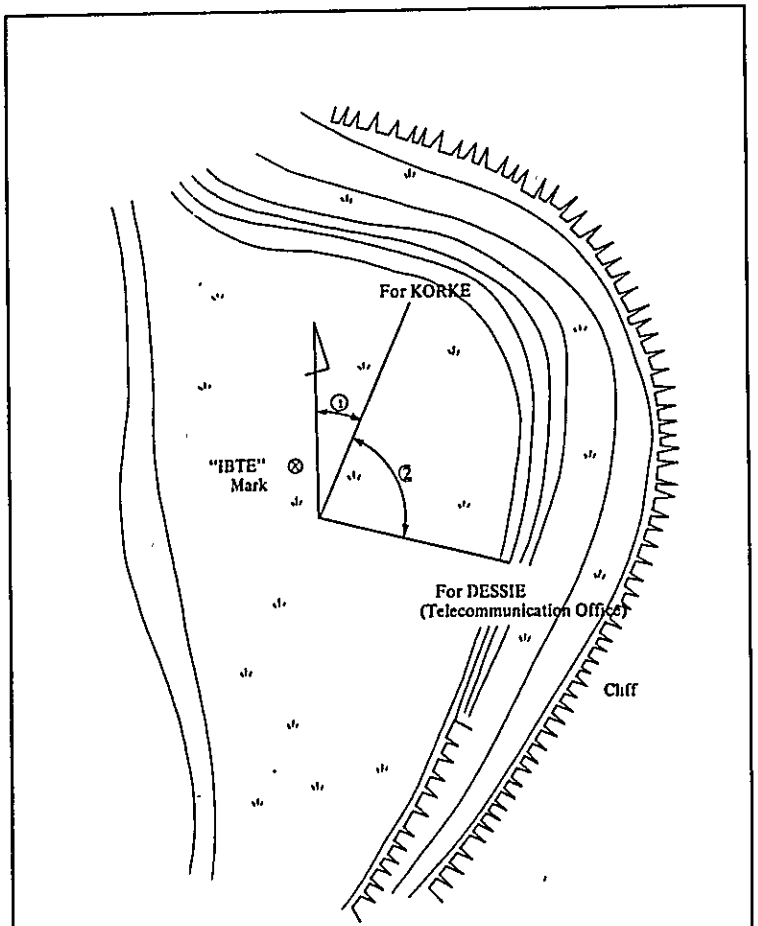
(1) about 159° 25'
(2) about 75° 34'
(3) about 158° 35'

Topographic Sketch of the Site and Neighbourhood	KORKE
	Fig. II - 12

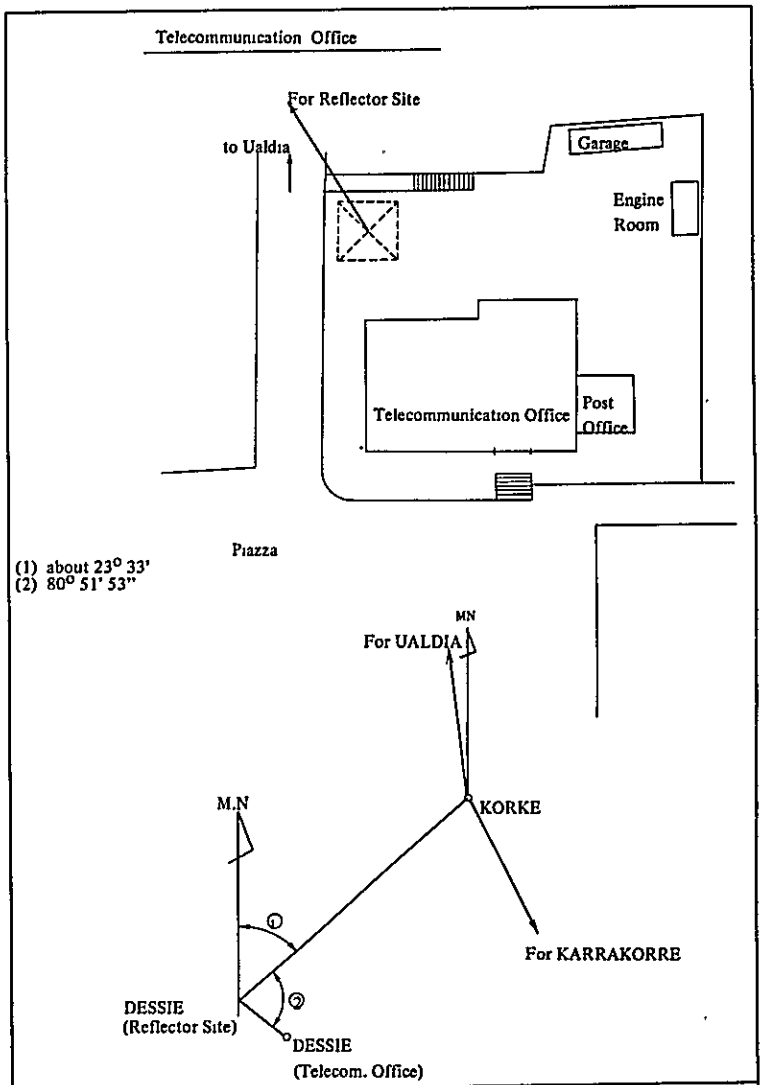
(1) - Telecommunication Office : about 1 km
(1) - Site : about 1 km, about 30 min. on foot



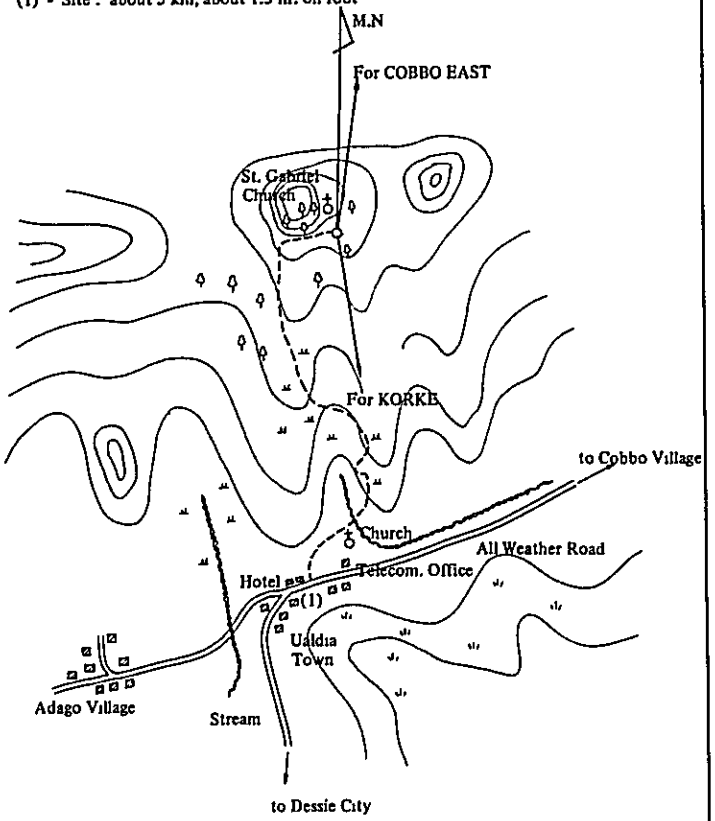
Guide Map of the Site	DESSIE
	Fig. II - 13



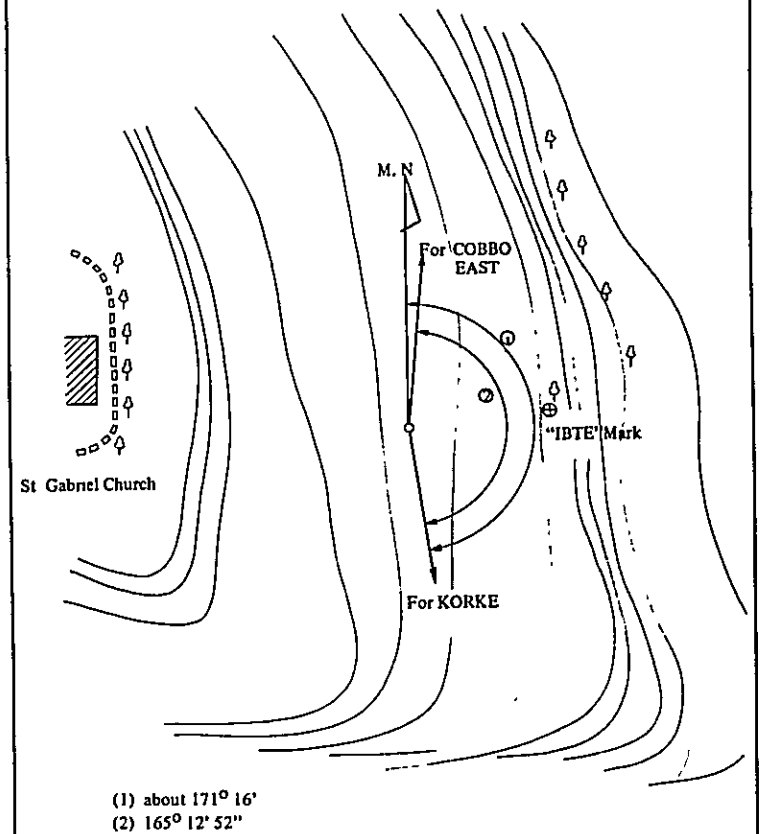
Topographic Sketch of the Site and Neighbourhood	DESSIE (Reflector Site)
	Fig. II - 14



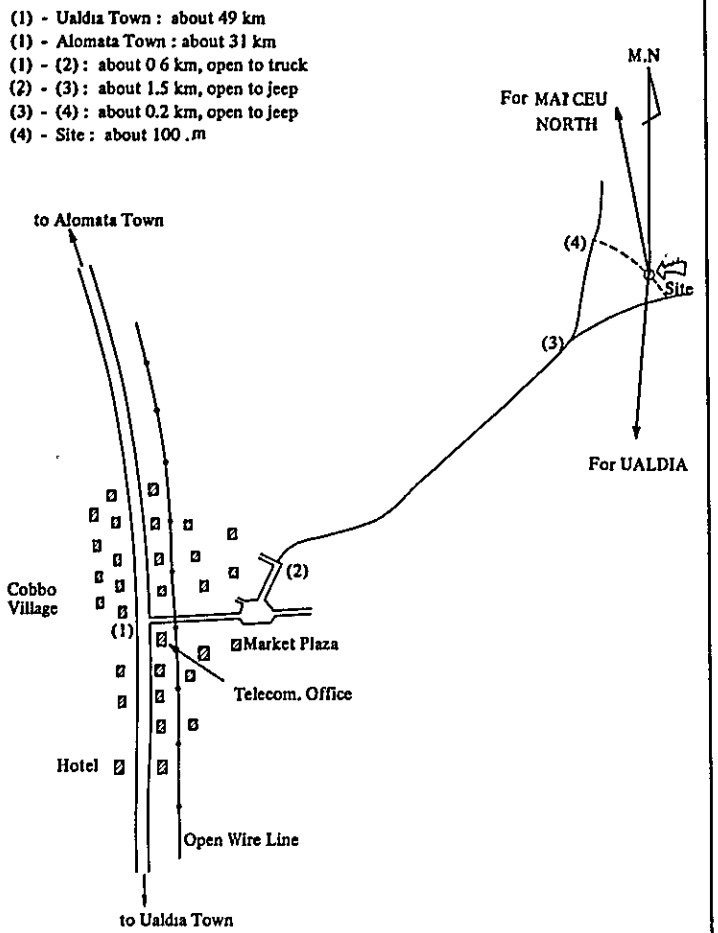
Topographic Sketch of the Site and Neighbourhood	DESSIE
	Fig II - 15



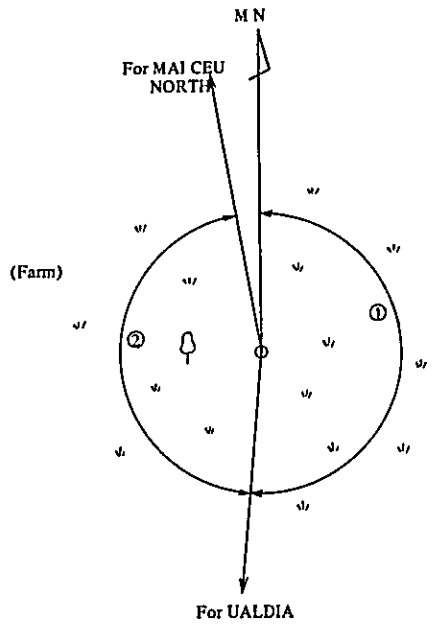
Guide Map of the Site	UALDIA
	Fig II - 16



Topographic Sketch of the Site and Neighbourhood	UALDIA
	Fig II - 17



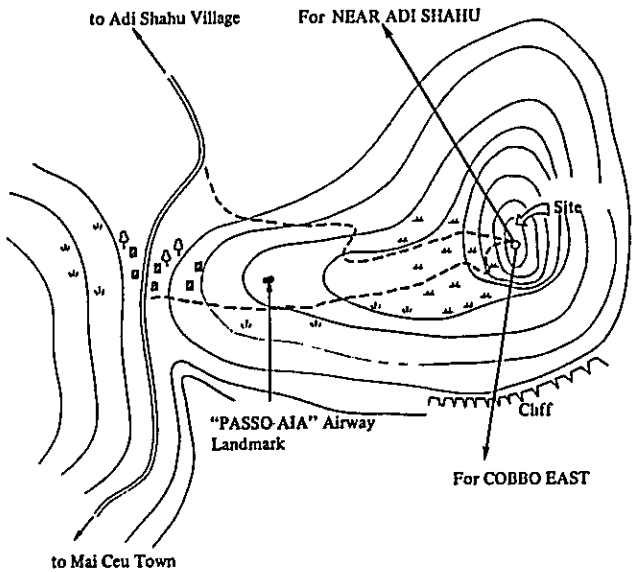
Guide Map of the Site	COBBO EAST
	Fig. II - 18



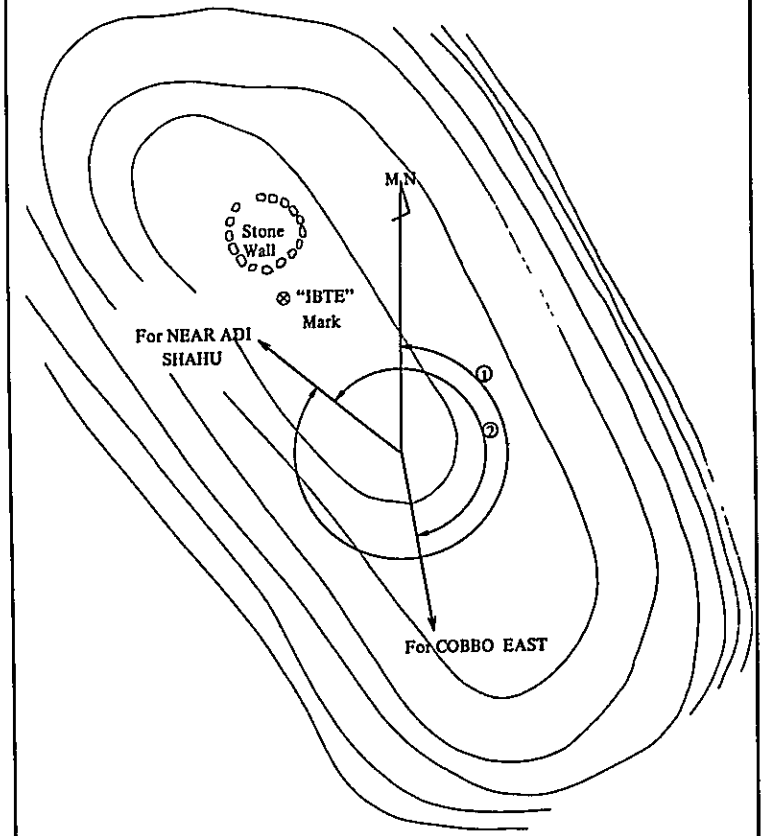
(1) about 185° 2'
(2) 165° 17' 18"

Topographic Sketch of the Site and Neighbourhood	COBBO EAST
	Fig. II - 19

(1) - Mai Ceu Town : about 16 km
(1) - Adi Shahu Village : about 16 km
(1) - Site : about 0.7 km, about 30 min. on foot
(2) - Site : about 1 km



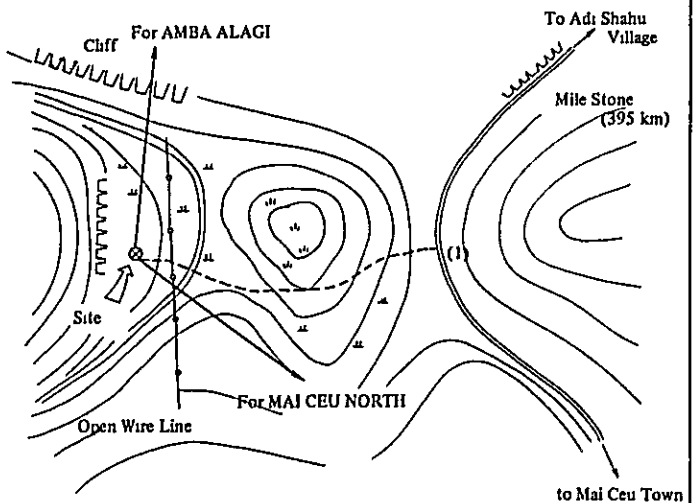
Guide Map of the Site	MAI CEU NORTH
	Fig. II - 20



(1) - about 309° 36'
(2) - 221° 38' 28"

Topographic Sketch of the Site and Neighbourhood	MAI CEU NORTH
	Fig. II - 21

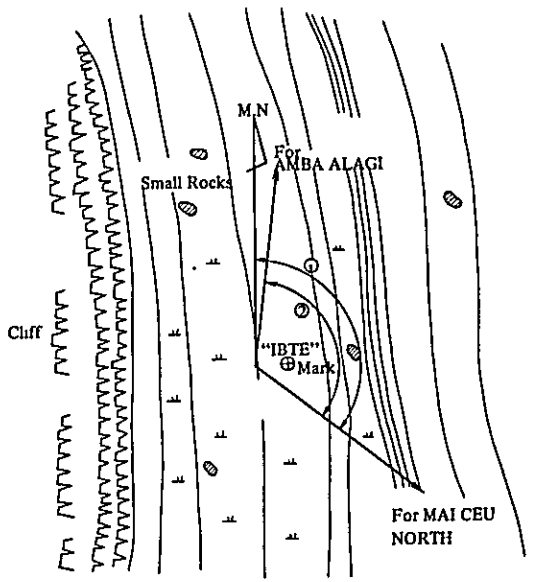
(1) - Mai Ceu Town : about 25 km
(1) - Adi Shahu Village . about 6 km
(1) - Site : about 0.6 km, about 15 min. on foot



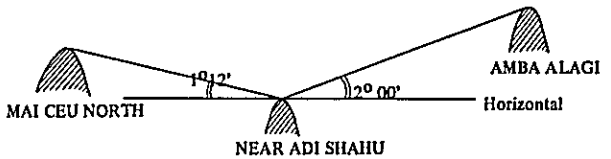
Guide Map of the Site

NEAR ADI SHAHU

Fig. II - 22



(1) about 128° 38'
(2) 121° 38' 54"

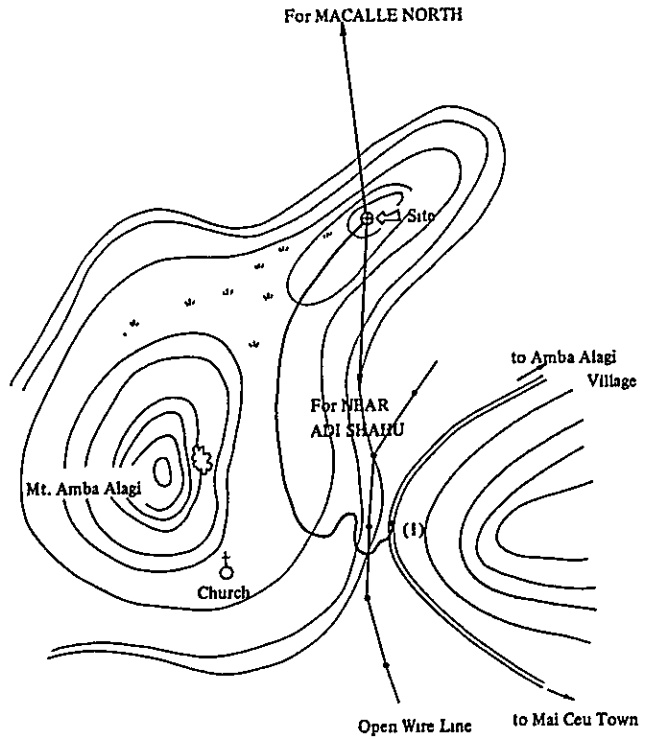


Topographic Sketch of the Site and Neighbourhood

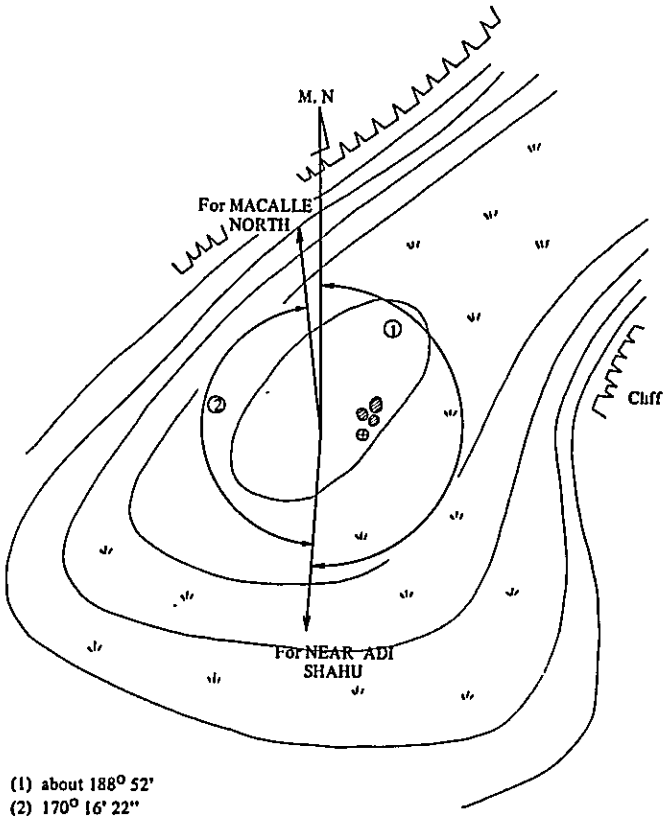
NEAR ADI SHAHU

Fig. II - 23

(1) - Mai Ceu Town : about 44 km
(1) - Amba Alagi Village : about 6 km
(1) - Site : about 1 km, open to jeep



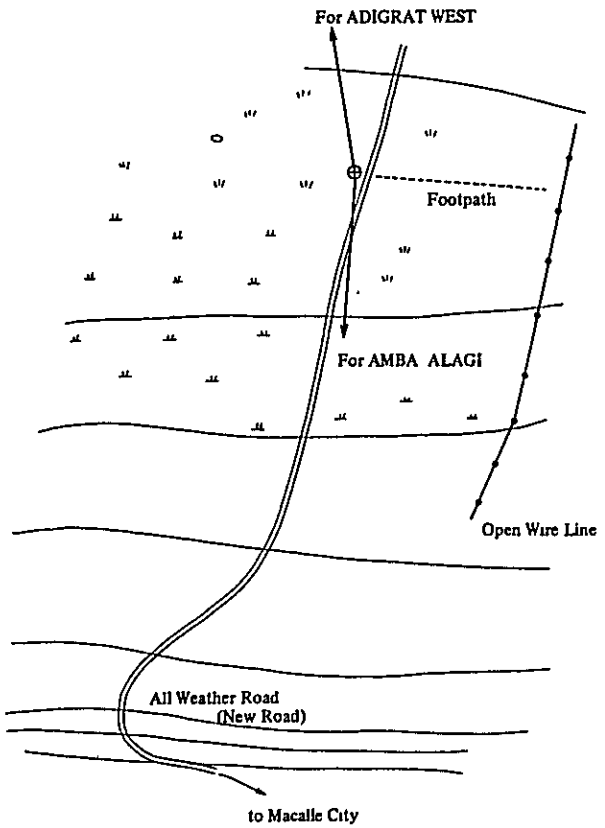
Guide Map of the Site	AMBA ALAGI
	Fig. II - 24



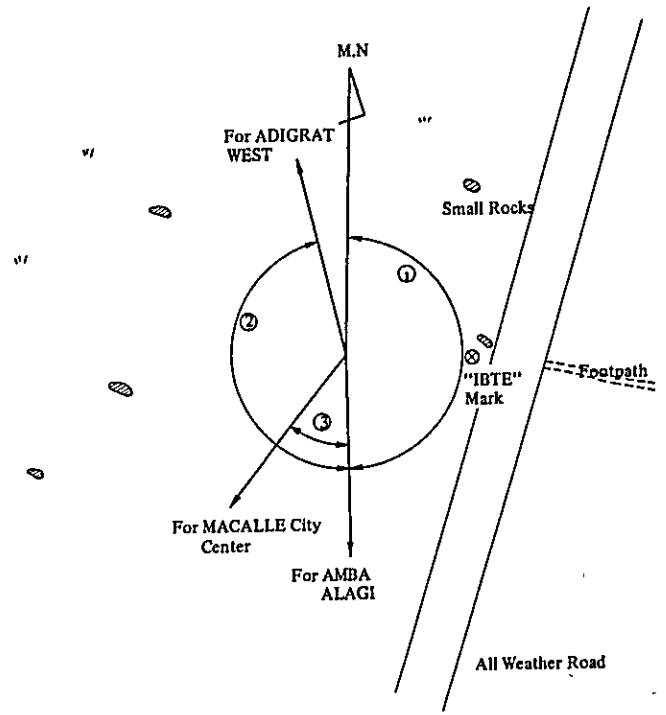
(1) about 188° 52'
(2) 170° 16' 22"

Topographic Sketch of the Site and Neighbourhood	AMBA ALAGI
	Fig. II - 25

Site - Adigrat Town : about 105 km
Site - Macalle City : about 13 km
(Telecommunication Office)

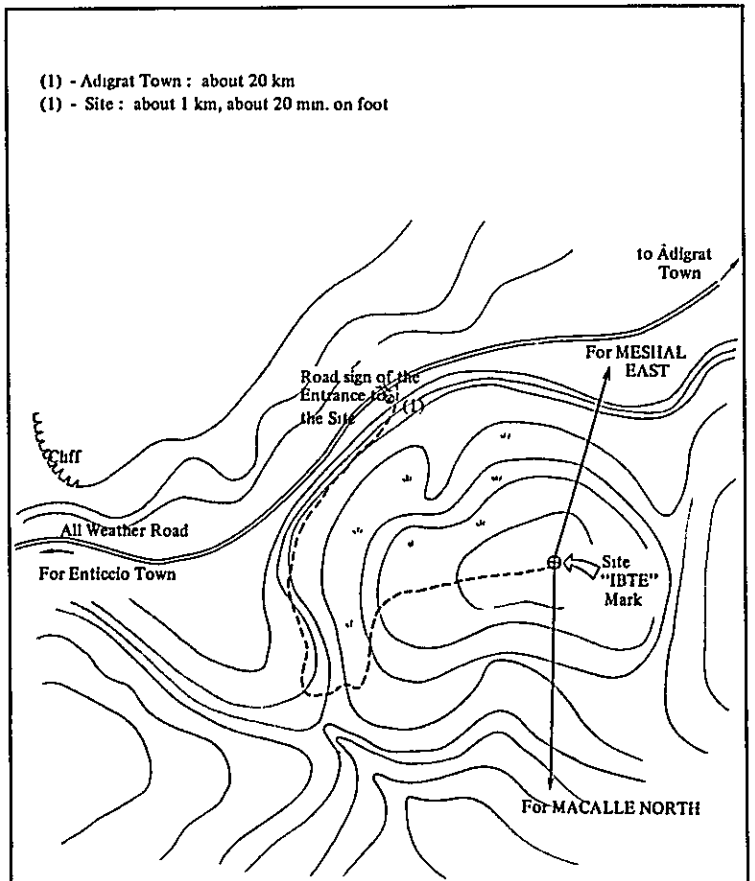


Guide Map of the Site	MACALLE NORTH
	Fig.. II - 26

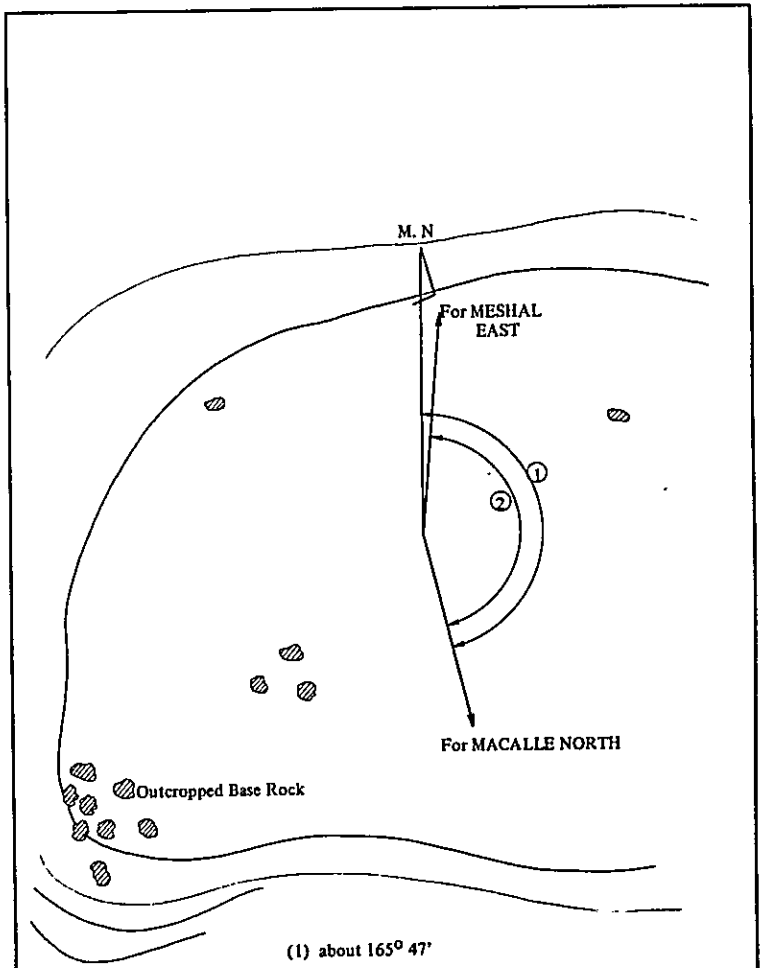


(1) about 178° 22'
(2) 167° 12' 36"
(3) about 38° 35'

Topographic Sketch of the Site and Neighbourhood	MACALLE NORTH
	Fig. II - 27

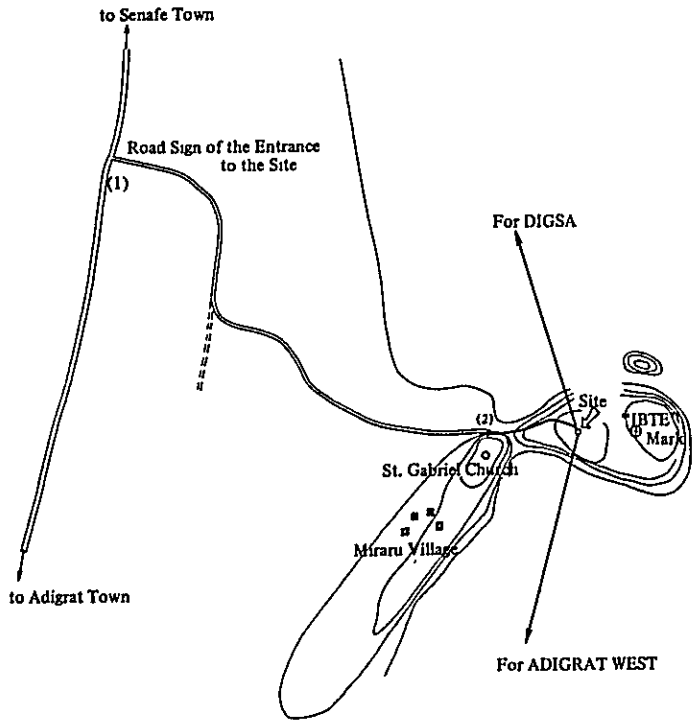


Guide Map of the Site	ADIGRAT WEST
	Fig. II - 28



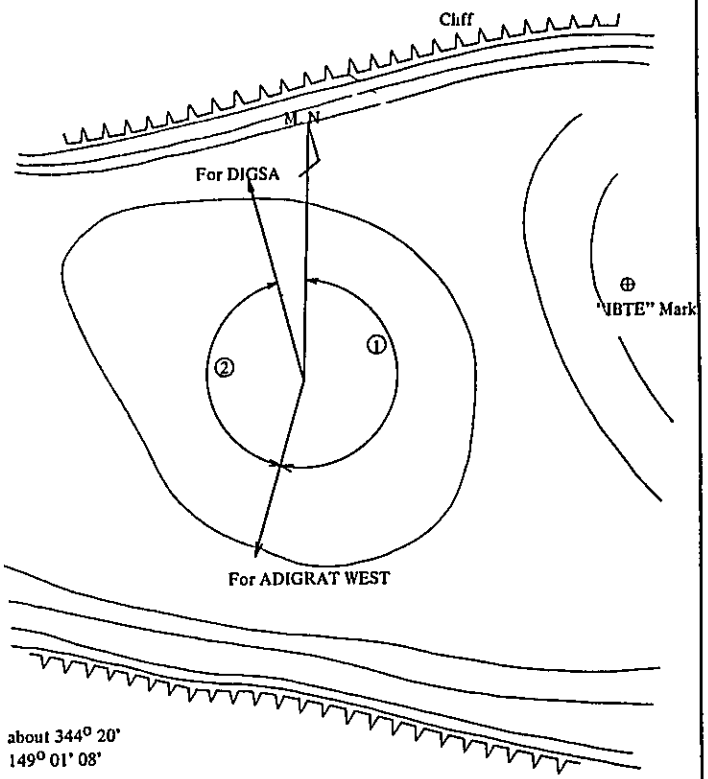
Topographic Sketch of the Site and Neighbourhood	ADIGRAT WEST
	Fig. II - 29

(1) - Adigrat Town : about 55 km
(1) - Senafe Town : about 10 km
(1) - (2) : about 2 km, open to jeep
(2) - Site : about 0.3 km, open to jeep



Site - "IBTE" Mark : about 100 m

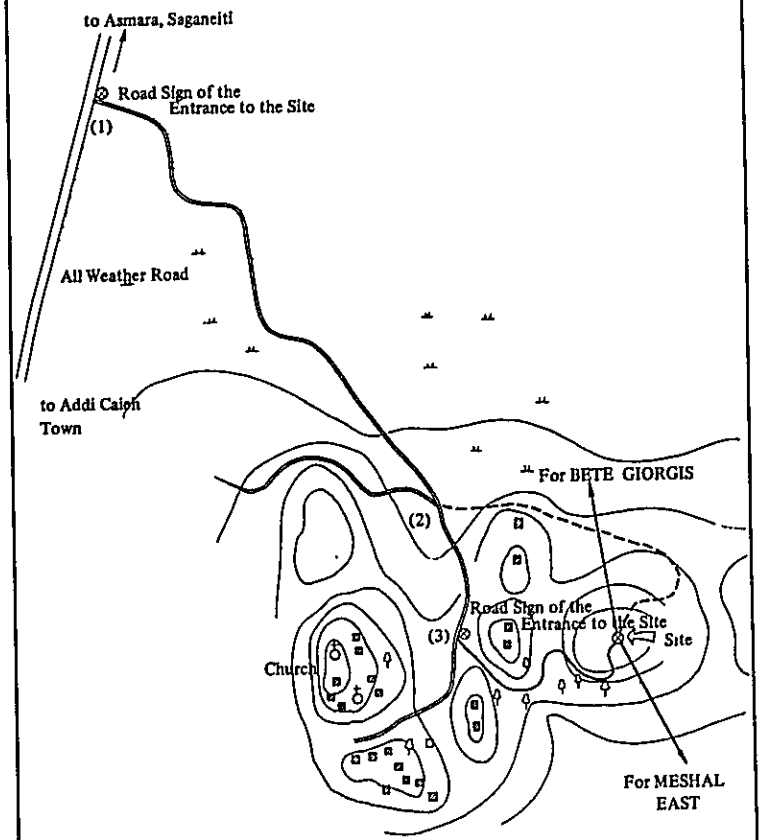
Guide Map of the Site	MESHAL EAST
	Fig. II - 30



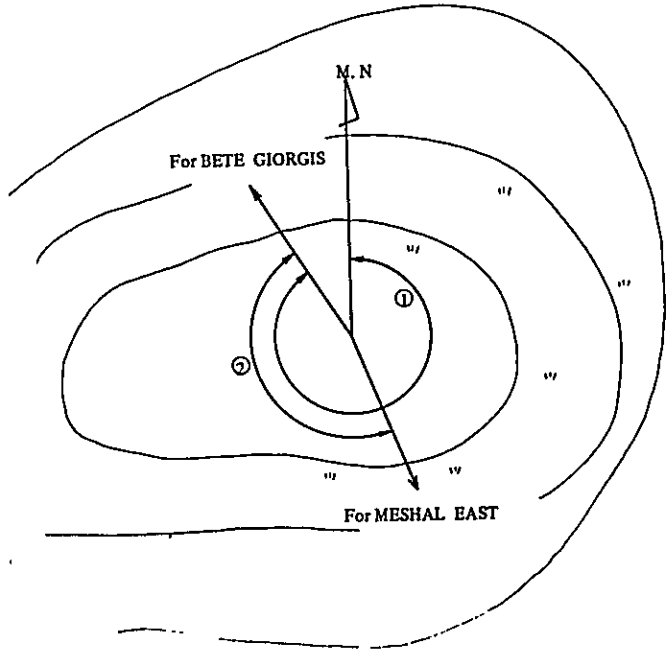
(1) about 344° 20'
(2) 149° 01' 08"

Topographic Sketch of the Site and Neighbourhood	MESHAL EAST
	Fig. II - 31

(1) - Addi Caieh Town : about 42 km
(1) - Asmara City : about 70 km
(1) - (2) : about :2km, open to jeep
(2) - (3) : about 0.3 km, open to jeep
(2) - Site : about 1 km
(3) - Site : about 0.3 km, about 10 min. on foot

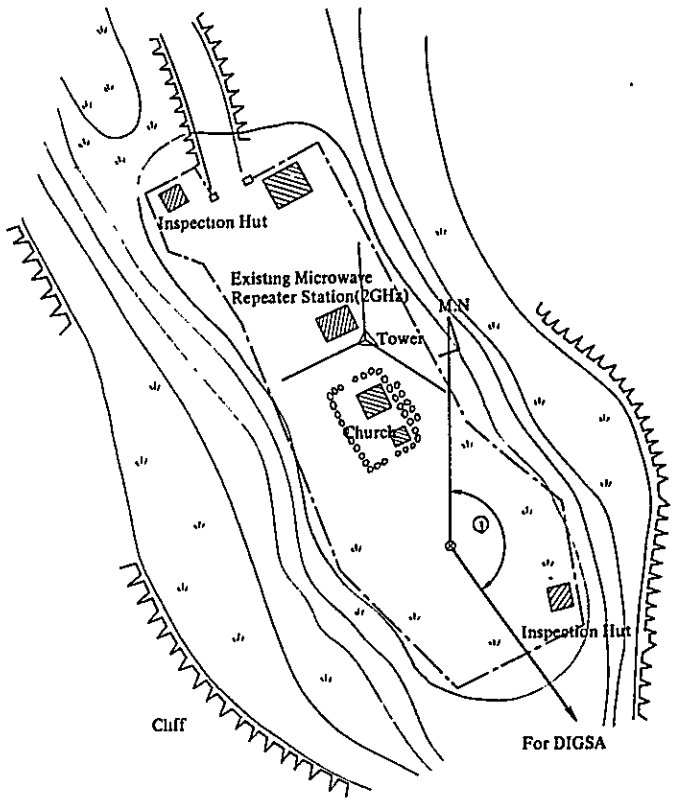


Guide Map of the Site	DIGSA
	Fig. II - 32



(1) about 327° 19'
(2) 169° 19' 40"

Topographic Sketch of the Site and Neighbourhood	DIGSA
	Fig. II - 33



(1) about 144° 15'

Topographic Sketch of the Site and Neighbourhood	BETE GIORGIS
	Fig II - 34

5. Calculation of the Various Factors on Each Propagation Path

The profile maps shown in Fig. II-35 - Fig. II-46 were prepared on the basis of the data obtained during this preliminary survey. Various factors on each propagation path shown in Table II-2 - Table II-7 were calculated from the data given by these profile maps.

These materials mentioned above should be complemented and amended in the course of the second survey.

(a) The profile maps were prepared on estimation based on the altitude of the sites and of All Weather Road measured by Aneroid Altimeter, the maps on a scale of 1:500,000, and the elevation and depression angles measured from each site.

(b) The various factors on each propagation path were calculated on the basis of the data given by these profile maps.

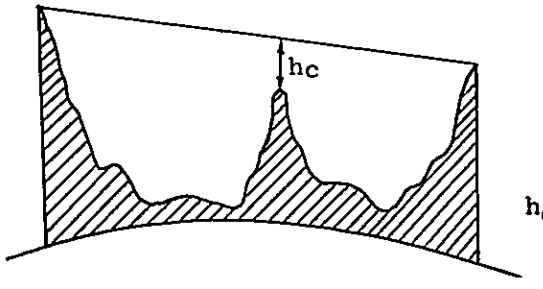
(c) Assumption was made that an antenna to be used at each station would be of 4 m ϕ in diameter.

(d) The determined antenna height at each station, is considered most appropriate judging from the profile maps and the feature of the vicinity of the site. But the antenna height adopted here does not include the additonal height which may be required to adopt the space diversity reception system, etc., in order to improve the propagation performance.

(e) The final decision on the frequency band to be used for this route will have to be made after the examination of the future plan, the interference with other microwave routes, etc. However, the various factors on each propagation path were tentatively calculated on the assumption that 6.7 GHz band be used for this route.

(f) All profile maps correspond to the condition with the coefficient of equivalent earth's radius of K=4/3, and the various factors were also calculated assuming the same condition.

As for the section where the clearance factor is smaller than 3, the value of clearance factor is shown in remarks. Here, the clearance factor is defined as the ratio of the path clearance, h_c, to the radius of 1st Fresnel Zone at the same point, h_o.



h_c/h_o : Clearance Factor

h_o : Radius of 1st Fresnel Zone

(g) The calculation of the ratio of signal to distortion noise, S/D, is based on the theoretical formula by R.G. Medhurst.

The necessary values of the ratio of desired signal to undesired signal, D/U, were calculated assuming that the allowable noise power due to the propagation distortion would be the same to the value in the noise distribution on 6 GHz system (1,200ch) and 4 GHz system (960ch) of N.T.T.P.C. (Nippon Telegraph and Telephone Public Corporation) which is 3 pw (S/D=85dB) per section.

(h) The Line-of-Sight of SHANO SOUTH - ANCOBER NORTH - KARRAKORRE sections has not been confirmed due to the mist. Therefore, preparation of profile maps and calculation of various factors for these sections were not made at this time.

(i) As for KARRAKORRE - KORKE section, it will be necessary to examine the possibility of selecting a propagation path with a shielding ridge for the reflected wave. In addition, as to DIGSA - BETE GIORGIS section, it will be necessary to make a study on the possibility of securing sufficient clearance even under the condition of K=2/3.

(j) As regards the reflection coefficient of various kinds of the reflection point, the following values have been adopted in accordance with empirical data obtained in Japan.

Water surface	:	1 (0dB)
Swamp	:	0.8 (2dB)
Farmland, Dry field	:	0.5 (6dB)
Mountain, Forest	:	0.2 (14dB)

Note: The above factors are to be used for 6 GHz frequency band.

III. CONCLUSION

This preliminary survey was carried out in a very short period of 45 days and several problems still remain unsolved. The problems awaiting future solution may be as follows.

(1) For SHANO SOUTH - ANCOBER NORTH and ANCOBER NORTH - KARRAKORRE sections, bad weather condition at ANCOBER NORTH prevented the team from carring out a mirror test. As a result, final decision on the location of the sites was not reached.

(2) As the reflection point between KARRAKORRE and KORKE is considered to be on the water surface, it will be necessary to investigate the possibility of selecting a propagation path with a ridge to shield the reflected wave.

(3) In regard to DIGSA - BETE GIOGIS section, reinvestigation of the propagation path, including the measurement of the ridge height, etc., will be required.

It is the desire of the team to make more detailed investigations by allocating ample time in order to solve the pending problems during the scheduled second survey.

1. Profile Map

2. Calculated Figures of Various Fundamental Factors on Each Section

Fig. II - 35 PROFILE MAP

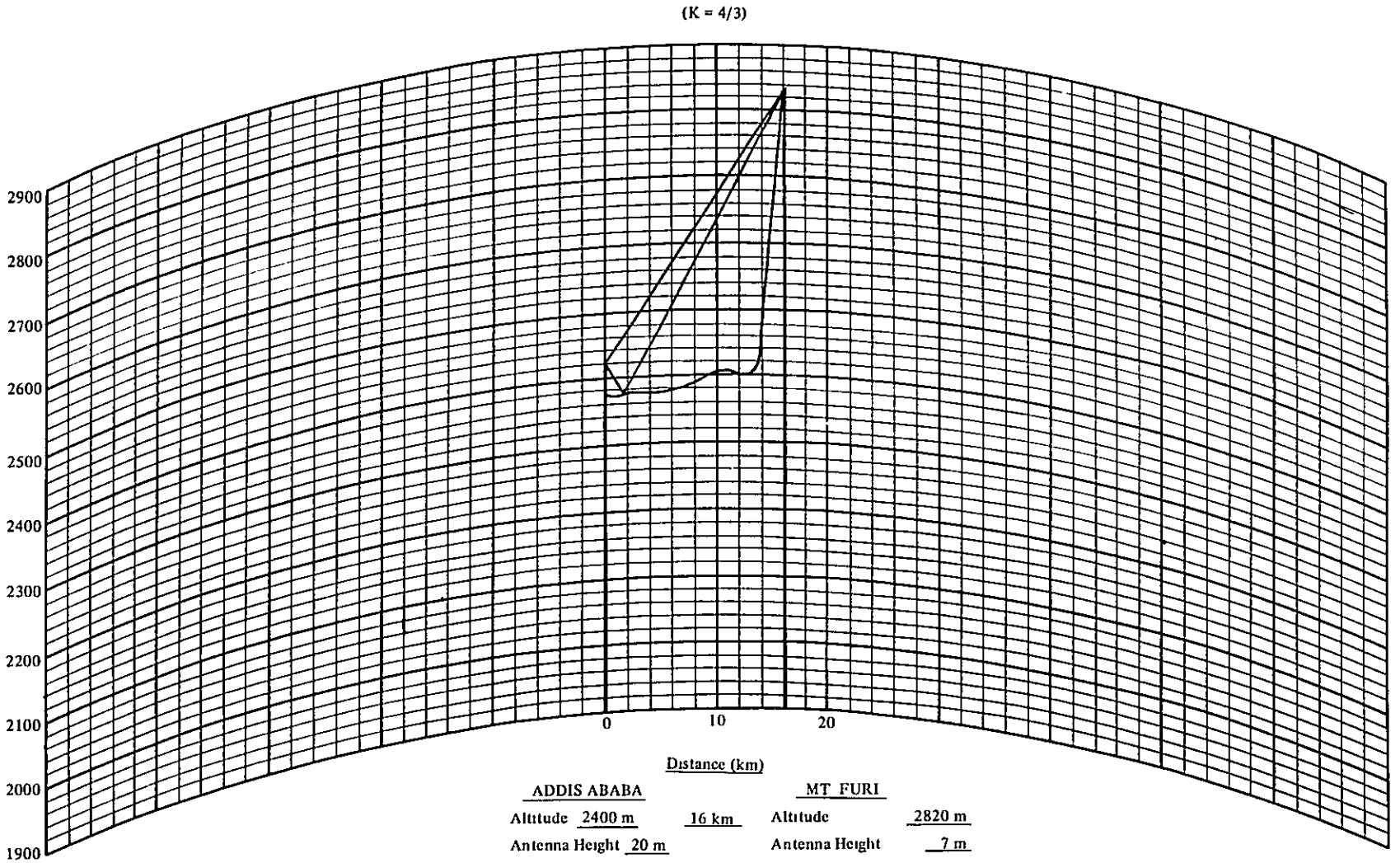


Fig. II - 36 PROFILE MAP

(K = 4/3)

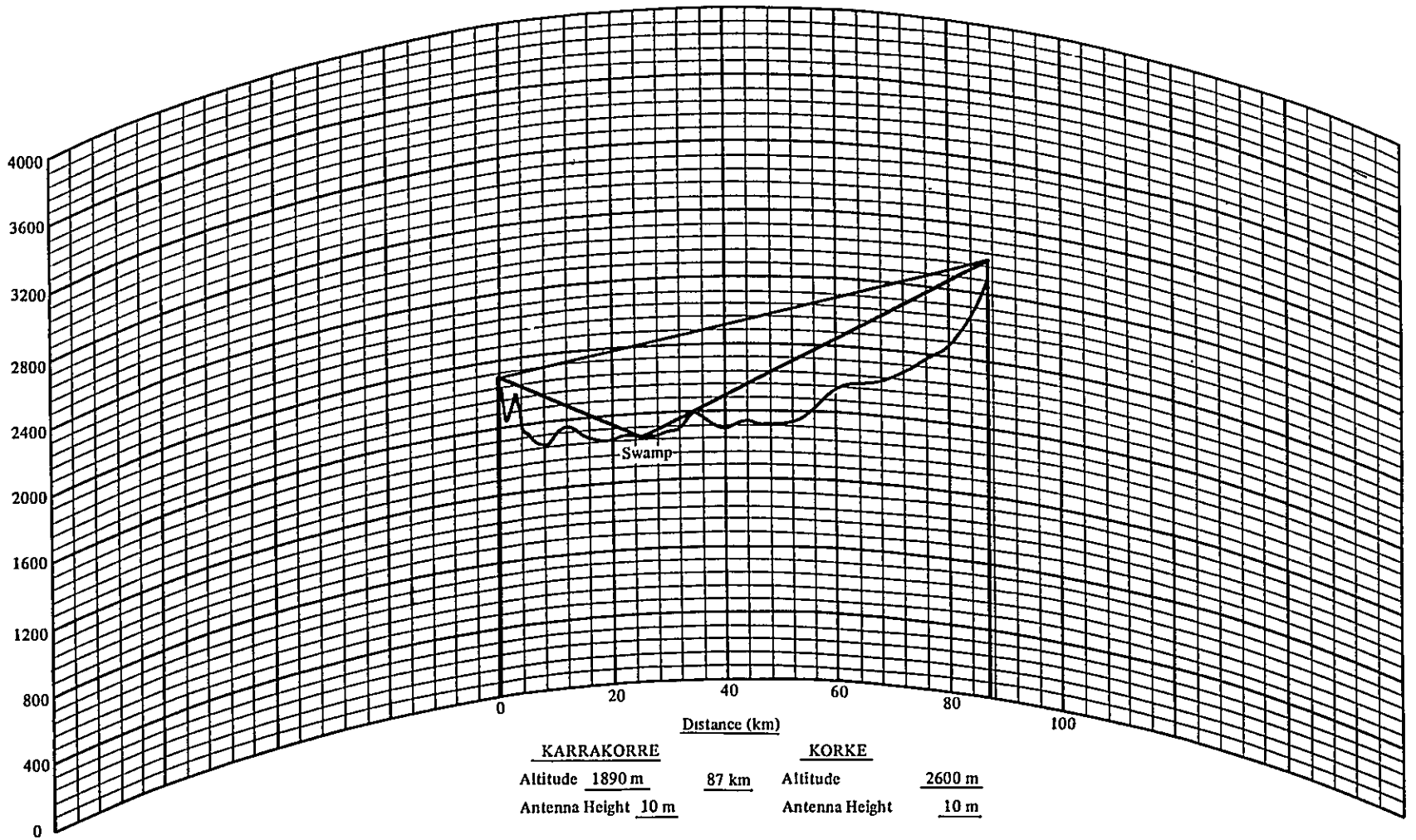


Fig. II - 37 PROFILE MAP

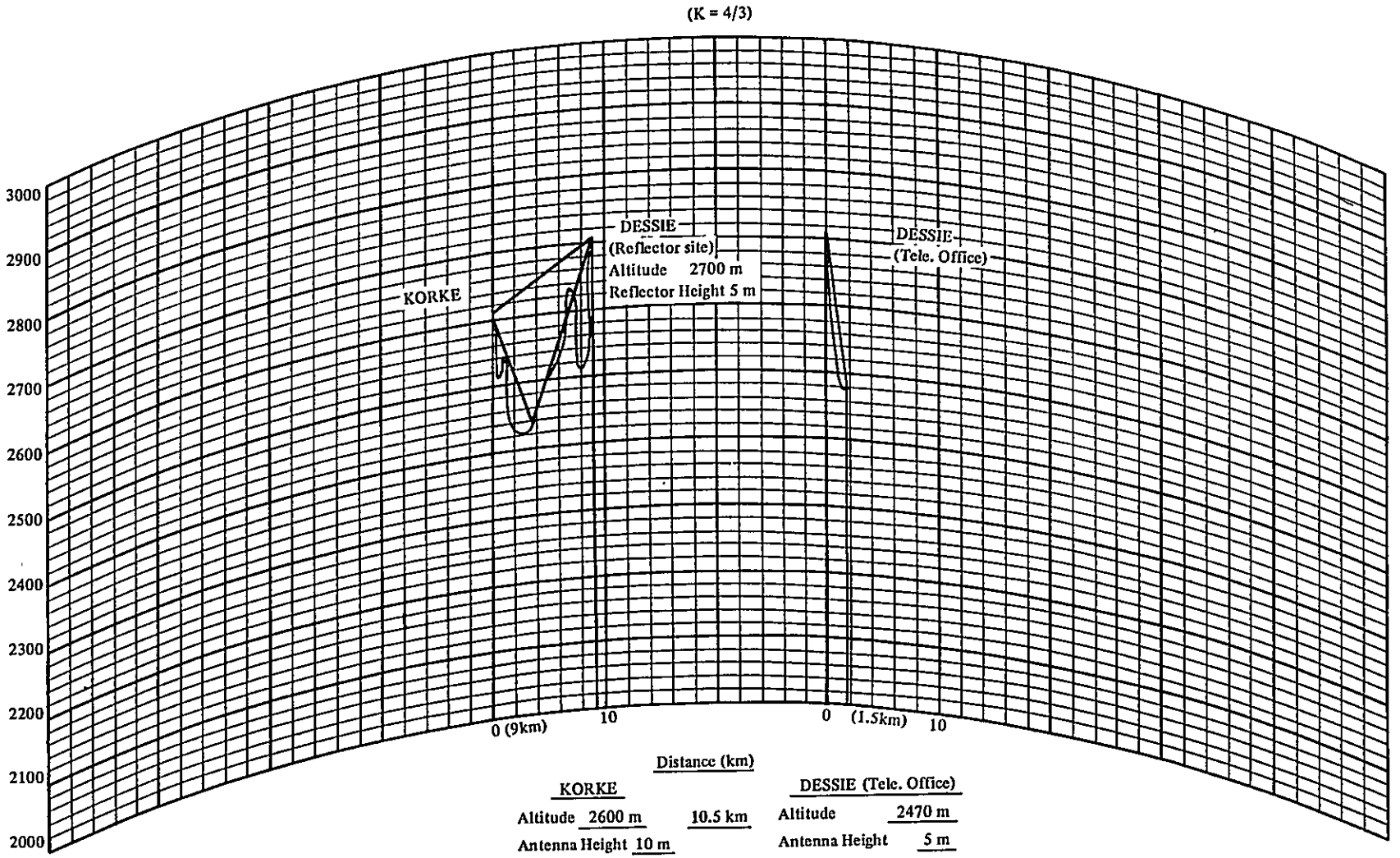


Fig. II - 38 PROFILE MAP

(K = 4/3)

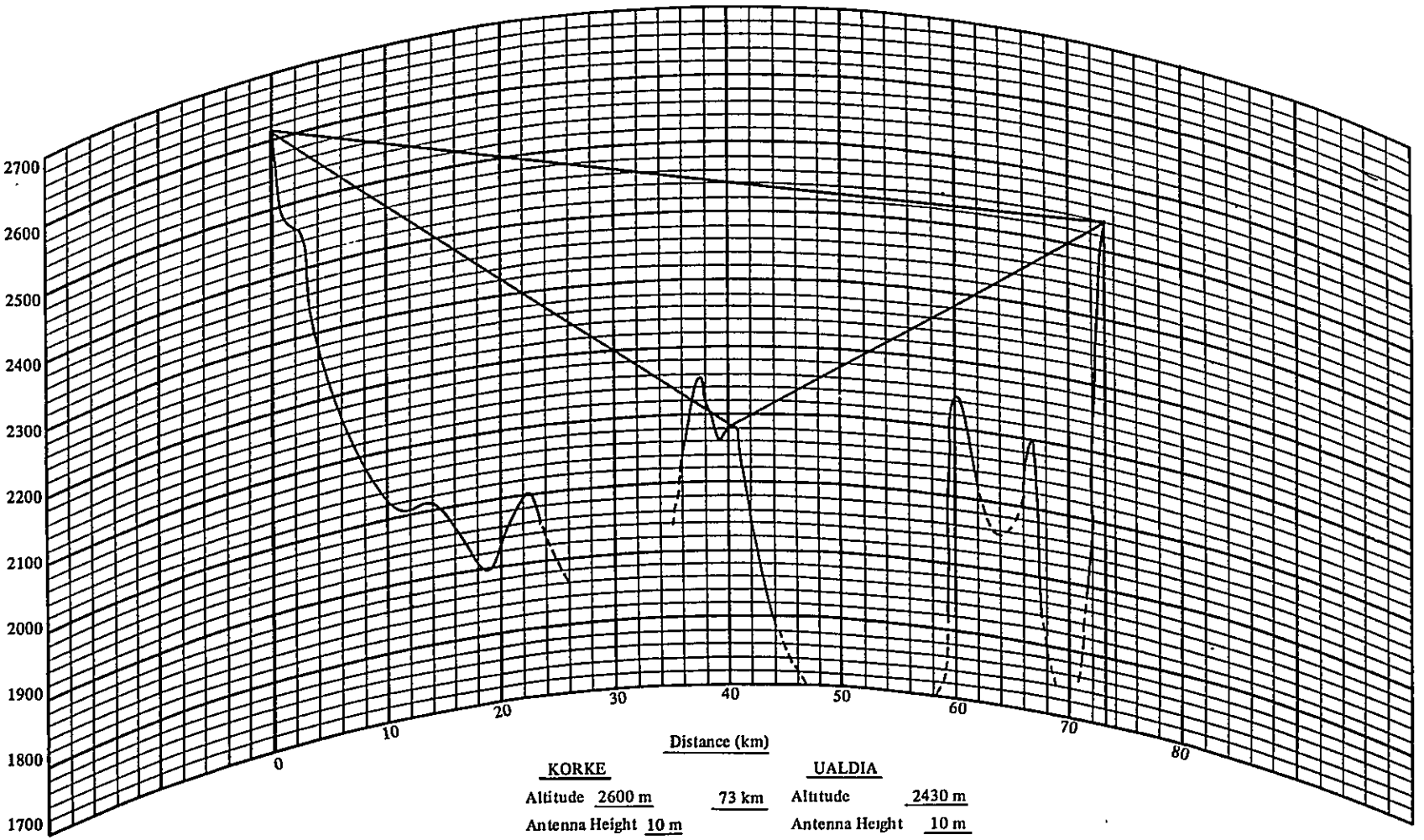


Fig. II - 39 PROFILE MAP

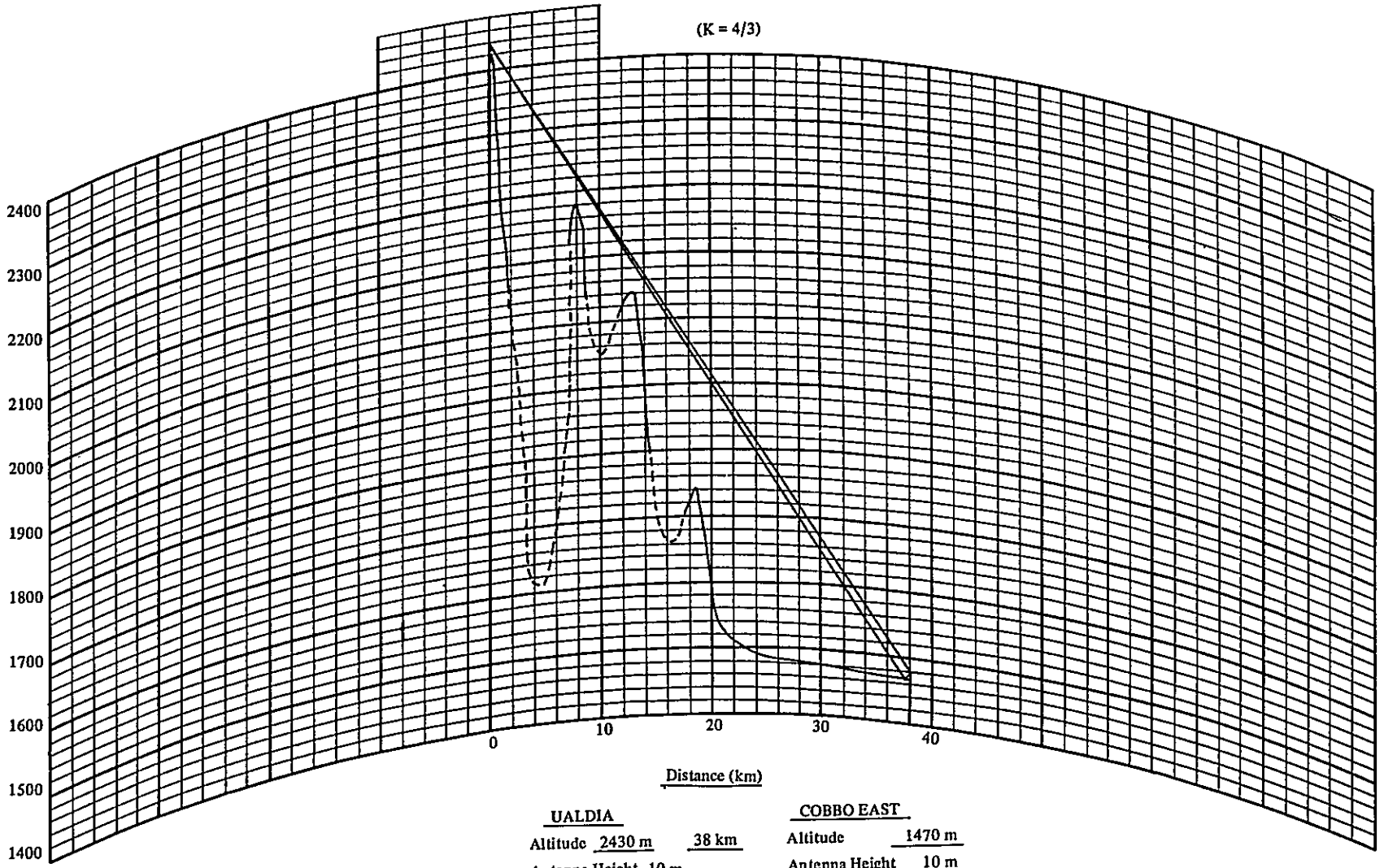


Fig. II - 40 PROFILE MAP

(K = 4/3)

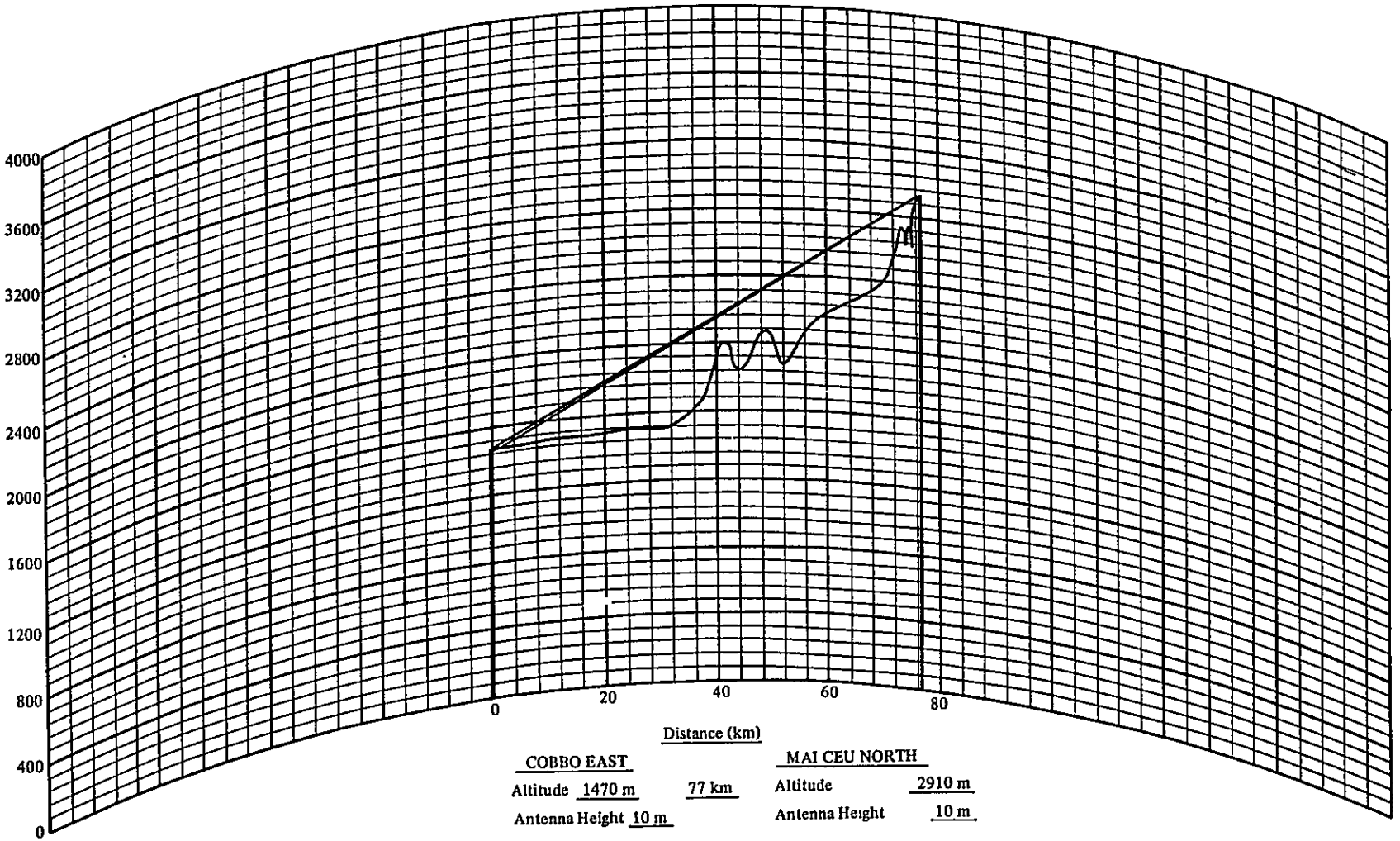


Fig. II - 41 PROFILE MAP

(K = 4/3)

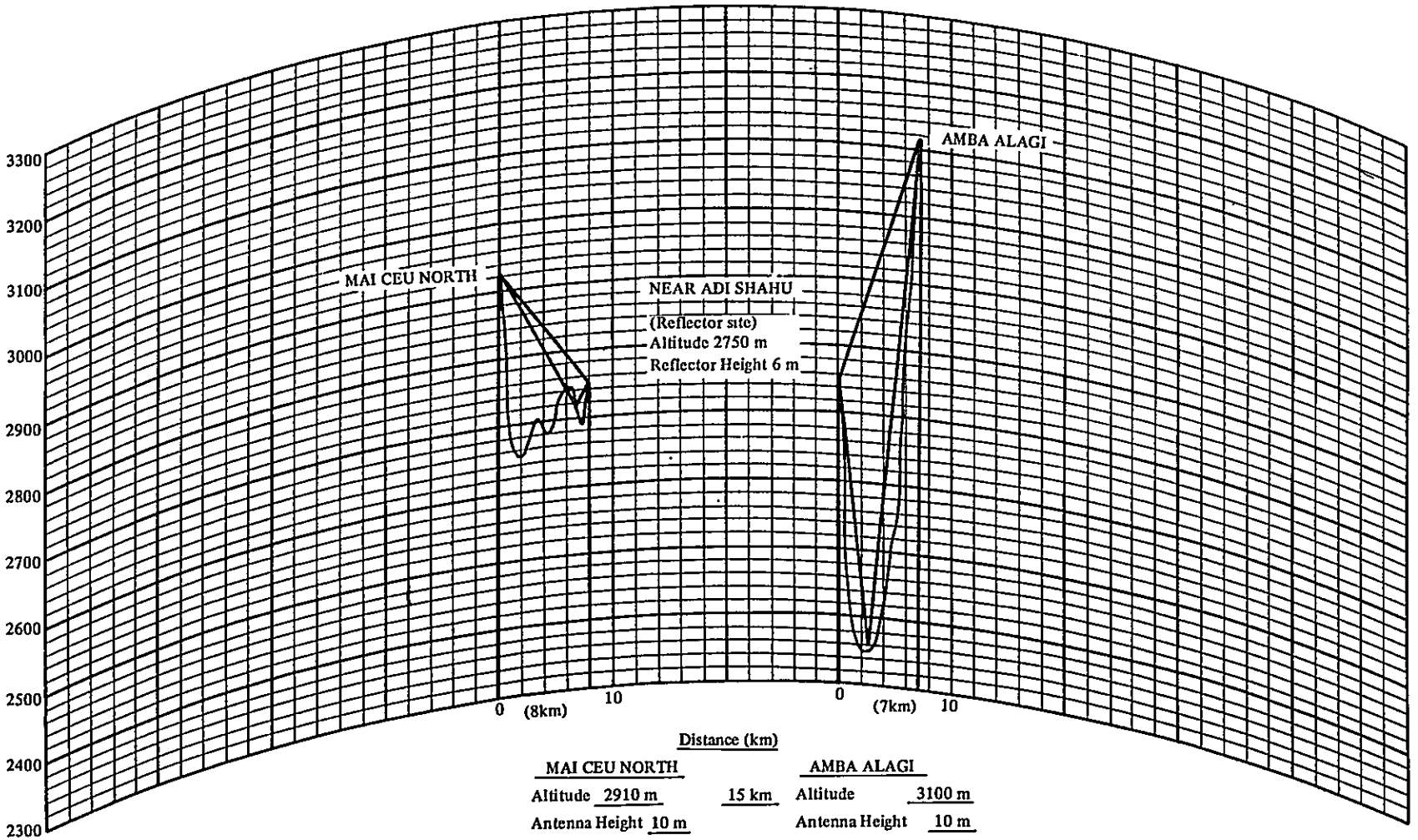


Fig. II - 42 PROFILE MAP

(K = 4/3)

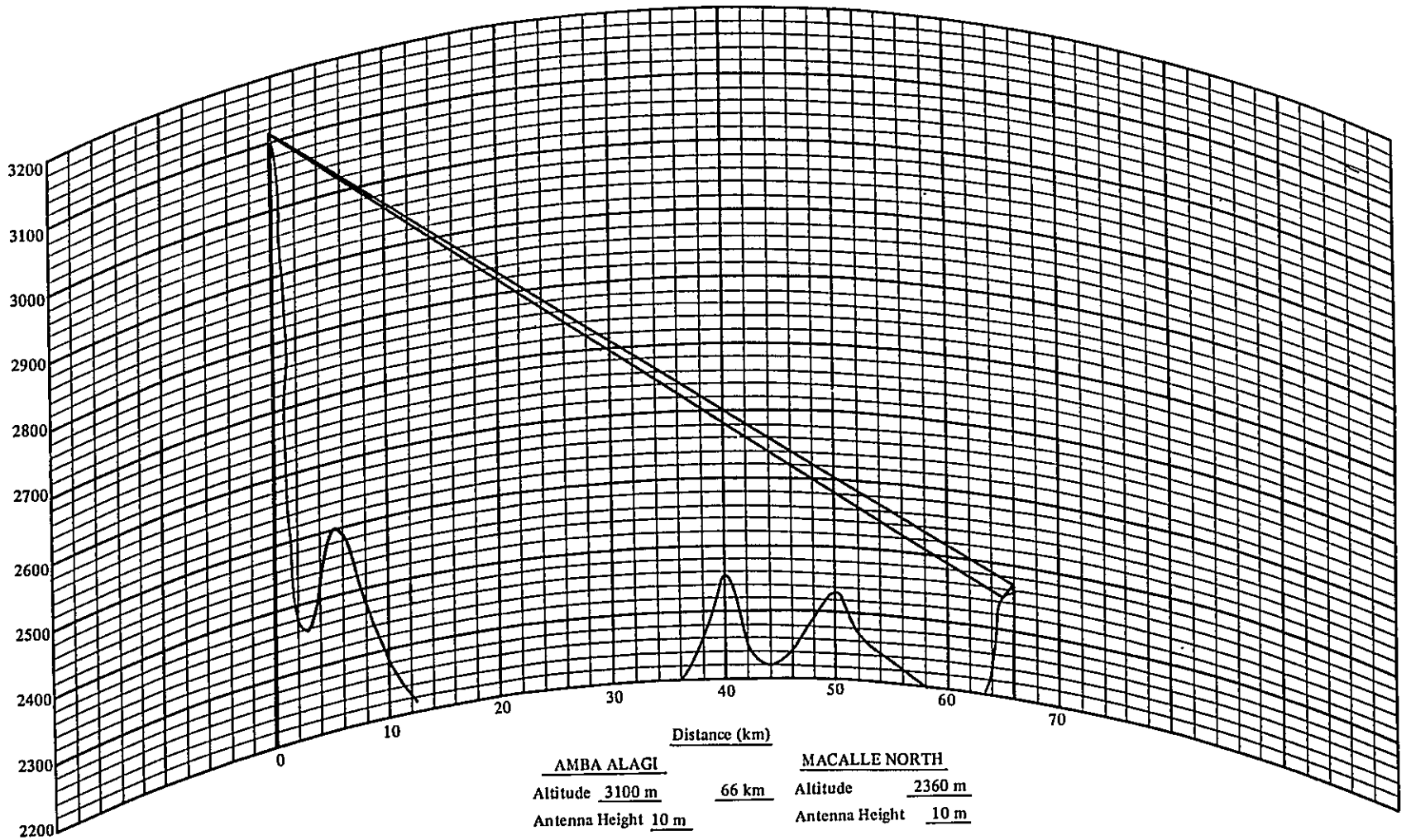


Fig. II - 43 PROFILE MAP

(K = 4/3)

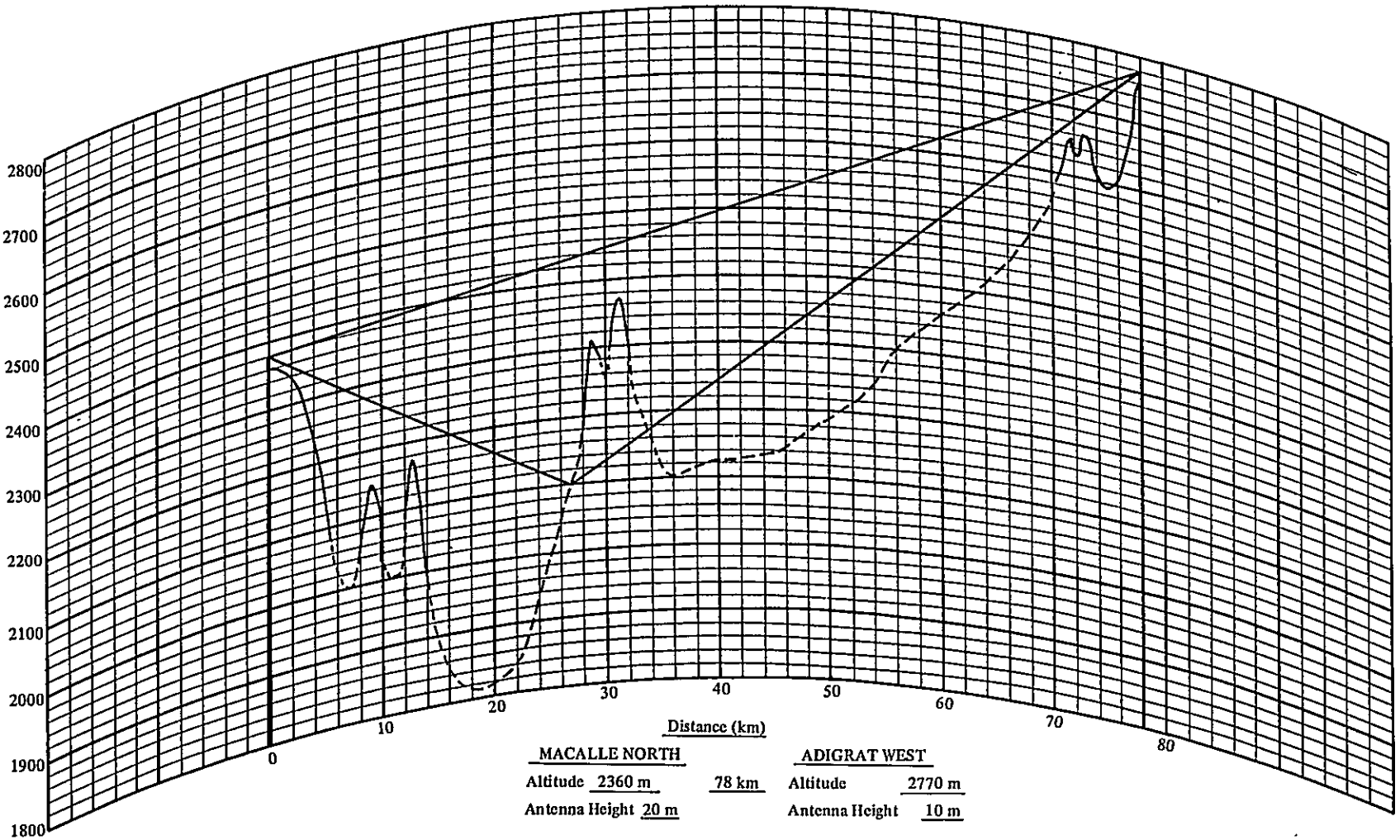


Fig. II - 44 PROFILE MAP

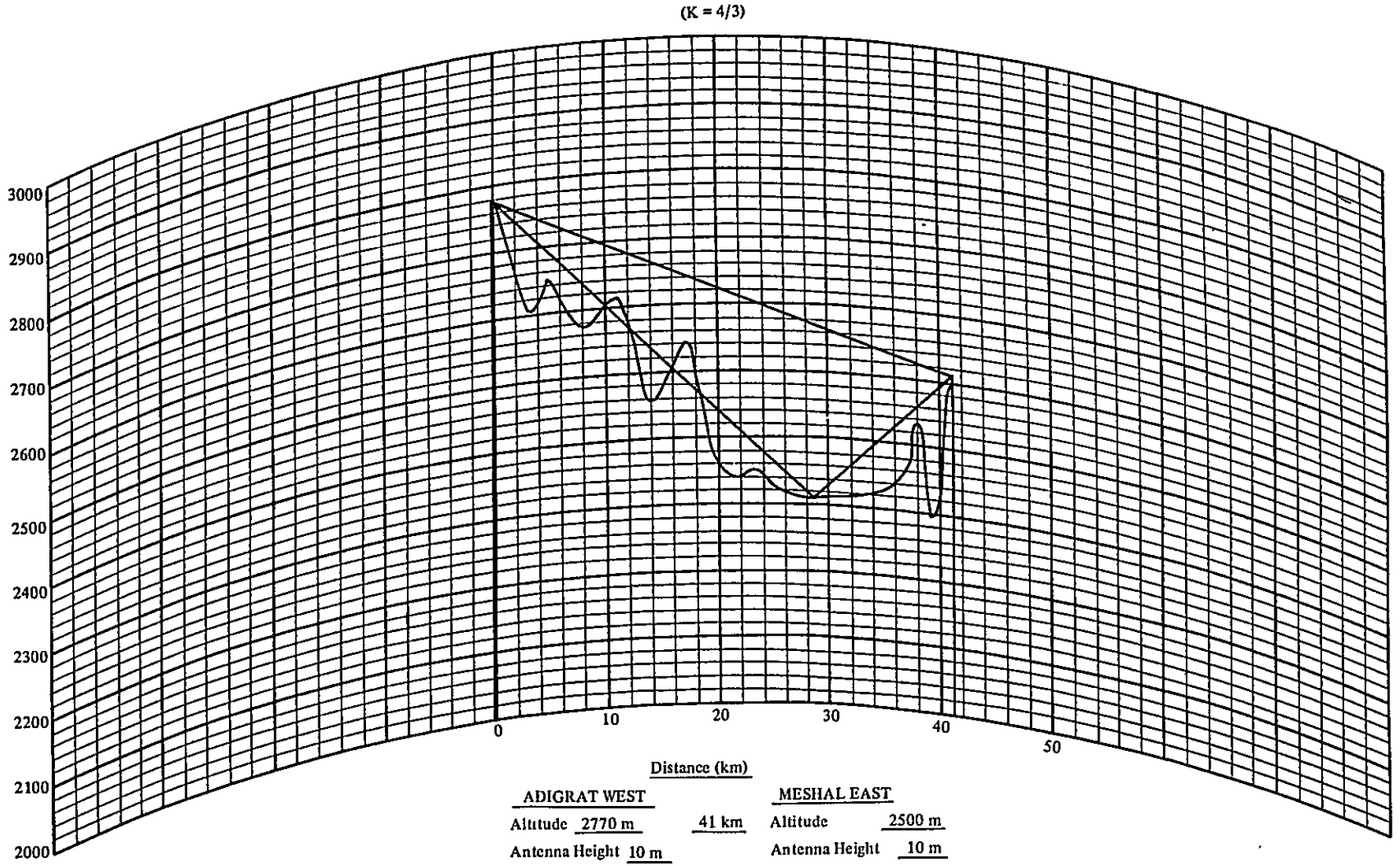


Fig. II - 45 PROFILE MAP

(K = 4/3)

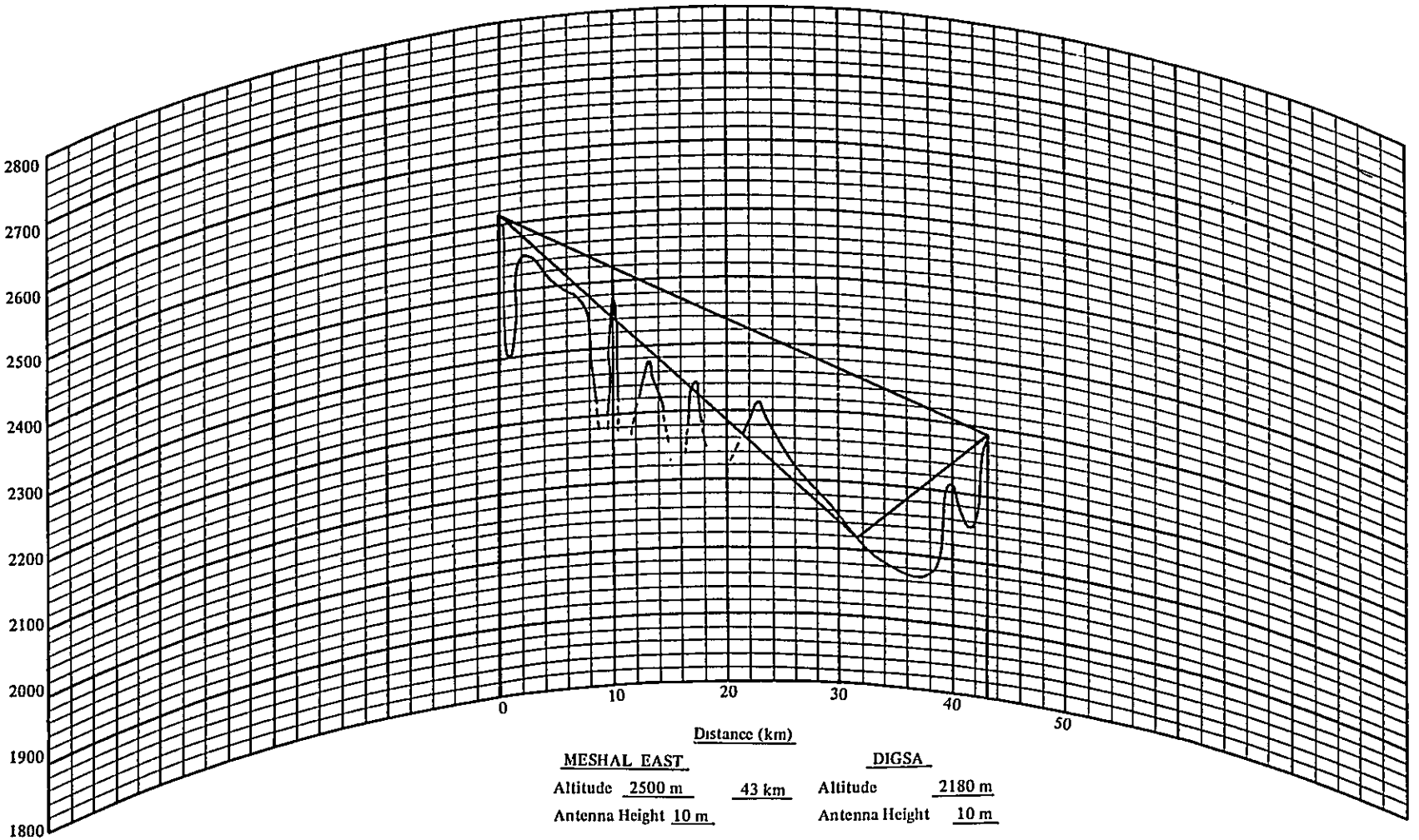


Fig. II - 46 PROFILE MAP

(K = 4/3)

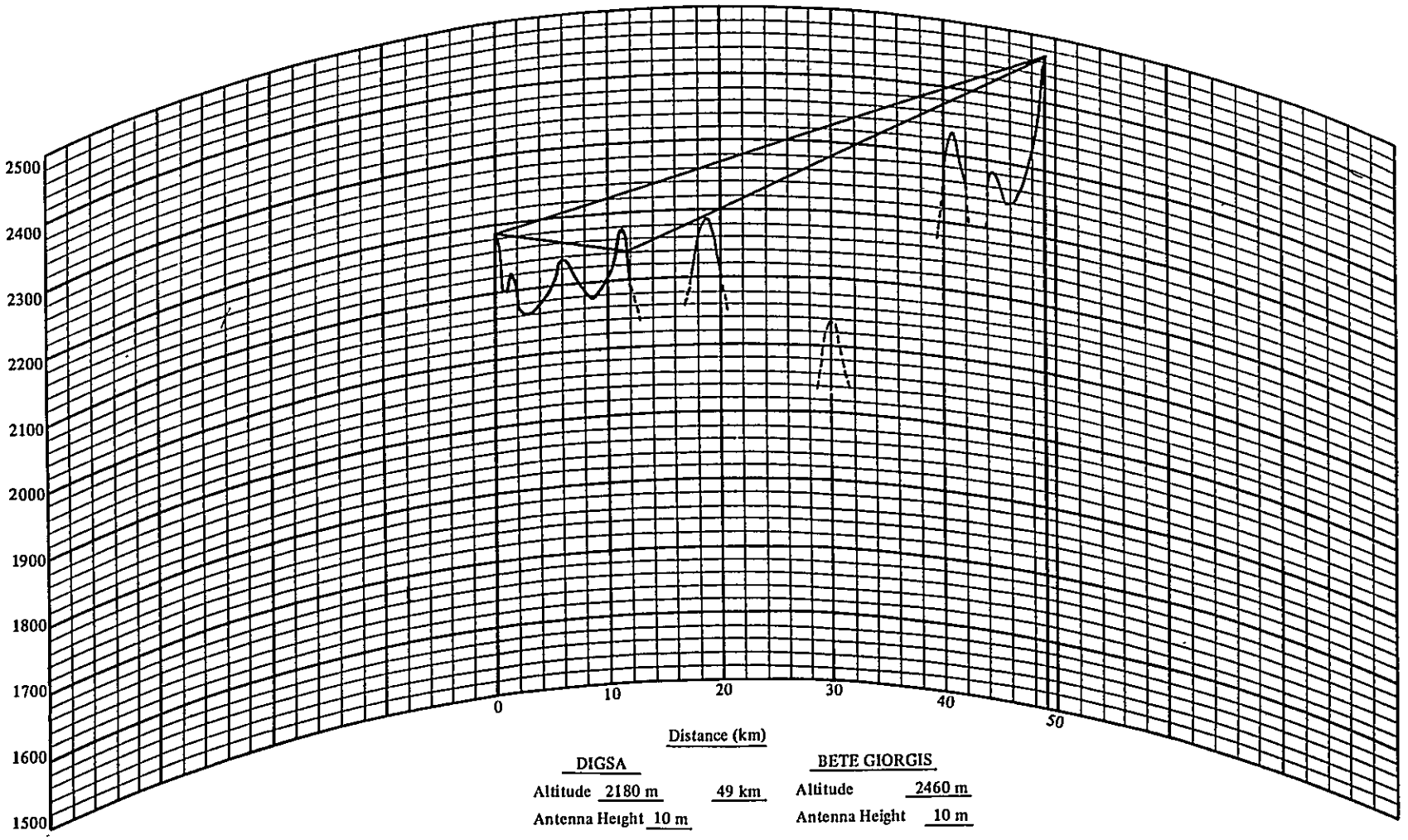


Table II - 2 Calculated Figures of Various Fundamental Factors on Each Section (K=4/3)

Item \ Name of Site				ADDIS ABABA		MT. FURI		KARRAKORRE		KORKE	
Altitude (m)				2390		2820		1890		2600	
Antenna Height above Ground(m)				20		7		10		10	
Effective Antenna Height (m)					34.9	439.1			398.7	921.4	
Half Pitch of Height Pattern (m)					0.46	5.9			1.2	2.9	
Effective Reflection Coefficient	Included Angle between Direct and Reflected Waves			° ′	3° 08'	15'			1°15'	31'	
	Attenuation of Reflected Waves due to Antenna Directivity			dB	more than 30	0.5			21.0	3.1	
	Shielding Ridge Loss of Reflected Wave			dB	0				0		
	Reflection Point	Distance from Site		km	1.2	14.8			25.2	61.8	
		Classification of Condition			City				Water Surface		
		Reflection Loss		dB	6				0		
		Altitude		m	2375				1464		
	Total Loss of Reflected Wave			dB	more than 36.5				24.1		
Path Difference	Path Difference between Direct and Reflected Waves			m	1.9				8.5		
	Required D/U for S/D of 85 dB			dB	19.0				45.0		
Propagation Path Length				km	16				87		
Propagation Loss in Free Space				dB	133.0				147.7		
Profile Map					Fig. II -35				Fig. II -36		
Clearance					no problem				no problem		
Remarks											

Table II - 3 Calculated Figures of Various Funcamental Factors on Each Section (K=4/3)

Item \ Name of Site			KORKE		DESSIE (Reflector Site)		DESSIE (Telephone Office)	
Altitude (m)			2600		2700		2470	
Antenna Height above Ground (m)					5		5	
Effective Antenna Height (m)				169.3	263.2	234.9	5	
Half Pitch of Height Pattern (m)							4.0	0.07
Effective Reflection Coefficient	Included Angle between Direct and Reflected Waves		° '	3°22'	2° 08'	22'	18°20'	
	Attenuation of Reflected Wave due to Antenna Directivity		dB	more than 30	30	9	more than 30	
	Shielding Ridge Loss of Reflected Wave		dB	28.3		0		
	Reflection Point	Distance from Site	km	3.5	5.5	1.47	0.03	
		Classification of Condition		Farm		City		
		Reflection Loss	dB	6		6		
		Altitude	m	2440		2470		
	Total Loss of Reflected Wave		dB	more than 94.3		more than 45 0		
Path Difference	Path Difference between Direct and Reflected Waves		m	9.9		1.6		
	Required D/U for S/D of 85 dB		dB	48		15		
Propagation Path Length			km	9		1.5		
Propagation Loss in Free Space			dB	128.0		112.4		
Profile Map				Fig. II - 37		Fig. II -37		
Clearance				no problem		no problem		
Remarks								

Table II - 4 Calculated Figures of Various Fundamental Factors on Each Section (K = 4/3)

Item			Name of Site	KORKE		UALDIA		COBBO EAST		MAI CEU NORTH	
Altitude (m)				2600		2430		1470		2910	
Antenna Height above Ground (m)				10		10		10		10	
Effective Antenna Height (m)					436.0	296.0	887.3	10	10	1107.6	
Half Pitch of Height Pattern (m)					2.9	2.4	45	0.58	0.88	more than 100	
Effective Reflection Coefficient	Included Angle between Direct and Reflected Waves			° '	31'	37'	2'	2° 28'	1° 39'	1'	
	Attenuation of Reflected Waves due to Antenna Directivity			dB	3.2	4.5	0	more than 30	26.0	0	
	Shielding Ridge Loss of Reflected Waves			dB	22.0		0		0		
	Reflection Point	Distance from Site		km	40.0	33.0	37.6	0.4	0.7	76.3	
		Classification of Condition			Mountain		Farm		Farm		
		Reflection Loss		dB	14		6		6		
		Altitude		m	2080		1470		1470		
	Total Loss of Reflected Wave			dB	43.7		more than 36.0		32.0		
Path Difference	Path Difference between Direct and Reflected Waves			m	3.6		0.5		0.3		
	Required D/U for S/D of 85 dB			dB	30		less than 5		less than 5		
Propagation Path Length				km	73		38		77		
Propagation Loss in Free Space				dB	146.2		140.5		146.6		
Profile Map					Fig. II -38		Fig. II -39		Fig. II -40		
Clearance					no problem		no problem		no problem		
Remarks						hc/ho = 2.6					

Table II - 5 Calculated Figures of Various Fundamental Factors on Each Section (K = 4/3)

Item \ Name of Site				MAI CEU NORTH	ADI SHAHU		AMBA ALAGI		MACALLE NORTH	
Altitude (m)				2910	2750		3100		2360	
Antenna Height above Ground (m)				10	6		10		10	
Effective Antenna Height (m)					217.6	55.8	405.6	758.8	504.0	9.9	
Half Pitch of Height Pattern (m)					1.8	0.45	0.1	0.2	more than 100	1.6	
Effective Reflection Coefficient	Included Angle between Direct and Reflected Waves			° '	47'	$3^{\circ}10'$	$12^{\circ}25'$	$6^{\circ}39'$	1'	52'	
	Attenuation of Reflected Waves due to Antenna Directivity			dB	7.9	more than 30	more than 30	more than 30	0	9.5	
	Shielding Ridge Loss of Reflected Waves			dB	12.2		0		0		
	Reflection Point	Distance from Site		km	6.4	1.6	2.4	4.6	64.7	1.3	
		Classification of Condition			Mountain		Farm		Dry Land		
		Reflection Loss		dB	14		6		6		
		Altitude		m	2700		2350		2360		
	Total Loss of Reflected Wave			dB	more than 64.1		more than 66		15.5		
Path Difference	Path Difference between Direct and Reflected Waves			m	3.0		87.1		0.2		
	Required D/U for S/D of 85 dB			dB	27.0		69.0		less than 5		
Propagation Path Length				km	8		7		66		
Propagation Loss in Free Space				dB	126.9		125.8		145.3		
Profile Map					Fig. II-41		Fig. II-41		Fig. II-42		
Clearance					no problem		no problem		no problem		
Remarks											

Table II - 6 Calculated Figures of Various Fundamental Factors on Each Section (K = 4/3)

Item \ Name of Site			MAI CEU NORTH	ADIGRAT WEST		MESHAL EAST		DIGSA	
Altitude (m)			2360	2770		2500		2180	
Antenna Height above Ground (m)			20	10		10		10	
Effective Antenna Height (m)				243.0	165.0	412.0	181.0	421.3	152.4
Half Pitch of Height Pattern (m)				1.8	3.6	2.9	1.3	3.6	1.3
Effective Reflection Coefficient	Included Angle between Direct and Reflected Waves		° '	46'	22'	36'	1° 09'	24'	1° 07'
	Attenuation of Reflected Waves due to Antenna Directivity		dB	7.0	1.6	3.2	17.3	2.1	13.1
	Shielding Ridge Loss of Reflected Waves		dB	more than 30		more than 30		more than 30	
	Reflection Point	Distance from Site	km	51.0	27.0	28.5	12.5	31.6	11.4
		Classification of Condition		Dry Land		Dry Land		Dry Land	
		Reflection Loss	dB	6		6		6	
		Altitude	m	2100		2320		2030	
	Total Loss of Reflected Wave		dB	more than 44 6		more than 56.5		more than 51.2	
Path Difference	Path Difference between Direct and Reflected Waves		m	1.4		3.6		3.0	
	Required D/U for S/D of 85 dB		dB	13		30		27	
Propagation Path Length			km	78		41		43	
Propagation Loss in Free Space			dB	146.7		141.2		141.6	
Profile Map				Fig. II - 43		Fig. II - 44		Fig. II - 45	
Clearance				no problem		no problem		no problem	
Remarks				hc/ho = 2.9		hc/ ho = 1.9			

Table II - 7 Calculated Figures of Various Fundamental Factors on Each Section (K = 4/3)

Item \ Name of Site			DIGSA		BETE GIORGIS	
Altitude		(m)	2180		2460	
Antenna Height above Ground		(m)	10		10	
Effective Antenna Height		(m)		92.1	297.8	
Half Pitch of Height Pattern		(m)		2.1	7.4	
Effective Reflection Coefficient	Included Angle between Direct and Reflected Waves		o ,	42'	13'	
	Attenuation of Reflected Waves due to Antenna Directivity		dB	6.1	0.6	
	Shielding Ridge Loss of Reflected Waves		dB	more than 30		
	Reflection Point	Distance from Site	km	11.6	37.4	
		Classification of Condition		Mountain		
		Reflection Loss	dB	14		
		Altitude	m	2090		
	Total Loss of Reflected Wave			more than 30.7		
Path Difference	Path Difference between Direct and Reflected Waves		m	1.1		
	Required D/U for S/D of 85 dB			9		
Propagation Path Length			km	49		
Propagation Loss in Free Space			dB	142.7		
Profile Map				Fig. II - 46		
Clearance				no problem		
Remarks			hc/ho = 2.7			

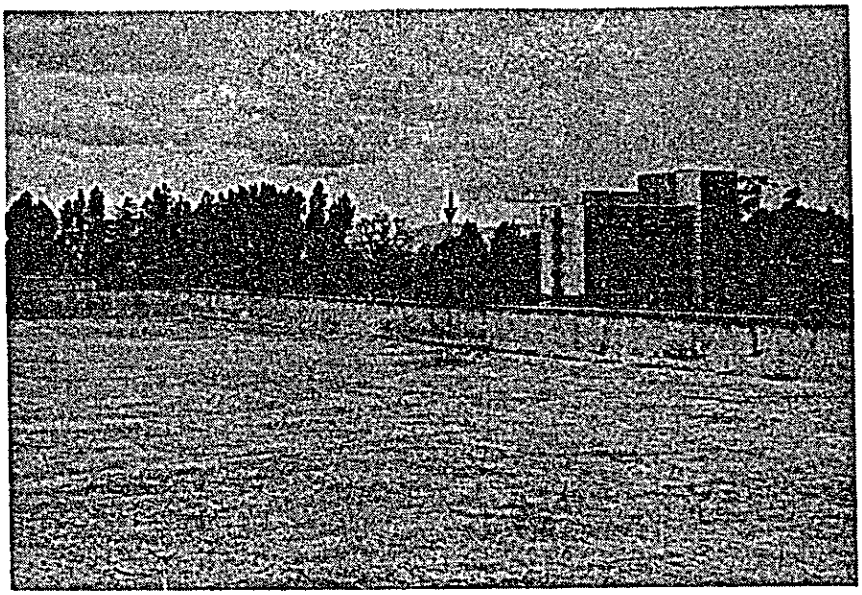


Fig. II - 47 Distant view of MT. FURI from the roof of IBTE (Filwoha Office)

Fig. II - 48 IBTE (Filwoha Office)

MT. FURI

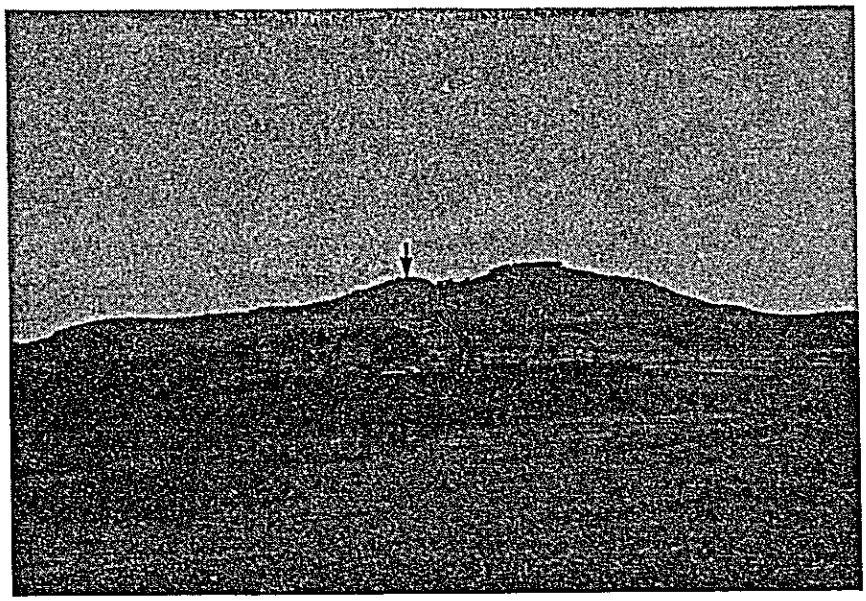


Fig. II - 49 Distant view of MT. FURI from All Weather Road

Fig. II - 50 Distant wiew of SHANO SOUTH from MT. FURI

SHANO SOUTH

Fig. II - 51 Distant view of MT. FURI from SHANO SOUTH

Fig. II - 52 View of the site

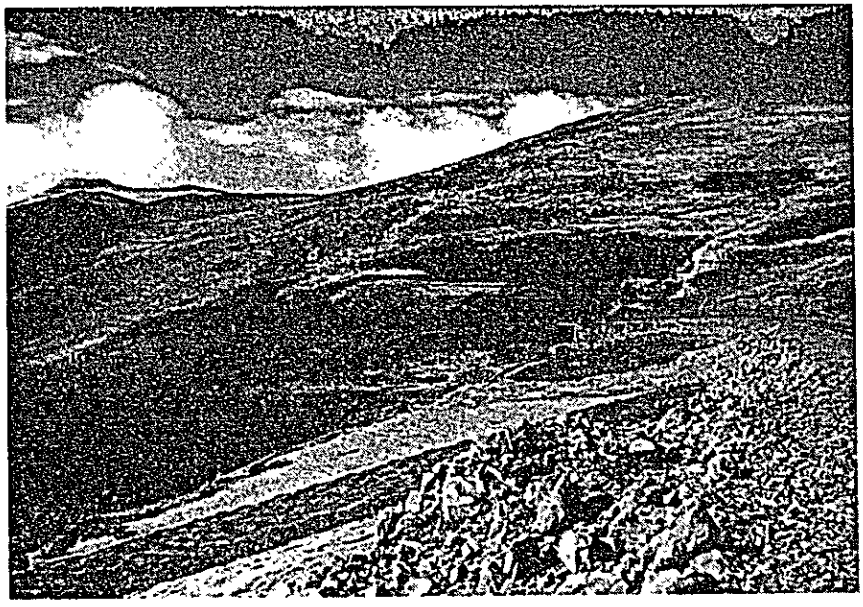


Fig. II - 53 View of Grass House for land mark from All Weather Road

ANCOBER NORTH

Fig. II - 54 Distant view in the direction of SHANO SOUTH from road side of the site

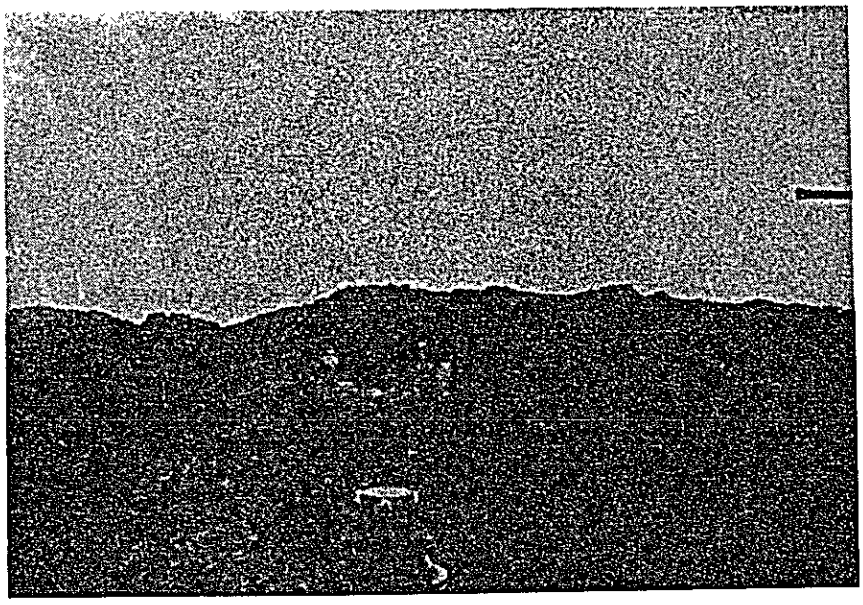


Fig. II - 55 Distant view in the direction of SHANO SOUTH from the site (summit)

ANCOBER NORTH

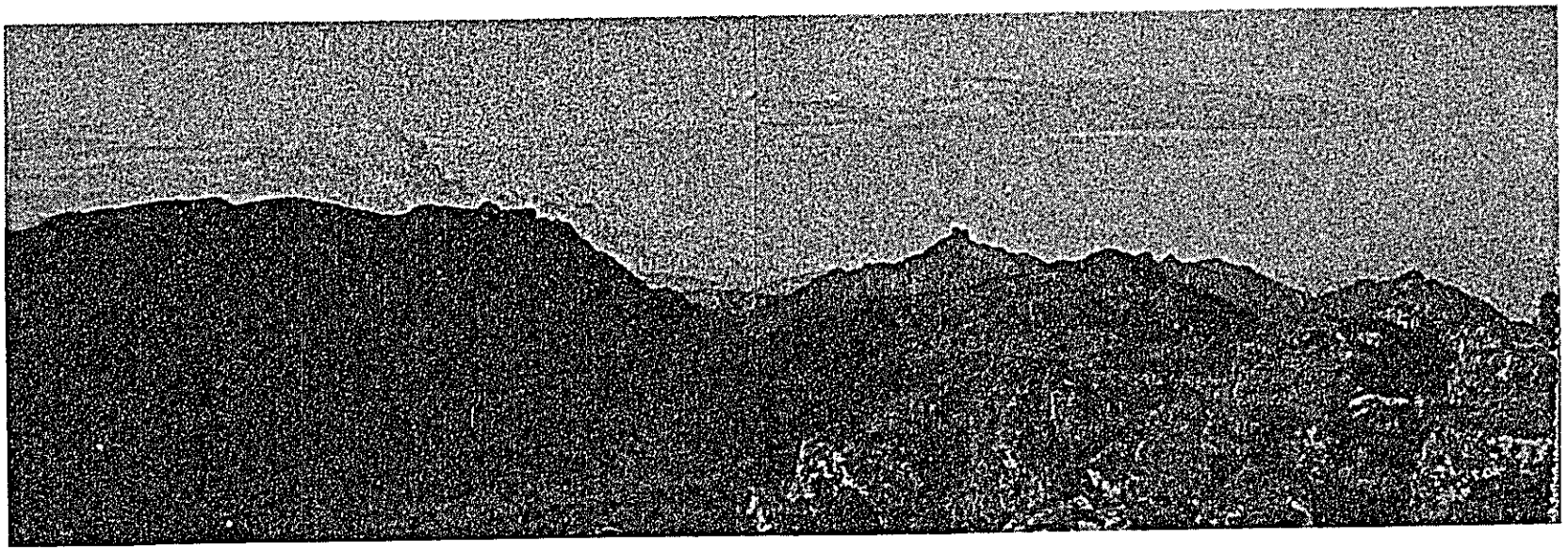


Fig II-56 Distant view in the direction of KARRAKORRE from the site (summit)

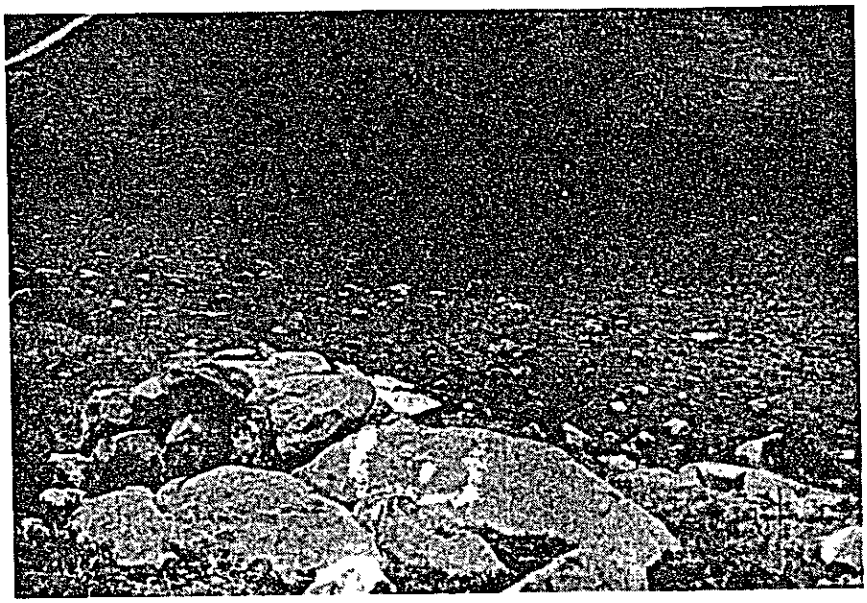


Fig. II - 57 View of the site

Fig. II - 58 Distant view in the direction of ANCOBER NORTH from the site

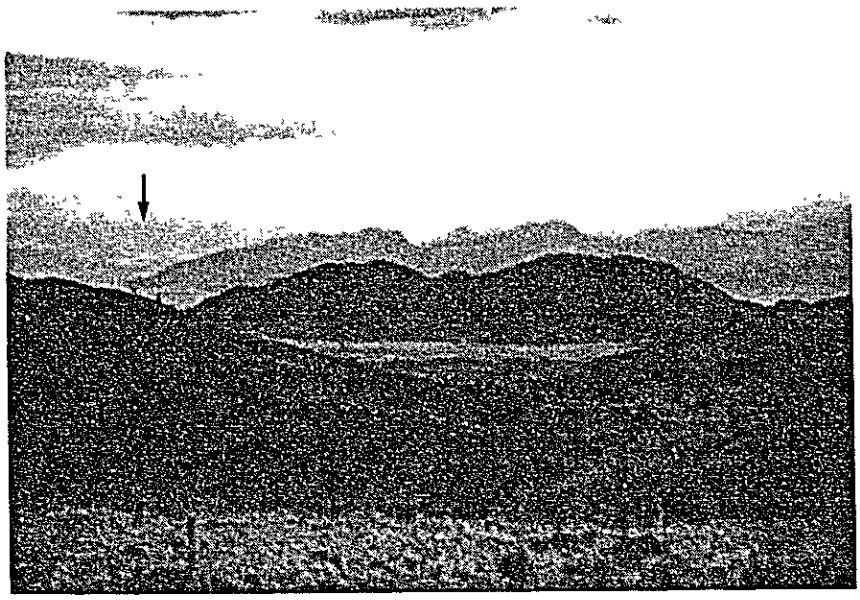


Fig. II - 59 Distant view of KORKE from the site

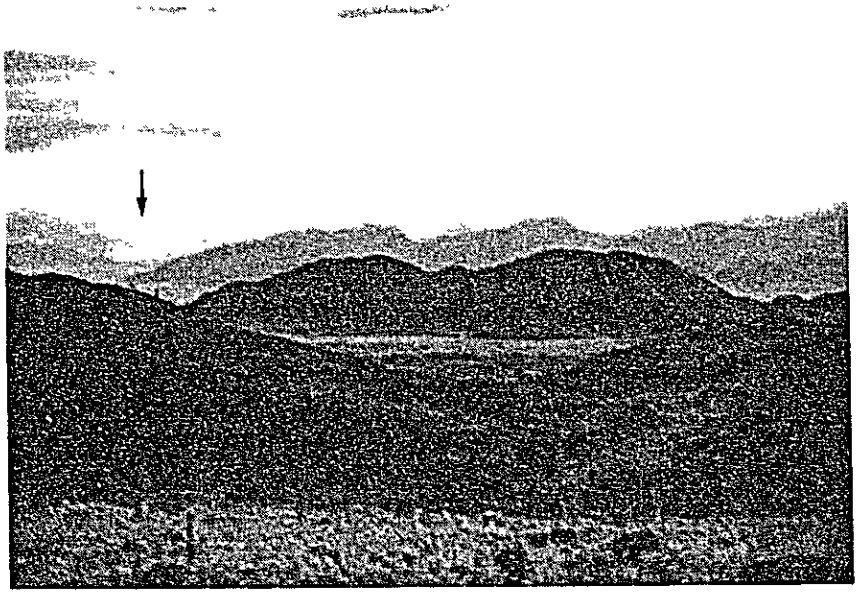


Fig II - 59 Distant view of KORKE from the site

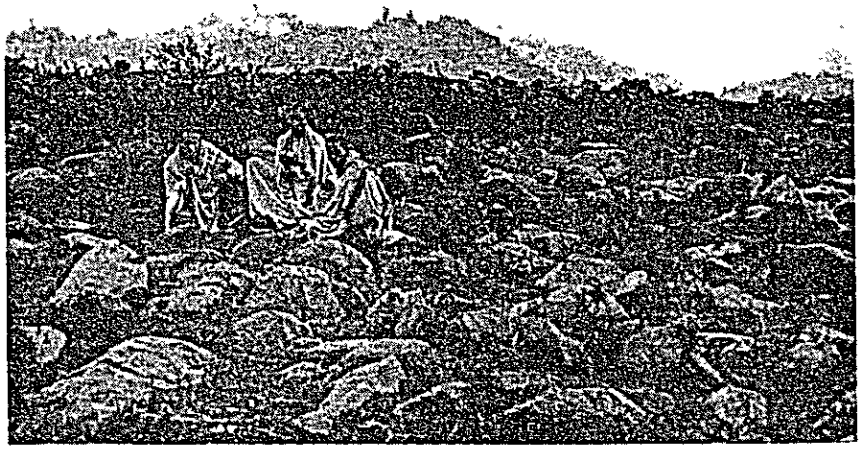


Fig. II - 60 View of the site

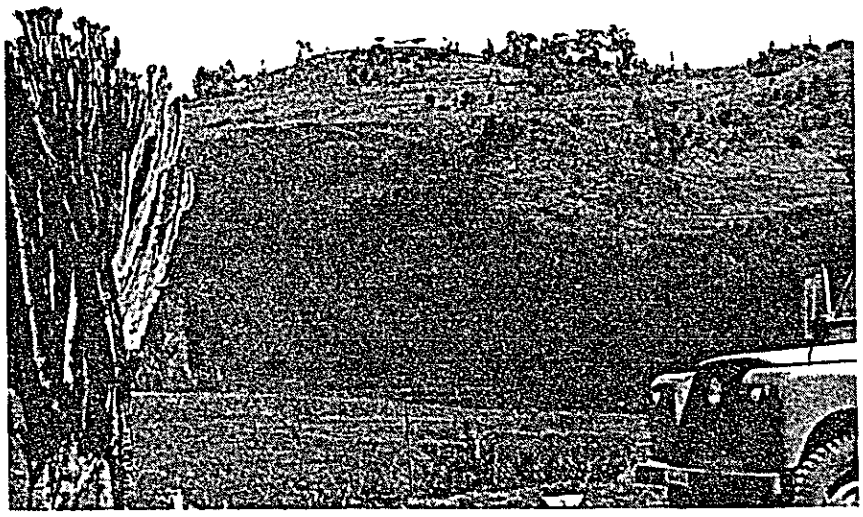


Fig II - 61 Distant view of the site from All Weather Road

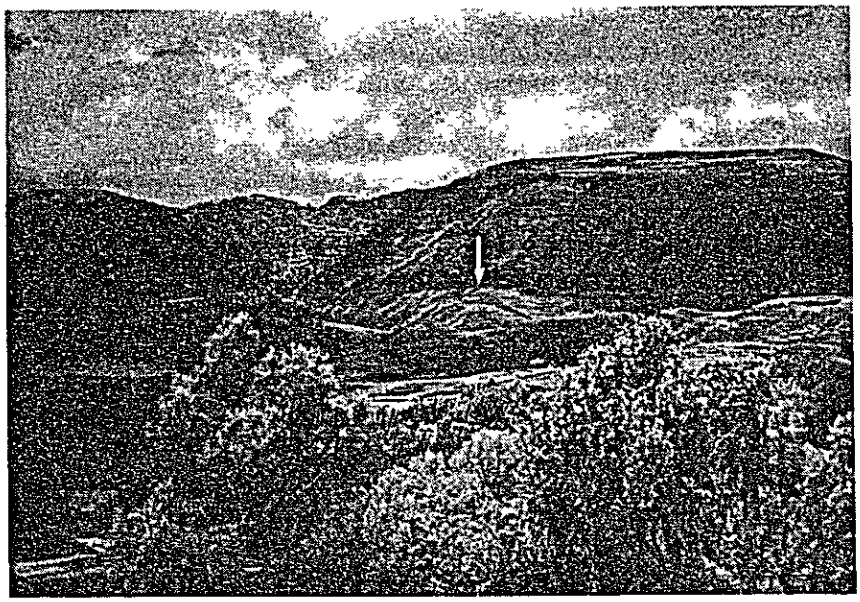


Fig II - 62 Distant view of DESSIE Reflector Site from the site

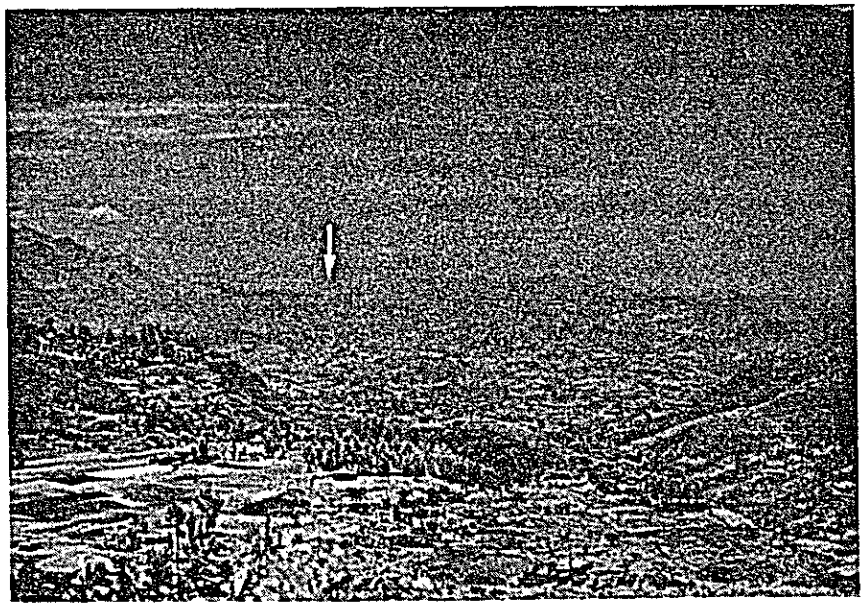


Fig II - 63 Distant view of UALDIA from the site

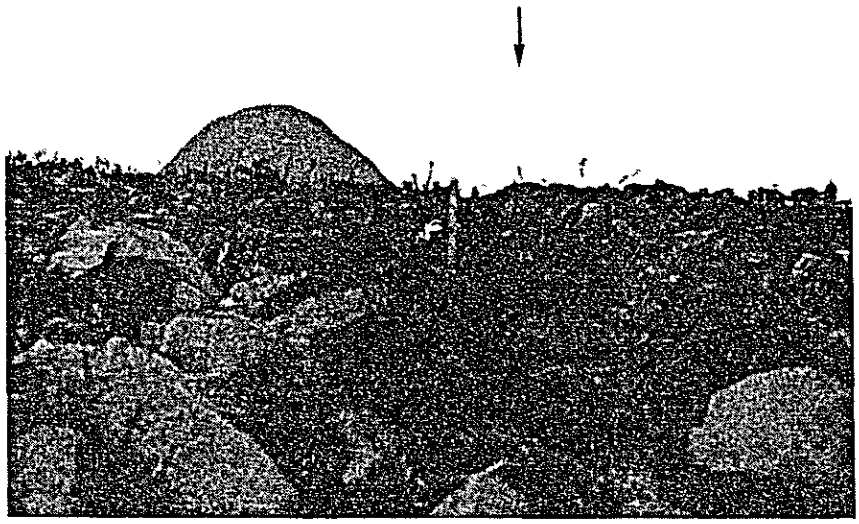


Fig II - 64 Distant view of KARRAKORRE from the site

DESSIE (Reflector site)

Fig II - 65 Distant view of KORKE from the site

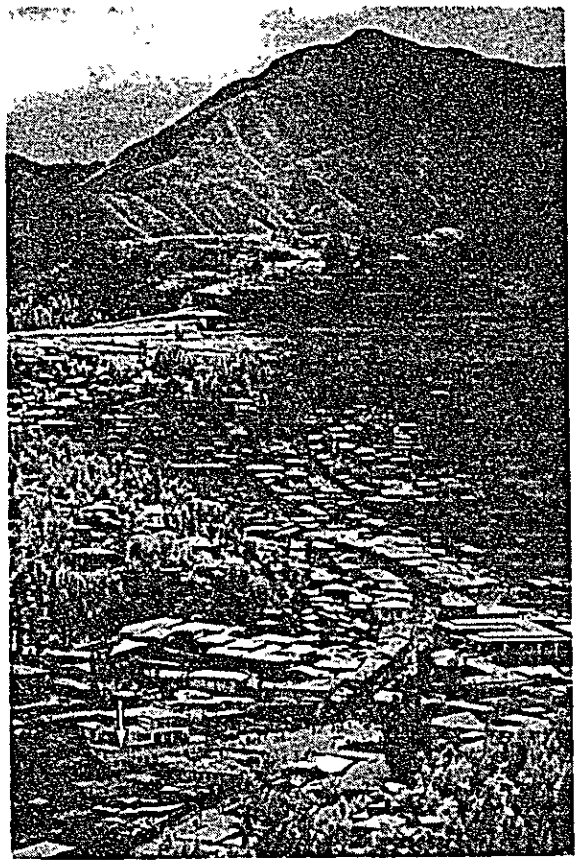


Fig. II - 66 Distant view of Dessie Telephone Office from the site

DESSIE (Tele. office)

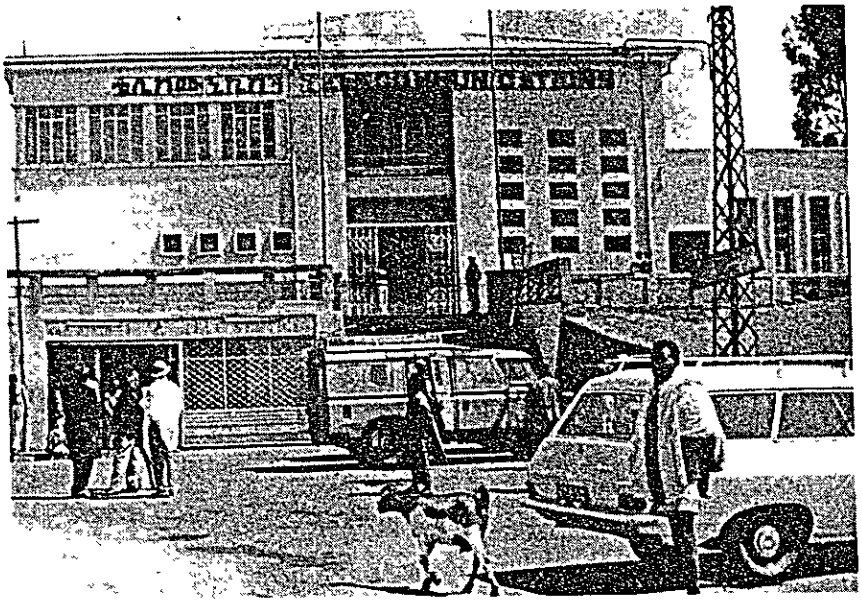


Fig. II - 67 View of Telephone Office of Dessie City

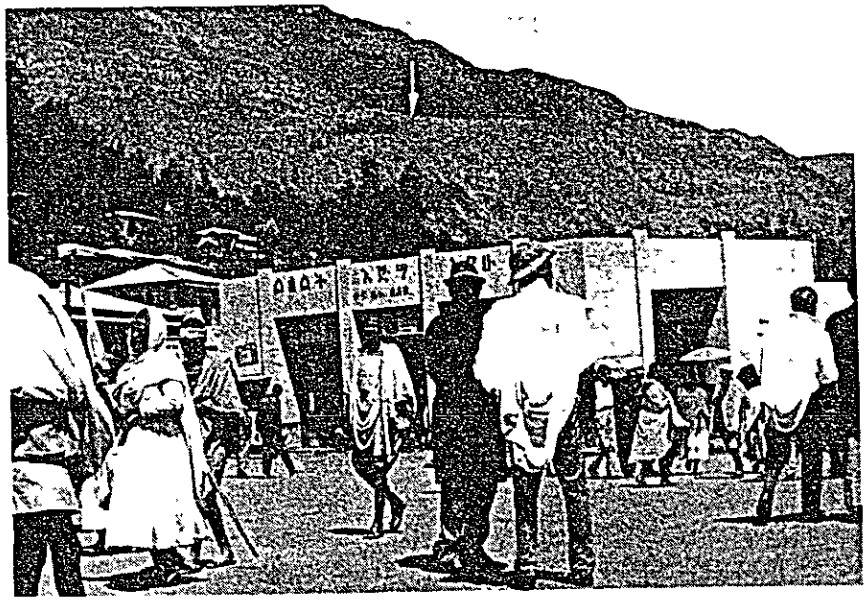


Fig. II - 68 Distant view of DESSIE Reflector Site from piazza in front of Telephone Office

Fig II - 69 View of the site

Fig. II - 70 Distant view of KORKE from the site

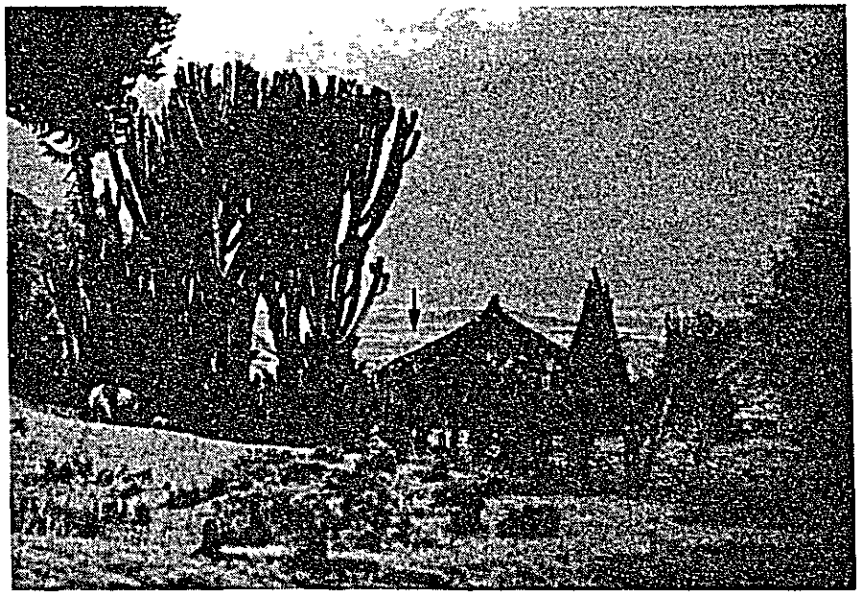


Fig II - 71 Distant view of COBBO EAST from the site

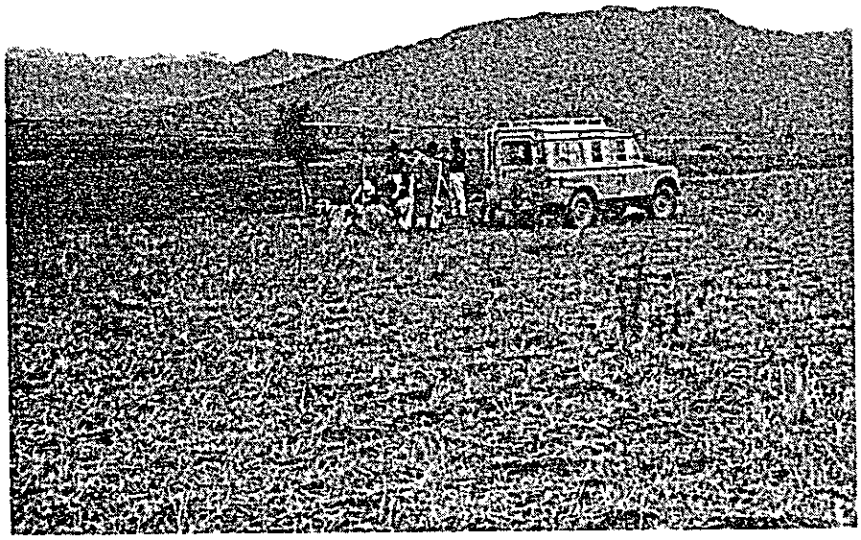


Fig. II - 72 View of the site

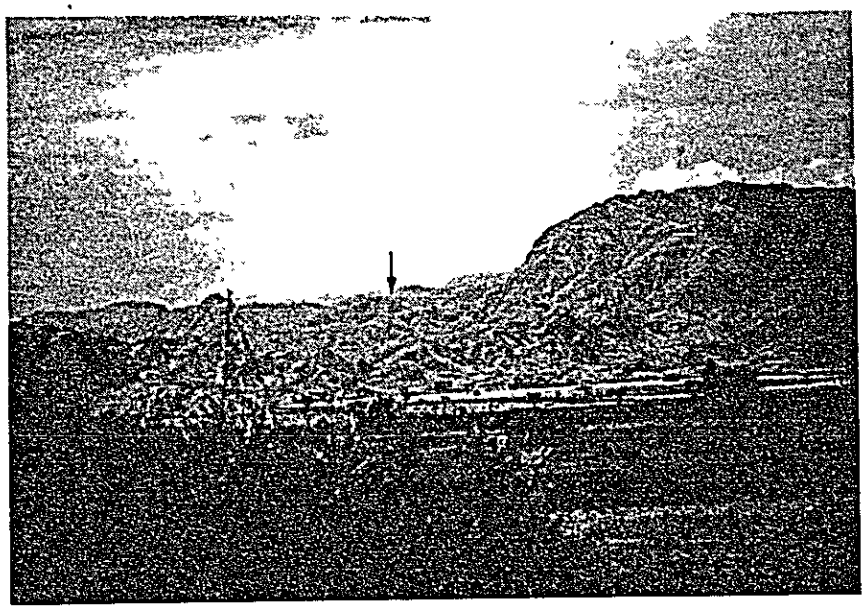


Fig. II - 73 Distant view of UALDIA from the site

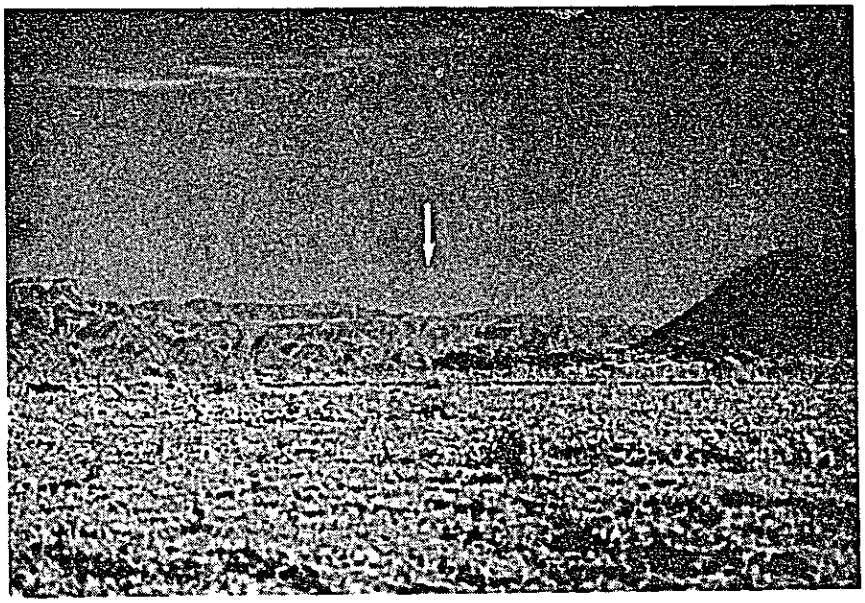


Fig. II - 74 Distant view of MAI CEU NORTH from the site

MAI CEU NORTH

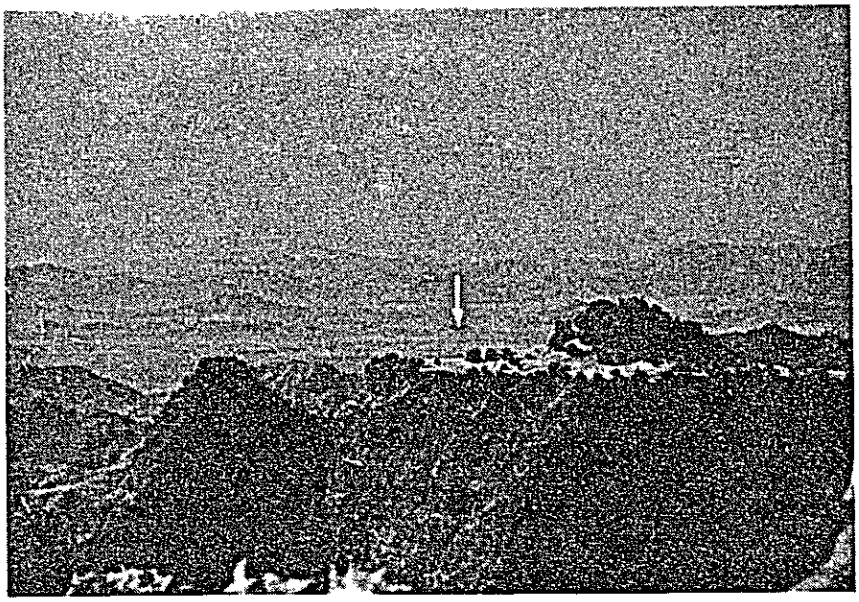


Fig II - 75 Distant view of COBBO EAST from the site

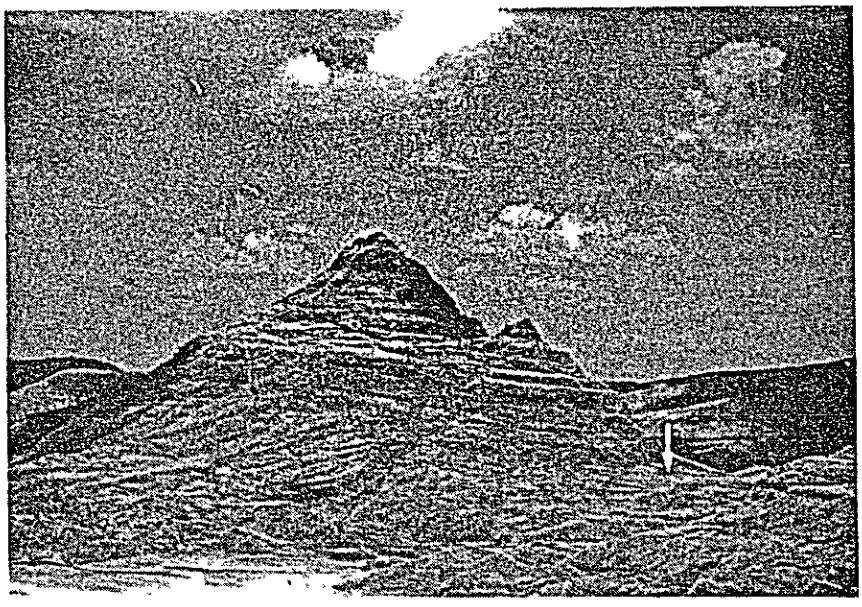


Fig. II - 76 Distant view of ADI SHAHU from the site

NEAR ADI SHAHU

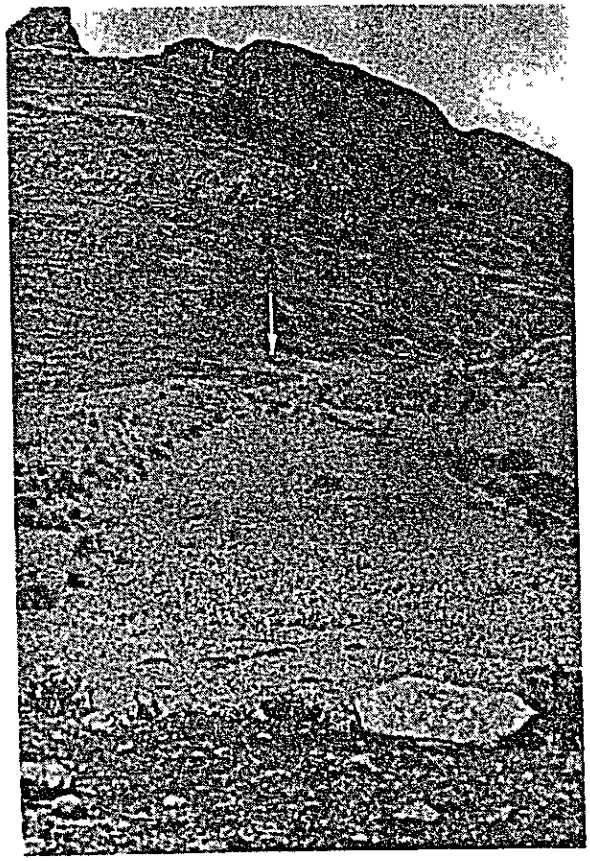


Fig II - 77 View of the site from All Weather Road

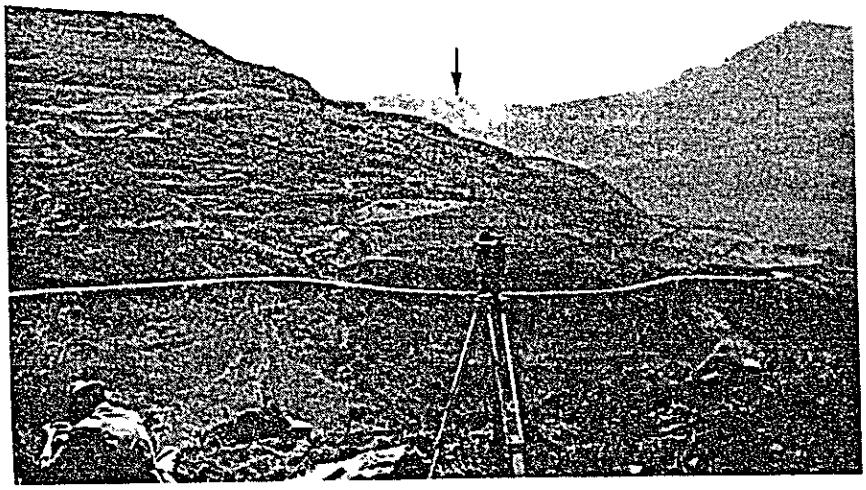


Fig II - 78 Distant view of MAI CEU NORTH from the site

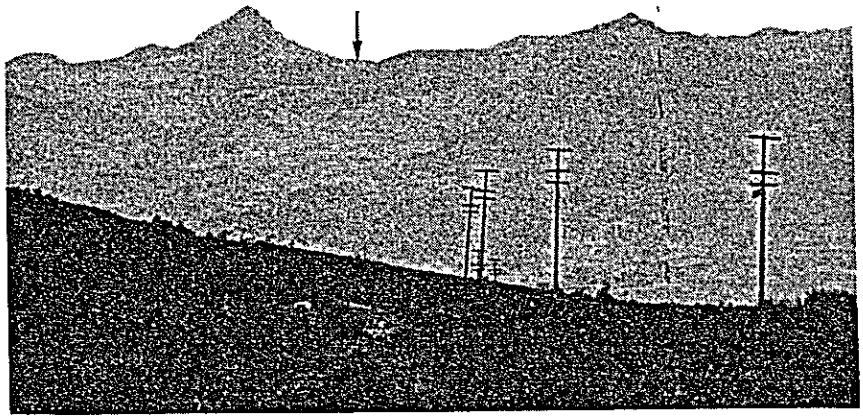


Fig. II - 79 Distant view of AMBA ALAGI from the site

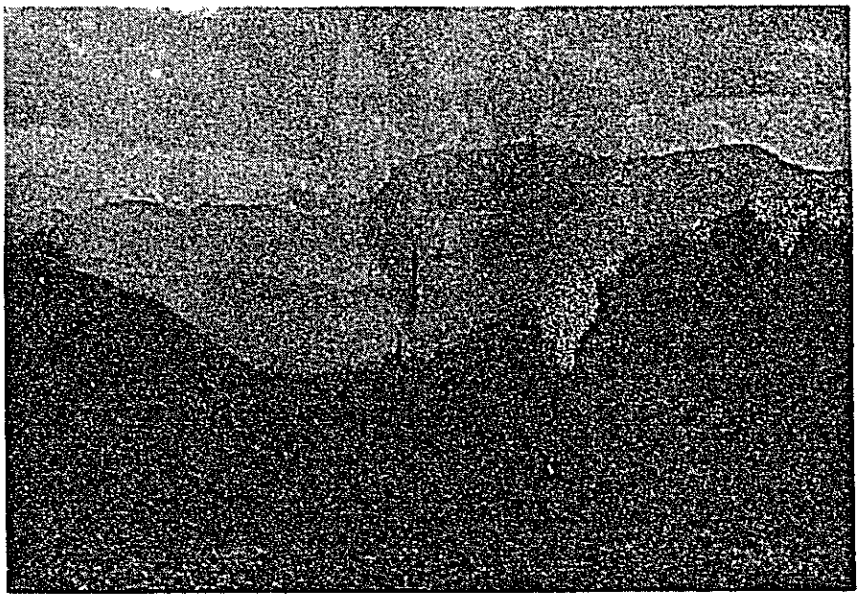


Fig. II - 80 Distant view of ADI SHAHU from the site

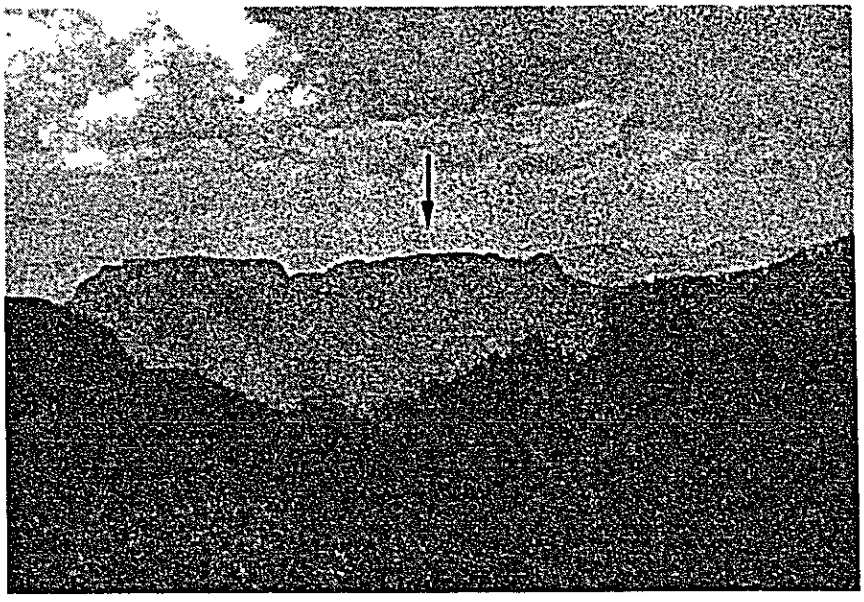


Fig II - 81 Distant view of MACALLE NORTH from the site

Fig. II - 82 Distant view of MACALLE NORTH from the site

MACALLE NORTH

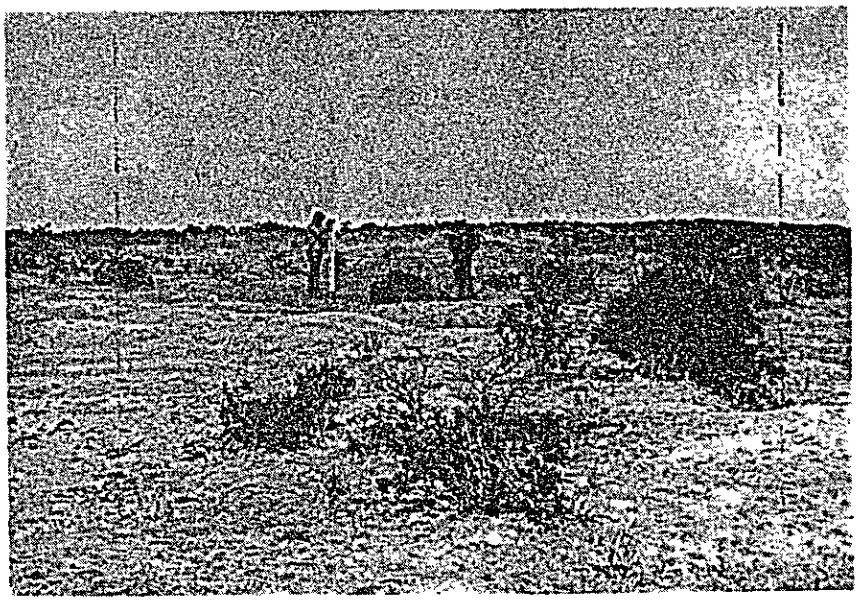


Fig. II - 83 View of the site

Fig. II - 84 Distant view of AMBA ALAGI from the site

MACALLE NORTH

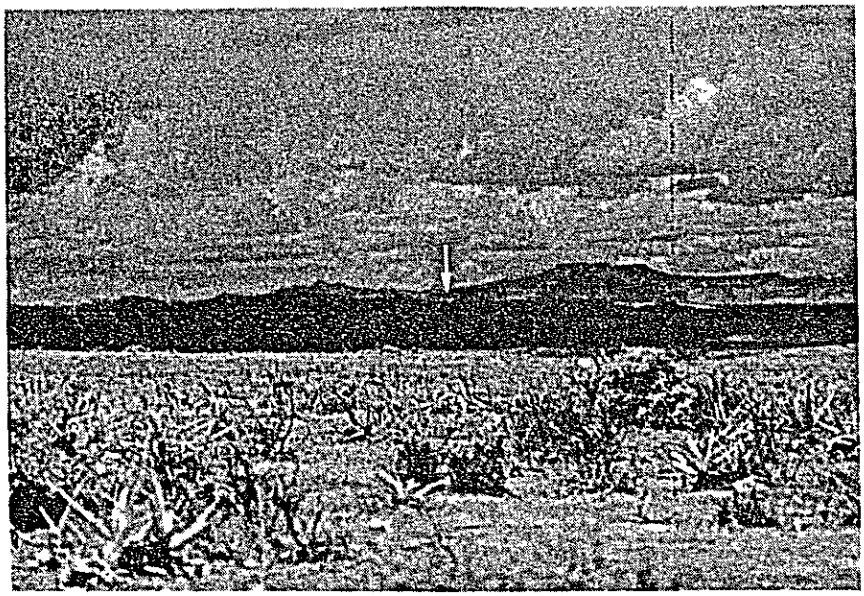


Fig. II - 85 Distant view of ADIGRAT WEST from the site

Fig. II - 86 View of the site

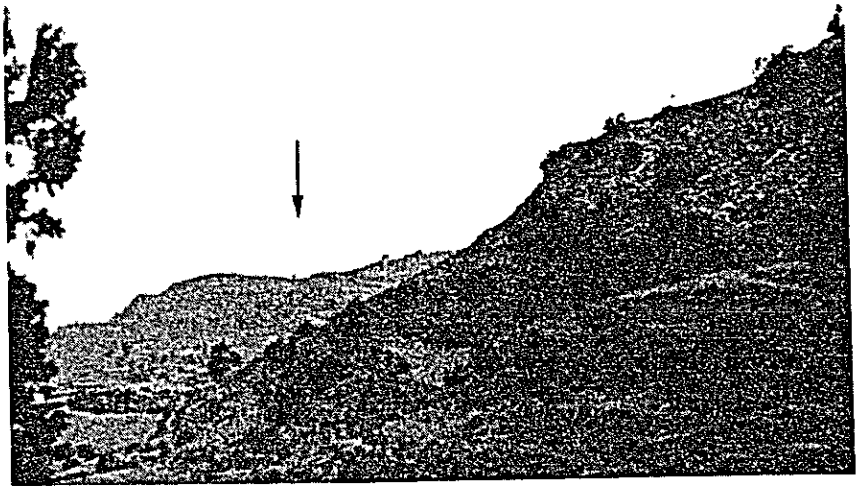


Fig. II - 87 Distant view of MACALLE NORTH from the site

Fig. II - 88 Distant view of MESHAL EAST from the site

MESHAL EAST

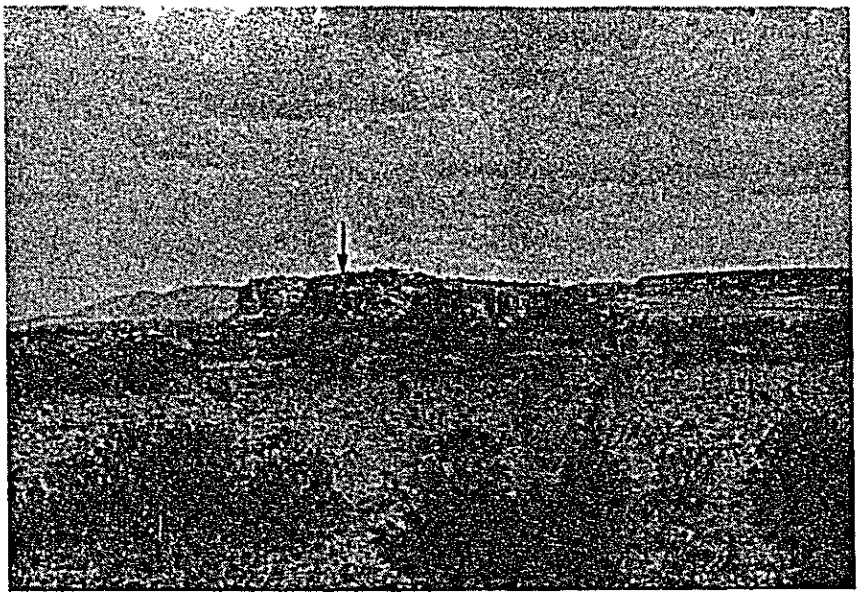


Fig.. II - 89 View of the site from All Weather Road

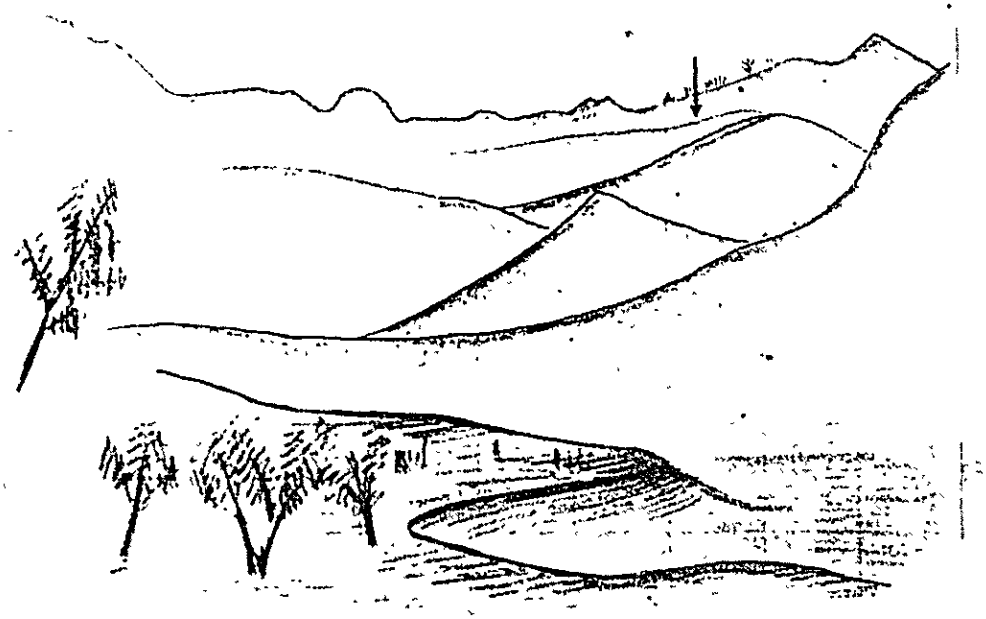


Fig. II - 90 Distant view of ADIGRAT WEST from near the site

Fig. II - 91 Distant view of DIGSA from near the site

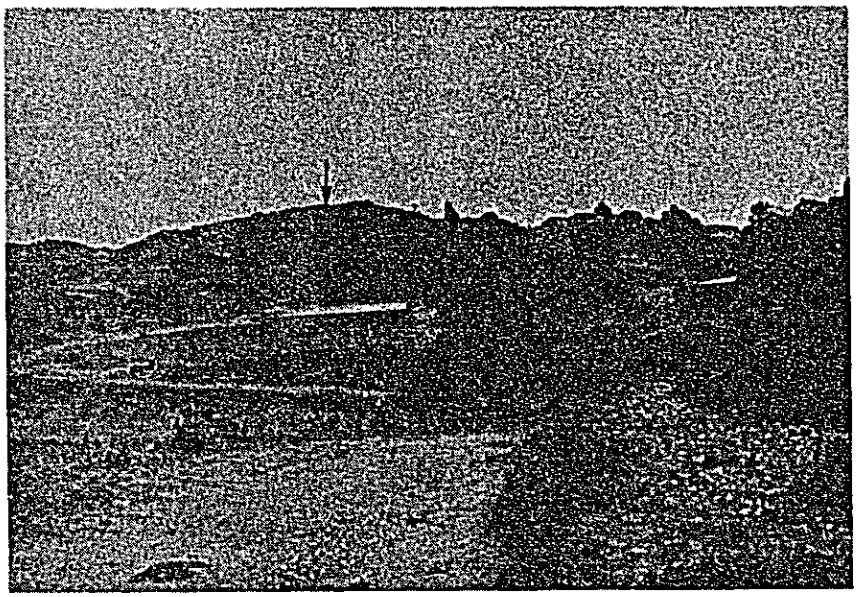


Fig. II - 92 View of the site from the entrance to Digsa Village

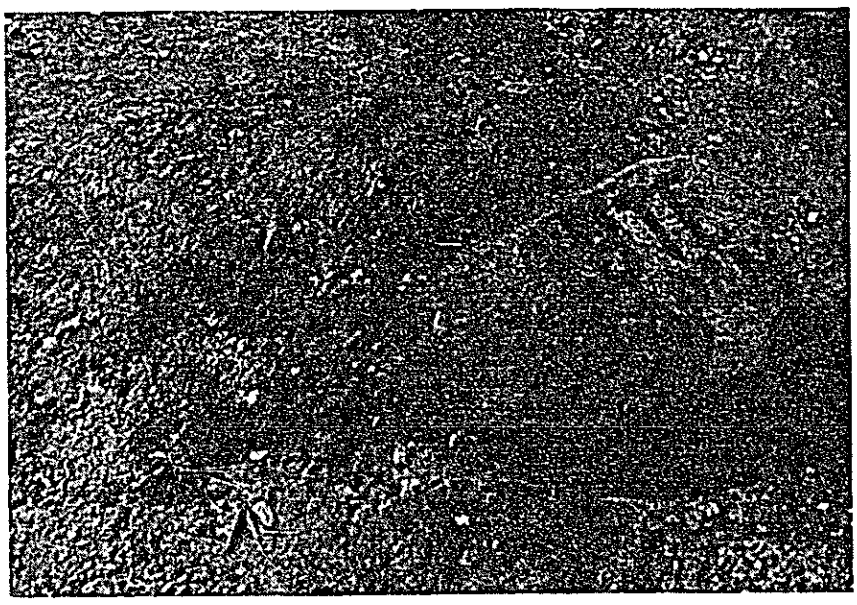


Fig. II - 93 The site mark

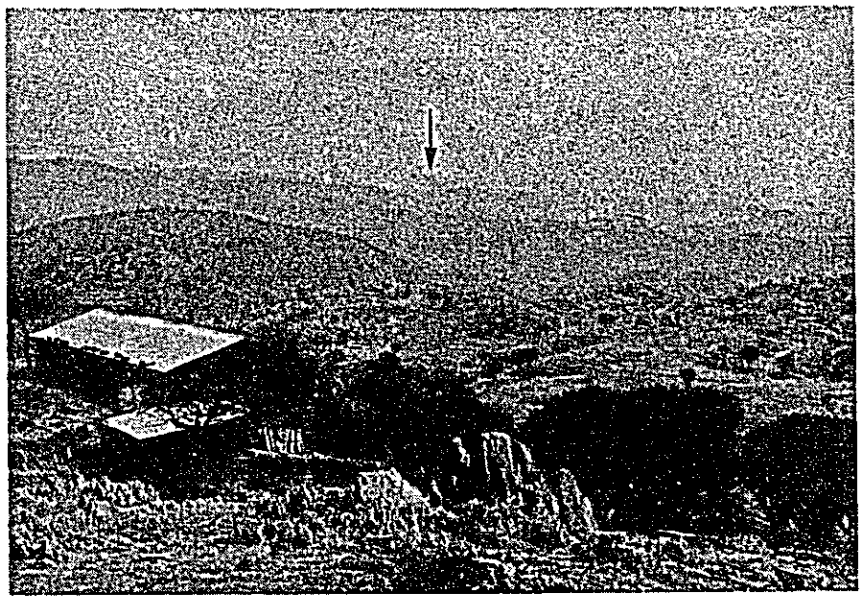


Fig.. II - 94 Distant view of MESHA EAST from the site

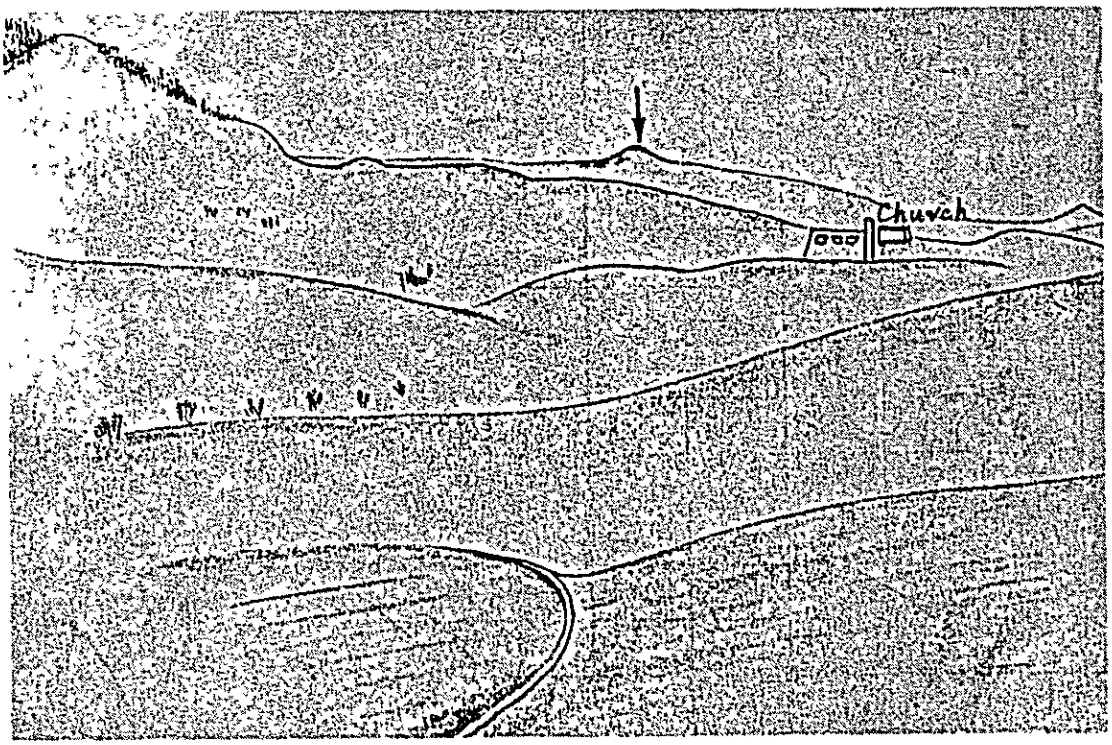


Fig. II - 95 Distant view of BETE GIORGIS from the site

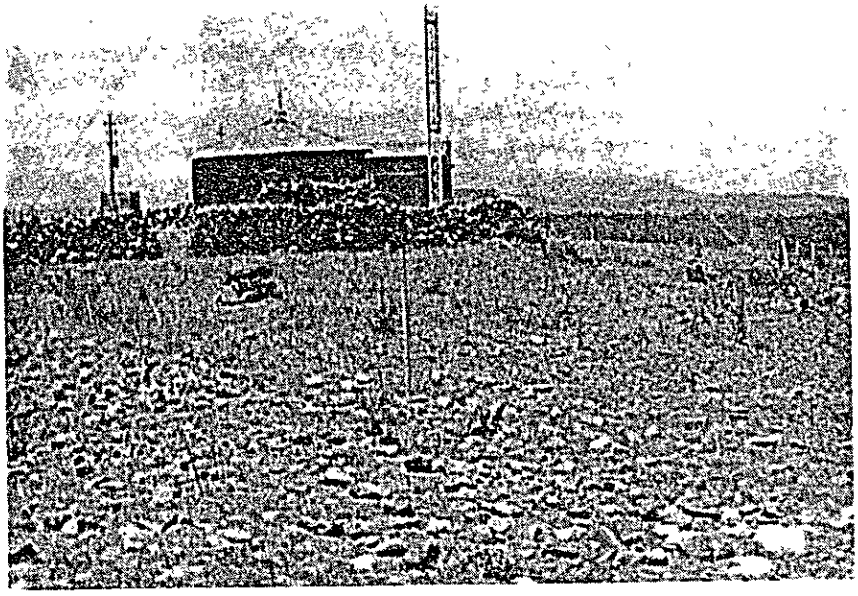


Fig. II - 96 View of the site

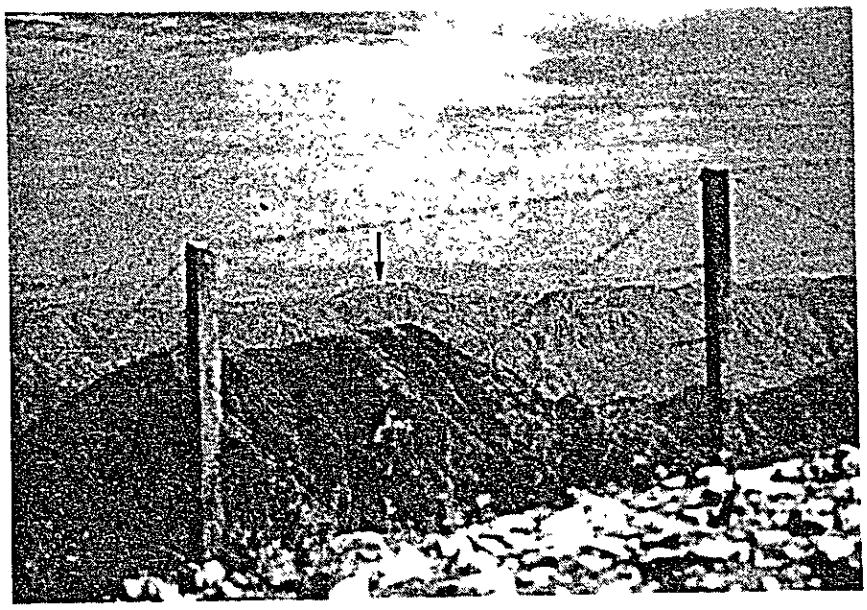


Fig. II - 97 Distant view of DIGSA from the site