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JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)
MONGOLIAN STATE ADMINISTRATION OF GEODESY AND CARTOGRAPHY(MSAGC)

TOPOGRAPHIC MAPPING OF ULAAN-TSAV AREA IN MONGOLIA

FINAL REPORT

JUNE, 1996

INFRASTRUCTURE DEVELOPMENT INSTITUTE
PASCO INTERNATIONAL Inc.

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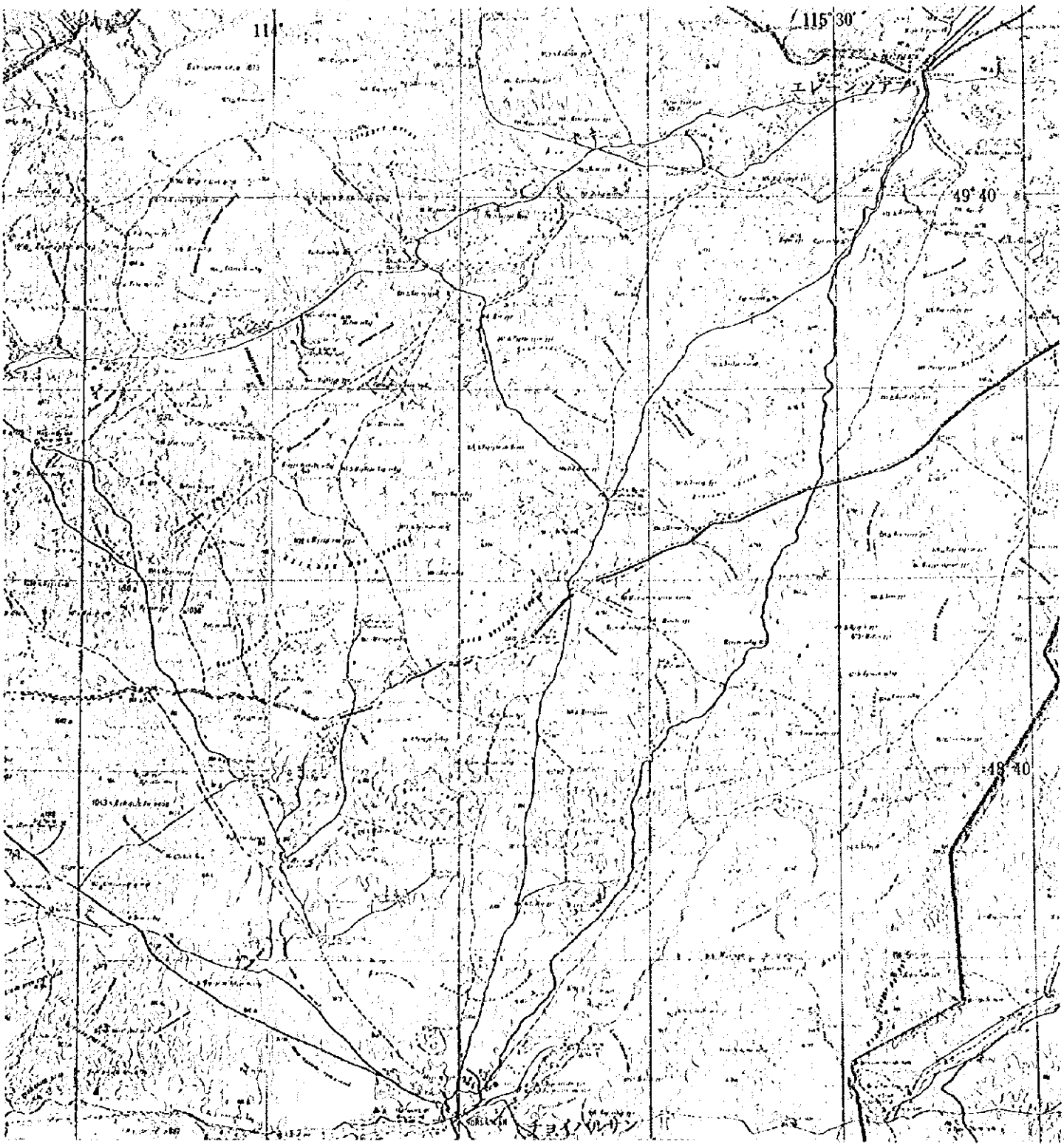
THE TOPOGRAPHIC MAPPING OF ULAAN-TSAV AREA IN MONGOLIA

モンゴル国
ドルノド県ウランツアブ地域
国土基本図作成調査



PREFACE

In response to a request from the Government of Mongolia, the Government of Japan decided to conduct a study on the Topographic Mapping of Ulaan-Tsav Area in Mongolia and entrusted the study to the Japan International Cooperation Agency (JICA).

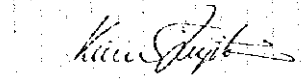
JICA sent to Mongolia a study team, headed by Mr. Sho Saito, the Infrastructure Development Institute and composed of the members from the Infrastructure Development Institute and PASCO International Inc., three times between May 1993 and July 1996.

The team held discussions with the officials concerned of the Government of Mongolia, and conducted field surveys at the study area. After the team returned to Japan, such works as aerial triangulation, stereo plotting, drawing, compilation were carried out and 1:25 000 topographic maps were prepared, together with the present report.

I hope that this report, together with the above-mentioned maps, will contribute to the promotion of development plans of the region and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of Mongolia for their close cooperation extended to the team.

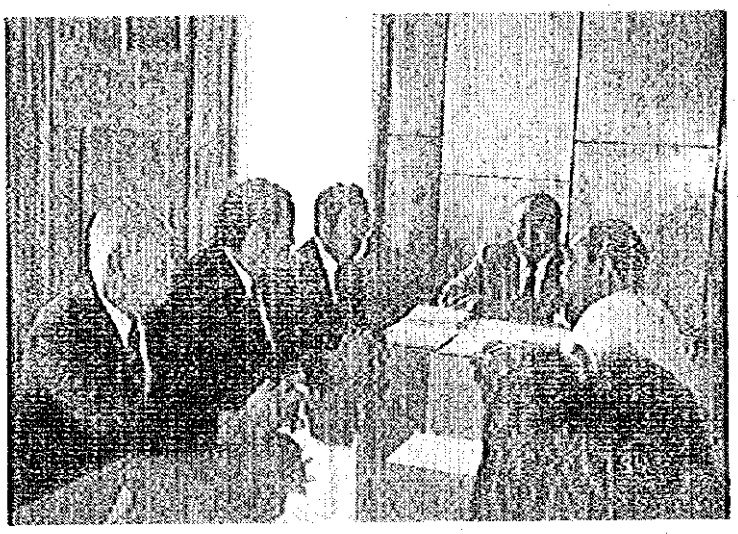
July 1996



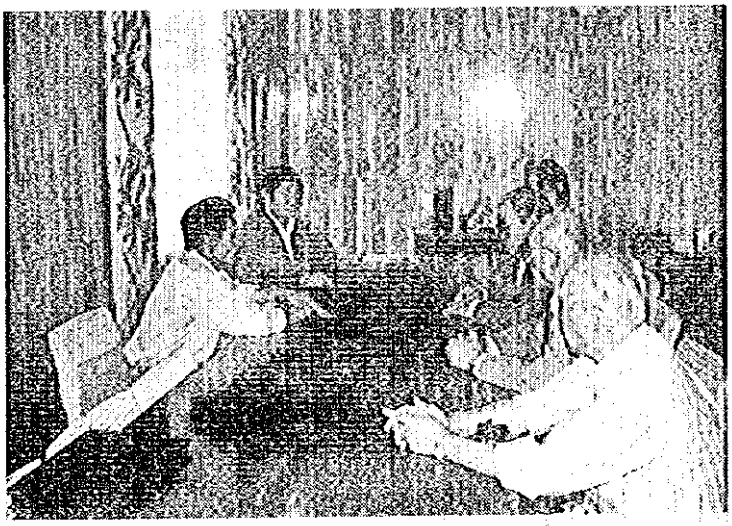
Kimio FUJITA
President
Japan International Cooperation Agency

Meetings

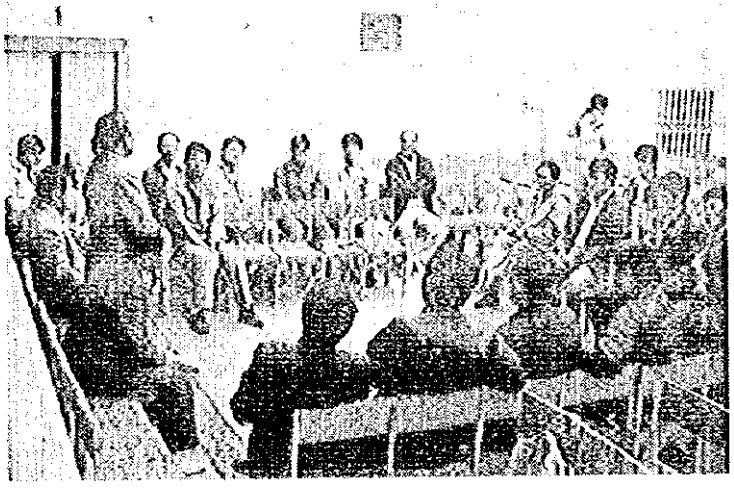
Meeting with SAGCM



Courtesy call to the Governor of Dornod Aymag

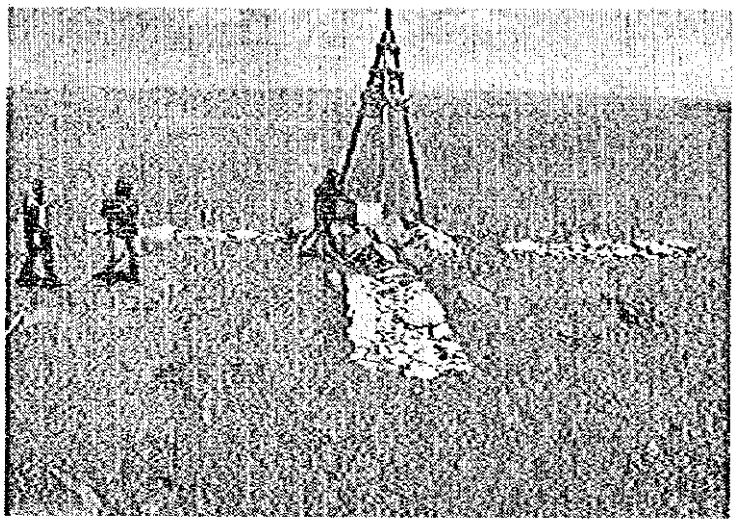


Consultation with counter-Parts

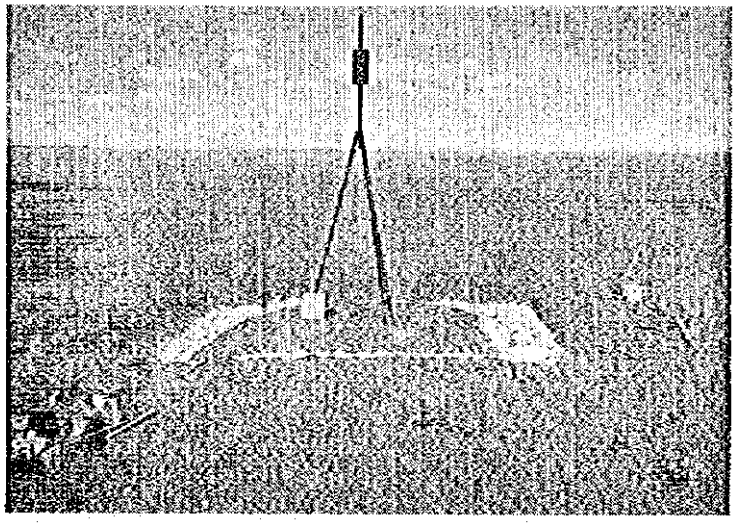


Aerial Signal

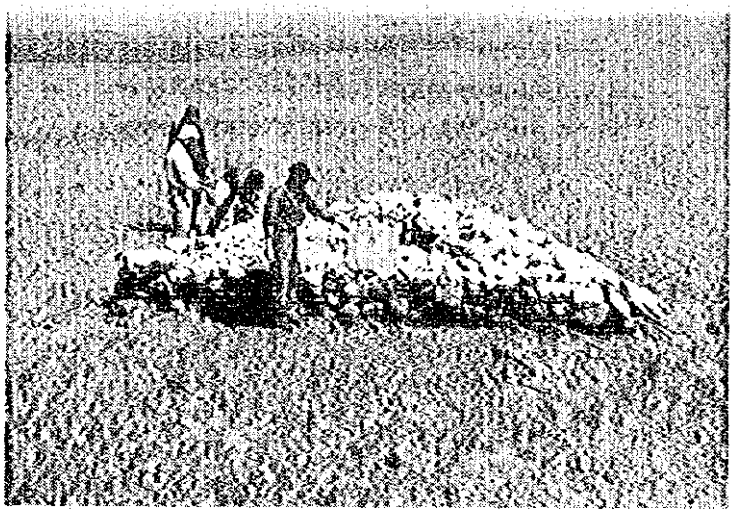
Y type



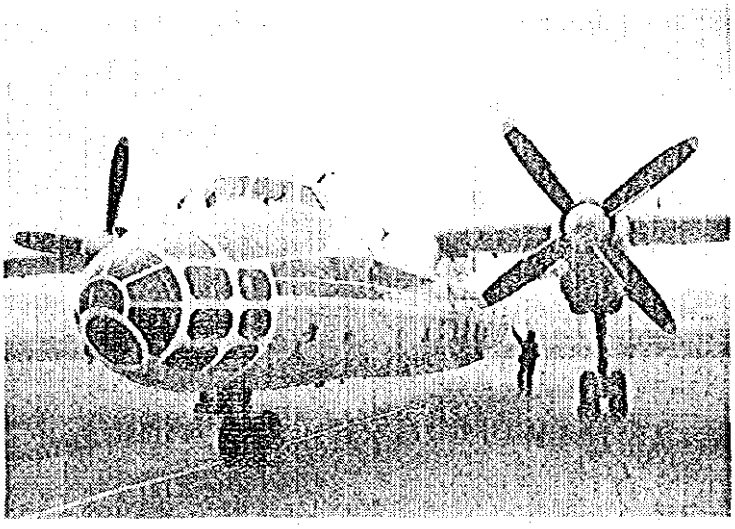
Square type



Triangular type



Aircraft Antonov An-30

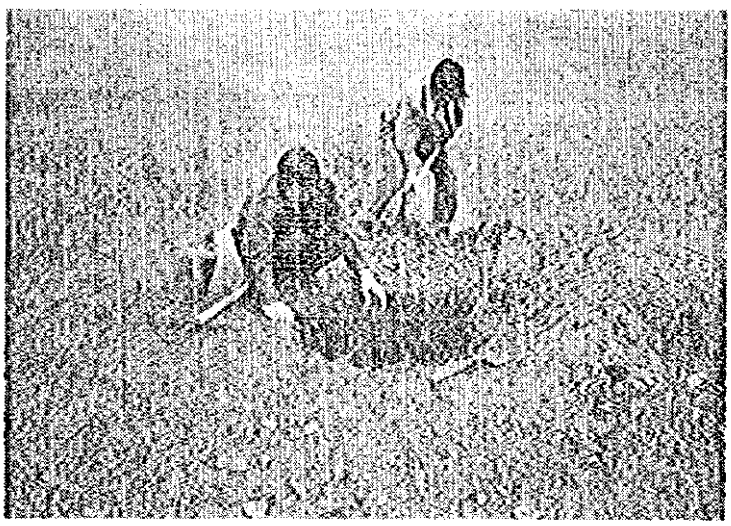


Inside of the aircraft

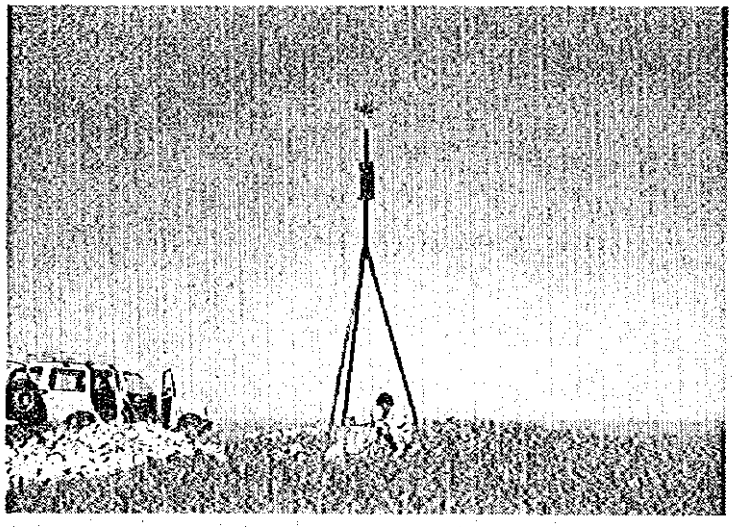
Photo-processing

Geodetic Control Point Survey and Leveling

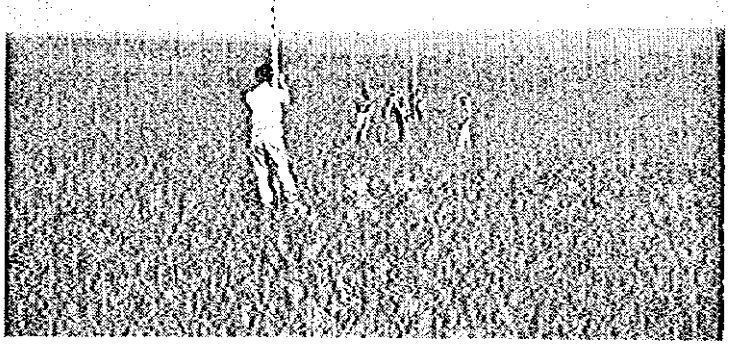
Setting of new point



GPS observation under tower

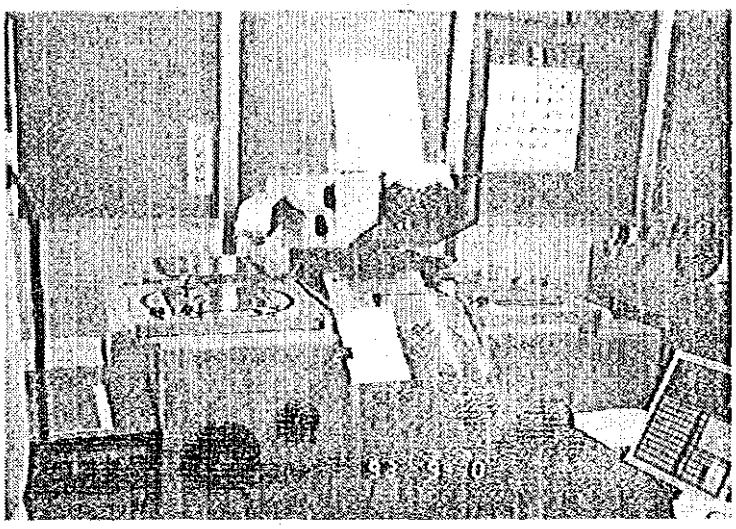


Leveling

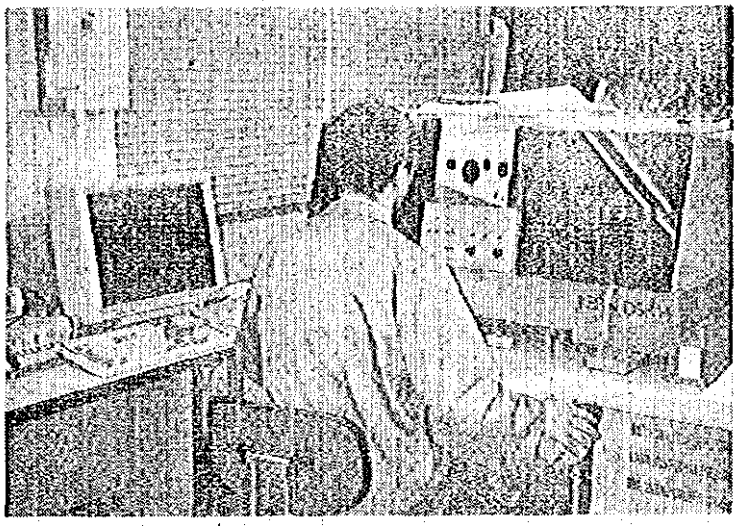


Aerial Triangulation and Stereo Plotting

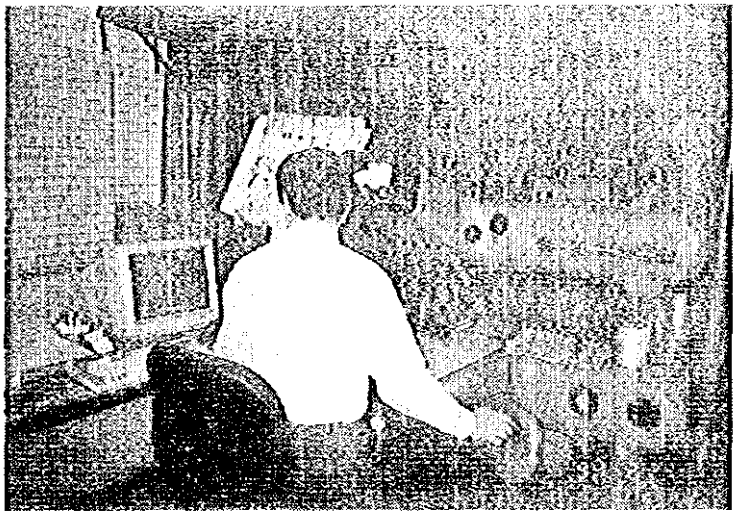
Stereo comparator
(STECOMBTER)



Analytical plotter
(KERN DSR 14)

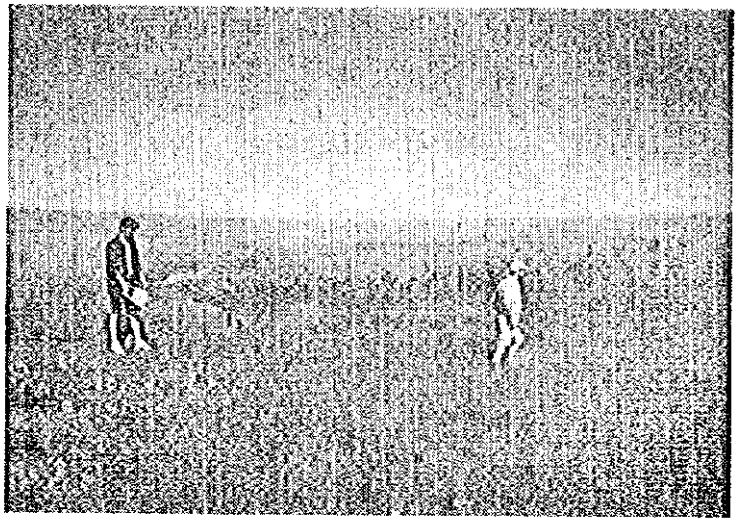


Analogic plotter
(AVIOMAP AMH)



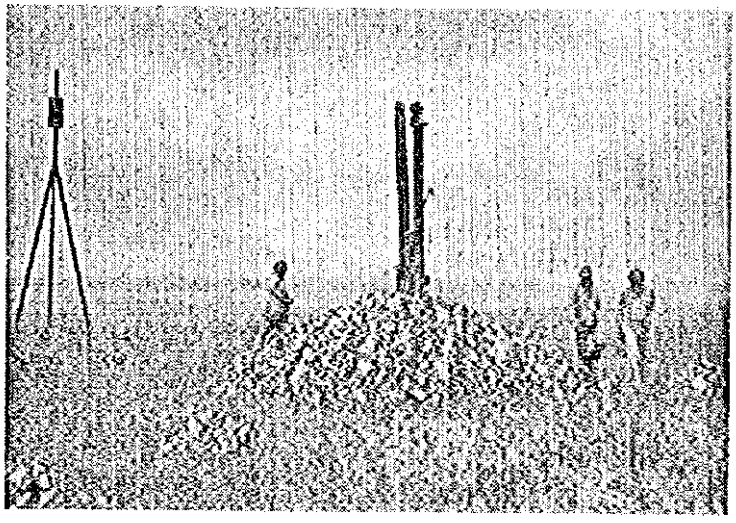
Field Identification

Study of river breadth, water depth, etc.



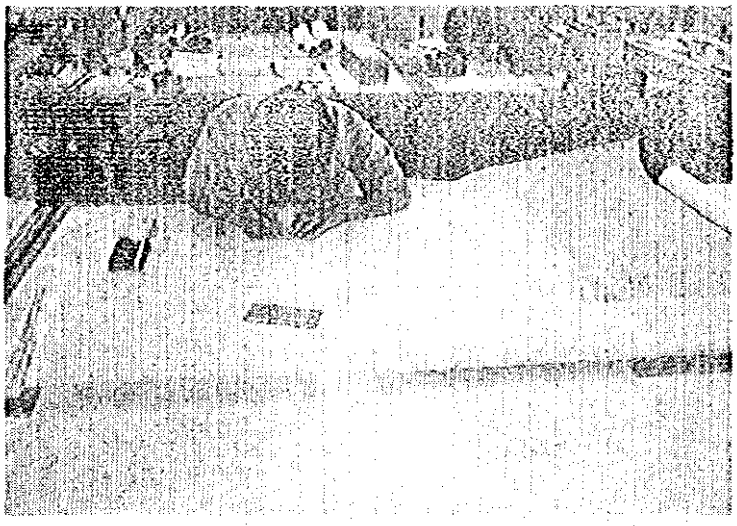
Study of well

Study of oboo

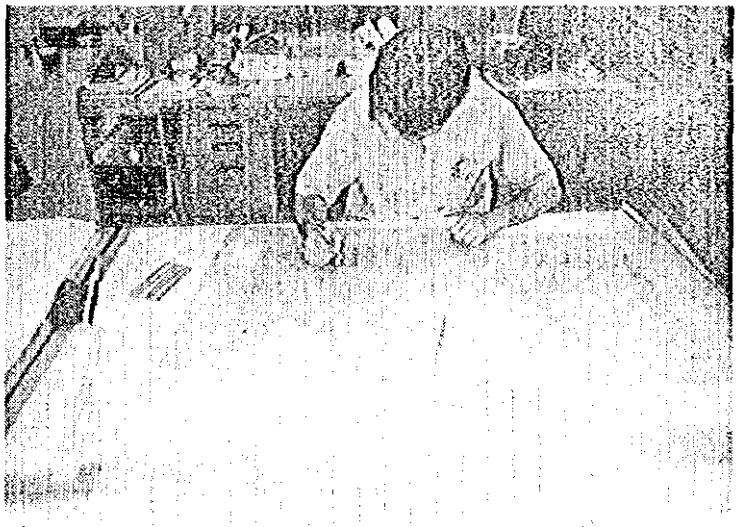


Compilation

Drawing up of the original manuscript of the topographicmap



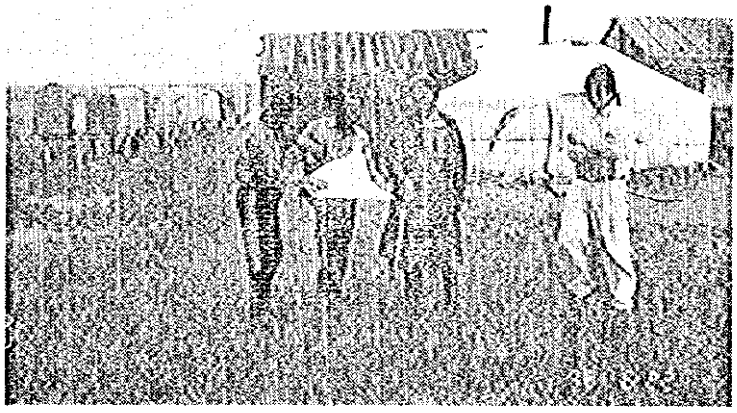
Drawing up of the vegetation data sheet



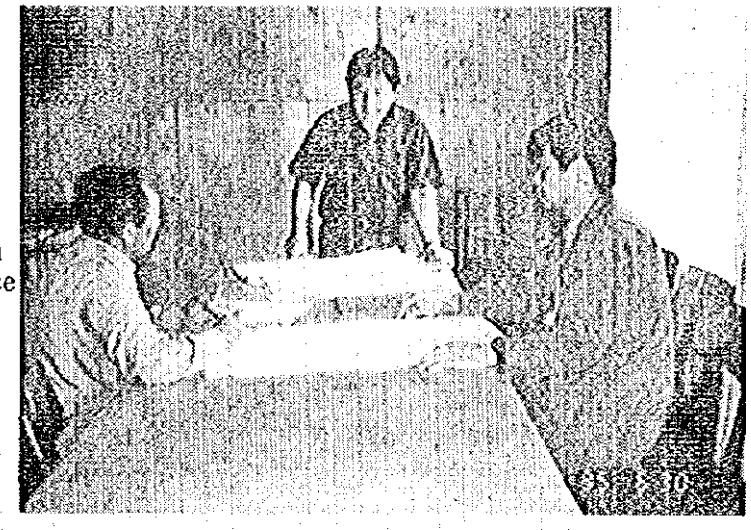
Drawing up of the annotation data sheet

Field completion

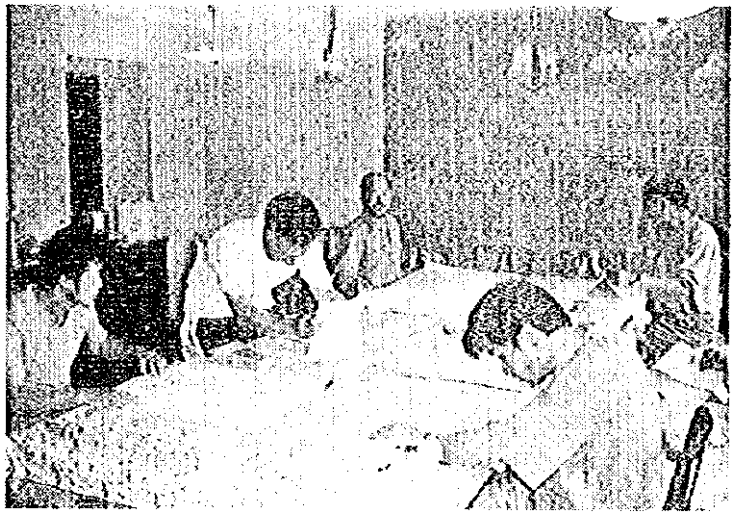
Hearing of toponym, etc.



Request of the confirmation of toponym at the sym office

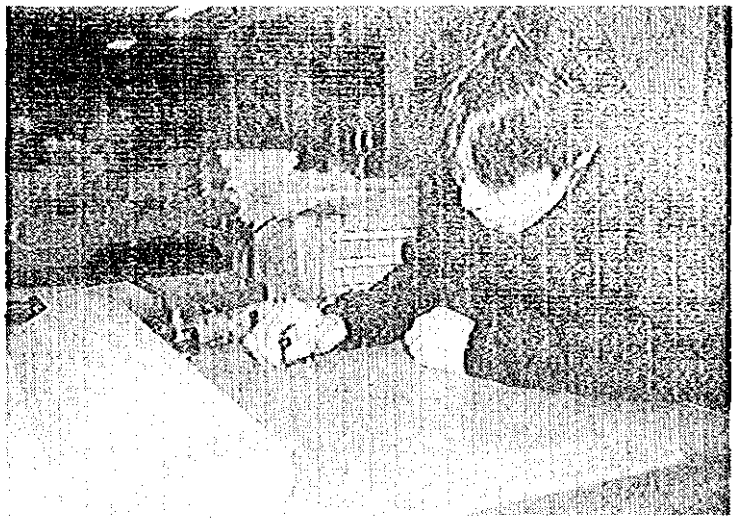


Adjustment of the results of field completion

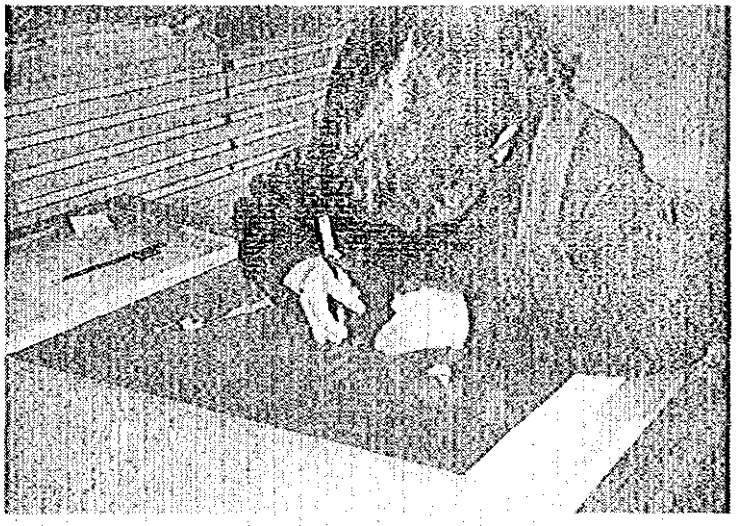


Final Drafting

Scribing



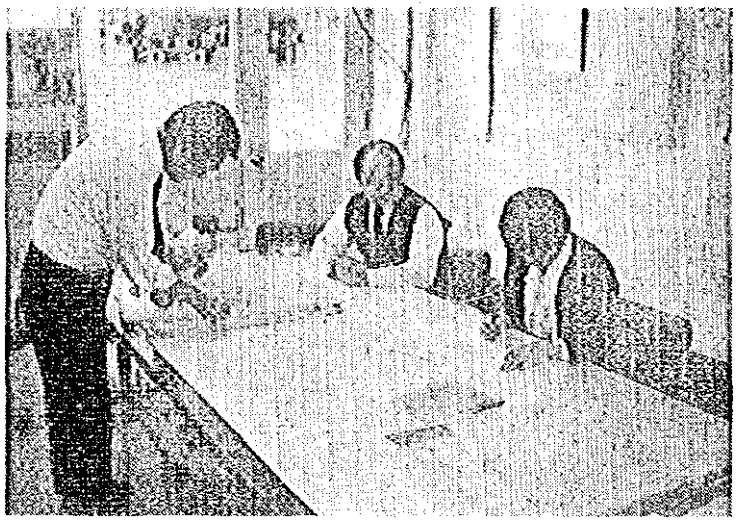
Preparation of mask sheet



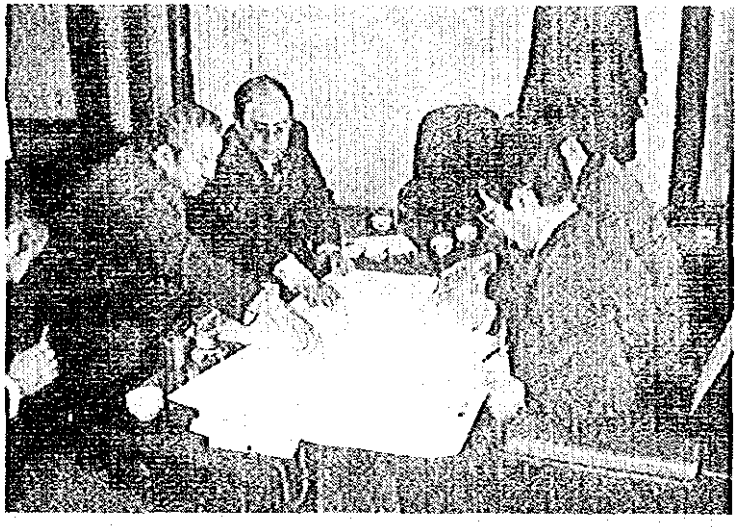
Preparation of annotation sheet

Checking of Drafting and Printing

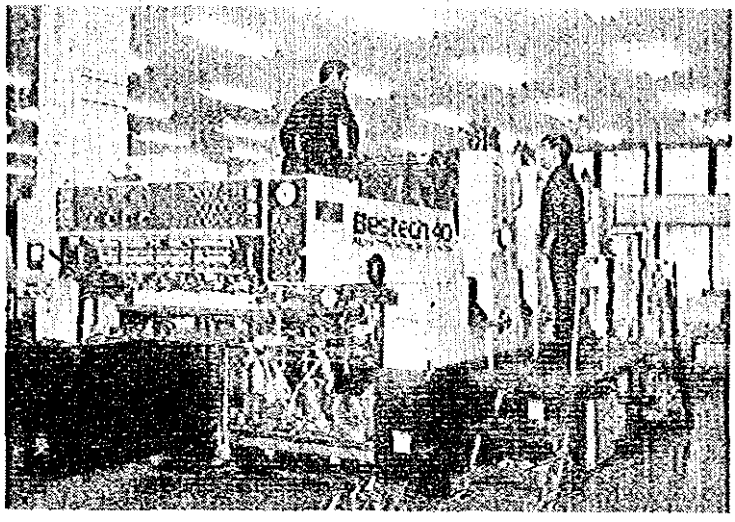
Checking of final draft by counterpart



Checking of color by the Director, MSAGC



Printing of topographic map by four-color printing machine



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APPENDICES

TOPOGRAPHIC MAPPING OF ULAAN-TSAV AREA IN MONGOLIA

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1 INTRODUCTION

In response to the request of the government of Mongolia, the government of Japan executed the study of topographic mapping of the Ulaan-Tsav area (hereinafter referred to as the "Study"), aerial photography of 1:50 000 and preparation of 1:25 000 topographic maps covering the area of 10 800 km².

The Study started in February, 1993. Through the field operation of setting of aerial signals, aerial photography, ground control point survey, field identification of aerial photographs, field completion and laboratory study of aerial triangulation, stereo plotting, compilation, drafting, and printing, it was accomplished in July, 1996 during the period of four yeas and five months.

The study area is situated in the northern part of the Dornod aymag extending from 40° 40′ N to 49′ 40′ N in latitude and from 114° 00′ E to 115° 30′ E in longitude. To the north of the study area, is situated the town of Эрээнцав borderring on the Russian border. Several ten kilometers to the south, is situated the town of

Choibalsan, the capital of Dornod aymag. The study area includes a part of sums of Дашбалбар, Гурванзагал, Сэргэлэн, and Choibalsan, and small parts of Баяндун and Чулуунхороот (Fig. 1).

The area is a mountainous region with gentle undulation. The highest point is Mt. Хөгнө (1 131.7 m at the triangulation point on it) and the lowest point is less than 580 m at the surrounding of the triangulation point 593 m at the edge of the northeastern part of the area. In Mongolia, the height is less than 600 m only at the surroundings of Lake Буйр in the eastern part of Dornod aymag and of Lake Хөх east of the above mentioned triangulation point 593 m.

A "filling valley map" is shown in Fig. 2. This map shows the topography of the area by 100 m contour lines filling valleys narrower than 2 km in width on a 100 000 topographic map. It is similar to a summit level map.

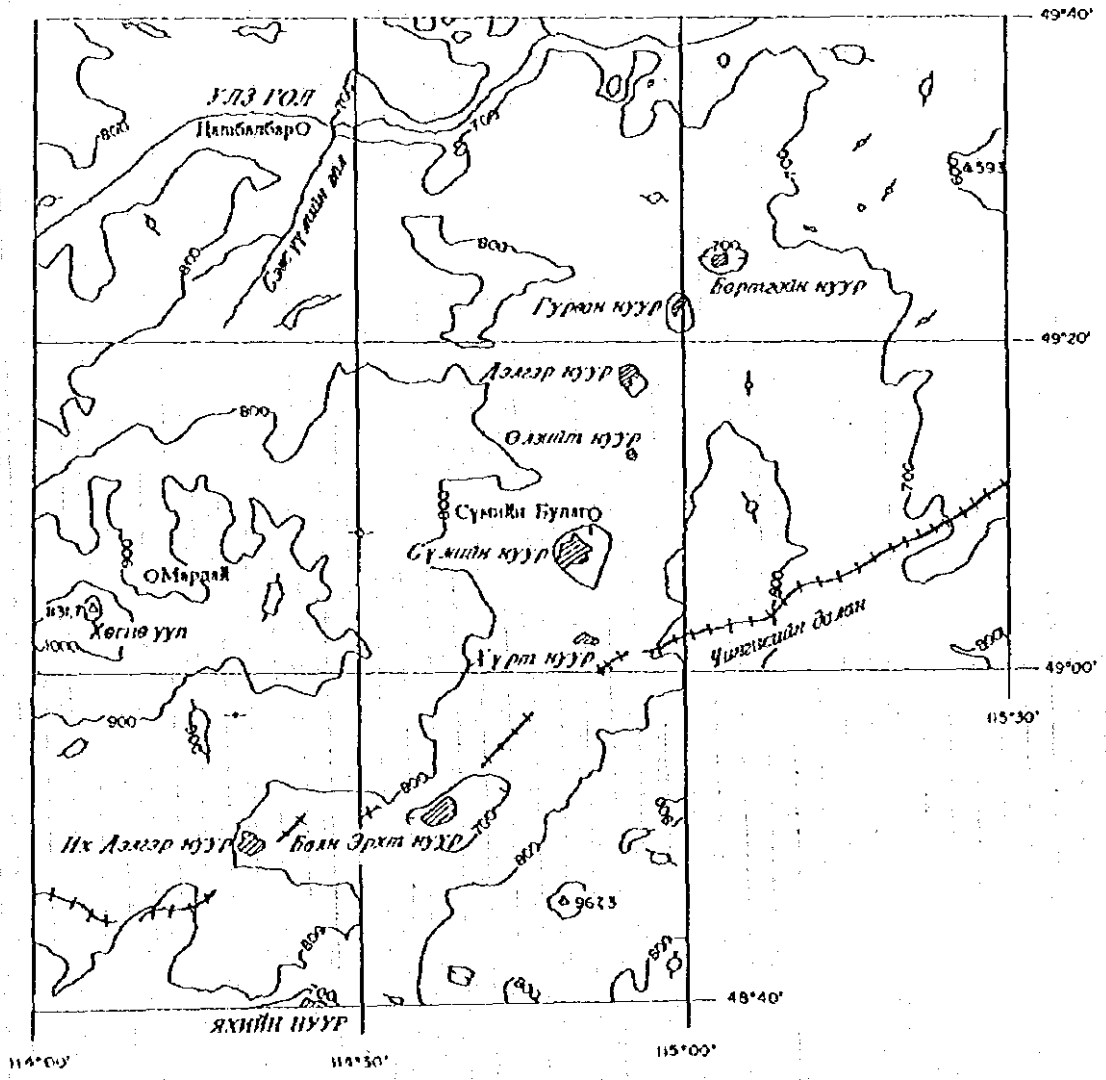
The original topography of the study area estimated from the filling valley map would be a plain involving basaltic plateau, etc. In the vicinity of Мардай, there is a plateau higher than 900 m and the height reduces gradually toward north, east and south. In the central part, from north-northeast to south-southwest, Lakes Дэлгэр, Өлзийт, Сүмийн, Хүрэм, БаянЭрхэм, and Яхийн form a straight line constituting depressions of lower than 700 m in height. It is considered that the straight linear alignment of these lakes wold be of tectonic nature. The similar linear structure is also recognized in the valleys along the railroad neighbouring to the east. These tectonic lines are thought to settle the topographic alignment of the area.

Fig. 1 Syudy Area with Map Index

M－50

114° 0′			114° 30′			115° 0′			115° 30′		
85-А-а ТАСАРХАЙ ТОЛГОЙ	85-А-б ШИЛИЙН ХОНХОР УУЛ	85-Б-а ГАНЦ ТОЛГОЙ	85-Б-б ЗАХ ӨНДӨР ТОЛГОЙ	86-А-а ЗААГ-ОВООТ ТОЛГОЙ	86-А-б НОМИНТ УУЛ	86-Б-а ЛҮҮТ ТОЛГОЙ	86-Б-б ЦОГ УУЛ	87-А-а ҮЛЭ ГОЛ	87-А-б ДӨРӨЛЖИЙН ҮХАА	87-Б-а ХҮРЭН ТОЛГОЙ	87-Б-б ДӨРӨӨ УУЛ	49° 40′
85-А-в ХӨХ ЧУЛУУТ ТОЛГОЙ	85-А-г ДАШБАЛБАР УУЛ	85-Б-в БОР ӨНДӨР ТОЛГОЙ	85-Б-г ДАШБАЛБАР	86-А-в ЧУХЫН БАГ	86-А-г ЧУХЫН АМРАЛТ	86-Б-в МОДОТ ТОЛГОЙ	86-Б-г ЗАГАЛ УУЛ	87-А-в БИЛҮҮТ УУЛ	87-А-г ХАЙЛААСТЫН НҮҮР	87-Б-в ДӨРӨЛЖИН ТОЛГОЙ	87-Б-г ХӨХ ТОЛГОЙ	
85-В-а ЖАРААХАЙ БАГ	85-В-б МОДОТ УУЛ	85-Г-а ХӨХ ЧУЛУУТ УУЛ	85-Г-б ДУН УУЛ	86-В-а ДЭЛ ӨНДӨР УУЛ	86-В-б ДЭЛИЙН УРД ӨНДӨР ТОЛГОЙ	86-Г-а МӨСТ ТОЛГОЙ	86-Г-б ЗАГАЛЫН ХООЛОЙ	87-В-а БОРТГОЙН УУЛ	87-В-б ХУРД ТОЛГОЙ	87-Г-а ХАР ТОЛГОЙ	87-Г-б УЛААН ТОЛГОЙ	
85-В-в ҮГАЛЗҮҮР УУЛ	85-В-г ЗҮҮН ЭӨӨРТ ТОЛГОЙ	85-Г-в САЯГИЙН ӨНДӨР ТОЛГОЙ	85-Г-г ГАНЖИРТ ӨӨСӨ	86-В-в БУРГАСТ ТОЛГОЙ	86-В-г АР ХООЛОЙН ОХОН ТОЛГОЙ	86-Г-в ТӨМСТ ТОЛГОЙ	86-Г-г ШАР ТОЛГОЙ	87-В-в БУРД УУЛ	87-В-г ЗҮҮН ХОЖУУЛТ ТОЛГОЙ	87-Г-в ЧОНЫН УУЛ	87-Г-г ЖИНСТ ТОЛГОЙ	
97-А-а ХОЛБООГИЙН МОДОТ ТОЛГОЙ	97-А-б НОГООН БҮРД	97-Б-а ЗҮҮН СҮҮЖ ТОЛГОЙ	97-Б-б ДААГАЙН ХӨНДИЙ	98-А-а ХАРГУЙТ БАРУУН ТОЛГОЙ	98-А-б ГУРВАЛЖ ТОЛГОЙ	98-Б-а ЦАНТ ТОЛГОЙ	98-Б-б ТАРВАГАТ ТОЛГОЙ	99-А-а БАРУУН ХОЖУУЛТ УУЛ	99-А-б ХӨМӨГ УУЛ	99-Б-а ЦЭГЭЭН УУЛ	99-Б-б ЧИНГИСИЙН ДАЛАН	49° 20′
97-А-в БАРУУН СҮҮЖ УУЛ	97-А-г МАРДАЙН ХАР ӨНДӨР УУЛ	97-Б-в ДАВХАР ТОЛГОЙ	97-Б-г БӨЛЧИР ТОЛГОЙ	98-А-в ХАРГУЙТ УУЛ	98-А-г ЦАГААН ЧУЛУУТ ТОЛГОЙ	98-Б-в ӨЛЗИЙТ УУЛ	98-Б-г СОНИЖ ТОЛГОЙ	99-А-в ИХ ХОНГОР УУЛ	99-А-г ЦАГААН ТОЛГОЙ	99-Б-в ӨЛӨНТ ТОЛГОЙ	99-Б-г БААРДАГ УУЛ	
97-В-а БАРУУН СҮҮЖИЙН ХООЛОЙ	97-В-б МАРДАЙ	97-Г-а ӨРХТ УУЛ	97-Г-б ЦАГААН ЧУЛУУТ ТОЛГОЙ	98-В-а БОР ТОЛГОЙ	98-В-б ХАСУУ ТОЛГОЙ	98-Г-а СУМИЙН НҮҮР	98-Г-б СУМИЙН БУЛАГ	99-В-а ЦАГААН ЧУЛУУТ УУЛ	99-В-б ХАЙЧ ТОЛГОЙ	99-Г-а ӨМБЫН ТОЛГОЙ	99-Г-б БАРУУН ХӨРЭМТИЙН НҮҮР	
97-В-в ХӨГНӨ УУЛ	97-В-г МАРДАЙН ӨРТӨӨ	97-Г-в БАРУУН МОРЬТ УУЛ	97-Г-г БОР ӨНДӨР УУЛ	98-В-в ӨӨР ГУРВАН ОВООТ УУЛ	98-В-г УЛААН ОВООТ ТОЛГОЙ	98-Г-в ХУРТ НҮҮР	98-Г-г СОНИЖ НҮҮРЫН ТОЛГОЙ	99-В-в ХУЖИРТ УУЛ	99-В-г ТАРИА БРИГАД	99-Г-в ХОЛБОО ТОЛГОЙ	99-Г-г СҮҮЖИЙН ӨНДӨР ТОЛГОЙ	49° 0′
109-А-а УЛААН ӨНДӨР ТОЛГОЙ	109-А-б ХАР ТОЛГОЙ	109-Б-а ЦАГААН ТОЛГОЙ	109-Б-б ШАР УУЛ	110-А-а ХУЛАНТ ТОЛГОЙ	110-А-б ЗУСЛАНГИЙН НҮҮР	110-Б-а ИХ БУЛАГ	110-Б-б ХУЖИРТЫН ЦАГААН ТОЛГОЙ					
109-А-в ДӨРӨЛЖИН ТОЛГОЙ	109-А-г ТАЛЫН ТОЛГОЙ	109-Б-в ДЭЭД МААНЬТ ТОЛГОЙ	109-Б-г ӨГӨӨМӨР УУЛ	110-А-в ДАРЬ УУЛ	110-А-г АШТАЙ БУЛЦТАЙ БА	110-Б-в САЙХАН БУЛАГИЙН ҮХАА	110-Б-г ЯМААТ УУЛ					
109-В-а ХАЙЛААСТ ТОЛГОЙ	109-В-б ЧУЛУУТ ТОЛГОЙ	109-Г-а БУРХАНТ ТОЛГОЙ	109-Г-б ХАР-ӨНДӨР ТОЛГОЙ	110-В-а БАЯН ДУН УУЛ	110-В-б БАРУУН ЦАГААН ЧУЛУУТ УУЛ	110-Г-а ДЭЛГЭР МӨНХ УУЛ	110-Г-б ХАЛЗАН ХОНЬТ УУЛ					
109-В-в ХУРГАН ХӨНДИЙН БАГ	109-В-г ДУНД ХАЖИТ ТОЛГОЙ	109-Г-в ЦАГААН ТОЛГОЙ	109-Г-г ДЭЛГЭР-ӨЛЗИЙТ ТОЛГОЙ	110-В-в ХӨХ ТОЛГОЙ	110-В-г ЛЭГТ НҮҮР	110-Г-в БАЙШИНТ ТОЛГОЙ	110-Г-г ЖАВХАЛ ТОЛГОЙ					
			48° 40′									

Fig. 2 Filling Valley Map



Because of small quantity of rainfall in this area, no sufficient development of the water system can be seen. Only River Улз gathering the water in the northern part of Dornod aymag and flowing into Lake Тарь is the river with permanent water. River Сэвсүүлийн, a tributary, joins River Улз gathering water of north slope of Mt. Хөгнө.

Rivers flown down from Mt. Хөгнө forms rivers of permanent water. However, in the down stream where river bed tends gently, they become of seasonal type. Most of rivers in other basins are of seasonal type with surface water in rainy season. There are scarcely any rivers with permanent water. In general, low lands along rivers with permanent water form marshes. In low lands along seasonal river scarcely form marshes. Most of them form salty area like area around lakes.

On account of the dry weather, both species and distribution of vegetation is limited. According to the vegetation classification of the topographic map, "ordinary grasses" are grown covering a wide range. Next predominant vegetation is the "pillow family plants". In the southern part of the study area, they distribute along valleys of higher than 800 m. and from the north slope of Mr. Хөгнө to the northern part of the area, along valleys and in marshes up to around 700 m. in height. In marshes along rivers Улз and Сэвсүүлийн, many "marsh plants" grow among the pillow family plants. In marshes and around some lakes in the northern part of the area, there grow дэрс. They are used to make a broom. There are no big forests of "needle-leaf trees" and/or "broad-leaved trees", but small forests and "isolated tree".

Such being the vegetation distribution, the area is mostly used for grazing. Next predominant usage is mowing place for feed. A few barley field scatter in the flat area.

The population of this area is small. Most of the inhabitants are nomadic. In the vast steppe, there are towns, such as Д а ш б а л б а р , С үм и й н Б у л а г , М а р д а й , etc. Most of them are seats of local governments and/or other public agencies. They are also collecting and distributing centers of materials. М а р д а й is, however, exceptional. It was built by the Russian for uranium mining. It is said that about 6 000 Russian miners lived in this town, but that the population is decreasing owing to decrease of the demand of uranium.

Like the excavation of uranium in М а р д а й , it is expected the existence of the abundant underground resources in the study area. Their development and utilization have to be dependent on studies from now on. We hope aerial photographs, topographic maps, etc., the results of the Study, will be used.

The detailed progress of the Study shall be referred to early reports cited at the end of the present report.

2 OUTLINE OF THE STUDY

2-1 Request of the Government of Mongolia and Settlement of the Details of the Study

2-1-1 Background of the Request

In October 1991, the Government of Mongolia submitted a request letter of the study of topographic mapping of Ulaan-Tsav area, Dornod aymag to the embassy of Japan in Mongolia.

In the letter it is described that the Government of Mongolia takes up the development of natural resources as an important subject for the economic development and strengthening of the export capability in the fundamental principle of the socioeconomic development plan from 1991 to 1992. Especially, it is expected the development of Ulaan-Tsav area as an area of abundant mineral resources. But topographic maps indispensable for the planning and execution of geological survey and improvement of infrastructures have scarcely been prepared all over the territory of Mongolia. In Ulaan-Tsav area no maps of proper scale are available.

On account of the above background, the Government of Mongolia submitted a request of the the technical cooperation for the study of 1/25 000 topographic mapping needed for the promotion of the development of Ulaan-Tsav area in Dornod aymag.

2-1-2 Outline of the Request

The outline of the Mongolian request is as follows:

(1) Study Area Ulaan-Tsav area, Dornod aymag
(approximately 10 800 km²)

(2) Contents of the Request

1) Aerial photography of the area
2) Preparation of 1:25 000 topographic maps
3) Transfer of technology to engineers and surveyors of the Mongolian State Administration of Geodesy and Cartography (hereinafter referred to as the "MSAGC")

2-1-3 Settlement of the Contents of the Study

Prior to dispatch a preliminary study mission of the Study, the Japan International Cooperation Agency (hereinafter referred to as the "JICA") drew up a Japanese draft Scope of Work (hereinafter referred to as the "S/W") against the above Mongolian request.

After confirmation of the Mongolian request, the Government of Japan dispatched a preliminary study mission to Mongolia on September 22, 1992, for the discussion and signing of S/W.

The preliminary study mission had discussions with MSAGC, to be a counterpart agency for the Study. After discussion with other governmental agencies concerned of Mongolia and reconnaissance study in the field, the results of discussions were summarized on the S/W and the Minutes of Meeting on the Topographic Mapping of Ulaan-Tsav area in Mongolia. They were signed by Dr. J. Sanjaajamts, Director General of MSAGC and Mr. Norio Dohi, Leader of the Preliminary Study Mission on October 19, 1992. (Appendix 1)

2-2 Study Plan and its Execution

2-2-1 Specifications of the Study

The specifications of the Study are as follows:

Item	Specifications
Results	Aerial Photos Scale: 1/50 000 (with super-wide angle lens) Area covered: approximately 10 800 km² *Topographic maps* Scale: 1/25 000 Area covered: approximately 10 800 km² Number of sheets: 128 sheets (in 4 colours) Number of copies per sheet: 150
Conventional signs & application rules	Observe the conventional signs and their application rule settled after discussions with MSAGC
Standards of the Study	Reference ellipsoid: Krassovsky Projection: Gauss-Krueger Map format: 7.5′ in longitude 5.0′ in latitude contour interval: 10 m.

Accuracy of the Study	Map accuracy: "Class A" of the "Specifications of geodetic and photogrammetric surveying for overseas", JICA, 1983. Accuracy of geodetic control point survey: (relative accuracy between two points) $10X10^{-5}$

2-2-2 Study Volume Planned and Executed in Each Phase

The Study was planned to execute in 42 months from February 1993 to July 1996. The period was devided into 5 phases. The flow of the Study per respective phase is shown in Fig. 3. The Study was completed almost as planned as shown in Tab. 1.

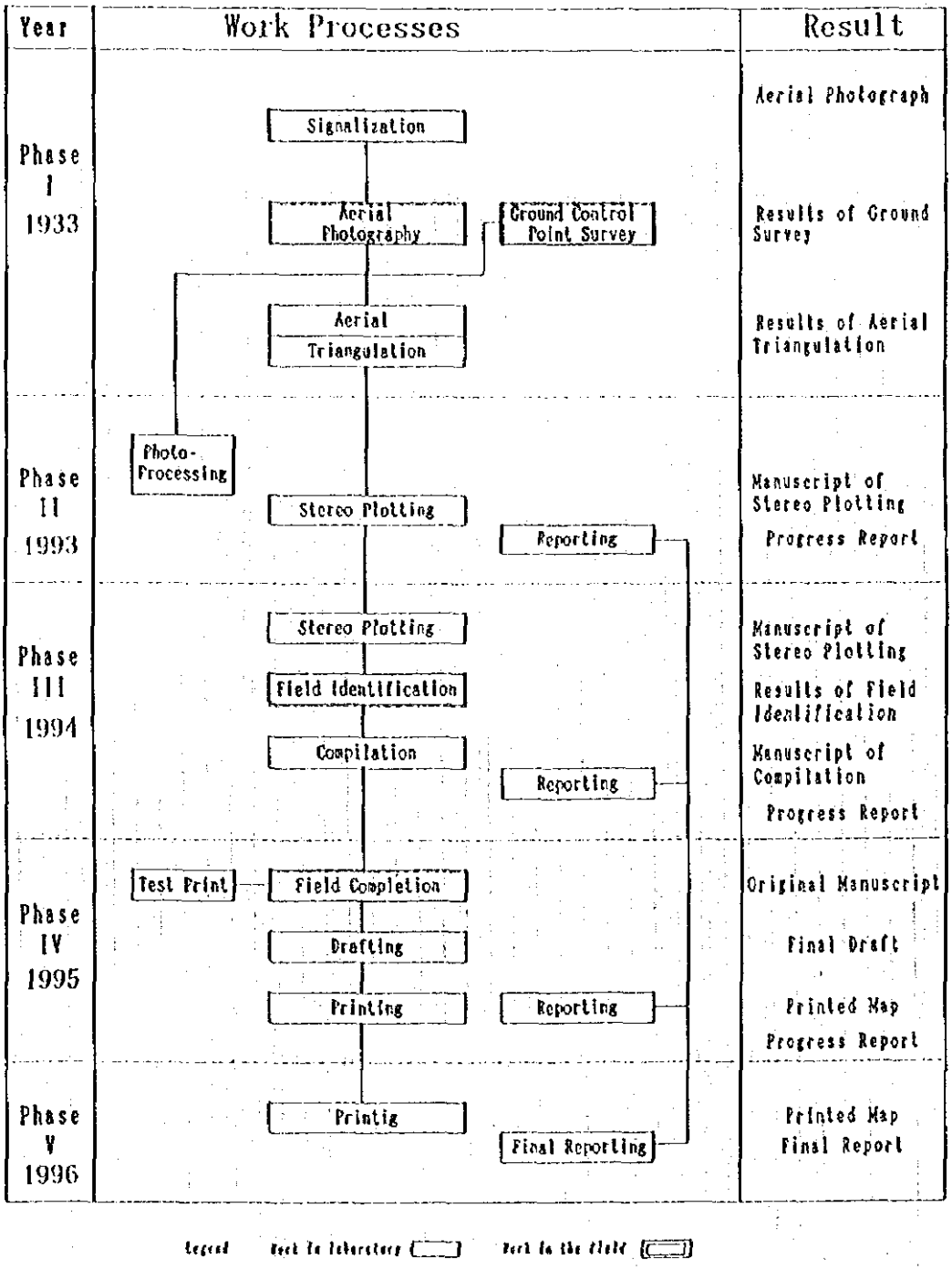
2-3 Discrepancy between the Initial Plan and the Execution

No change was occurred in the study schedule initially planned. While execution, however, it was found necessary to modify the study volume in some processes. The modification is as follows:

1) Signalization

Aerial signals were planned to set up at 32 points. Initially, triangulation points to use for the aerial triangulation were selected on the existing maps. As the result of the study at MSAGC and field reconnaissance, however, it was found the existence of points without coordinates and/or monuments. Consequently, alternative points had to be chosen.

Fig. 3 Flow of Topographic Mapping



Tab, 1 Study Plan and Execution per Phase

Phase	Item	Study Volume	Planned	Executed	Period
I	Signalization	Existing point	29 pts	As planned	Feb. 26,1993
		New point	3 pts	4 pts	~ Sept.20,
	Pricking	Existing point	0 pts	3 pts	1993
	Aerial photo-	Scale	1/50 000	As planned	Field study
	graphy	Coverage	ca.10 800 km²	As planned	May 14,1993
		Flight length	ca.1 640 km	1762 km	~ July 15,
			15 courses		1993
	Control point	GPS observation			
	survey	New point	3 pts	7 pts	
		Geoidal surface			
		survey	12 pts	17 pts	
	Aerial tri-		ca.415 mdls	378 mdls	
	angulation				
II	Stereo plot-		8 100 km²	As planned	Nov. 1,1993
	ting		96 shts		~ Mar. 28,
	Reporting	For Phases I&II	30 copies	As planned	1994
		(in English)			
III	Field Iden-		ca.10 800 km²	As planned	Apr. 28,1994
	tification				~ Mar. 6,
	Stereo plot-		ca.2 700 km²	As planned	1994
	ting		32 shts		Field study
	Compilation		ca.10 800 km²	As planned	May 27,1994
	Reporting	For Phase III	30 copies	As planned	~ July 26
		(in English)			
IV	Field Comp-		ca.10 800 km²	As planned	May 22,1994
	letion				~ Mar. 6,
	Drafting		ca.10 800 km²	As planned	1996
			128 shts		Field study
	Printing		77 shts,	As planned	June 4,1995
			150 copies		~ July 30,
			each		1995
	Reporting	For Phase IV	30 copies	As planned	
		(in English)			
V	Printing		51 shts	As planned	Apr. 19,1996
			150 copies		~ June 28,
			each		1996
	Reporting	Final report	50 copies	As planned	
		(in English)			
		Guide book	150 copies	Additional	
		(in Russian)			

As the result, besides 29 points of existing points and 2 points of new points, one triangulatlion points without coordinates and one bench mark were selected. After all, aerial signals were set up at one more point than initially planned.

2) Pricking

The pricking was not initially planned. But, if aerial signals were not identified on the aerial photograph, it was to cope with the situation by pricking, in principle. After aerial photography, aerial signals were checked on the aerial photographs. It was found difficult to identify 3 points out of 33 points. It was tried to substitute these 3 points by pricking. However, points possible to prick were all off several kilometers from the proper points and it was unable to measure the eccentricity elements by conventional method. Consequently, GPS survey was executed at a spot close to a prickable ground feature, the elements of eccentricity of the ground feature from the spot was measured by the conventional way of eccentricity measurement. The GPS survey was carried out either including in the godetic control point survey network or independently. One of the 3 points not identified on the aerial photograph in the field was identified on the enlarged photographs after coming back to Japan.

3) Extension of Flight Courses

The length of the actually flown flight courses was 1 762 1km against the initially planned course length of 1 640 1km. The discrepancy was caused by the reflight owing to the cloud disturbance, additional selection of a bench mark outside the study area as an alternative control point for aerial triangulation, etc.

4) Control Point Survey

To establish 3 control points necessary for aerial triangulation and to graps the distribution of the geoidal surface around 6 existing triangulation points with height, the GPS survey was planned. On account of the reason stated in the preceding paragraphs 2) and 3), a control point and 3 pricked points were increased. After all the volume the GPS survey for new points tended to 7 points. In consequence, the volume of existing triangulation points was increased from 12 points to 17 points.

5) Aerial Triangulation

The aerial triangulation was initially planned for 415 models, 115 % of the number of models against the case ideally flown. After aerial photography, the effective number frames necessary for aerial triangulation turned out 378, because of the following reasons:

a. It was not necessary to supplement additional flight courses owing to the discrepancy from the planned flight courses,
b. and not so many frames were reflown.

2-4 Meetings with MSAGC

1) Meetings before the Commencement of the First Year's Field Study

Signalization, aerial photography and geodetic control point survey were planned as the field study and aerial triangulation as the laboratory study for the first year's study. These studies were compiled as the Plan of Operations (hereinafter referred to as the "P/O"). (cf.

Reference 1) It was submitted to MSAGC and the details were discussed. On the basis of the Scope of Work (hereinafter referred to as the "S/W"), it was discussed and confirmed the undertakings of Japan and Mongolia. The Japanese side touched upon the draft P/O of the second year and after. After meetings, agreements and confirmations were collected together into the Minutes of Meetings (hereinafter referred to as the "M/M"). (Appendix 2)

2) Meetings at the Completion of the First Year's Field Study

On the basis of the progress report the JICA Study Team (hereinafter referred to as the "Team") reported the progress of the first year's field study and MSAGC acknowledged it.

In parallel with the field study, specialists of the Team and MSAGC discussed the conventional signs and their application rule to be applied to the Study. The results were collected together into a report "Technical Discussions on Conventional Signs and their Application Rule for the 1/25 000 Topographic Map" and submitted it to the meeting. (cf. Reference 1) After some amendments, the report was accepted by the meeting.

The Team explained the laboratory study after going back to Japan and the studies of the second (stereo plotting) and the third (field identification) years. The results of meetings were collected together into the M/M. (Appendix 3)

3) Meetings at the Commencement of the Third Year's Field Study

JST reported the laboratory studies carried out in Phases I and II. and that the plan of operations of Phase III was to carry out stereo plotting continued from Phase II and, after returning from the field, compilation.

Prior to the commencement of the field study, it was discussed the execution of the field study based on P/O brought with the Team. (cf. Reference 2) It is confirmed that the study of geographical name, administrative name and administrative boundary was in charge of MSAGC. The results of discussions were brought together into a M/M. (Appendix 4)

4) Meetings at the Completion of the Third Year's Field Study

On the basis of the progress reported prepared by the Team, the Team reported the progress of the field study. MSAGC acknowledged the report. (cf. reference 3) In parallel with the field study, specialists of both sides held meetings to study the conventional signs and their application rule in details. It was brought together into a report "Technical Discussions on Conventional Signs and their Application Rule for the 1:25 000 Topographic Map" and submitted to the meeting. (cf. Reference 2) After some amendments, the report was accepted by the meeting. (Appendix 5)

5) Meetings at the Commencement of the Fourth Year's Field Study

In Phase IV, it was planned field completion based upon the manuscripts of compilation prepared in Phase III,

drafting and a part of printing. Prior to the field study, both sides discussed the execution of the field study based on P/O prepared by the Team.(cf. Reference 3)

Based upon test prints prepared by the Team, it was discussed the specification of drafting and printing.

The results of discussions were brought together into a M/M. (Appendix 6)

6) Meetings at the Completion of the Fourth Year's Field Study

At the completion of the field study, the Team reported the progress of the field study on the basis of a progress report drawn up. (cf. Reference 3) It was accepted by the meeting.

In parallel with the field study, the said specialists had another look at conventional signs and application rule. The results of the discussion and the change of sheet name of some sheet were proposed to the meeting by them. After a partial amendment the proposal was accepted by the meeting. (cf. Reference 3)

Discussions were also made on test prints continued from the last phase and the results were reported to the meeting. (Appendix 7, Attachment 1)

The results of discussions were brought together into M/M. (Appendix 7)

2-5 Supervision of the Field Study

Supervisors were dispatched from JICA as follows during each field study period to observe field operations:

1) First Year

a. Name

Mr. Hiroshi Kosuga: Deputy Head, Planning and Coordination Div., Planning Dept., Geographical Survey Institute (GSI), Ministry of Construction

Mr. Yuichi Sugano: First Development Study Div., Social Development Study Dept., JICA

b. Period

From May 17, 1993, to May 26, 1993

2) Third Year

a. Name

Mr. Hiroshi Kosuga: Deputy Head, Planning and Coordination Div., Planning Dept., GSI, Ministry of Construction

Mr. Hidenori Kumagaya: First Development Study Div., Social Development Study Dept., JICA

b. Period

From May 30, 1994, to June 8, 1994

3) Fourth Year

a. Name

Mr. Kiyoto Hayashi: Planning Div., Map Dept., GSI, Ministry of Construction

Mr. Yuuich Endo: Legal Affairs Div., General Affairs Dept., JICA

b, Period

From June 6, 1995, to June 14, 1995

2-6 Organization of the Team and Dispatched Period

The organization and dispatched period of JST are as follows:

1) First Year

Period

Headquarters From May 14, 1993, to July 15, 1993

Signalization From May 20, 1993, to June 11, 1993

Aerial photography From June 1, 1993, to July 11, 1993

Ground control point survey From June 12, 1993, to July 11, 1993

Organization

Duty	Name	Dispatched Period
Leader	S. Saito	from May 14 1993 to June 3 1993 from June 27 1993 to July 15 1993
Deputy leader	K. Muraoka	from May 14 1993 to July 15 1993
Map planner	K. Okumura	*ibid.*
Chief engineer	H. Yoshida	*ibid.*
Interpreter	T. Horiuchi	from May 14 1993 to 15 July 1993
Mechanic	S. Ishiwata	*ibid.*

Signalization, Ground control point survey	Y. Katagami	from May 14 1993 to July 11 1993
"	M. Satoji	from May 20 1993 to July 11 1993
"	H. Izutsu	*ibid.*
"	S. Takebuchi	*ibid.*
Signalization, Ground control point survey	M. Tsujimoto	from May 29 1993 to July 11 1993
"	A. Tanaka	*ibid.*
"	M. Tokita	*ibid.*
"	Y. Watanabe	*ibid.*
Supervisor of aerial Photography	H. Hosoda	from May 14 1993 to July 11 1993
Cameraman	T. Miyazaki	from June 1 1993 to July 11 1993
Navigator	T. Kubota	*ibid.*
Coordinator	Y. Kokufu	from May 14 1993 to July 15 1993

2) Third Year

Period

Headquarters From May 27, 1994, to July 26, 1994

Field identification From May 27, 1994, to July 26, 1994

Organization

Duty	Name	Dispatched period
Leader	S. Saito	from May 27 1994 to June 15 1994 from July 7 1994 to July 26 1994
Deputy leader	K. Muraoka	from May 27 1994 to July 26 1994
Mapping planner	K. Okumura	*ibid.*
Chief engineer	H. Yoshida	*ibid.*
Interpreter	T. Horiuchi	*ibid.*
Mechanic	S. Ishiwata	*ibid.*
Field identification	M. Ohnaka	*ibid.*
"	H. Saito	*ibid.*

Field identification	M. Satoji	from May 27 1994 to July 26 1994
"	H. Hosoda	*ibid.*
"	S. Takibuchi	*ibid.*
"	M. Tsujimoto	*ibid.*
"	K. Kamimura	*ibid.*
"	K. Noguchi	*ibid.*

3) Fourth Year

Period

Headquarters From June 4 1995 to July 30 1995

Field completion From June 11 to July 30 1995

Organization

Duty	Name	Dispatched period
Leader	S. Saito	from June 4 1995 to June 25 1995 from July 18 1995 to July 30 1995
Deputy leader	K. Muraoka	from June 4 1995 to July 30 1995

Mapping planner	K. Okumura	from June 4 1995 to July 30 1995
Chief engineer	H. Yoshida	*ibid.*
Interpreter	T. Horiuchi	*ibid.*
Mechanic	S. Ishiwata	*ibid.*
Field completion	M. Ohnaka	*ibid.*
"	H. Saito	from June 11 1995 to July 30 1995
"	M. Satoji	*ibid.*
"	H. Hosoda	from June 4 1995 to July 30 1995
"	S. Takebuchi	from June 11 1995 to July 30 1995
"	M. Tsujimoto	from June 4 1995 to July 30 1995
"	K. Kamimura	from June 11 1995 to July 30 1995
"	K. Noguchi	*ibid.*

2-7 Counterparts participated in the Field Study

In connection with the execution of the Study, many Mongolican counterparts joined the Study in various phases, such as the discussion of P/O, of conventional signs to be used for the map, administrative jobs in the field headquarters, etc., as well as the execution of the field study. At the same time the transfer of technology was realized.

Counterparts who joined the Study are as follows:

1) First Year

a. At the Headquarters

Name	Duties
Dr. J. Samjaajamts	Discussion of P/O, Administration
Mr. Z. Bataa	Discussion of P/O, Administration in the liaison
Mr. M. Enkhbayar	Discussion of P/O
Mr. Y. Serevjaa	Discussion of P/O
Mr. D. Tsedendor	Discussion of P/O
Mr. H. Jargal	Discussion of P/O, Technical discussions, Technical control in the field study

b. In the Field Parties

Name	Duties
Mr. N. Gunbat	Signalization, Ground control point survey
Mr. P. Boldbaatar	*ibid.*
Mr. B. Usekhbayar	*ibid.*
Mr. Hurelbaatar	Aerial photography, Photo processing
Mr. Enkhmandah	*ibid.*

2) Third Year

a. At the Headquarters

Name	Duties
Dr. J. Sanjaajamts	Discussion of P/O, Administration
Mr. Z. Bataa	Discussion of P/O, Administration in the field, Liaison
Mr. M. Enkhbayar	Discussion of P/O
Mr. H. Jargal	Discussion of P/O, Technical discussions, Administration in the field

b. In the Field Parties

Name	Duties
Mr. Erdenebaatar	Field identification
Mr. Bayaraa	*ibid.*
Mr. Adiyaa	*ibid.*

4) Fourth Year

a. At the Headquarters

Name	Duties
Dr. J. Sanjaajamts	Discussion of P/O, Administration
Mr. Z. Bataa	Discussion of P/O, Administration in the field, Liaison
Mr. M. Enkhbayar	Discussion of P/O
Mr. H. Jargal	Discussion of P/O, Technical discussions, Administration in the field
Mrs. B. Oyunchimeg	Technical discussions

b. In the field

Name	Duties
Mr. B. Erdenebaataar	Field completion
Mr. N. Gunbat	*ibid.*
Mr. B. Usekhbayar	*ibid.*

2-8 Individual Training

Besides the job training through the execution of the field study, following engineers were trained individually in Japan:

Name	Period	Subject
Mr. S. Gambold	From Jan. 26, 1994, to Mar. 6, 1995	Aerial triangulation, stereo plotting
Mr. H. Jargal	From Jan. 19, 1995, to Feb. 17, 1995	Map compilation
Mrs. B. Oyunchimeg	From Oct. 23, 1995, to Dec. 17, 1995	Map drafting
Dr. J. Sanjaajamts	From Jan. 22, 1996, to Feb. 9, 1996	Mapping in general

2-9 Summary of the Fifth Year's Study

Up to the fourth year, the progress of the Study have been reported by the yearly reports. Hereinafter, the progress of the fifth year's study shall be summarized.

2-9-1 Outline

In the fourth year, 77 sheets were printed out of 128 sheets (corresponding to approximately 60 % of the total number). In the fifth year printing of the rest of the sheets (51 sheets) was carried out including plate making, proof printing, proof reading, retouch of the final drafts like in the fourth year. (Fig. 4)

2-9-2 Study Plan

The fifth year's study plan was drawn up and completed as planned:

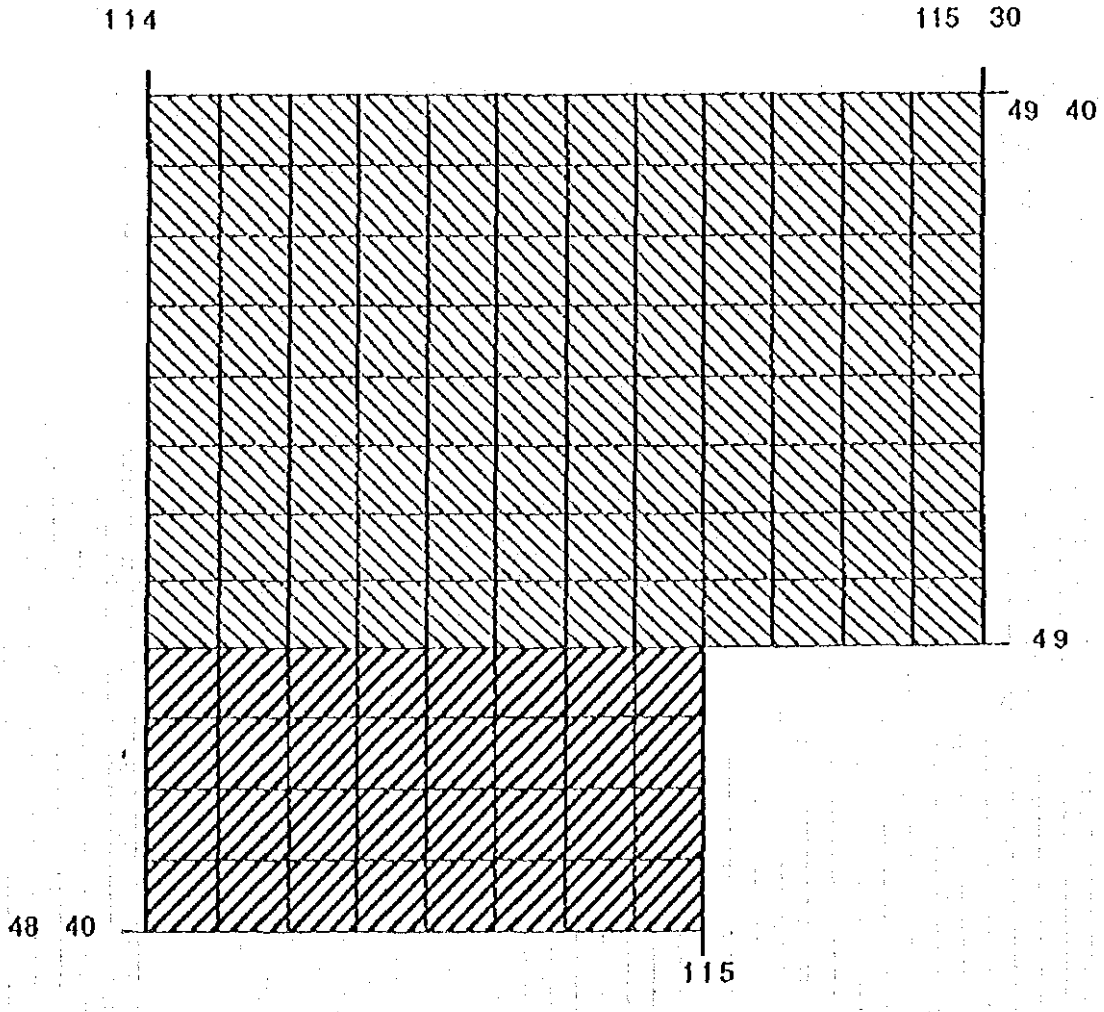
Item	Period
Printing	From Apr. 19, 1996 to June 27, 1996
Reporting	From Apr. 22, 1996 to June 27, 1996

1) Specifications

(1) Volume

51 sheets, 150 copies per sheet

Fig. 4 Printing



(2) Colour Allotment

Following colours were allotted to respective items.

Black	road, railway, geodetic control point, administrative boundary, electric power line, independent building, other ground features, conventional sign of vegetation, annotation, marginal information
Brown	contour line, cliff, contour value, rock cliff, isolated rock, sandy area, area of concentrated rocks, classification of road (paved road)
Blue	Water surface, river, swampy area, salty area, well, spring, water reservoir, pipe line, annotation relative to water
Yellow	road classification (maintained road), quarter of non-fireproofted buildings
Brown + Yellow*	Quarter of fireproofed buildings
Blue + Yellow*	Thick forest, sparse woods

* Superimposition of two colours

2) Execution

(1) Plate Making

On the basis of the original manuscript of drafting, printing plates were elaborated on the presensitized aluminum plate by multiple printing for each colour.

(2) Proof reading

Proof printing was executed by using the plates made for trial. After proof reading, original manuscript of drafting was corrected, if necessary, final printing plates were reproduced.

3) Printing

After finishing proof reading, topographic maps were printed with 4 colour offset printing machine in reference to the colour specimen. Endurable and suitable in reproducibility paper was used. Ink was selected such that it may fit with the colour specimen and be excellent in light resistance.

4) Preparation of composite films for plate making

In preparation to the reprinting in Mongolia, films were composed colour by colour in favor of plate making. The original manuscript of drafting to be used for plate making were composed of 21 sheets at most. Films for plate making were prepared by composing those sheets colour by colour reducing the number to 4 sheets.

5) Checking and Quality Control

Every copy of printed maps was checked on fitness between colour, stain, scratch, lack of pictures, etc. and the quality of the product was controlled. Only copies passed through the checking were adopted as the final products.

After checking, copies not passed the checking were abandoned burnt out and printing plates were abolished in the presence of the Team.

3 TECHNICAL REPORT

3-1 Study Plan

3-1-1 Objective

The objective of the Study is to take 1/50,000 aerial photographs and prepare 1/25,000 topographic maps covering an area of approximately 10,800 km² from the east of Long. 114° E to Long. 115° 30′ E and from the south of Lat.49° 40′ N to 'Lat. 48° 40′ N in Ulaan-Tsav area in Mongolia as shown in the figure on the front page of the report and in Fig. 3. The area is a steppe on the peneplain extending to the north of Choibarsan, the central city in the north-eastern part of Mongolia.

1. 1/50,000 Aerial photography	approx. 10,800 km²
2. 1/25,000 Topographic mapping	approx. 10,800 km² 128 sheets.

Through the execution of the Study, the transfer of technology shall be achieved. It is cordially requested the participation of Mongolian counterparts to various phases of the Study.

3-1-2 Scope of Work

The scope of work to achieve the captioned objective is stated in S/W. It covers,

Aerial photography (Signalization is included), Ground control point survey, Field identification, Aerial

triangulation, Stereo plotting, Compilation, Field completion, Drafting and Printing.

1. Signalization

Aerial signals shall be set up on existing triangulation points and newly established control points.

2. Aerial Photography

Vertical aerial photographs shall be taken using panchromatic film at a scale of 1:50,000 by super-wide angle camera.

3. Ground Control Point Survey

Existing triangulation points shall be used for photographic control for the aerial triangulation and stereo plotting. In case of necessity, new ground control points shall be established by GPS.

4. Aerial Triangulation

On the basis of the results of the ground control survey, the aerial triangulation shall be executed. The adjustment shall be carried out analytically using the method of independent models.

5. Field Identification

In accordance with the rule of the map representation, the items to represent on the map (land use, vegetation, etc.) shall be identified by comparing them with those on the

photograph in the field. Place names to adopt on the map shall be verified in the field on the basis of those collected in the field and materials provided by the Mongolian side. The collection and the verification of place names and of administrative names shall be indebted to the cooperation of the MSAGC.

6. Stereo plotting

The stereo plotting shall be executed by using stereo plotters at the scale of 1:25,000. (preparation of plotted manuscript)

7. Compilation

The compilation shall be executed on the basis of the field surveys at the scale of 1:25,000. (preparation of compiled manuscript)

8. Field Completion

Items not verified at the time of compilation shall be clarified in the field. Materials of administrative boundaries and names prepared by the MSAGC shall be verified in the field. (preparation of the original of the topographic map)

9. Drafting

On the basis of the original of the topographic map, final drafts shall be prepared for plate making and printing. The drafting shall be executed by color separation scribing. The conventional signs and their application rule applied in Mongolia shall be observed.

10. Printing

Using final drafts of the topographic map, printing plates shall be prepared by photo-lithography. Printing shall be executed by off-set printing in four colors. Before printing, the Mongolian side shall agree the commencement of printing by inspecting the final proof-prints.

3-2 Signalization

3-2-1 Outline

Using existing 1:100,000 topographic maps, by selecting 29 points out of existing triangulation points in accordance with the distribution standard specified by the operation specifications, a plan of distribution of aerial signals was drawn up in reference to the planned flight courses, in order to execute the aerial triangulation. For that purpose, 3 points were to newly establish and signalize to supplement the existing triangulation points.

3-2-2 Field Reconnaissance of Existing Geodetic Control Points and Selection of Points to Signalize

After arriving at the field, the proposed points to signalize were substituted for other points when their final results were missing or select new points when their monuments were not found on the spot at the time of the field reconnaissance.

The study field is a big steppe of gentle undulation and there were scarcely any land marks. It was anticipated the

difficulty in recoverring the monuments of existing points. However, the recovery was done without difficulty, because permanent iron observation tower was set up at almost all points and it was easy to identify it from a distant place. The recovery of the points without observation tower was successful owing to that the counterparts were well aware of the topography of the area and that each party was equipped with portable GPS receiver (Trimble Ensign) with which the position of the points to discover was estimated. In general, the discrepancy between the coordinates of the points in question and those of the measured values by GPS were within several ten meters.

The location of the new ground control points was selected in the area where triangulation points were not yet established. On these points, aerial signals were not necessarily set up when they were used only for the ground control point survey and not for the aerial triangulation.

After all, aerial signals were set up on the following 33 points.

Given point	Triangulation point with observation tower	29 points
Unknown point	Triangulation point without observation tower	1 point
"	Existing bench mark	1 point
"	Newly established ground control point	2 points
	Total	33 points

3-2-3 Execution

1) Outline

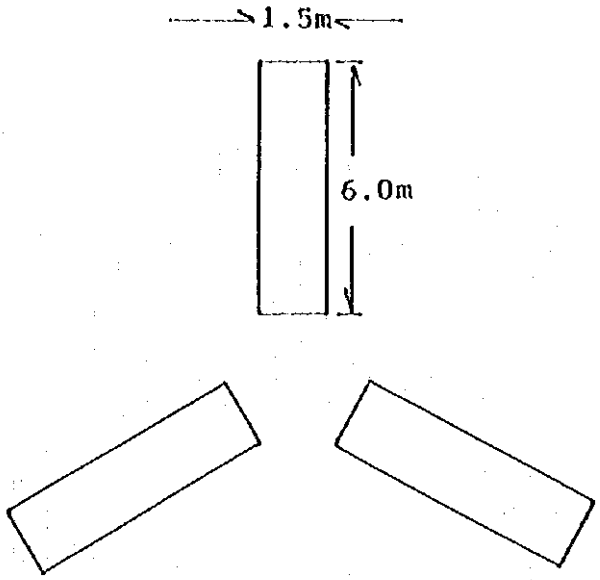
Signalization work was carried out by four parties, each composing of two Japanese engineers, one counterpart and one driver. Very few roads ran in the study area. However, the use of four wheel driven cars enabled to run relatively freely in spite of the speed having been limited. In the steppe, there were undulation and small lakes and swamps scattered in the low land. Once cars ran into such area and it happened to take time to get out of the area even with four wheel driven cars.

For the materials to make aerial signals, those easy to obtain were to use:
When lumps of rock were obtainable, they were arranged and painted with white paint (for one point with black paint), or if it was not obtainable, lime kneaded with water was painted to some thickness. For two points, white cloth was cut to the specified form and painted white.

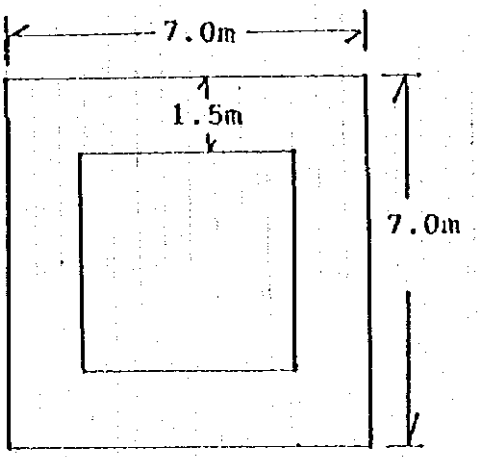
2) Specifications of the Aerial Signal

The size of the aerial signal was specified as 6~ 7 m × 1.5~ 2 m a piece and three pieces were to form a set of aerial signal and set up around the monument of the point as shown in Fig. 5 (a). Around more than half of the existing triangulation points, there remains the trace of establishment of aerial signal in the shape of a quadrangle as shown in Fig. 5 (b) or a triangle as shown in Fig. 5 (c) in the form of groove or pile of stone. The size of a side was 6~ 8 m× 1~ 2 m for the former and 5~ 6 m× 1~ 2 m for the latter. These traces were utilized to a great extent: lime was poured into the groove by kneading it with water or pile of stone was painted white.

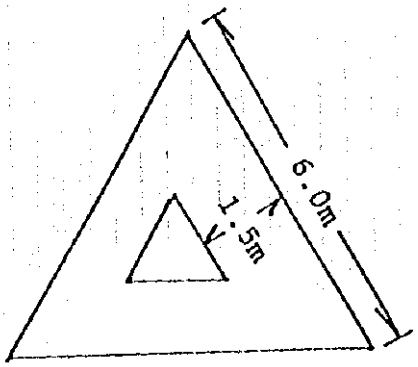
Fig. 5 Specifications of Aerial Signal



(a)



(c)



(b)

3) Other Jobs related to Signalization

(1) Taking the terrestrial photograph of the aerial signal and its environs and drawing up a sketch, the description of the aerial signal was prepared.

(2) In general, it was specified to establish an auxiliary aerial signal by selecting a ground feature judged clearly identifiable on the aerial photograph and measuring the eccentricity from the aerial signal in case the aerial signal was not identifiable on the aerial photograph. However, as no suitable ground features were found in the neighbourhood of the aerial signals, ground features apart several kilometer at the nearest from the aerial signal had to be used as an auxiliary point, when needed.

4) Confirmation of the Aerial Signal

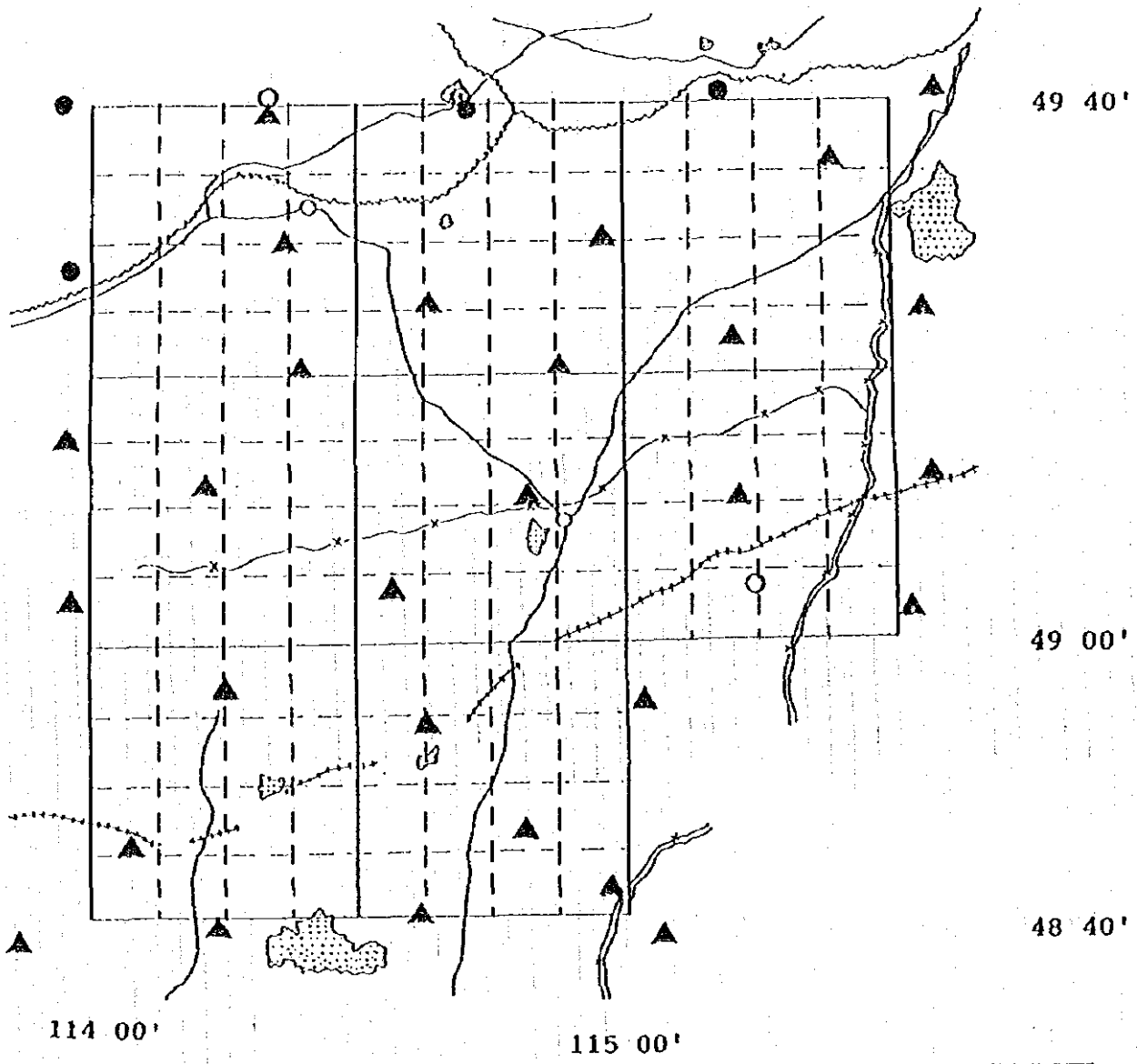
The aerial signals were confirmed on the newly taken photograph. 31 points were identified out of 33 points, as far as checked on the spot, although the aerial photographs used were rush prints made for the inspection of the aerial photography of poor quality.

The distribution of the identified aerial signals and the pricked points as alternatives is shown in Fig. 6.

3-2-4 Pricking of the Aerial Signals not Identified on the Aerial Photograph

Points N5, N6 and N7 were not identified on the aerial photographs prepared on the spot. Their alternative were not found in their neighbourhood, but several kilometers apart from them. The conventional way of the eccentricity

Fig. 6 Signalized Points and Pricked Points



Legend	
Signalized (Existing)	▲
Signalized (New-point)	●
Pricked Point	○