

No. 49

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
THE REPUBLIC OF CAMEROON
SOCIETE NATIONALE D'ELECTRICITE DU CAMEROUN

FEASIBILITY STUDY
ON
MEMVE ELE HYDROELECTRIC POWER
DEVELOPMENT PROJECT

FINAL REPORT
APPENDIX I
TOPOGRAPHY

OCTOBER 1993

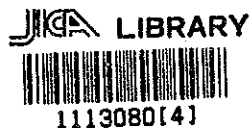
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APPENDIX I
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NIPPON KOEI CO., LTD.

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**FEASIBILITY STUDY
ON
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FINAL REPORT**

List of Report

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**FEASIBILITY STUDY
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MEMVE ELE HYDROELECTRIC POWER DEVELOPMENT PROJECT**

**FINAL REPORT
APPENDIX I TOPOGRAPHY**

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1. LAND, AREA AND LOCATION

The Republic of Cameroon is located at the west end part of Central Africa. It stretches about 1,200 km from Lake Chad to the north to the Atlantic Ocean to the south, lying between the latitudes 2 degrees and 13 degrees North and the longitudes 8 degrees and 16 degrees East. The country has a shape of roughly triangular and has a total area of 475,000 km².

Dorsale Camerounaise (a mountain chain) which divides the country into two parts lies from Mt. Cameroon (4,095 m) in the west to the border of Central Africa Republic in the east. The north of country is of lowlands representative of the area of Lake Chad. The south of country is extensively covered by the South Cameroon Plateau. The west coastal plains bordered on the Atlantic Ocean are relatively narrow.

The Ntem River on which the proposed Memvé Elé site is located, is one of the largest rivers of Cameroon. It drains a catchment area of about 31,000 km² at the southern edge of the country. In the upper reaches it flows along the border between Cameroon and Gabon and in lower reaches between Cameroon and Equatorial Guinea. Some of its tributaries originate in Gabon and Equatorial Guinea.

The proposed Memvé Elé site is situated in the lower reaches of the Ntem basin approximately 100 km upstream of the estuary. At this site there is a waterfall, called Memvé Elé falls, with about 35 m head offering favorable site for hydroelectric power development. The catchment area at the falls is 28,300 km² including two major tributaries; the Ndjo'o and Biwome.

2. SITE TOPOGRAPHY

The Memvé Elé waterfalls located immediately downstream of the proposed damsite set up remarkable change in the river characteristics between the upstream and downstream.

At the upstream of the waterfalls, the Ntem river flows slowly and abundantly on its gentle river gradient in the wide flat river sections. Near the waterfalls, the Ntem river spreads into branches and remains islands among the branches covered with a dense rain forest. Two tributaries, the Ndjo'o and Biwome rivers flow into the Ntem river just upstream of the waterfalls. Downstream of the waterfalls, the Ntem river so-called "Gorges du Ntem", runs rapidly and straight in a succession of short cascades and rapids in south-west direction. The width of the river is around 50 m. A rise of water level due to flood looks to be 5 to 6 m according to the trace of flood on the banks.

Taking a bird's-eye view of the topography, the damsite is rather flat and looks to embarrass a possibility of creation of a big reservoir. In the north-west part of the right bank of Biwome river, there exist rather high mountains having a height of 600 to 1,000 m.

3. TOPOGRAPHIC SURVEYS

3.1 Profile Survey along Seismic Exploration Lines

The profile survey along the seismic refraction survey lines was entrusted to Societe de Topographic et de Services (STS). The survey was conducted between the end of June 1991 and the middle August 1991.

The work includes the following items:

- (1) Alignment of the seismic survey lines with clearing vegetation (1 m wide) and installing wooden pegs marked on lines at 10 m interval.
- (2) Level survey for measurement of elevation of installed pegs, and
- (3) Drawing of profiles (1/1,000 scale) of the survey lines on blue printable tracing paper.

Alignment of the proposed seismic refraction lines is shown in the attached Fig. 1.

The following table shows the numbers and length of seismic refraction lines surveyed.

Line No.	Length (m)	Location
SD3	2,276	Damsite
SD4	1,352	-do-
SD5 (1)	398	-do-
SD5 (2)	1,105	-do-
SD5 (3)	528	-do-
SD5 (4)	757	-do-
SD5 (5)	981	-do-
SD5 (6)	603	-do-
SW1 (1)	1,297	Waterway & Powerhouse
SW1 (2)	1,744	-do-
SW1 (3)	825	Waterway & Powerhouse
SW2	2,582	-do-
SW6 (1)	1,000	-do-
SW6 (2)	1,421	-do-
TOTAL	16,869 m	

The topographic survey results, the profiles of 1/1,000 scale, were obtained by transit compass for setting of the lines and leveling of centimeter order. The drawings are attached in Data Book.

3.2 Topographic Survey of Dam-Powerhouse Area

The topographic survey of dam-powerhouse area was entrusted to STS. The survey started from the middle of June 1991 and completed in the middle of March 1992.

The survey method applied is "ground survey" instead of "photogrammetric survey" originally scheduled due to the following reasons.

- (a) Unavailability of aircraft timely
- (b) Weather unforeseen
- (c) Photogrammetric survey more costly

The location of bench marks (7 points) and principal and secondary traverse nets for traversing and leveling are shown in Data Book.

Second order bench marks which become control points for elevation exist at intervals of about 2 km along the public road starting from Ebolowa and going to Campo and Kribi via Nyabessan. The bench marks are kept relatively good condition, though there are some losses. Errors of closure for three bench marks located before and behind the nearest bench mark R.N.30 (EL. 407.427 m) were obtained by check survey, and were allowable range of 31 mm, 5 mm and 15 mm respectively. The bench mark R.N.30 was adopted as the basic control point for elevation.

Control points for coordinates do not exist near the Project site. The bench marks BM 1 located in the SONEL's base camp was adopted as the origin of coordinates.

The seven bench marks provided and surveyed by STS were checked again by the Study Team. The results of survey are shown below and indicate a little difference between them.

Bench Mark No.	Results of STS (m)	Results of Study Team (m)	Difference
R. N. 30	EL. 407.427	EL. 407.427	-
BN 1	EL. 403.729	EL. 403.730	+1mm
BN 2	EL. 394.669	EL. 394.691	+22mm
BN 3	EL. 383.773	EL. 383.801	+28mm
BN 4	EL. 384.085	EL. 384.081	-5mm
BN 5	EL. 385.741	EL. 385.772	+31mm
BN 6	EL. 393.817	EL. 393.792	-25mm
BN 7	EL. 377.340	EL. 377.303	-37mm

The work items and the quantities carried out are shown below;

Work Item	Quantity
1. Site preparation Works	L.S.
2. Control Point Survey and Bench Mark	
2.1 Bench Mark	7 points
2.2 Leveling	22 km
3. Ground Survey	
(A) 1/5,000 Scale Mapping	
3.A.1 Traverse Survey	66 km
3.A.2 Leveling	66 km
3.A.3 Contour Survey and Mapping	2,260 ha
(B) 1/1,000 Scale Mapping	
3.B.1 Traverse Survey	10 km
3.B.2 Leveling	10 km
3.B.3 Contour Survey and Mapping	310 ha
(C) Dam Site Profile and Cross Section Survey	
3.C.1 In River Channels	0.82 km
3.C.2 On Banks	0.73 km
3.C.3 Cross Sections on Banks	0

The 1/5,000 scale maps (2 sheets), 1/1,000 scale maps (15 sheets) and profile of river channels and banks (8 sheets) are attached in Data Book.

3.3 Topographic Survey of Reservoir Area

The topographic survey of reservoir area was also entrusted to STS. The survey work started from the beginning of December 1991 and completed in the end of July 1992.

The survey method applied is "compass survey" instead of "photogrammetric survey" originally scheduled. The survey shall cover the area below EL. 405 m, upstream of the proposed dam at Nyabessan (some 80 km²). Maps are of 1/10,000 scale and 5 m contour lines.

The work items and quantities carried out in the fiscal years of 1991/1992 and 1992/1993 are as follows;

Work Item	Q' ty in fiscal year 1991/1992	Q' ty in fiscal year 1992/1993
1. Site Preparation Works	L.S.(100%)	-
2. Principal Traverse Lines		
2.1 Along existing road with leveling	20 km	-
2.2 In bush/forest without leveling	13 km	-
3. Secondary Traverse Lines	13.2 km	8.8 km
4. Contour Line Survey (by Compass)	300 km	500 km
5. Sketch Survey		
5.1 Housing	100 units	100 units
5.2 Farm lends (perimeter survey)	20 km	20 km
6. Compilation of Survey Data and Preparation of Maps	-	L.S.(100%)

The location of principal traverse nets for traversing, leveling and compass surveying, and the 1/10,000 scale maps (4 sheets) are attached in Data Book.

3.4 Additional Topographic Surveys

The following additional surveys were carried out by STS in 1992 under the request of JICA study team.

- (1) Counter survey 1/1,000 along the existing road where the elevation is low and provision of a saddle dam or raising of road formation is required.
 - At Abem and Melongo villages
 - Near Alen II villages
 - Between Nemeyong and Alen I villages
 - At Nsebito Bethel villages
- (2) Contour survey 1/1,000 near the boat station connecting Nyabessan with Aloum I including river bed sounding survey. (about 36 ha).
- (3) Compass survey 1/10,000 in the area behind south low ridge of the reservoir area.
- (4) Compass survey 1/10,000 in the proposed borrow area. The survey should cover EL.405, 410, 415 m or higher.

The results of items (1) and (2) are shown in Data Book. The results of items (3) and (4) are reflected in the reservoir area maps of 1/10,000 scale.

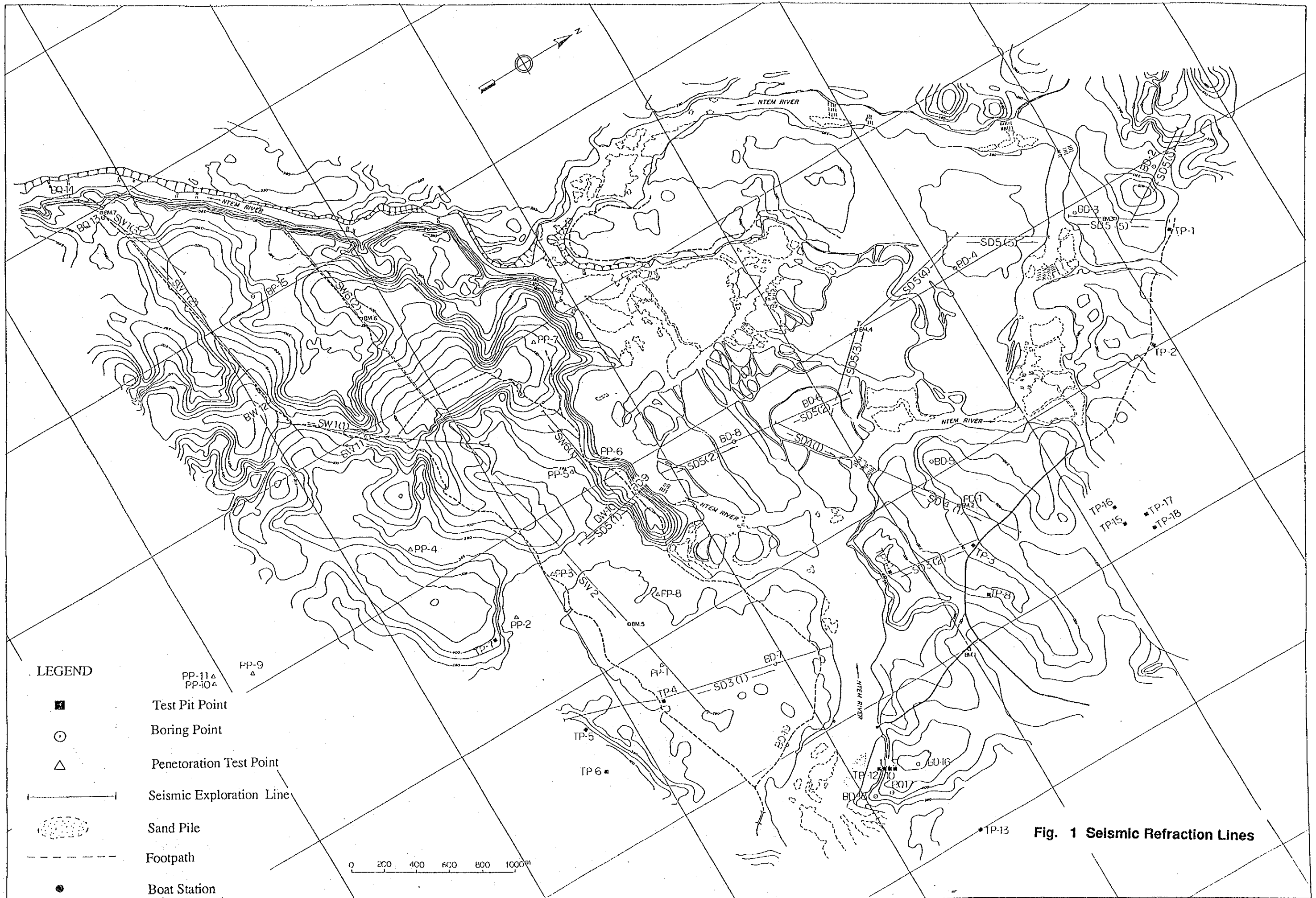


Fig. 1 Seismic Refraction Lines

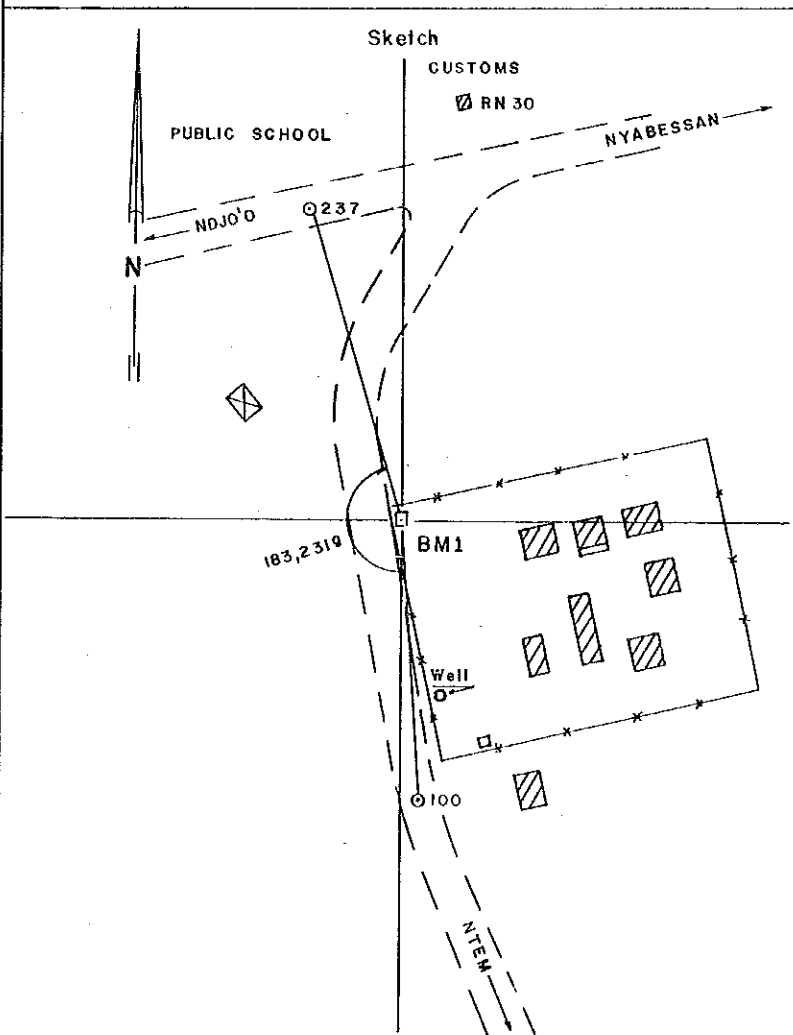
CONTROL STATION-IDENTIFICATION (N° BM 1)

FINAL RESULT SHEET

	B	L	X · E	Y · N	H
Station BM 1			500000,000	30 000,000	403,729
Eccentric point 237			499972,169	30 082,168	406,306
Eccentric point 100			500004,868	29 923,050	400,759

Place	IN CAMP SONEL NYABESSAN VILLAGE
Route	

	DATA	Full name	Note
Selecting of point			
Setting of signal			
Observed by			



Photograph of station



Profile

Aerial photo

Strip N°

Phot N°

- △ Triangulation point
- Bench mark
- Traverse station

Date

Wrifeed by

Checked by

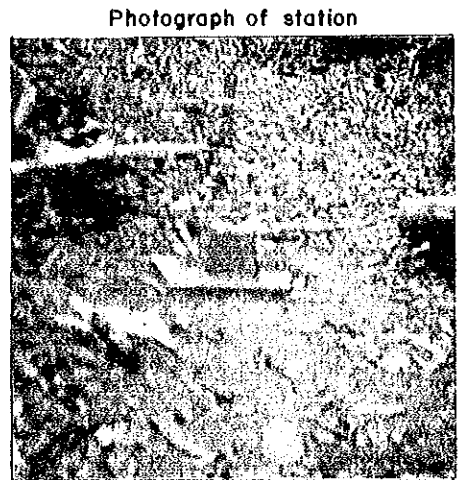
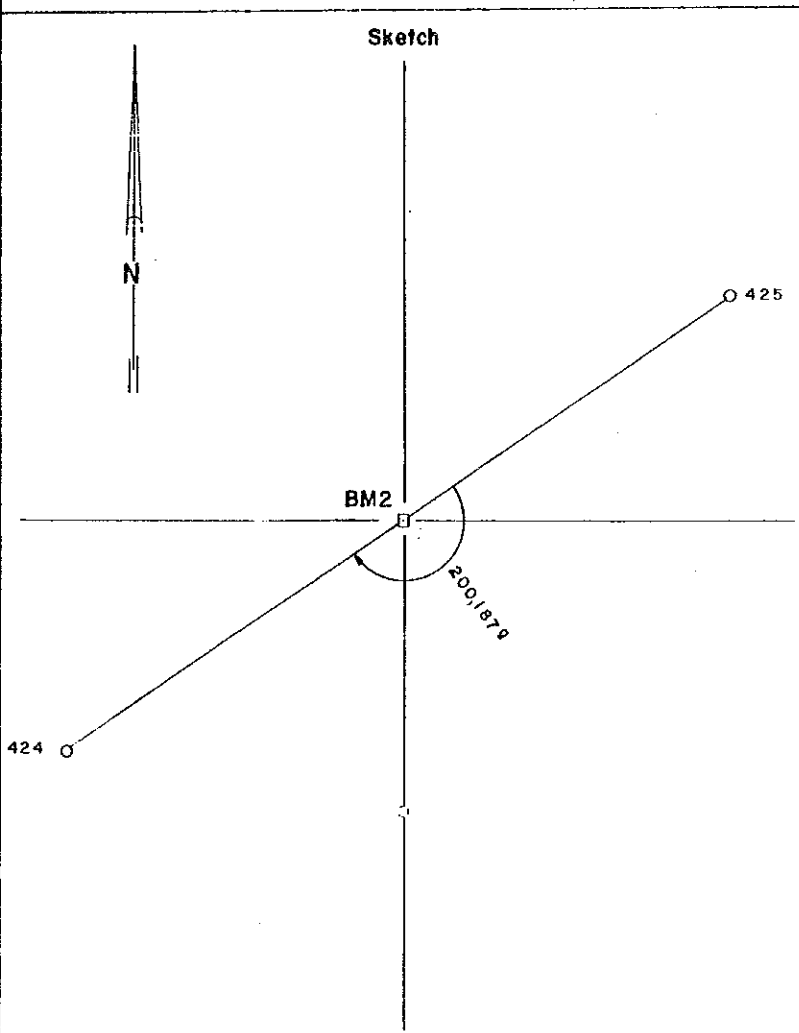
CONTROL STATION-IDENTIFICATION (N° BM 2)

FINAL RESULT SHEET

	B	L	X · E	Y · N	H
Station BM 2			499 229,456	30 387,664	394,669
Eccentric point 424			499 088,258	30 289,529	384,553
Eccentric point 425			499 396,016	30 502,705	399,588

Place	SIESMIC LAYON SD4
Route	

	DATA	Full name	Note
Selecting of point			
Setting of signal			
Observed by			



Profile

Aerial photo	
Strip N°	Phot N°

- △ Triangulation point
- Bench mark
- Traverse station

Date Written by Checked by

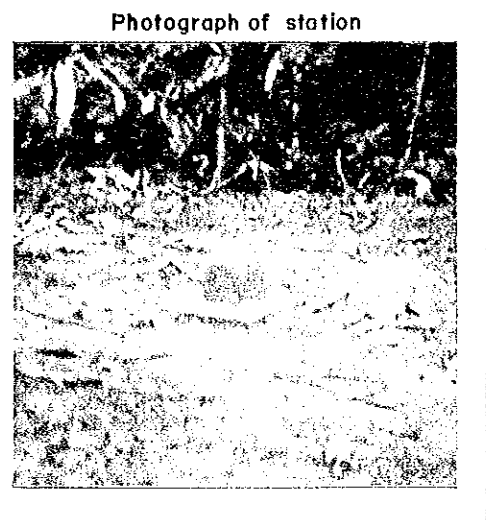
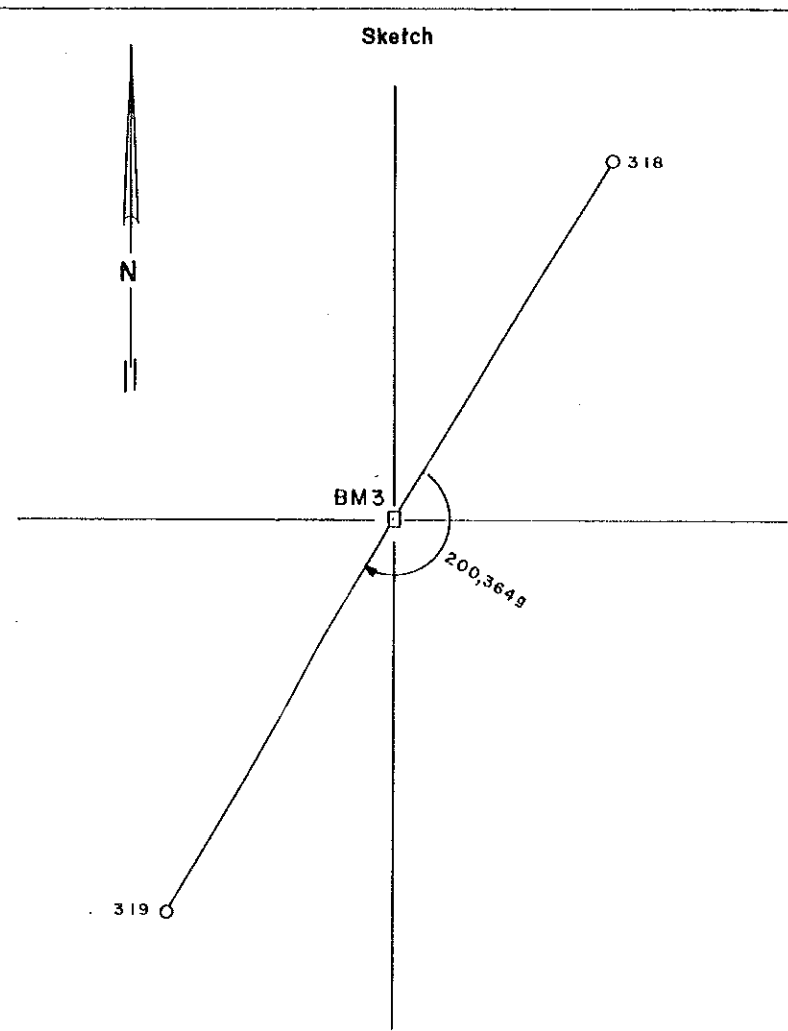
CONTROL STATION-IDENTIFICATION (N° BM 3)

FINAL RESULT SHEET

	B	L	X · E	Y · N	H
Station BM 3			498198,043	32098,886	383,773
Eccentric point 318			498243,471	32174,990	387,747
Eccentric point 319			498122,724	31974,332	381,977

Place	SIEMIC LAYON SD5.5
Route	

	Data	Full name	Note
Selecting of point			
Setting of signal			
Observed by			



Profile

Aerial photo	
Strip N°	Phot N°

- △ Triangulation point
- Bench mark
- Traverse station

Date Writed by Checked by

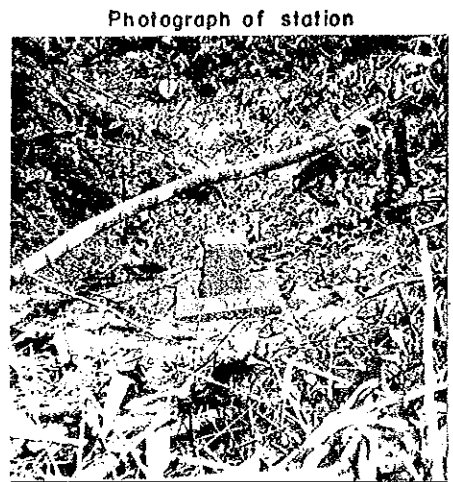
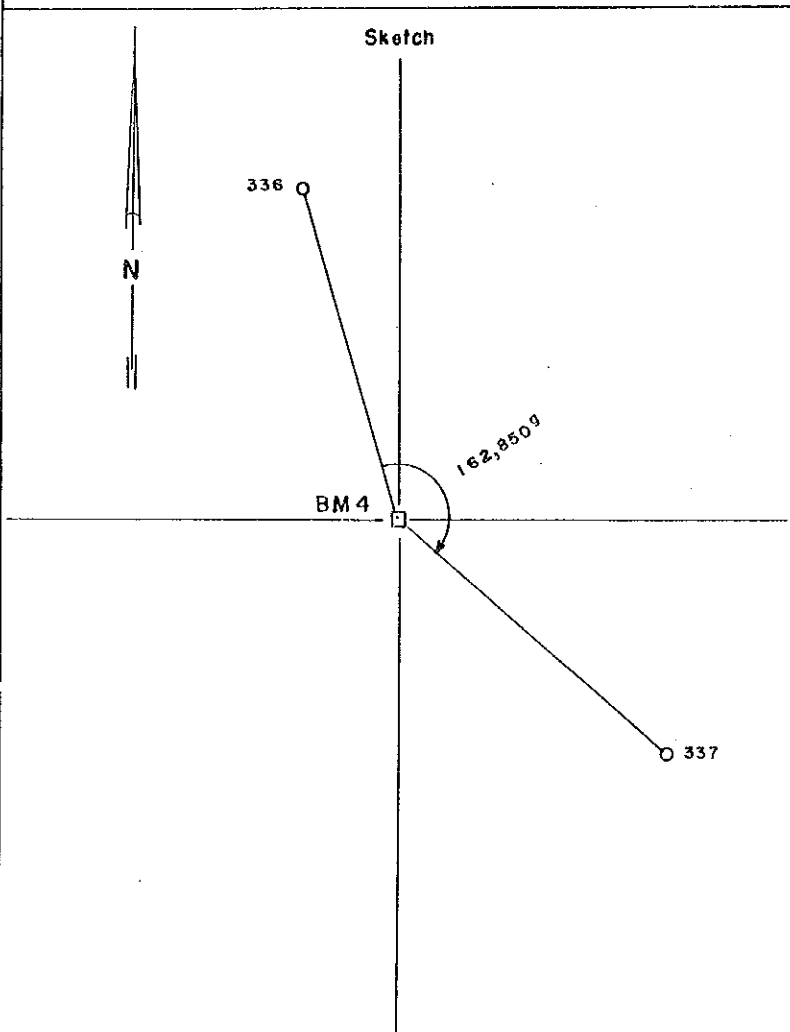
CONTROL STATION-IDENTIFICATION (N° BM 4)

FINAL RESULT SHEET

	B	L	X · E	Y · N	H
Station BM 4			497 994,047	30 410,086	384,085
Eccentric point 336			497981,729	30 453,470	383,905
Eccentric point 337			498074,672	30317,942	385,470

Place	SIESMIC LAYON SD5 (4) SD5(3)
Route	

	DATA	Full name	Note
Selecting of point			
Setting of signal			
Observed by			



Profile	
Aerial photo	
Strip N°	Phot N°

- △ Triangulation point
- Bench mark
- Traverse station

Date

Wrieded by

Checked by

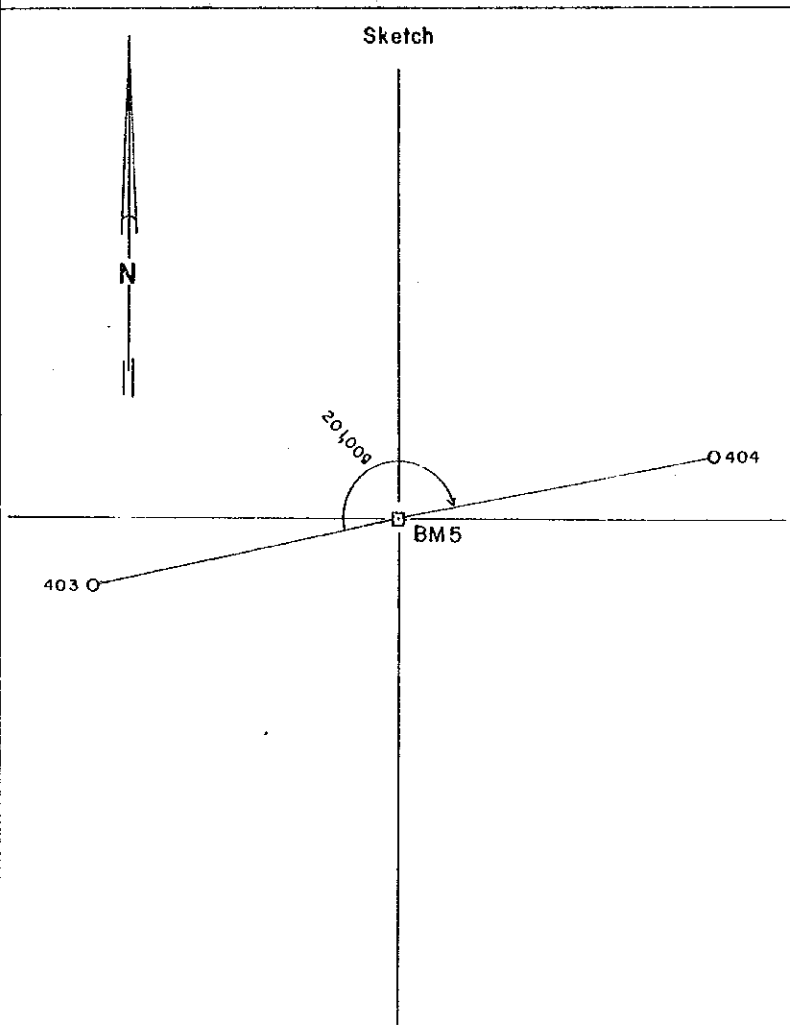
CONTROL STATION-IDENTIFICATION (N° BM 5)

FINAL RESULT SHEET

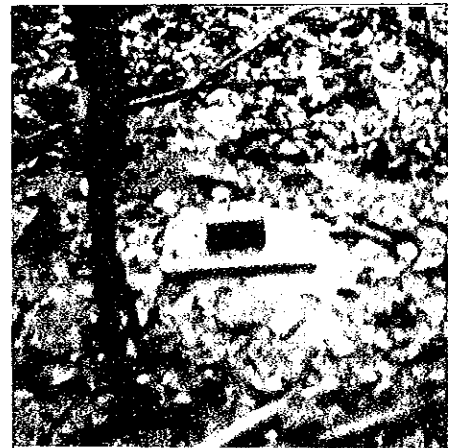
	B	L	X · E	Y · N	H
Station BM 5			498 827,140	28 284,823	385,741
Eccentric point 403			498 671,006	28 252,943	386,594
Eccentric point 404			498 984,637	28 314,410	385,862

Place	SIEMIC LAYON SW2
Route	

	DATA	Full name	Note
Selecting of point			
Setting of signal			
Observed by			



Photograph of station



Profile

Aerial photo.

Strip N°	Phot N°

- △ Triangulation point
- Bench mark
- Traverse station

Date

Writfeed by

Checked by

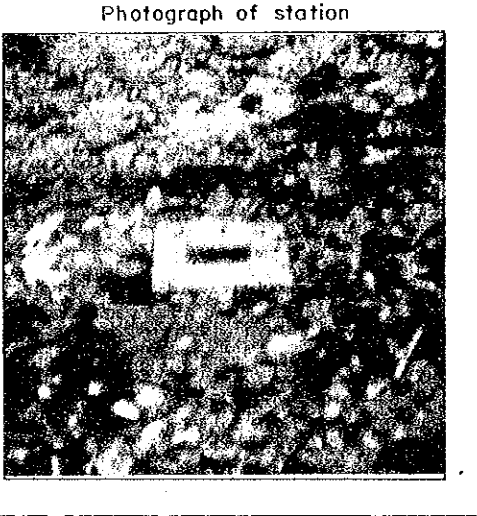
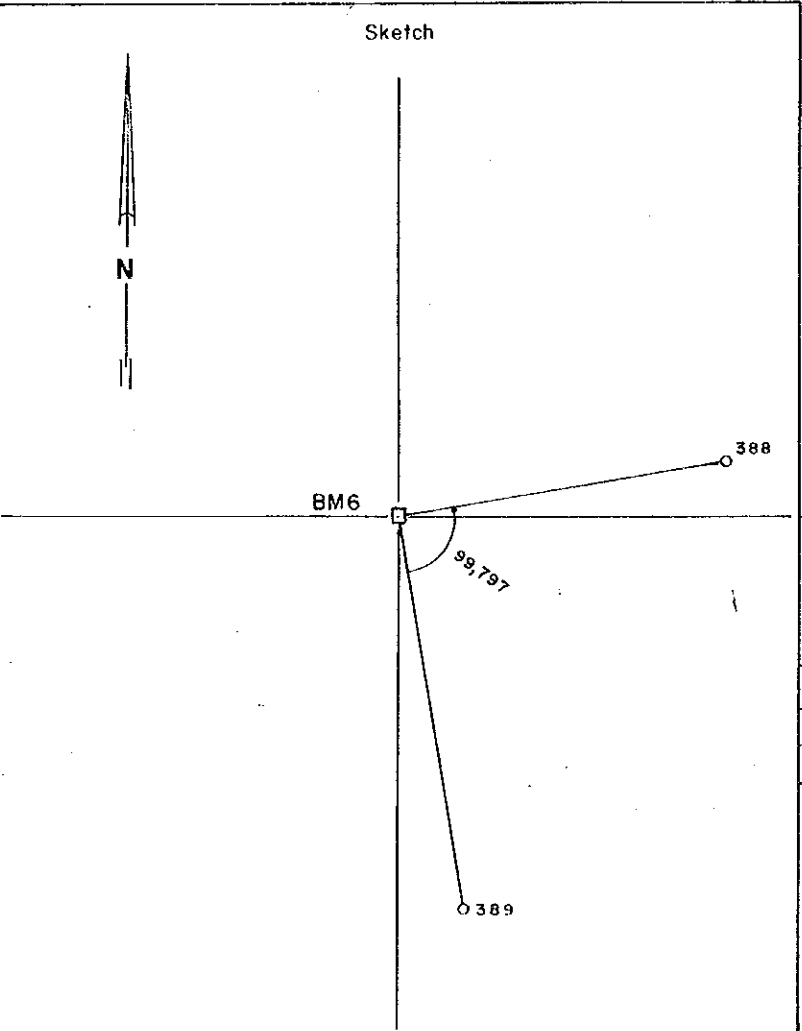
CONTROL STATION-IDENTIFICATION (N^o BM 6)

FINAL RESULT SHEET

	B	L	X · E	Y · N	H
Station BM.6			496 389,651	27 808,478	393,817
Eccentric point 388			496 436,712	27 816,487	392,000
Eccentric point 389			496 402,428	27 734,815	386,664

Place	SIESMIC LAYON SW6(2)
Route	

	DATA	Full name	Note
Selecting of point			
Setting of signal			
Observed by			



Profile	
Aerial photo.	
Strip N ^o	Phot N ^o
<p> △ Triangulation point □ Bench mark ○ Traverse station </p>	

Date _____ Written by _____ Checked by _____

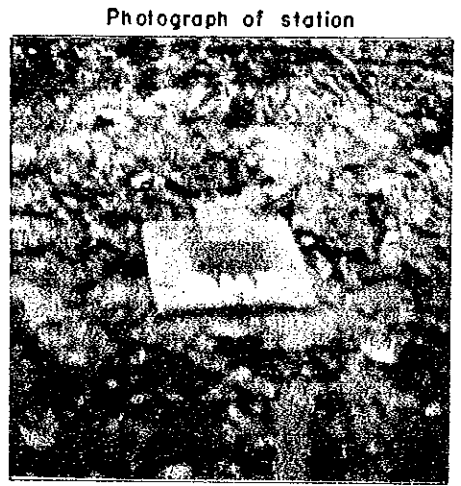
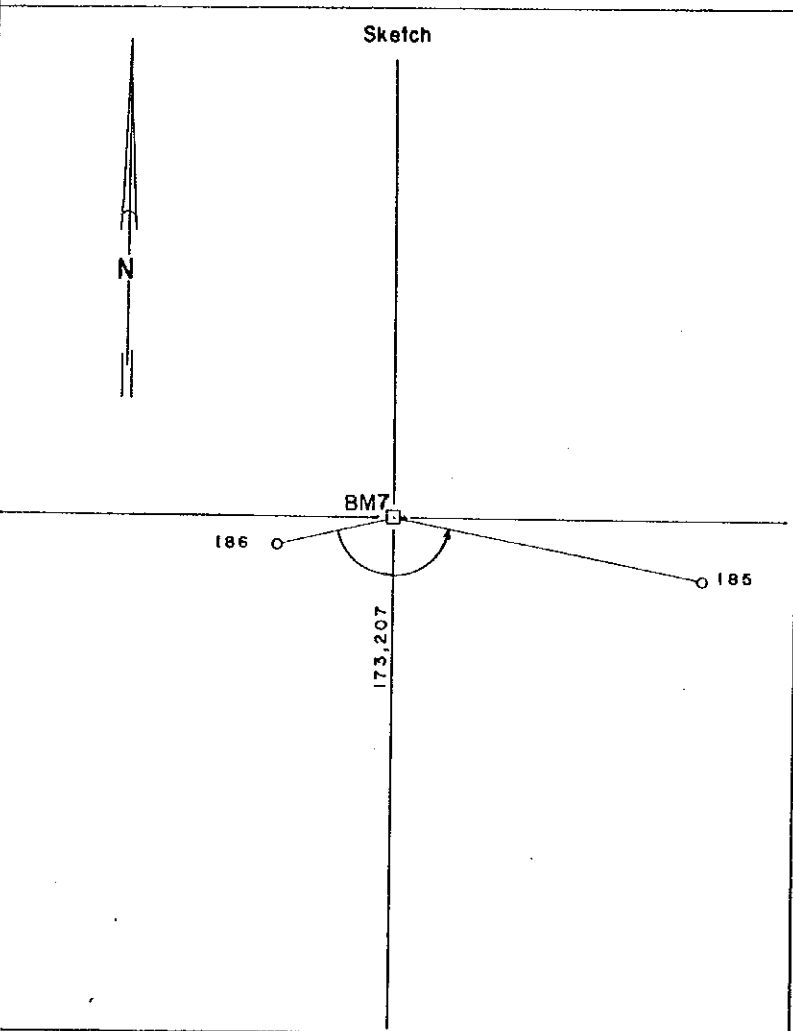
CONTROL STATION-IDENTIFICATION (N^o BM 7)

FINAL RESULT SHEET

	B	L	X · E	Y · N	H
Station BM 7			495 034,403	267 88,331	377,340
Eccentric point 185			495 100,475	267 75,522	376,501
Eccentric point 186			495 030,394	267 87,395	377,327

Place	SIESMIC SW1 (3)
Route	

	DATA	Full name	Note
Selecting of point			
Setting of signal			
Observed by			



Profile

Aerial photo

Strip N ^o	Phot N ^o

- △ Triangulation point
- Bench mark
- Traverse station

Date _____ Written by _____ Checked by _____

JICA