The San Kampaeng geothermal development project in the Kingdom of Thailand
deep electric survey report (supplementary)

THE SAN KAMPAENG GEOTHERMAL DEVELOPMENT PROJECT IN THE KINGDOM OF THAILAND

DEEP ELECTRIC SURVEY REPORT (SUPPLEMENTARY)

MACH, 1985

JAPAN INTERNATIONAL COOPERATION AGENCY

CONTENTS

LIST OF APPENDED DRAWINGS

I. General Description

I. GENERAL DESCRIPTION

I.1 Investigation Item Name

Kingdom of Thailand San Kampaeng area deep electric survey (MT method) [Supplementary investigation]

I.2 Object of Investigation

The object of this investigation is to obtain data on the geothermal reservoirs by checking the distribution of resistivity (or conductance) in the survey area by measuring ratios of electric field to magnetic field through execution of magnetotelluric method (MT method) and vertical electromagnetic sounding method (CSAMT method: Controlled Source Audiofrequency Magnetotelluric method). The particular objects of supplementary survey conducted this time are selection of survey well excavating positions for the thirdary investigation as well as investigation of expansion and form of the low resistivity zone in the Ban Mae area located in the Southeastern part of the survey area.

I.3 Survey Area

This survey was conducted in an area of about 50 km^2 in the San Kampaeng area, located in the Northern part of the Kingdom of Thailand as shown in Fig. 1, and measurements by MT method and CSAMT method were conducted at the counding points indicated in this figure.

The survey area is located at a point of about 30 km to the East from The place where a sign of presence of geothermal energy is located at an intermediate point between Wat Pong Hom and Ban Pong Nok in the Northwestern part of the survey area. It is characterized by springing of high temperature hot springs.

I.4 Particulars of Investigation

The components of measurement by MT method are two components of underground natural electric field (Ex, Ey) and three components of natural magnetic field (Hx, Hy, Hz). The total number of sounding points in this survey by MT method was 20, and sounding points were selected in about 1 km mesh as a rule. In the Ban Pong Nok area, however, the spacing between sounding points was determined as 500 to 600 meters. The components of measurement by CSAMT method are two components of magnetic field (Hx, Hz) and a component of electric field (Ey), which are induced by loop. Four loops, i.e., loops D, F, G and H, were prepared. The same points as used for the survey by MT method were employed for the sounding points of the deep electric survey. The total number of sounding points was 20, which is same as that of the MT method.

1.5 Survey Period

Field survey: From January 10, 1984

To February 8, 1984

Analysis and drawup of report:

From February 15, 1984

To March 20, 1984

1.6 Investigators

Chief engineer	Hisayoshi Nakamura
Field and analysis engineer	Sumio Seki
	Shinji Takasugi

II. Method for Electromagnetic Sounding

II. METHOD FOR ELECTROMAGNETIC SOUNDING

II.1 Method of measurement of MT survey

II.1.1 Apparatus for measurement

The specification of the apparatus employed in the present MT survey is as follows.

Apparatus	Amount	Specification
Amplifier unit for electric field	2	(1st Stage) Input Level 1 micro V Max. Gain 2 x 10^2 1.00 Hz High Cut Filter (2nd Stage) Max. Gain 5 x 10^4 0.33 Hz High Cut Filter
Amplifier unit for magnetic field	3	Max. Gain 8 x 10^4 0.33 Hz High Cut Filter
Wave form Recorder	1	Full Scale ± 5V or 10V Chart Speed Slow 1200mm/hour Fast 120mm/min
Data Logger (Double cassette)	1	Full Scale ± 5V Sampling Rate 100ms/1 DATA 5 Sample Multiplexer
Battery	2	12V, 100A
Magnetic sensor (Induction type coil)	3	115mmφ x 1050mmL ab. 10 kg Insert

(Accessory) M.T. cable a suit. Electrode a suit
Tools a suit. Others a set

II.1.2 Method of measurement

The method of measurement in this MT survey is as shown in the following Fig. II.1

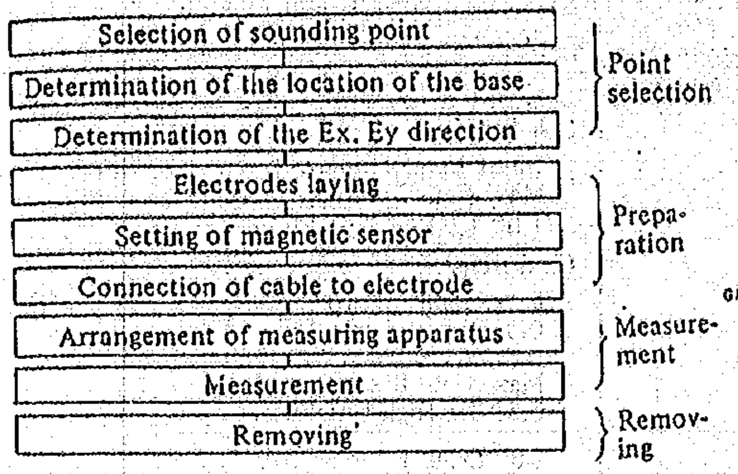


Fig. II.1 Measurement of MT survey

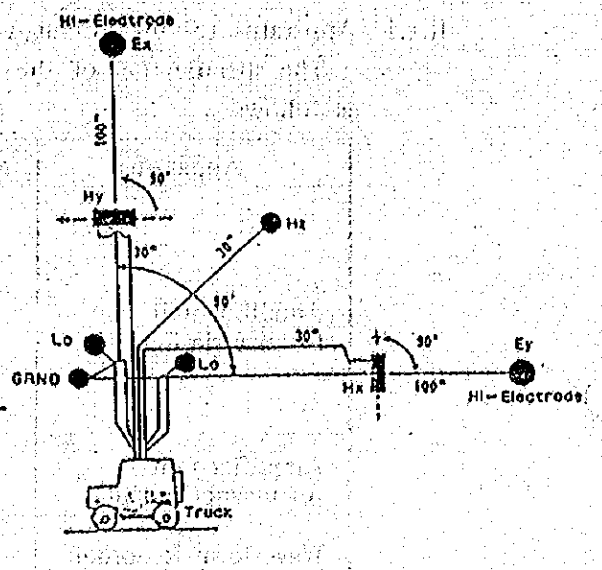


Fig. II.2

1) Selection of sounding points

Places which permit measurement were selected in the vicinity of the programmed points, avoiding steep slopes and assuring that noise sources are not located in the neighborhood. Furthermore, the base points were selected in the most appropriate sites in the actual field condition, where it is possible to establish survey lines. Two survey lines of the length of 100 meters were laid out in an L-shape array. Directions, topographical undulation and conditions of surrounding area were recorded on the field note at each point.

The relation of the locations of Ex base and Ey base is as shown. The survey line on the left-hand side as viewed from the vase is Ex and the survey line on the right-hand side is Ey.

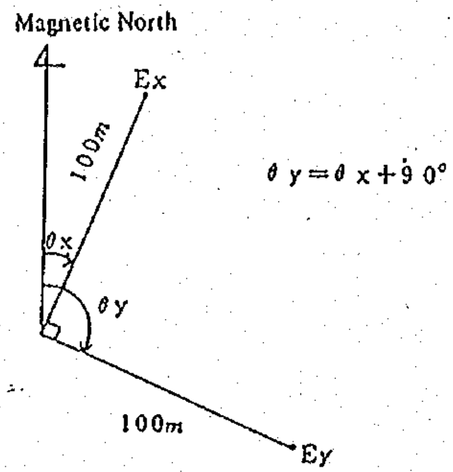


Fig. II Provision of survey lines

2) Preparation

Sensor was placed in a way as shown in Fig. II.2. The electrodes were placed at 5 sites; 3 at the base and one each at the sites of Ex and Ey. The way of laying these electrodes is shown in Fig. II.4. A hole 30 cm deep with diameter of 20 cm was sunk, in which water and soil were thrown in to make mud. After laying non-polarized electrode of $CuSO_4$ – Cu system, soil was piled as high as 20 cm.

Hx and Hy coils were placed on the wooden stand with the coil axes, Also coil for Hz was buried as deep as about 60 cm with its head upward. To stand it vertically, level was used. After confirming the directions of coils, levelling and perpendicularity, wooden box or polyethylene bucket was put on them and fixed with soil cover to avoid direct sunbeam and wind. (Fig. II.5, 6).

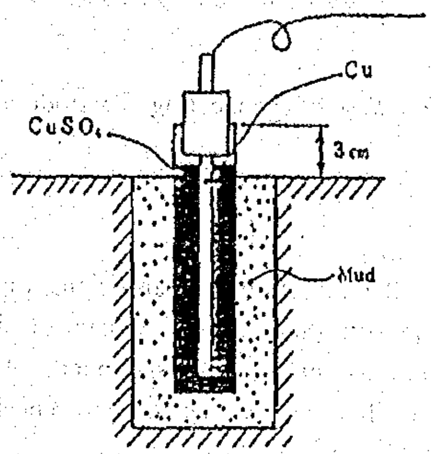
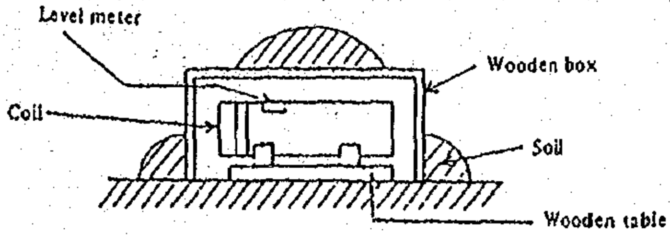


Fig. II.4 Way of laying electrode



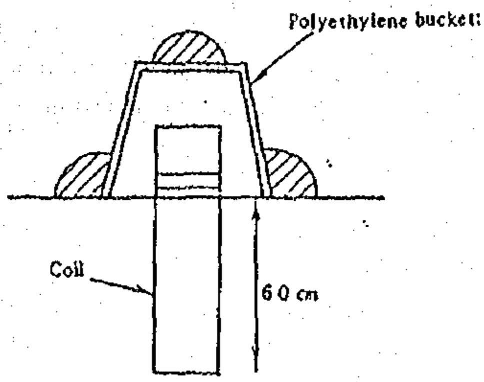


Fig. II.5 Way of setting Hx, Hy coils   Fig. II.6 Way of setting Hz coil

The connection of cables to the electrode was by wire-cuts. To avoid direct sun beam, bucket was put on connection box as a covering and weight like soil or stone was placed on it (Fig. II.7).

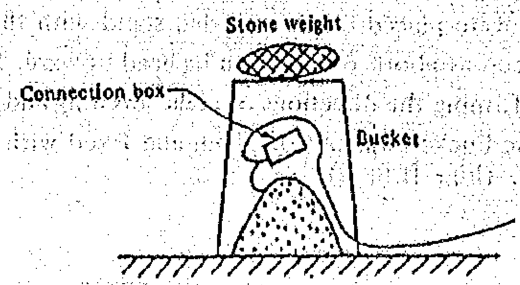


Fig. II.7 Way of connecting electrode to cable

3) Measurement

As the process of the measurement, apparatus were connected in the first place, followed by the measurement of coil resistance and earthing resistance. After connection of the cables to the pannel, adjustment of the amplifier and setting the cassette tape to the data logger, signals were checked for a while. Then recording began by starting the data logger.

In the course of the measurement, the graphic paper was being watched to check noises. For the analysis of electromagnetic field of the period up to 200 second, recording of data was continued for more than 2 hours 30 min. and for more than 4 files of noiseless data, taking 25 minutes' record to be one file in case of single measurement.

II.2 Measurement of CSAMT method

II.2.1 Apparatus for measurement

For the measurement of CSAMT method, the following apparatus were employed.

Apparatus	Amount	Specification
Transmitter	1	Frequency 2240, 1120, 560, 280, 140, 70, 35, 17.5, 8.75, 4.38, 2.19, 1.09 Hz Power 1 kW
Receiver	2	Input level 10 micro V Output Display Digital 4 figures Band Pass Filter, Notch Filter 50 Hz/60 Hz
Sensor	1 set	Telluric Current Sensor x 1 Magnetic Field Sensor x 2

(Accessory)

Handheld Computer	a set
Tools	a set
Others	a set

II.2.2 Method of measurement

Method of measurement by CSAMT survey is shown in Fig. II.8, roughly.

After generating power by 1 kw generator, electric current of 12 steps of 2240, 1120, 560, 280, 140, 70, 35, 17.5, 8,75, 4.38, 2.19 and 1.09 Hz were input into a square loop of a side of the approximate length of 300 meters to generate artificial magnetic field.

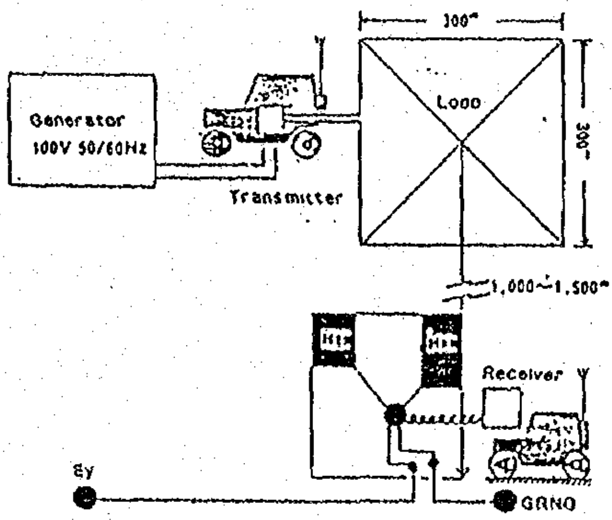


Fig. II.8 Method of measurement of CSANT survey

A receiver was located at a point that is spaced apart by about 700 to 1,500 meters from those loop, and signals were revelved with sensors of Hx, Hz and Ky. As the reveived signals were as low as 10 to 20 microvolts, they were at first amplified with an amplifier and were then fed through a band-pass filter matched with the frequency of the current flowing through the loop and a 50 Hz notch filter. Finally, an averaged value was digitalized and was directly read out of the display panel. This value was input to a hand-held computer for data processing and simple data processing was executed on the field. Computation of apparent resistivity curve, penetration depth curye and of bostic inversion was made as this data processing. Measurement was taken once again in the case where the result of this computation was judged unsatisfactory.

III. Analysis and Results

III. ANALYSIS AND RESULTS

III.1 Method for Analysis

The analyzing procedure is indicated below.

1. CSAMT method
2. MT method
3. Figure/table
4. Data
5. Spectrum analysis
6. Tipper, impedance tensor analyses
7. Geophysical parameters
8. Sounding curve
9. Apparent resistivity isocontours
10. One-dimensional analysis
11. Total conductance isocontour
12. Division of layers
13. Structure isocontours for the top of conductive formation
14. Electrical foundation
15. Two-dimensional model analysis
16. Two-dimensional sectional view

III.1.1 Results of the CSAMT method

The apparent resistivity was calculated from the field records of the measured values, according to the following formula.

$$\rho a = (K/\mu_0 f)\ [Ey/Hx]^2$$

Here ρa: apparent resistivity (ohm-m)

μo: magnetic permeability

f : frequency (Hz)

K : correction coefficient

This formula is similar to that used as the base for the MT method. However, in this case of the formula for CSAMT method, correction coefficient K which is a function of (Hx/Hz) is included. The apparent resistivity is obtained according to the following formula, too.

$$\rho a = K' \mu o r^2\ 2\pi f/(9Hx/Hz)$$

Here ρa: apparent resistivity (ohm-m)

μo: magnetic permeability

f : frequency (Hz)

K' : correction coefficient

r : distance between the receiver and the center of the loop (m)

In this formula, K' is also a function of Hx/Hz.

III.1.2 Method for Analysis of MT Method

The data of five components of electric field and magnetic field obtained through measurement by MT method are at first converted by spectrum analysis into frequency region from time region. In the frequency region, the magnitude and phase of amplitude of each component are expressed as complex numbers.

The following discussions are made in the frequency region.

After the spectrum analysis, the data of these five components are analyzed in accordance with two analysis techniques, that is, impedance tensor analysis and tipper analysis, and geophysical parameters are obtained as a result. Impedance tensor analysis is to obtain various parameters by analyzing the relation of four components of horizontal components of electric field and magnetic field; and tipper analysis is to obtain various parameters through analysis of the relation among three components of magnetic field.

(1) Tipper analysis

The relation between the horizontal components and vertical components of magnetic field is expressed by such a linear coupling that is shown below.

$$H_2 = Tx\ Hx + Ty\ Hy$$

This is the expression that regulates the action from a horizontal magnetic field to a vertical magnetic field. Txty is the contant that determines the inclination (tip) of pole division of the magnetic field/and is called a tipper. It can be obtained when the following formulas are solved.

$$<Hz\ Hs^*> = Tx\ <Hx\ Hx^*> + Ty\ <Hy\ Hx^*>$$

$$<Hz\ Hy^*> = Tx\ <Hx\ Hy^*> + Ty\ <Hy\ Hy^*>$$

* means a conjugate complex number, and < > means a power spectrum.

The parameters obtained from this topper are explained below.

a) Tipper magnitude

Tipper magnitude = $Tx^2 + Ty^2$

This magnitude is an index that indicates the structure. One-dimensional character is strong when this value is close to zero and two-dimensional character is strong when this value is larger. Furthermore, this index remains unchanged despite rotation of the coordinates with Z-axis as the center.

b) Minimum value of Tx (MIN Tx)

The value of Tx changes when the orthogonal coordinates system is rotated with Z-axis as the center. When the angle at which the value of Tx is the minimum is selected, this value becomes zero if the earth is of two-dimensional structure. It is possible to learn the structure of the earth when this value and the tipper magnitude mentioned earlier are considered together.

c) Tipper strike

Tipper strike indicates the rotating angle of the coordinates that gives the minimum value of Tx mentioned in paragraph b) above, and it is obtained by the following expression.

$$\theta t = 1/2 \tan^{-1} \frac{2Re\ (Tx\ Ty^*)}{|Tx|^2 - |Ty|^2}$$

When the angle at which the value of Tx is the minimum is selected, it is parallel with the direction of the structure.

d) Tipper's phase

This is the phase of Tx after rotation of coordinates. It indicates the action from a horizontal magnetic field in the direction that is normal to the travelling direction to a vertical magnetic field.

(2) Impedance tensor analysis

The relation among four horizontal components of the electric field and magnetic field is expressed by such a linear coupling that is indicated below.

$$Ex = ZxxHx + ZyyHy$$
$$Ey = ZyxHx + ZyyHy$$

The matrix of coefficients is expressed by tensor with the electric field and magnetic field as vectors, and it is called impedance vector.

It can be obtained when the following formulas are solved like the case of tipper.

$$\langle Ex\ Ax^* \rangle = Zxx\ \langle Hx\ Ay^* \rangle + Zxy\ \langle Hy\ Ay^* \rangle$$
$$\langle Ex\ Ay^* \rangle = Zxx\ \langle Hx\ Ay^* \rangle + Zxy\ \langle Hy\ Ay^* \rangle$$
$$\langle Ey\ Ax^* \rangle = Zyx\ \langle Hx\ Ax^* \rangle + Zyy\ \langle Hy\ Ax^* \rangle$$
$$\langle Ey\ Ay^* \rangle = Zyx\ \langle Hx\ Ay^* \rangle + Zyy\ \langle Hy\ Ay^* \rangle$$

Either electric field ExEy or magnetic field HxHy may be selected here as AxAy.

Various parameters obtained through this impedance tensor analysis are explained below.

a) Skew

Skew is defined by the following expression.

$$SKEW = \frac{|Zxx + Zyy|}{|Zxy - Zyx|}$$

If the earth is of one-dimensional or two-dimensional structure, this value is zero. The magnitude of this value is an index that indicates the three-dimensional property. Further, this value remains unchanged despite rotation of the coordinates.

b) Rotating angle

$$\Theta z = \frac{1}{4} \arctan \frac{2 \, Re \, [(Zyy-Zxx)(Zxy^* + Zyx^*)]}{|Zxy + Ayx|^2 - |Zyy-Zxx|^2}$$

This angle means rotating angle Θz at which components Zxy Zyx of impedance stensor become the maximum when the coordinates are rotated with Z-axis as the center, and it is indicated by the angle formed between the measured X direction and the travelling direction.

c) Apparent resistivity and phase

The apparent resistivity and phase are obtained by the following expression by making use of impedance tensor after rotation of the coordinates mentioned above.

1. Axial apparent resistivity $[(Rhox) = 0.2 \, |Zxy|^2$
2. Axial phase $(Phasex) = \tan^{-1}[(IMAG(Zxy)/REAL(Zxy)]$
3. Radial apparent resistivityy $(Rhoy) = 0.2 \, |Zyx|^2$
4. Radial phase $[(Phasey) = \tan^{-1} (IMAG(Zyx)/(REAL(Zyx)]$

d) Simple coherency (Coh ( ))

The simple coherency can be obtained by the following expression.

$$COH (AB) = \frac{\langle AB^* \rangle}{[\langle AA^* \rangle \langle BB^* \rangle]^{1/2}}$$

A and B are components of electric field and magnetic field. Values after rotation of the coordinates were also used here.

e) Multiple coherency (ExPred Ex EyPred Ey)

$$\text{Multiple coherency} = \frac{< E^Q\ E^{Q*} >}{[< E^Q\ E^{Q*} >\ < E\ E^* >]^{1/2}}$$

E^Q is this expression is a value that should be called a forecast value of the electric field computed from the impedance tensor obtained through computation and the measured value of the magnetic field. It indicates the coherency between measured value E of the electric field and forecast value E^Q of the electric field obtained through impedance analysis. If no noise has entered the measured data, this value is 1. In other words, the data is better when this value is closer to 1 and that the data is worse when this value is closer to O.

f) Error bar

The error bar shown in the numeral chart and graph of apparent resistivity expresses the product of each apparent resistivity value and the multiple coherency mentioned above.

III.1.3 One-Dimensional Model Analysis

First of all, one-dimensional model analysis was conducted at each one of all sounding points based on the apparent resistivity value of each period measured by both CSAMT method and MT method. It was conducted in such a manner that an electrical underground layer model of the bed is assumed, a theoretical apparent resistivity curve is obtained and is compared with the curve obtained through measurement; and if they are not matched, the layer model is automatically changed and this sequence is repeated until both of them are completely matched, in order to obtain the depthwise distribution of the underground resistivity. The total conductance value was computed by the following expression after the depth analysis using the one-dimensional model mentioned above.

$$Ct = \sum_{i=1}^{11} (\Delta\ Hi/\rho i)$$

Ct	:	Total conductance	1
Δ Hi	:	Thickness of layer i (m)	2
ρi	:	Specific resistivity of layer i (Ω−m)	3

III.1.4 Two-dimensional Model Analysis

Two-dimensional model analysis was conducted in order to determine the conductive ground layer and the approximate depth of promising fracture in the area in which abnormality in conductance was observed in the total conductance isocontours.

In the two-dimensional model analysis, computation is made assuming that the conductance value is fixed in the direction that is vertical to the specified section. The reason why two-dimensional model analysis is effective despite presence of such an assumption is that it may be considered that even if the electrical structure of the earth in practice is of a three-dimensional structure, it can be similarly handled as a two-dimensional structure in the case where it has a symmetrical axis along a certain direction. Furthermore, the most effective method for application of a two-dimensional model in practice is to select an area in which sudden changes in the conductance value are observed in the total conductance isocontours.

In this two-dimensional model analysis, model computation of theoretical conductance values was repeated, and the two-dimensional model was determined so as to become close to the conductance value obtained from measured values.

In conductance was observed in the total conductance isocontours.

III.2 Results of Geophysical Analysis

III.2.1 Computation of Geophysical Parameters

Geophysical parameters were computed in accordance with the method described in the preceding section, i.e., method for analysis by MT method. The obtained results are indicated in the results of computation of geophysical parameters in the appendices in the form as output out of a computer. They are arranged for each sounding point and are described as follows.

Table 1	Typical result of tipper analysis
Table 2	Typical simple coherency of magnetic field Typical tipper coherency
Table 3	Typical plotting of tipper magnitude vs. period
Table 4	Typical plotting of tipper strike vs. period
Table 5	Typical plotting of tipper's phase vs. period
Table 6	Typical result of impedance tensor analysis
Table 7	Typical plotting of apparent resistivity vs. period
Table 8	Typical plotting of phase vs. period
Table 9	Typical plotting of rotating angle vs. period

(All of plottings are with error bar indications.)

Table 1 Typical result of tipper analysis

Tipper Results for Station 103 San Kampaeng, Thailand

PERIOD	TIPPER	MIN TX	STRIKE	PHASE
2.3	.1684 +/- .0787	.0753 +/- .0709	124.5 +/-18.1	20.7 +/- 9.6
2.3	.1861 +/- .0752	.0591 +/- .0597	137.2 +/-11.3	7.7 +/- 7.1
2.3	.1871 +/- .0808	.0967 +/- .0764	165.1 +/-18.9	-22.5 +/- 8.9
2.9	.1322 +/- .0833	.0750 +/- .0828	146.4 +/-51.8	1.9 +/-31.5
3.0	.1761 +/- .0946	.0861 +/- .0833	176.7 +/-24.6	-26.2 +/-12.4
3.0	.1726 +/- .0956	.0826 +/- .0815	5.0 +/-24.5	156.7 +/-13.2
3.8	.4002 +/- .1684	.0627 +/- .0888	139.9 +/- 9.4	4.9 +/- 7.5
3.9	.4504 +/- .1722	.1048 +/- .1112	143.6 +/- 8.4	4.7 +/- 6.2
4.0	.4786 +/- .1849	.2016 +/- .1591	142.1 +/-11.3	13.9 +/- 6.7
4.9	.7679 +/- .2954	.1868 +/- .1768	159.8 +/- 7.1	-3.4 +/- 6.3
5.2	.5771 +/- .2730	.0025 +/- .0205	173.2 +/- 8.5	-2.7 +/- 9.5
5.3	.5927 +/- .2585	.0418 +/- .0802	167.6 +/- 7.5	-22.9 +/- 8.1
6.4	.4296 +/- .3012	.2147 +/- .2424	170.7 +/-38.3	-53.2 +/-29.0
10.7	.1838 +/- .1542	.0202 +/- .0558	174.2 +/-24.7	-16.6 +/-29.9
11.1	.2716 +/- .1917	.0467 +/- .1072	84.0 +/-27.5	-40.8 +/-21.2
12.8	.1792 +/- .1422	.0738 +/- .1014	168.6 +/-35.2	-104.2 +/-39.0
16.0	.1775 +/- .1422	.0228 +/- .0519	6.2 +/-19.9	134.0 +/-27.6
18.3	.1677 +/- .1224	.0329 +/- .0563	171.0 +/-18.1	-39.9 +/-23.1
20.1	.1430 +/- .1143	.0238 +/- .0481	177.9 +/-20.9	-45.1 +/-27.7
25.6	.2671 +/- .1210	.0534 +/- .0797	55.7 +/-13.7	-179.3 +/- 8.8
26.9	.1513 +/- .1055	.0323 +/- .0492	141.7 +/-16.0	-95.5 +/-22.7
27.7	.1464 +/- .1110	.0151 +/- .0360	134.6 +/-17.2	-103.7 +/-24.9

Table 2 Typical simple coherency of magnetic field Typical tipper coherency

Magnetic Field Coherencies for Station 103 San Kampaeng, Thailand

PERIOD	Coh(HxHy)	Coh(HxHz)	Coh(HyHz)	Hz PredHz
2.3	.316	.079	.073	.007
2.3	.320	.095	.102	.014
2.3	.313	.067	.097	.008
2.9	.251	.043	.050	.002
3.0	.250	.044	.073	.004
3.0	.251	.038	.068	.003
3.8	.187	.107	.119	.021
3.9	.221	.124	.145	.028
4.0	.227	.123	.136	.022
4.9	.103	.096	.180	.036
5.2	.131	.034	.129	.017
5.3	.090	.051	.148	.023
6.4	.085	.040	.055	.002
10.7	.140	.007	.048	.002
11.1	.208	.086	.005	.008
12.8	.100	.034	.055	.002
16.0	.323	.014	.067	.005
18.3	.546	.028	.087	.010
20.1	.568	.082	.115	.010
25.6	.590	.217	.171	.061
26.9	.613	.125	.126	.015
27.7	.627	.120	.103	.017

Table 3 Typical plotting of tipper magnitude vs. period

Tipper Magnitude for Station 103 San Kampaeng, Thailand

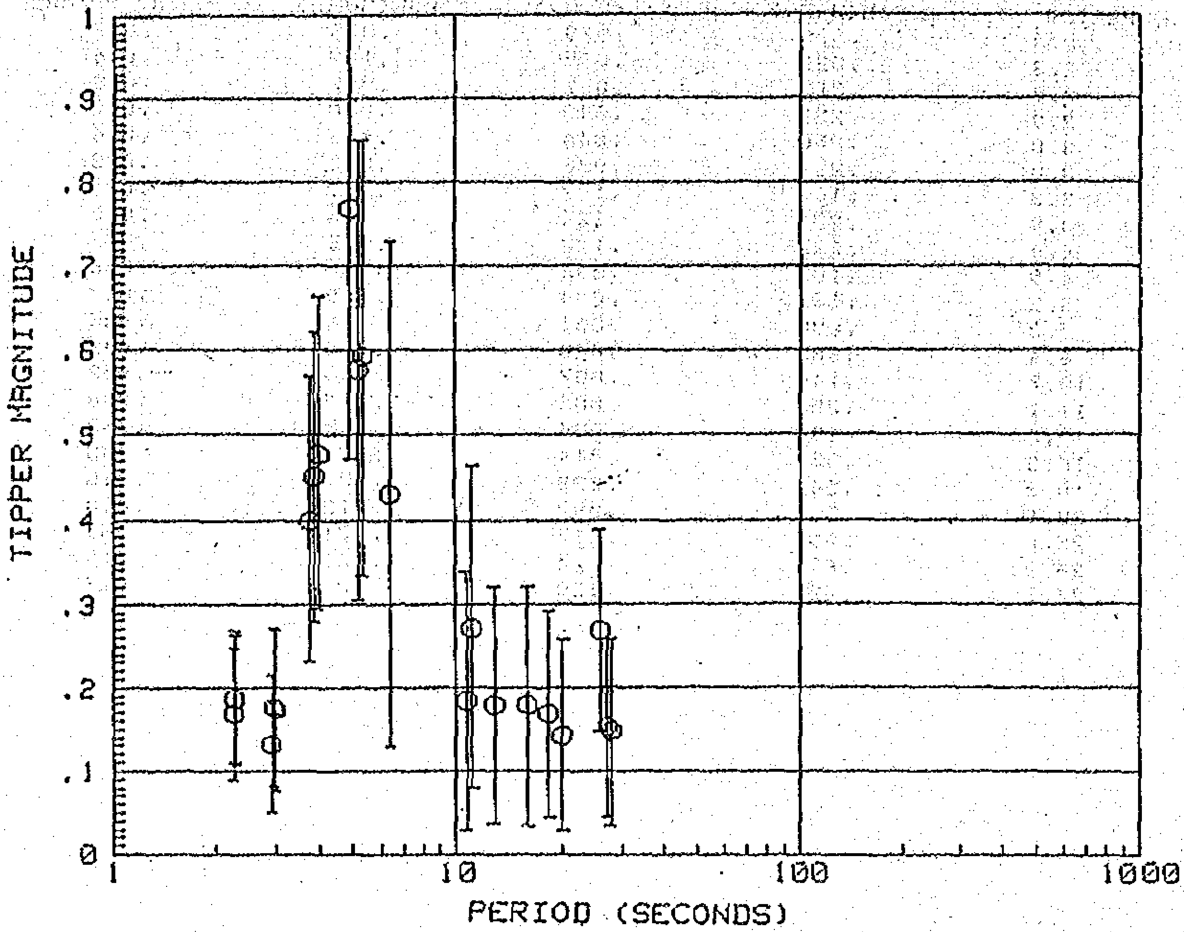


Table 4 Typical plotting of tipper strike vs. period

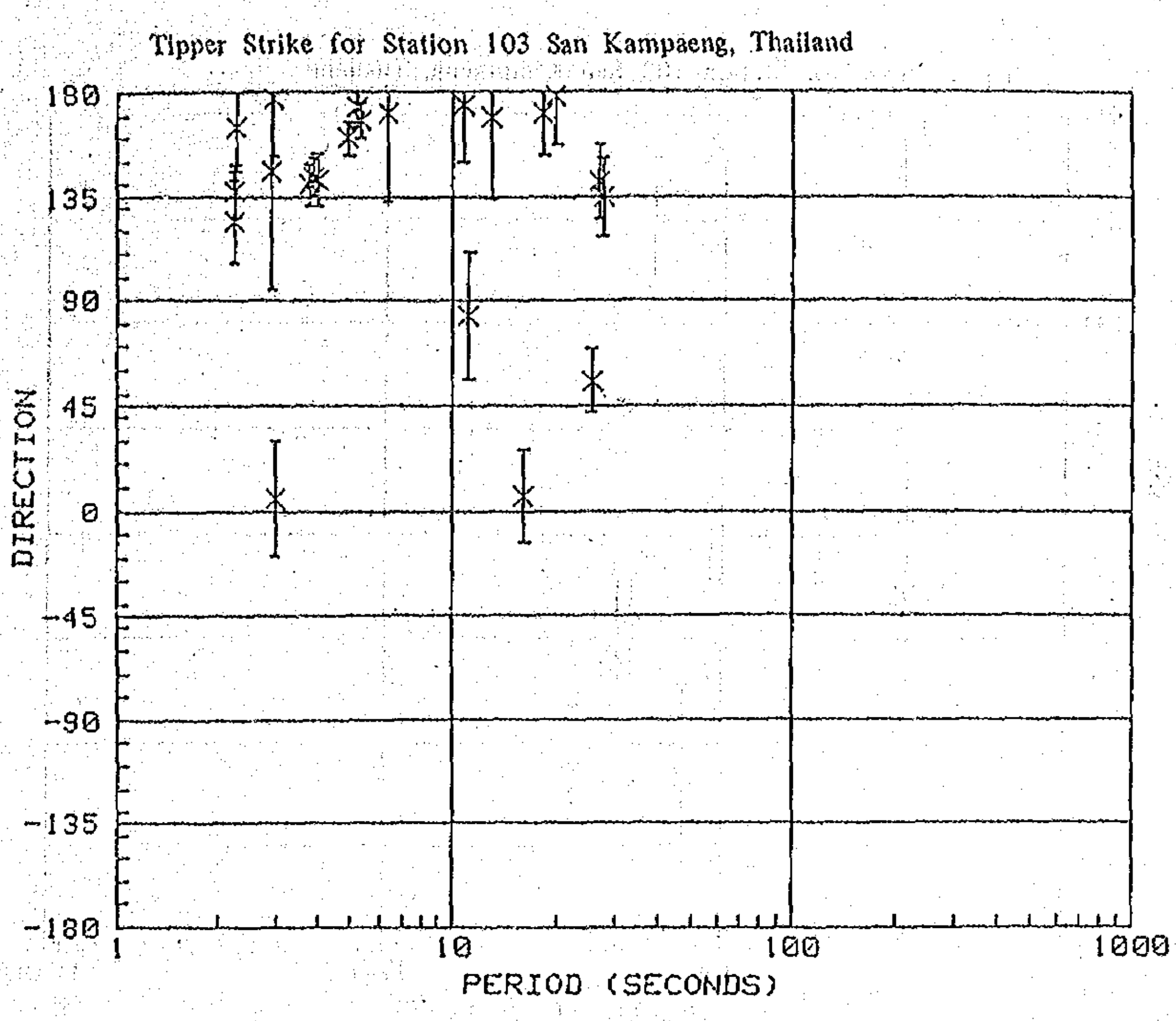


Table 5 Typical plotting of tipper's phase vs. period

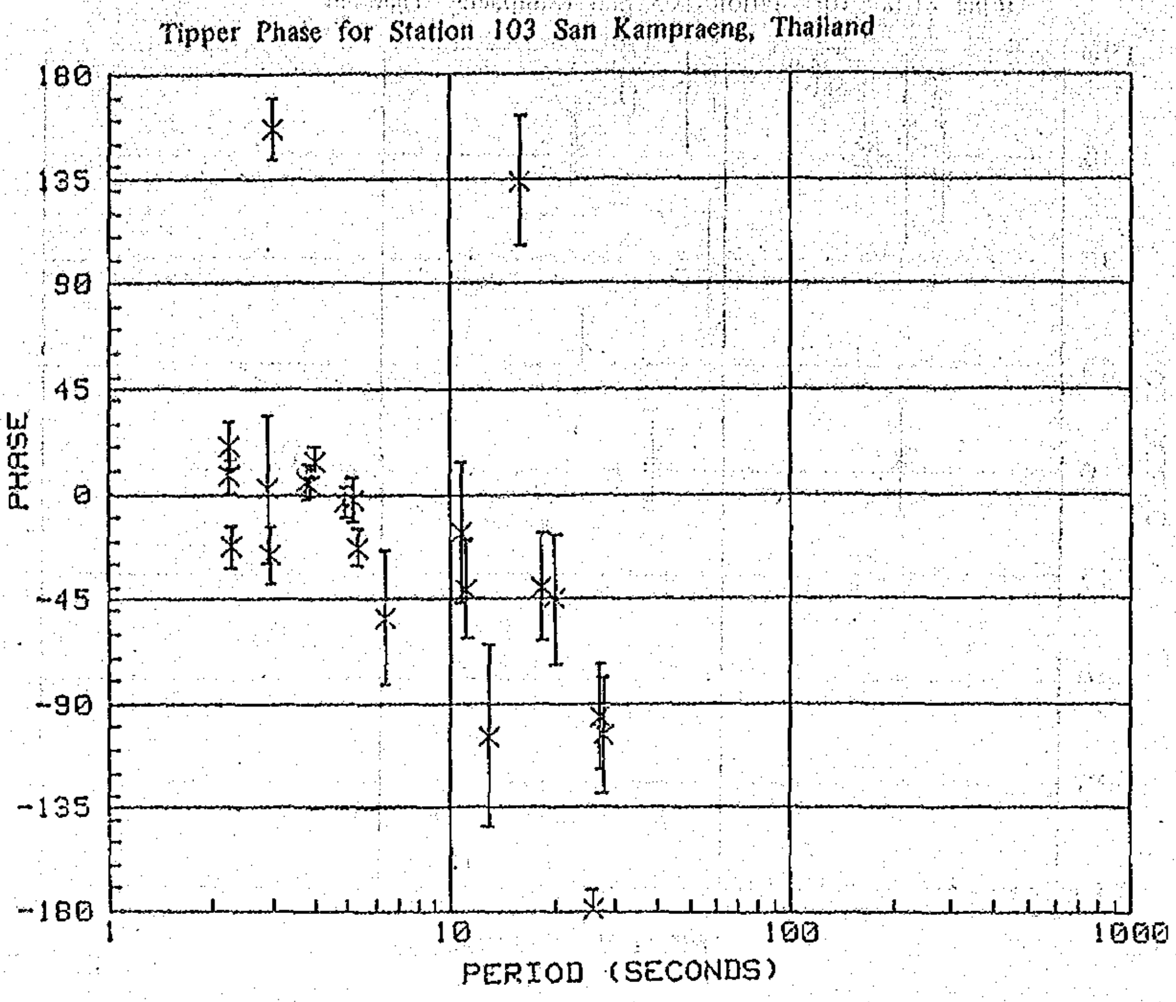


Table 6 Typical result of impedance tensor analysis

MT Results for Station 103 San Kampaeng, Thailand

PERIOD	Ex PredEx	Rho X		PHASE X		
2.3	.438	9.55E+01	+/-3.33E+00	53.4	+/-	1.1
2.3	.420	9.03E+01	+/-3.16E+00	55.4	+/-	1.1
2.3	.422	9.00E+01	+/-3.19E+00	55.8	+/-	1.1
2.9	.437	1.11E+02	+/-4.43E+00	62.0	+/-	1.2
3.0	.444	1.21E+02	+/-4.70E+00	61.6	+/-	1.1
3.0	.440	1.21E+02	+/-4.56E+00	62.5	+/-	1.1
3.8	.346	1.01E+02	+/-4.75E+00	62.0	+/-	1.4
3.9	.364	1.03E+02	+/-4.65E+00	61.6	+/-	1.4
4.0	.379	1.01E+02	+/-4.61E+00	63.2	+/-	1.4
4.9	.361	7.87E+01	+/-4.60E+00	62.2	+/-	2.0
5.2	.379	7.95E+01	+/-4.29E+00	65.7	+/-	1.7
5.3	.403	8.34E+01	+/-4.44E+00	65.6	+/-	1.6
6.4	.324	8.93E+01	+/-5.35E+00	66.5	+/-	1.7
6.9	.366	8.74E+01	+/-5.01E+00	65.7	+/-	1.7
7.3	.330	8.49E+01	+/-4.88E+00	63.9	+/-	1.7
8.4	.333	7.15E+01	+/-5.39E+00	62.6	+/-	2.4
9.3	.352	7.69E+01	+/-5.84E+00	59.8	+/-	2.2
10.7	.538	1.21E+02	+/-6.20E+00	62.8	+/-	1.5
11.1	.564	1.47E+02	+/-7.60E+00	62.1	+/-	1.5
12.8	.740	1.81E+02	+/-5.72E+00	62.8	+/-	.9
14.8	.860	2.06E+02	+/-6.49E+00	61.3	+/-	.9
16.0	.873	1.97E+02	+/-9.56E+00	62.0	+/-	1.4
18.3	1.018	2.04E+02	+/-8.59E+00	62.1	+/-	1.2
20.1	1.018	1.96E+02	+/-9.43E+00	62.2	+/-	1.4
26.9	1.060	1.84E+02	+/-1.14E+01	60.0	+/-	1.8
27.7	1.093	1.89E+02	+/-1.35E+01	59.9	+/-	2.1
39.4	.887	1.55E+02	+/-7.16E+00	57.2	+/-	1.4
42.7	.791	1.57E+02	+/-1.83E+01	46.2	+/-	3.3
60.2	.657	1.28E+02	+/-5.57E+00	51.8	+/-	1.3
102.4	.542	1.28E+02	+/-1.20E+01	47.8	+/-	2.7
204.8	.610	1.03E+02	+/-1.16E+01	41.3	+/-	3.2

PERIOD	Ey PredEy	Rho Y		PHASE Y		
2.3	.408	1.74E+01	+/-8.66E-01	-117.6	+/-	1.5
2.3	.398	1.75E+01	+/-8.63E-01	-117.5	+/-	1.6
2.3	.392	1.68E+01	+/-8.07E-01	-117.1	+/-	1.5
2.9	.392	1.65E+01	+/-1.02E+00	-124.7	+/-	1.8
3.8	.386	1.40E+01	+/-1.17E+00	-129.2	+/-	2.5
3.9	.390	1.44E+01	+/-1.21E+00	-128.4	+/-	2.6
4.0	.378	1.40E+01	+/-1.16E+00	-129.7	+/-	2.6
4.9	.347	1.41E+01	+/-1.24E+00	-125.3	+/-	3.2
5.2	.364	1.45E+01	+/-1.25E+00	-126.8	+/-	2.7
5.3	.370	1.45E+01	+/-1.16E+00	-126.1	+/-	2.5
6.4	.377	1.09E+01	+/-1.39E+00	-135.0	+/-	3.6
6.9	.381	1.30E+01	+/-1.48E+00	-130.3	+/-	3.3
7.3	.367	1.12E+01	+/-1.27E+00	-128.5	+/-	3.4
8.4	.326	1.30E+01	+/-1.56E+00	-121.2	+/-	3.8
9.3	.312	1.04E+01	+/-1.47E+00	-119.8	+/-	4.1
12.8	.755	1.31E+01	+/-1.03E+00	-116.4	+/-	2.3
14.8	.887	1.34E+01	+/-3.77E-01	-118.9	+/-	.9
18.3	.996	1.08E+01	+/-1.26E+00	-114.2	+/-	3.5
20.1	1.019	1.11E+01	+/-1.54E+00	-112.5	+/-	4.1
26.9	1.060	1.20E+01	+/-1.84E+00	-111.3	+/-	4.5
27.7	1.106	1.22E+01	+/-2.18E+00	-113.5	+/-	5.3
39.4	.884	1.01E+01	+/-2.89E-01	-111.4	+/-	.6
102.4	.543	8.91E+00	+/-2.01E+00	-75.6	+/-	6.5

PERIOD	SKEW	ROT ANG	Coh(HxHy)	(ExHx)	(ExHy)	(EyHx)	(EyHy)
2.3	.14 +/- .02	-60.4 +/- 1.3	.316	.458	.603	.631	.297
2.3	.14 +/- .02	-61.0 +/- 1.4	.320	.447	.592	.625	.287
2.3	.15 +/- .02	-61.4 +/- 1.3	.313	.449	.593	.619	.231
2.9	.20 +/- .02	-63.2 +/- 1.2	.251	.461	.573	.619	.241
3.0	.21 +/- .02	-64.1 +/- 1.2	.250	.462	.580	.626	.226
3.0	.21 +/- .02	-65.7 +/- 1.1	.251	.464	.576	.633	.226
3.8	.27 +/- .02	-71.4 +/- 1.4	.187	.432	.480	.623	.131
3.9	.27 +/- .02	-71.0 +/- 1.5	.221	.454	.491	.626	.155
4.0	.26 +/- .02	-70.2 +/- 1.6	.227	.461	.507	.616	.168
4.9	.24 +/- .03	-68.0 +/- 2.5	.103	.404	.483	.591	.096
5.2	.20 +/- .03	-65.4 +/- 2.1	.131	.419	.505	.601	.133
5.3	.23 +/- .02	-65.0 +/- 1.8	.090	.434	.502	.606	.100
6.4	.23 +/- .03	-65.0 +/- 1.7	.085	.416	.417	.618	.172
6.9	.20 +/- .03	-65.1 +/- 1.9	.115	.429	.465	.616	.149
7.3	.14 +/- .03	-64.1 +/- 1.8	.101	.383	.449	.598	.145
8.4	.09 +/- .03	-63.1 +/- 2.8	.052	.322	.490	.562	.109
9.3	.02 +/- .04	-55.1 +/- 2.1	.029	.331	.488	.537	.144
10.7	.21 +/- .03	-47.9 +/- 1.2	.140	.407	.618	.515	.306
11.1	.14 +/- .03	-50.5 +/- 1.3	.208	.487	.636	.669	.413
12.8	.18 +/- .02	-48.7 +/- .8	.100	.465	.754	.775	.443
14.8	.18 +/- .01	-50.0 +/- .6	.236	.459	.756	.829	.375
16.0	.23 +/- .03	-46.6 +/- 1.0	.323	.548	.756	.605	.366
18.3	.20 +/- .02	-47.6 +/- .4	.546	.553	.803	.832	.519
20.1	.21 +/- .02	-47.0 +/- .6	.568	.588	.821	.850	.557
26.9	.27 +/- .00	-45.9 +/- 1.0	.613	.413	.879	.764	.428
27.7	.26 +/- .01	-45.6 +/- 1.2	.627	.380	.869	.783	.416
39.4	.29 +/- .02	-44.5 +/- .6	.330	.277	.778	.814	.206
42.7	.50 +/- .09	-40.3 +/- 2.3	.267	.299	.750	.309	.200
60.2	.47 +/- .05	-39.8 +/- 1.3	.133	.548	.728	.772	.478
102.4	.60 +/- .05	-40.0 +/- 1.5	.270	.255	.655	.684	.372
204.8	.64 +/- .08	-35.8 +/- 1.9	.366	.468	.759	.681	.706

Table 7 Typical plotting of apparent resistivity vs. period

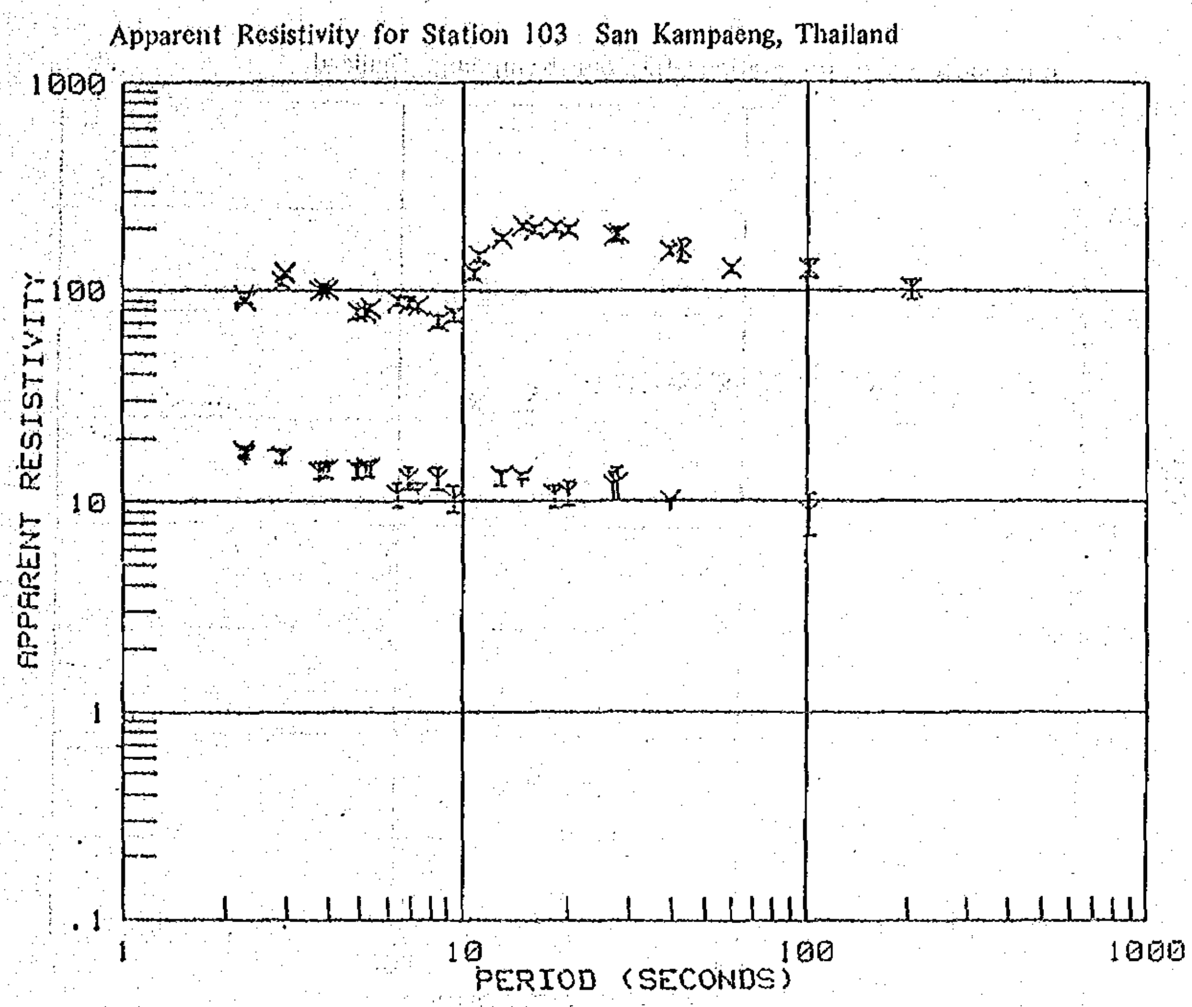


Table 8 Typical plotting of phase vs. period

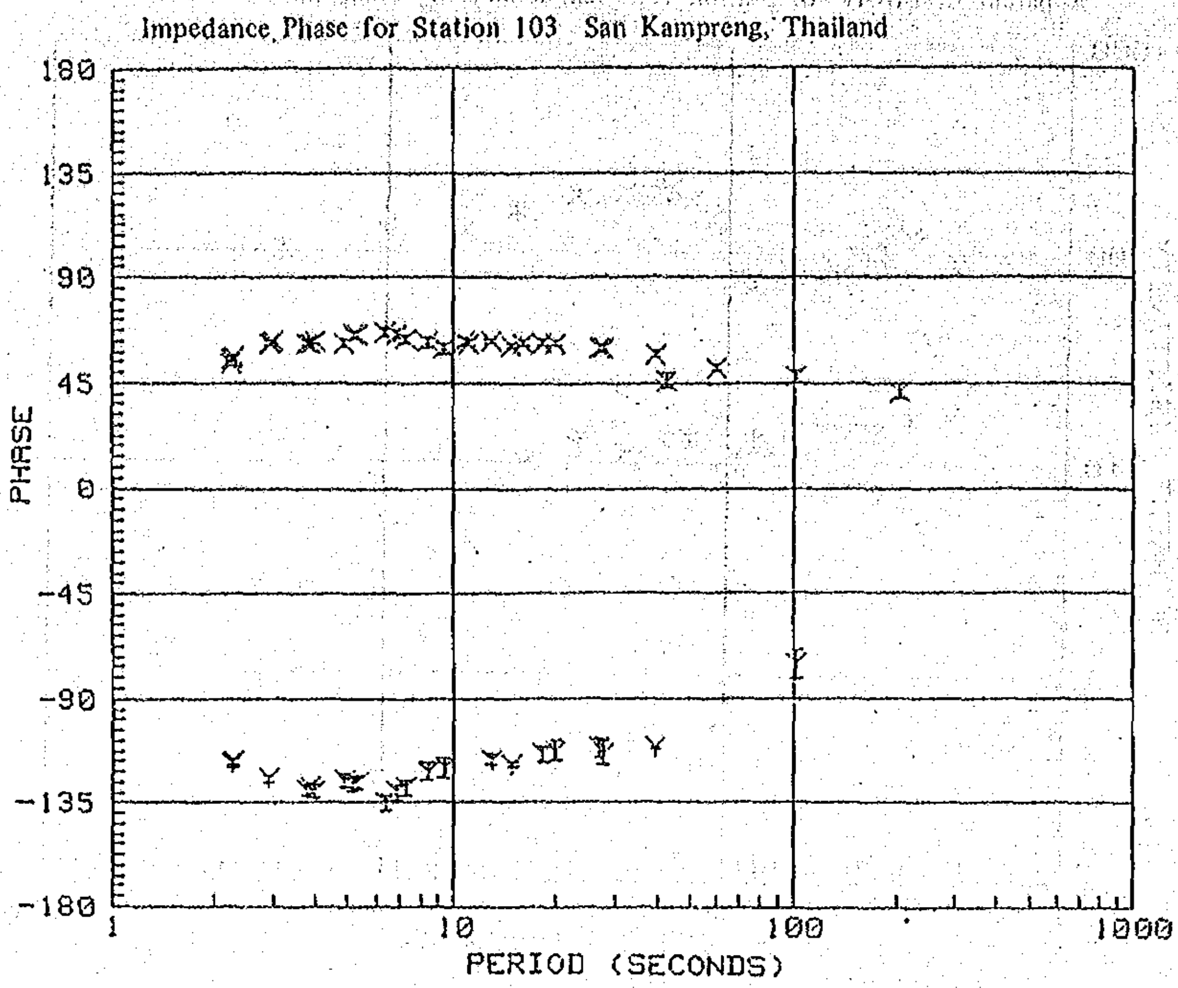
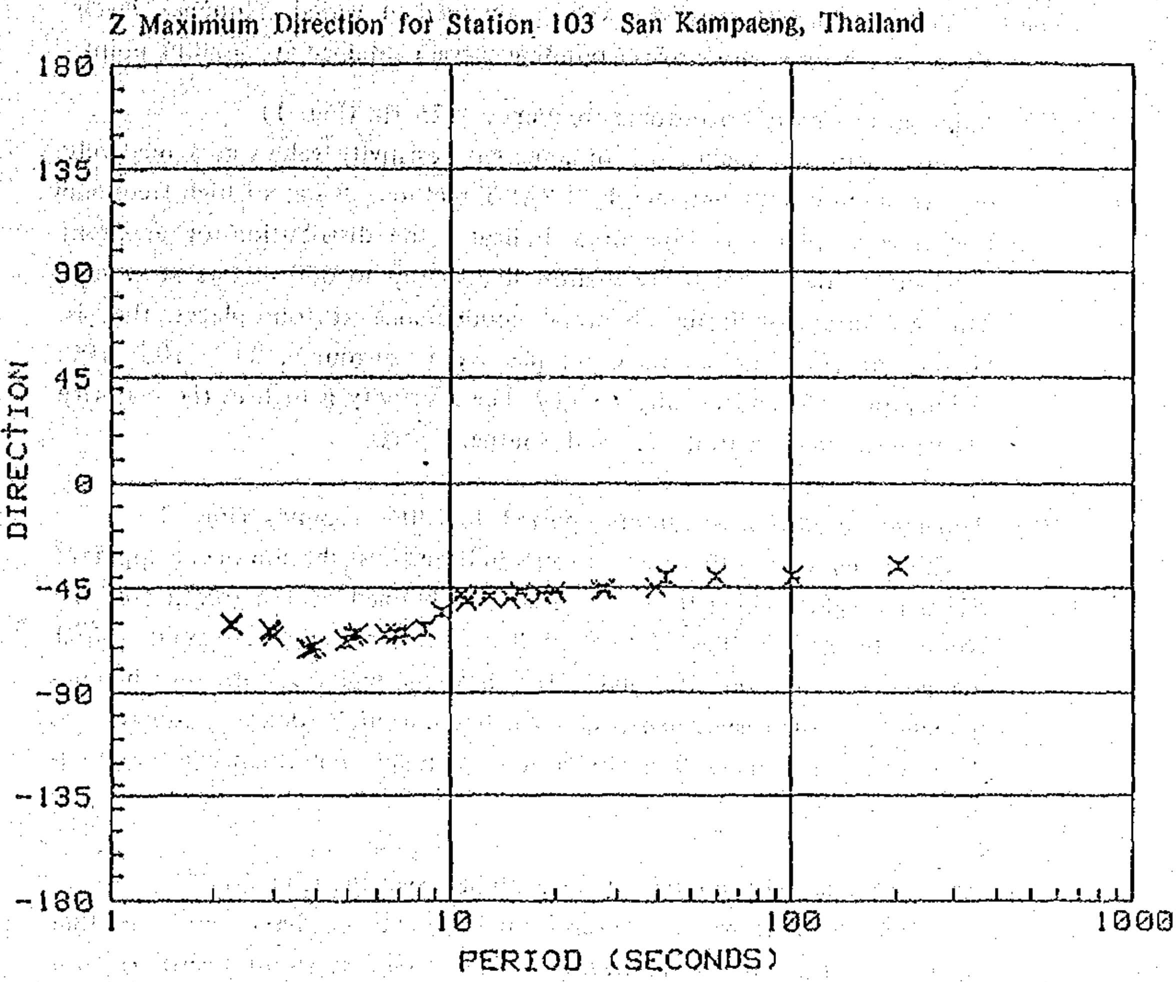


Table 9 Typical plotting of rotating angle vs. period



III.2.2 Drawings Indicating Results of Analysis

Apparent resistivity isocontours at three frequency (period) levels were drawn up as drawings indicating results of geophysical analysis. These isocontours were produced by drawing iso-apparent-resistivity lines on topographical maps with the apparent resistivity values obtained at varied frequency levels from the apparent resistivity curves (sounding curves) obtained at sounding points.

(1) Apparent resistivity isocontour; frequency 8.75 Hz (Fig. 1)

This isocontour makes use of apparent resistivity values at a relatively high frequency level obtained by CSAMT method. Being of high frequency level means that this isocontour indicates the distribution of apparent resistivity values at relatively shallow depths (up to 600 meters at average). This isocontour indicates abnormal conductance at four places, that is, vicinity of sounding points 0–1; place that surrounds 2–2, 105' 109; vicinity of 2–7; and vicinity of 119. The resistivity is high in the majority of western part, central part and southern part.

(2) Apparent resistivity isocontour; period 11.1304 secounds (Fig. 2)

This apparent resistivity isocontours indicates distribution of the apparent resistivity values along the main direction obtained by the rotation of the coordinates axis in the MT method. The central area that surrounds sounding points 2–2, 106, 109 and 110 indicates a major abnormality in conductance. In the eastern part, the area that surrounds sounding points 4–5, 3–6, 112, 118 and 119 is also a zone of major abnormality in conductance.

(3) Apparent resistivity contour; period 39.384 seconds (Fig. 3)

This isocontour was also drawn up in a manner that is equal to that of Fig. 2. However, it indicates distribution of apparent resistivity at a very deep depth because of use of apparent resistivity values at a period of 39.384 seconds.

When a comparison is made with the results obtained in 1983, it is learned that the area of abnormal conductance at the central part has become slightly small and that the area of abnormal conductance in the eastern part has considerably become large.

III.3 Results of One-Dimensional Analysis

III.3.1 One-Dimensional Model Analysis

The underground layer models for this survey were determined as shown in the computer output forms of results of depth analysis attached to the end of this report. They are arranged for each sounding point.

The details of the matters indicated in the attached computer output forms showing the results of analysis are as follows.

Table 10 Typical one-dimensional model analysis

a) Plotting of measured apparent resistivity vs. period (with error bar indication) after rotation of coordinates system

b) Apparent resistivity curve computed based on the distribution of resistivity obtained through one-dimensional model analysis

c) Total conductance value

d) Distribution of resistivity obtained through one-dimensional model analysis

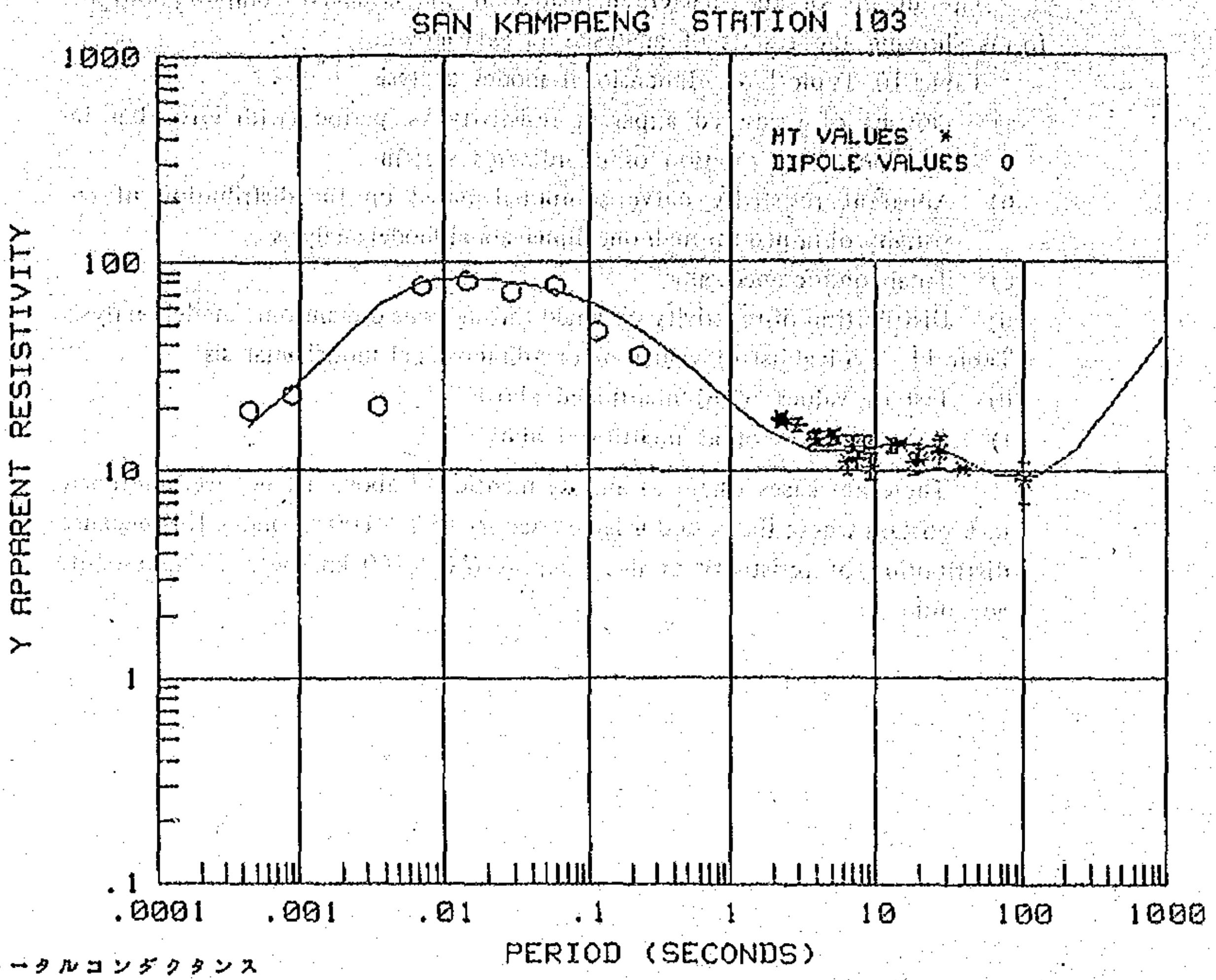
Table 11 Typical list of values of one-dimensional model analysis

e) List of values of b) mentioned above

f) List of values of a) mentioned above

There are cases where a) and b) mentioned above are not well matched in a portion where the period is large (vicinity of T = 100 seconds). It is because distribution of resistivity at deep depths (40 to 60 km) was not taken into account.

Table 10 Typical one-dimensional model analysis



トータルコンダクタンス
TOTAL CONDUCTANCE = 281.8 (MHOS) (FOR TOP 7 LAYERS)

LAYERED MODEL

RESISTIVITY	DEPTH(KM)	ALTITUDE(M)
		360.0 (SURFACE)
20.0	.021	339.0
3.0	.024	336.0
400.0	.350	10.0
40.0	1.000	-640.0
3.0	1.010	-650.0
15.0	1.300	-940.0
5.0	2.500	-2140.0
25.0	8.000	-7640.0
6.0	15.000	-14640.0

Table 11 Typical list of values of one-dimensional model analysis

SAN KAMPAENG STATION 103

MODEL DATA

PERIOD (SECONDS)	APPARENT RESISTIVITY
.0004	16.46
.0009	24.60
.0018	40.55
.0036	62.49
.0071	80.16
.0143	84.69
.0286	80.97
.0570	73.77
.1143	62.50
.2286	47.72
.4571	33.48
.9143	22.18
1.8286	15.13
3.6571	12.18
7.3142	12.32
14.6284	13.60
29.2569	12.56
64.0000	9.51
128.0000	9.33
234.0550	12.59
468.1100	22.27
936.2244	43.08

Y-AXIS FIELD DATA

PERIOD (SECONDS)	APPARENT RESISTIVITY		
.0004	19.33		
.0009	22.84		
.0036	20.49		
.0071	77.75		
.0143	80.73		
.0286	72.52		
.0571	77.14		
.1143	46.26		
.2283	35.43		
2.2605	17.37	±	.866
2.2756	17.52	±	.863
2.2857	16.84	±	.907
2.9257	16.45	±	1.015
3.7926	14.01	±	1.168
3.9084	14.36	±	1.205
4.0000	14.03	±	1.157
4.9231	14.09	±	1.239
5.1717	14.53	±	1.247
5.3333	14.47	±	1.163
6.4000	10.88	±	1.386
6.9189	12.95	±	1.483
7.3143	11.15	±	1.268
8.3934	13.00	±	1.556
9.3091	10.41	±	1.466
12.8000	13.13	±	1.033
14.8406	13.35	±	.377
18.2857	10.78	±	1.262
20.0784	11.13	±	1.540
26.9474	12.04	±	1.838
27.6757	12.24	±	2.177
39.3846	10.13	±	.289
102.4000	8.91	±	2.011

III.3.2 Electrical Classification of Layers

Next, classification of layers was made using electrical synthetic layers over the entire survey area based on the results of one-dimensional analysis at each of the sounding points mentioned earlier. The resistivity value of each layer was represented by the mean value of resistivity obtained through one-dimensional analysis for each point. Classification was made to the following four combinations from the results of measurements at 53 sounding points in total including the sounding points at which measurements were taken in 1983.

R indicates a layer of high resistivity and C indicates a layer of high contance.

First combination

This combination is composed of the following 7 sounding points at which the total conductance value is up to 50 mho.

Sounding points: 1–3, 2–0, 3–0, 3–4, 4–2, 101 and 108

Mean resistivity value	Corresponding layer name
2170,0 Ω·m	Ra 1
3,0	Ca
2870,0	Rb 1
5,0	Cb
3417,0	Rc 1
54,0	Cc 1
	Foundation

The foundation is of extremely high resistivity. Symbol R indicates a layer of relatively high resistivity and symbol C indicates a bed of high conductance.

Second combination

This combination is composed of the following 12 sounding points at which the total conductance value is over 50 to 100 mho.

Sounding points: 0–1, 0–2, 1–1, 1–2, 2–4, 2–5, 2–6, 3–1, 4–0, 4–1, 102 and 111

Mean resistivity value	Corresponding bed name
533.0 Ω·m	Ra 2
3.0	Ca
618.0	Rb 2
5.0	Cb
4250.0	Rc 2
35.0	Cc 2
	Foundation

Third combination

This combination is located on the west side of sounding point 112 and includes sounding points of total conductance value of over 100 mho.

This combination is composed of the following 23 sounding points.

Sounding points: 0–3, 1–0, 1–4, 1–5, 1–6, 1–7, 2–1, 2–2, 2–3, 2–7, 3–2, 3–3, 3–5, 4–3-2, 4–3, 4–4, 103, 104, 105, 106, 107, 109 and110

Mean resistivity value	Corresponding bag name
565.0 Ω·m	Ra 3
3.0	Ca
858.0	Rb 3
5.0	Cb
3961.0	Rc 3
29.0	Cc 3
	Foundation

There occasionally are cases where base Cc 3 is of an extremely large thickness.

Fourth combination

This combination is composed of 11 sounding points of total conductance value of over 100 mho. This combination includes sounding point 112 and measuring points located on its east side.

Measuring points: 3–6, 4–5, 112, 113, 114, 115, 116, 117, 118, 119 and 120

Mean resistivity value	Corresponding bag name
130.0 Ω·m	Ra 4
3.0	Ca
81.0	Rb 4
5.0	Cb
5687.0	Rc 4
27.0	Cc 4
	Foundation

The foundation is not of so high resistivity, and base Cc 4 is of a very large thickness.

III.3.3 Drawings indicating results of one-dimensional analysis

(1) Total conductance isocontour (Fig. 4)

This drawing was drawn based on the total of conductance of each layer obtained through one-dimensional model analysis mentioned earlier. The total conductance is what was obtained with the Rc^1 layer or the upper layer of the electrical foundation.

(2) Structure isocontours for the top of conductive formation (shallow part and deep part) (Fig. 5, Fig. 6).

Structure isocontours for the top of conductive formation for the shallow part and deep part were drawn up like in the previous year. Structure isocontour for the top of conductive formation for the shallow part (Fig. 5) is what indicates the boundary plane of Ra layer bottom and Ca^1 layer (3 Ω-m) from the sea level. Structure isocontour for the top of conductive formation for the deep part (Fig. 6) is what draws the top of the Cb^1 layer (5 Ω-m).

(3) Isopachs of the high resistivity overburden (Fig. 7)

This drawing indicates changes in the thickness of the overburden of high resistivity that covers conductive layer Cb^1. (It was considered that the thickness of the Ca layer can be ignored because it is thinner than the Cb layer.)

(4) Electrical foundation drawing (Fig. 8)

This drawing indicates the depth from the sea level of the lower part of conductive layer Cb. According to the result of this survey there are cases where the resistivity vakue of the electrical foundation is not large.

III.3.4 Results of Analysis

Two major conductive layers were indicated in the survey area as a result of one-dimensional analysis. One is the Ca layer (mean resistivity 3 Ω-m) located in a shallow part, and another is the Cb layer (mean resistivity 5 Ω-m) located in a deeper part.

Two places with abnormal conductivity can be observed in the total conductance isocontour. One is located in the central part that includes sounding points 2–1, 2–2 and 103, and another is located in the south-eastern part that includes sounding points 3–6, 4–5, 112 and 113. The expansion of the place with abnormal conductance is the south-eastern part was clarified as a result of this survey, and it was found out to be of a considerably large area size.

The inclided axis shown in the structure isocontour for the top of conductive formation (deep part) and this place where total conductance is abnormal are almost match. Furthermore, they are also matched with the inclined axis of the electrical foundation. It has become apparent, therefore, that a thickconductive layer is located on top of the raised electrical foundation and that it indicates abnormal conductivity.

III.4 Results of Two-Dimensional Model Analysis

Results of two-dimensional model analysis of two sections named 1–84 and 2–84 are shown in Fig. 9 and Fig. 10 respectively.

Section 1–84 runs across sounding points 1–2, 105, 2–2, 106 and 3–2; and section 2–84 runs across sounding points 2–1, 103, 2–2, 109 and 2–3. These two sections make intersection almost vertically to each other.

Symbol F used in the results of two-dimensional model analysis means a fracture zone, and it indicates a narrow and small form of very high conductance. Its resistivity value was assumed as 1 Ω-m here.

Section 1-84 (Fig. 9)

Four new layers Cb-b_1, Cb-b_2, Cb-b_3 and Cb-b_4 are required besides layer Cb-b having a resistivity value that is same as what was indicated in the report of the primary investigation, and the range of their resistivity values is 26 to 36 Ω-m.

As for the range of high resistivity, the resistivity values which are same as those of the last time were used for layers Ra, Rb, Rc, Ra-b and Ra-a (it is same as Ra-a mentioned earlier).

Additional layer Ra-a_2, which is of a resistivity that is slightly higher than that of Ra-a_1, was necessary to match the total conductance value.

Use of many additional layers appears to be in conflict with the conception of standard columnar sections of four types described in section 3 of this chapter. But standard columnar sections were determined based on one dimensional hypothesis, and these layers have become necessary in order to cause the measured values to match the computed values of conductance using two-dimensional models.

Section 1-84 indicates that sounding point 2-2 is located almost at the center of a thick conductive layer (a relative narrow zone of about 400 to 500 meters of high resistivity is located in it). Furthermore, a very thick surface soil layer (Ra layer) has developed on the west side of sounding point 1-2 and on the east side of sounding point 3-2.

Section 2-84 (Fig. 10)

Very good match is also observed in this section between the measured values and computed values of conductance like in section 1-84 mentioned earlier. Sounding point 2-2 is located almost at the center of a thick conductive layer located at the depths of 1 to 3 kilometers. It is learned that the conductive layer that is located along this section is considerably larger than that is located along section 1-84.

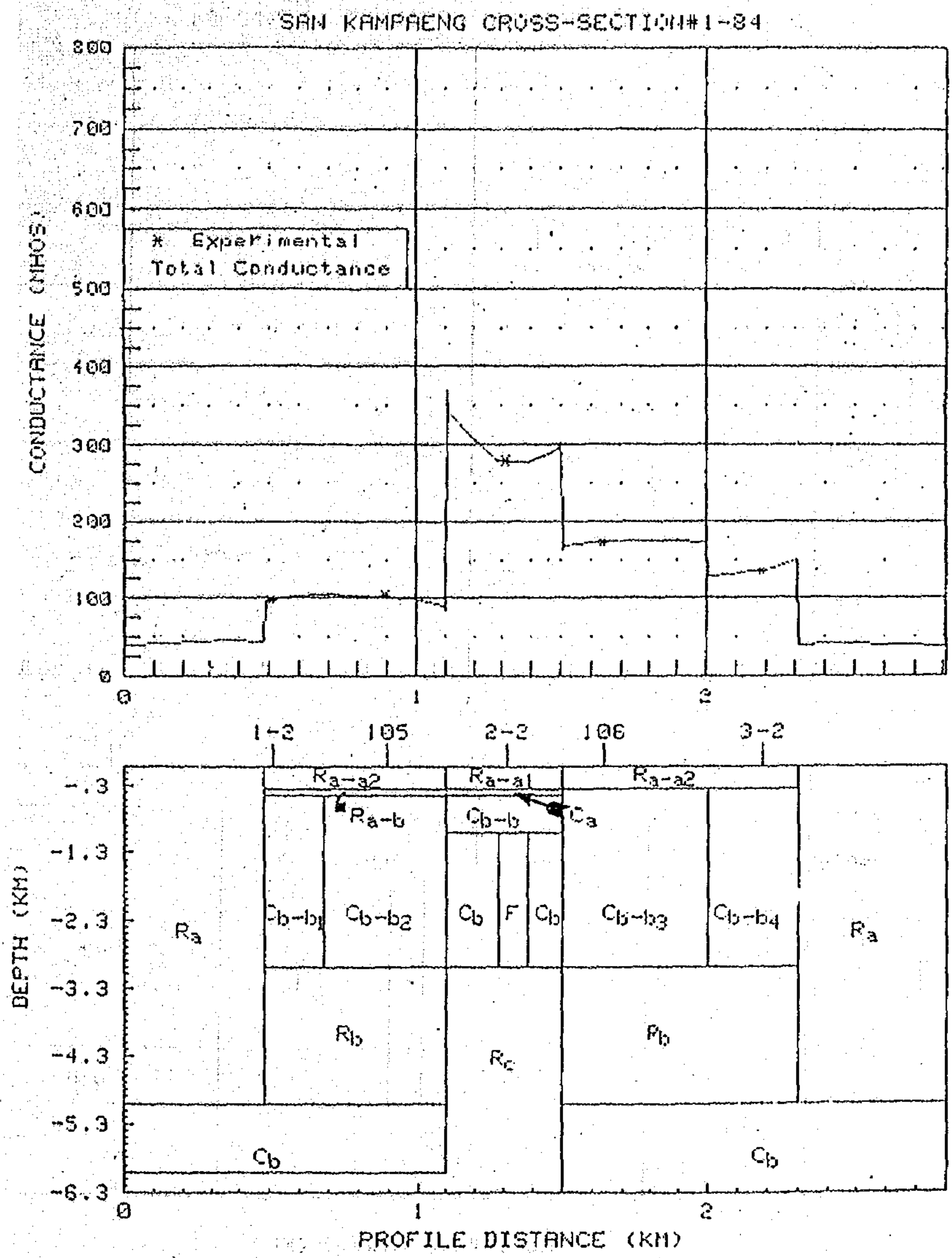


Fig. 9 Section 1–84

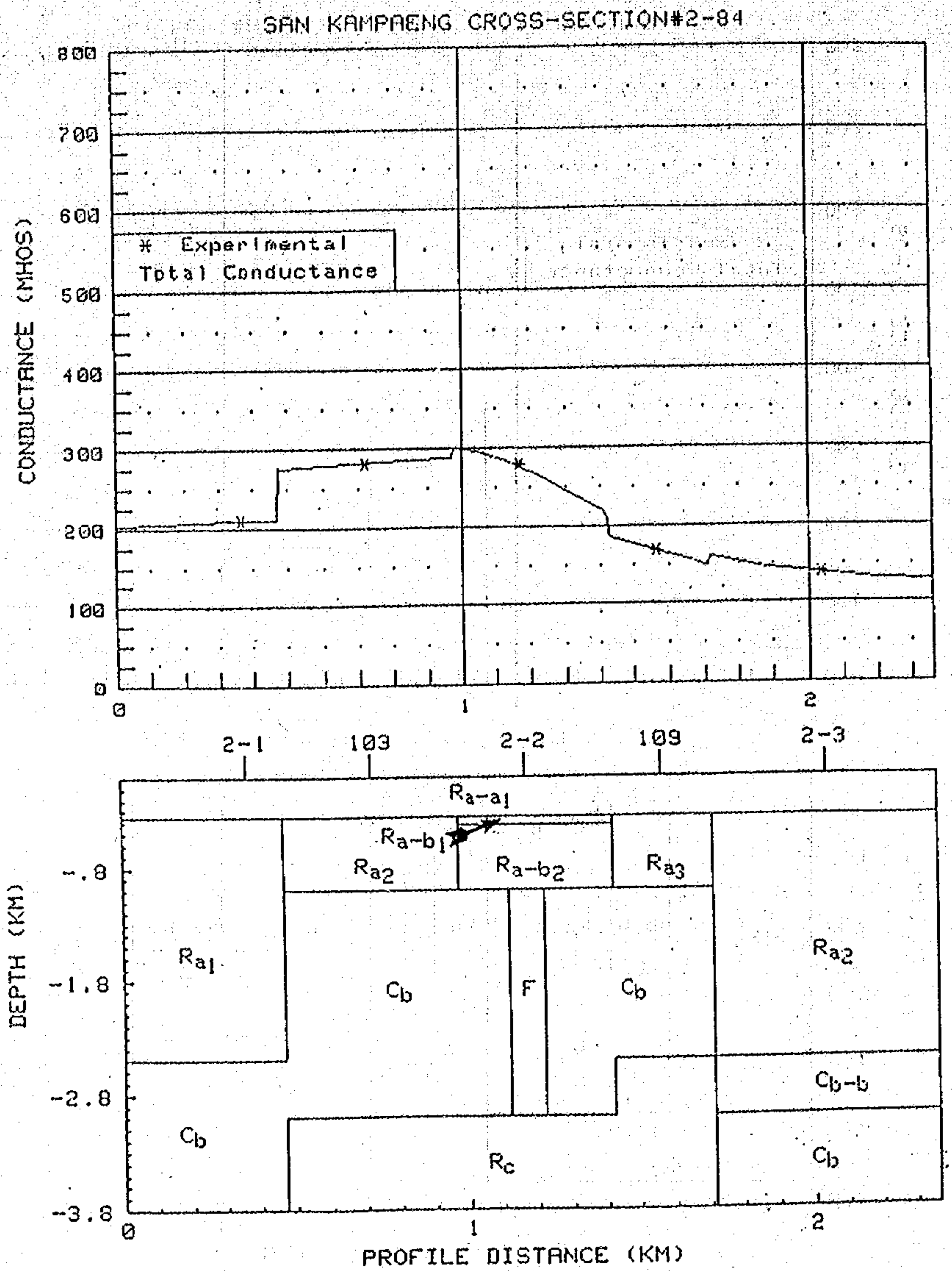


Fig. 10 Section 2–84

IV. Summary

IV. SUMMARY

Two areas which are regarded as promising geothermal zones which can be recommended as the points of excavation can be indicated in the San Kampaeng survey area based on various isocontours obtained earlier and two two-dimensional models. These two interesting areas may be decided as they are drawn with 200 mho contour lines in the total conductance isocontours. The following three promising excavation points can be recommended in these two areas.

i) Sounding point 2–2

Sounding point 2–2 is located in the central part with abnormal conductance that includes sounding points 2–1, 2–2, and 103. This abnormal part is slightly long along the axis in NW–SE direction. (Both of the two two-dimensional sections indicate that this sounding point is located about at the center of the conductive layer and that the conductive layer is as thick as about 2,000 meters. It is considered that the possibility of appearance of a good fracture is very high in such a thick layer.

ii) Sounding point 4–5

The abnormal part in the eastern part is particularly attractive because its scale is large, and it is estimated that sounding point 4–5 is a promising excavation point.

This sounding point is located in a zone where the local geological conditions are equal to what are observed at sounding point 2–2 (high total conductance value, along the inclined axis of electrical foundation and thick conductive layer). This sounding point, therefore, can probably be recommended as a promising excavation point due to the same reasons.

iii) Sounding point 112

Sounding point 112 located on the north side of the abnormal conductance area in the eastern part indicates that there is a deep but very thick conductive layer. This sounding point, however, is relatively isolated. If additional measurements are taken at a number of points in the vicinity of this sounding point, it will become clear whether a thick conductive layer can be expected in the shallow part of the vicinity of this abnormal conductance area or not.

V. References

V. References

1) Cagniard, L. (1953); Basic theory of magneto-telluric method of geophysical prospecting; Geophysics Vol. 18. p603

2) Hermance, J.F. (1973); Processing of magnetotelluric Data, Physics of the Earth and Planetary Interiors 7,349–364

3) J. Hermance, et, al (1975); The telluric-magnetotelluric method, Geophysics, Vol. 40. No.4, p664–668

4) Kunetz, G. (0972); Processing and interpretation of magnetotelluric sounding, Gyophysics, Vol. 37. No.6, p1005–1021.

5) L. Celati, et,al (1973); Geothermal Prosecting with the magneto-telluric method (M.T.-5-E.X.) in the Travale Area (Tsucany, Italy). Geothermics, Vol. 2. No. 3–4, p186–190

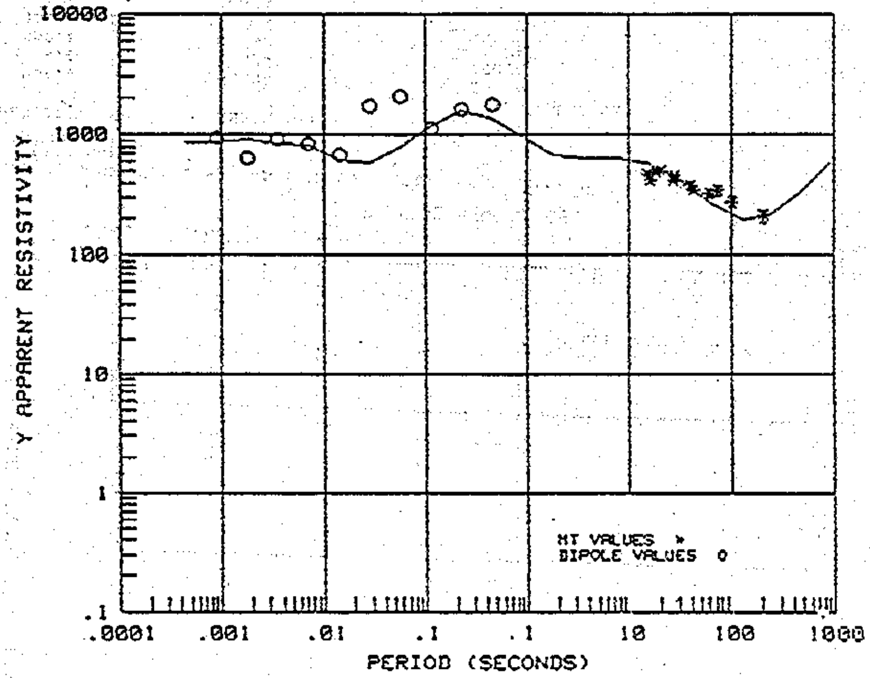
6) L. Muse (1973); A five-Component Magneto-telluric Method in Geothermal Exploration-the M.T.-5-EX; Geothermics, Vol. 2 p41-50

7) Vozoff. K. (1972); The Magnetotelluric method in the Exploration of Sedimentary Basins, Geophysics, Vol.37. No. 1, p98–141

8) Chuji Araki (1982); Journal of the Geothermal Energy Research & Development Vol. 7, No. 3 Ser. Nos. 19

APPENDED DRAWINGS

SAN KAMPAENG STATION 101



TOTAL CONDUCTANCE = 34.1 (MHOS) (FOR TOP 6 LAYERS)

LAYERED MODEL

RESISTIVITY	DEPTH(KM)	ALTITUDE(M)
		360.0 (SURFACE)
850.0	.215	145.0
900.0	1.000	-640.0
1200.0	1.250	-890.0
3.0	1.256	-896.0
12000.0	11.000	-10640.0
5.0	11.150	-10790.0
3000.0	15.000	-14640.0
1500.0	35.000	-34640.0
100.0	75.000	-74640.0

SAN KAMPAENG STATION 101

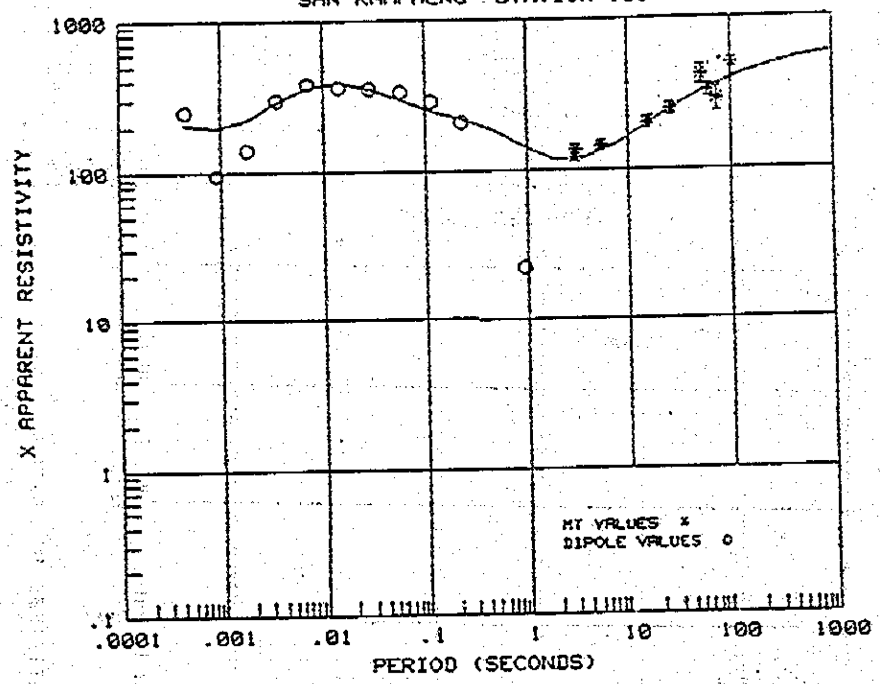
MODEL DATA

PERIOD (SECONDS)	APPARENT RESISTIVITY
.0004	852.25
.0009	853.33
.0018	910.57
.0036	850.00
.0071	825.98
.0143	620.13
.0286	579.84
.0570	779.58
.1143	1212.15
.2286	1567.11
.4571	1377.03
.9143	942.89
1.8286	686.11
3.6571	631.71
7.3142	646.82
14.6284	585.30
29.2569	439.95
64.0000	268.13
128.0000	199.07
234.0550	212.67
468.1100	327.23
936.2244	605.22

Y-AXIS FIELD DATA

PERIOD (SECONDS)	APPARENT RESISTIVITY		
.0004	.02		
.0009	934.17		
.0018	639.81		
.0036	927.62		
.0071	830.44		
.0143	685.72		
.0286	1721.02		
.0571	2079.16		
.1143	1131.19		
.2283	1656.02		
.4566	1781.22		
14.8406	479.00	±	23.184
16.0000	416.46	±	18.635
18.2857	409.83	±	20.621
20.0784	508.13	±	23.079
26.9474	421.05	±	18.150
27.6757	455.52	±	22.641
39.3846	386.05	±	22.123
42.6667	350.72	±	21.240
60.2353	333.76	±	29.646
73.1429	345.80	±	39.253
102.4000	277.04	±	[illegible]
204.8000	213.49	±	[illegible]

SAN KAMPAENG STATION 102



TOTAL CONDUCTANCE = 65.2 (MHOS) (FOR TOP 5 LAYERS)

LAYERED MODEL

RESISTIVITY	DEPTH(KM)	ALTITUDE(M)
		370.0 (SURFACE)
350.0	.100	270.0
4.0	.102	268.0
650.0	1.000	-630.0
130.0	5.300	-4930.0
5.0	5.450	-5080.0
300.0	6.000	-5630.0
700.0		

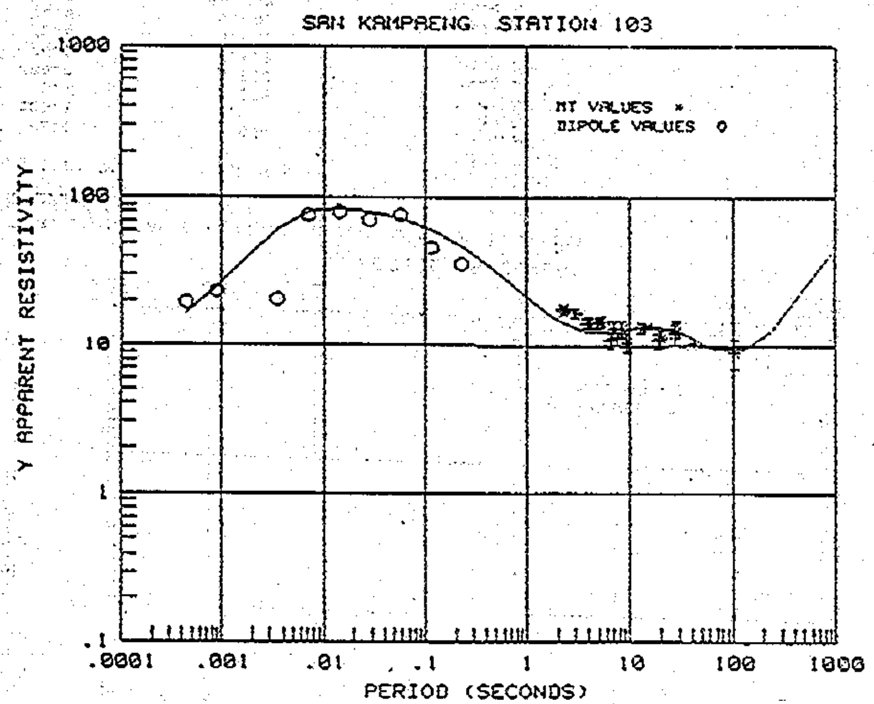
SAN KAMPAENG STATION 102

MODEL DATA

PERIOD (SECONDS)	APPARENT RESISTIVITY
.0004	207.34
.0009	196.96
.0018	225.69
.0036	291.70
.0071	365.42
.0143	390.64
.0286	356.26
.0570	299.27
.1143	249.13
.2286	223.35
.4571	190.47
.9143	144.68
1.8286	118.31
3.6571	120.95
7.3142	149.21
14.6284	198.45
29.2569	263.05
64.0000	345.08
128.0000	416.89
234.0550	473.63
468.1100	529.10
936.2244	573.47

X-AXIS FIELD DATA

PERIOD (SECONDS)	APPARENT RESISTIVITY
.0004	249.37
.0009	95.33
.0018	142.06
.0036	298.08
.0071	380.16
.0143	362.34
.0286	352.59
.0571	335.78
.1143	289.75
.2283	212.02
.9174	21.86
2.9257	122.05 +- 7.134
2.9767	138.75 +- 7.779
5.1717	144.67 +- 9.322
5.3333	148.28 +- 9.403
14.8406	204.87 +- 16.013
16.0000	214.78 +- 14.479
25.6000	254.08 +- 23.876
51.2000	419.44 +- 60.271
60.2353	330.00 +- 23.513
73.1429	291.65 +- 53.845
102.4000	495.45 +- 31.962



TOTAL CONDUCTANCE = 281.8 (MHOS) (FOR TOP 7 LAYERS)

LAYERED MODEL

RESISTIVITY	DEPTH(KM)	ALTITUDE(M)
		360.0 (SURFACE)
20.0	.021	339.0
3.0	.024	336.0
400.0	.350	10.0
40.0	1.000	-640.0
3.0	1.010	-650.0
15.0	1.300	-940.0
5.0	2.500	-2140.0
25.0	8.000	-7640.0
6.0	15.000	-14640.0

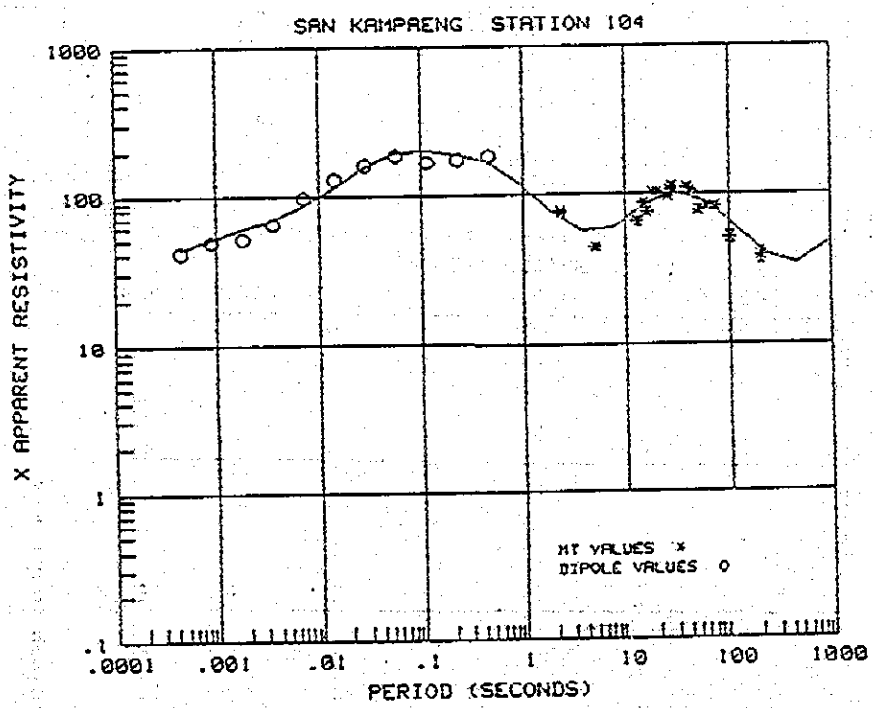
SAN KAMPAENG STATION 103

MODEL DATA

PERIOD (SECONDS)	APPARENT RESISTIVITY
.0004	16.46
.0009	24.60
.0018	40.53
.0036	62.49
.0071	80.16
.0143	84.69
.0286	80.97
.0570	73.77
.1143	62.50
.2286	47.72
.4571	33.40
.9143	22.10
1.8286	15.13
3.6571	12.10
7.3142	12.32
14.6284	13.60
29.2569	12.56
64.0000	9.51
128.0000	9.33
234.0550	12.59
468.1100	22.27
936.2244	43.00

Y-AXIS FIELD DATA

PERIOD (SECONDS)	APPARENT RESISTIVITY		
.0004	19.33		
.0009	22.84		
.0036	20.49		
.0071	77.75		
.0143	80.73		
.0286	72.52		
.0571	77.14		
.1143	46.26		
.2283	35.43		
2.2605	17.37	±	.866
2.2756	17.52	±	.863
2.2857	16.84	±	.807
2.9257	16.45	±	1.015
3.7926	14.01	±	1.168
3.9084	14.36	±	1.205
4.0000	14.03	±	1.157
4.9231	14.09	±	1.239
5.1717	14.53	±	1.247
5.3333	14.47	±	1.163
6.4000	10.88	±	1.386
6.9189	12.95	±	1.483
7.3143	11.15	±	1.268
8.3934	13.00	±	1.556
9.3091	10.41	±	1.466
12.8000	13.13	±	1.033
14.8406	13.35	±	.377
18.2857	10.78	±	1.762
20.0784	11.13	±	1.540
26.9474	12.04	±	1.838
27.6757	12.24	±	2.177
39.3846	10.13	±	.289
102.4000	8.91	±	2.011



TOTAL CONDUCTANCE = 124.2 (MHOS) (FOR TOP 6 LAYERS)

LAYERED MODEL

RESISTIVITY	DEPTH(KM)	ALTITUDE(M)
		360.0 (SURFACE)
45.0	.066	294.0
100.0	.271	89.0
3.0	.273	87.0
400.0	1.800	-1440.0
70.0	4.400	-4040.0
5.0	4.800	-4440.0
90.0	9.000	-8640.0
3500.0	30.000	-29640.0
5.0	38.000	-37640.0

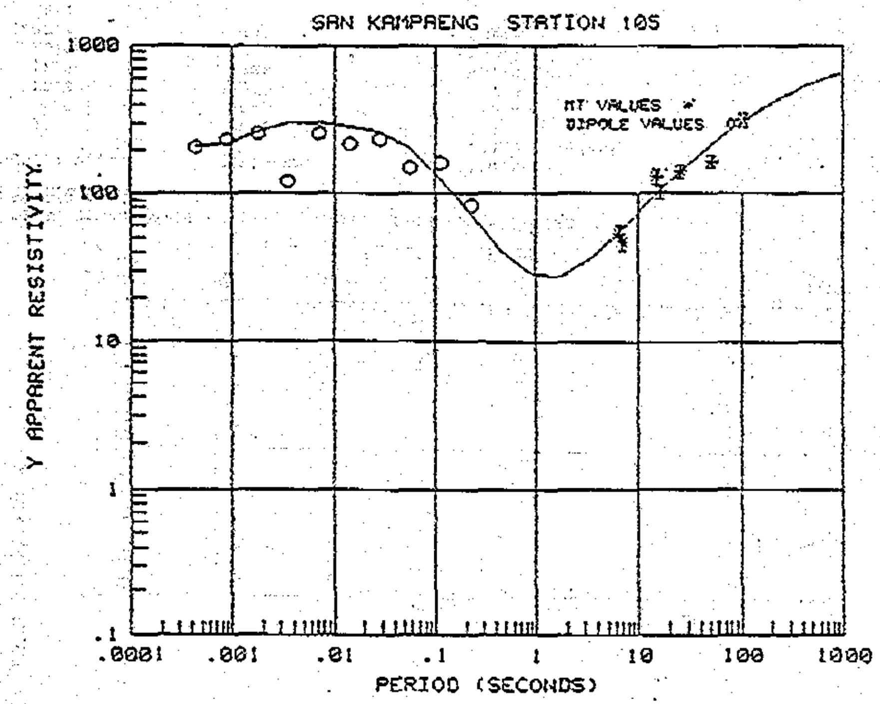
SAN KAMPAENG STATION 104

MODEL DATA

PERIOD (SECONDS)	APPARENT RESISTIVITY
.0004	42.78
.0009	50.71
.0018	60.26
.0036	70.31
.0071	86.23
.0143	116.07
.0286	160.86
.0570	198.20
.1143	202.00
.2286	190.32
.4571	165.58
.9143	118.89
1.8286	76.20
3.6571	56.25
7.3142	59.76
14.6284	82.19
29.2563	103.63
64.0000	86.57
128.0000	55.25
234.8550	38.10
468.1100	33.36
936.2244	44.87

X-AXIS FIELD DATA

PERIOD (SECONDS)	APPARENT RESISTIVITY		
.0004	41.50		
.0009	49.16		
.0018	51.08		
.0036	65.41		
.0071	99.83		
.0143	132.81		
.0286	164.85		
.0571	186.42		
.1143	169.18		
.2283	177.10		
.4566	184.55		
2.2605	76.93	±	2.382
2.2756	75.33	±	2.295
4.9231	43.29	±	2.221
12.8000	64.34	±	3.846
14.8406	86.65	±	4.790
16.0000	75.70	±	3.197
18.2857	102.97	±	3.748
20.0784	104.24	±	3.920
25.6000	96.09	±	2.821
26.9474	109.32	±	2.394
27.6757	114.70	±	3.576
39.3846	111.84	±	4.137
42.6667	104.57	±	3.567
51.2000	78.03	±	5.007
60.2353	82.71	±	4.355
73.1429	82.39	±	4.750
102.4000	50.10	±	4.323
204.8000	37.59	±	4.157



TOTAL CONDUCTANCE = 103.2 (MHOS) (FOR TOP 5 LAYERS)

LAYERED MODEL

RESISTIVITY	DEPTH(KM)	ALTITUDE(M)
		390.0 (SURFACE)
500.0	.087	303.0
4.0	.089	301.0
600.0	.531	-141.0
110.0	1.327	-937.0
5.0	1.800	-1410.0
300.0	4.000	-3610.0
1000.0		

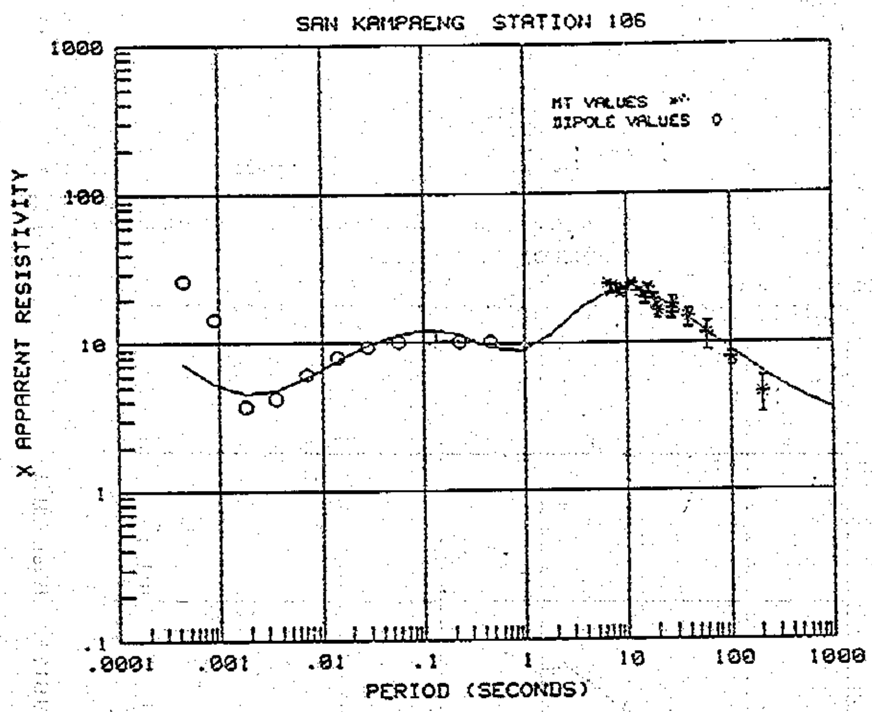
SAN KAMPAENG STATION 105

MODEL DATA

PERIOD (SECONDS)	APPARENT RESISTIVITY
.0004	214.37
.0009	220.44
.0018	266.86
.0036	306.94
.0071	302.85
.0143	286.38
.0286	261.66
.0570	201.29
.1143	126.40
.2286	71.17
.4571	40.98
.9143	28.41
1.8286	27.92
3.6571	37.96
7.3142	60.19
14.6284	98.30
29.2569	156.33
64.0008	247.92
128.0000	348.43
234.0550	443.88
468.1100	552.91
936.2244	652.40

Y-AXIS FIELD DATA

PERIOD (SECONDS)	APPARENT RESISTIVITY
.0004	207.12
.0009	234.49
.0018	255.91
.0036	121.32
.0071	261.60
.0143	217.35
.0286	232.07
.0571	150.78
.1143	161.24
.2283	82.59
6.4000	54.23 ± 7.032
6.9189	47.38 ± 6.149
14.8406	131.33 ± 15.160
16.0000	102.10 ± 11.058
25.6000	144.09 ± 16.751
51.2000	167.30 ± 16.185
102.4000	318.91 ± 34.489



TOTAL CONDUCTANCE = 171.2 (MHOS) (FOR TOP 5 LAYERS)

LAYERED MODEL

RESISTIVITY	DEPTH(KM)	ALTITUDE(M)
		370.0 (SURFACE)
22.0	.011	359.0
3.0	.040	330.0
20.0	.339	31.0
10.0	.800	-430.0
5.0	1.300	-930.0
3000.0	7.000	-6630.0
2.0		

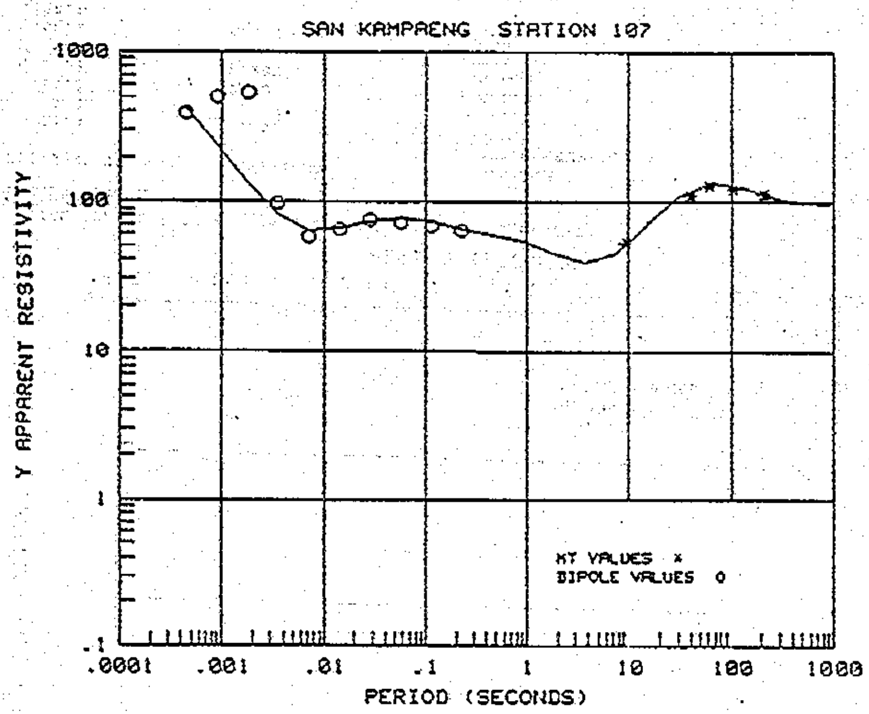
SAN KAMPAENG STATION 106

MODEL DATA

PERIOD (SECONDS)	APPARENT RESISTIVITY
.0004	7.22
.0009	5.32
.0018	4.54
.0036	4.76
.0071	5.82
.0143	7.63
.0286	9.69
.0570	11.34
.1143	12.43
.2286	11.53
.4571	9.15
.9143	8.66
1.8286	11.49
3.6571	17.47
7.3142	23.05
14.6284	22.45
29.2569	17.06
64.0000	11.19
128.0000	7.74
234.0550	5.83
463.1100	4.44
936.2244	3.58

X-AXIS FIELD DATA

PERIOD (SECONDS)	APPARENT RESISTIVITY	
.0004	26.76	
.0009	14.43	
.0018	3.77	
.0036	4.28	
.0071	6.12	
.0143	7.92	
.0286	9.49	
.0571	10.21	
.1143	11.01	
.2283	10.21	
.4566	10.09	
6.4000	25.26	± 1.148
6.9189	22.01	± .743
7.3143	24.65	± .756
8.3934	21.44	± 1.187
9.3891	23.54	± .904
10.6667	25.21	± 1.219
11.1304	25.07	± .838
12.8000	21.99	± 1.394
14.8406	19.94	± 1.662
16.0000	23.36	± 1.600
18.2857	19.32	± 1.946
20.0784	16.44	± 2.003
26.9474	15.74	± 1.667
27.6757	18.01	± 2.247
39.3846	14.82	± 2.106
68.2353	11.35	± 2.520
102.4000	7.67	± .849
204.8000	4.57	± 1.223



TOTAL CONDUCTANCE = 163.9 (MHOS) (FOR TOP 5 LAYERS)

LAYERED MODEL

RESISTIVITY	DEPTH(KM)	ALTITUDE(M)
		380.0 (SURFACE)
500.0	.166	214.0
3.0	.180	200.0
180.0	.800	-420.0
40.0	5.500	-5120.0
5.0	5.700	-5320.0
1000.0	50.000	-49620.0
10.0	55.000	-54620.0
120.0		

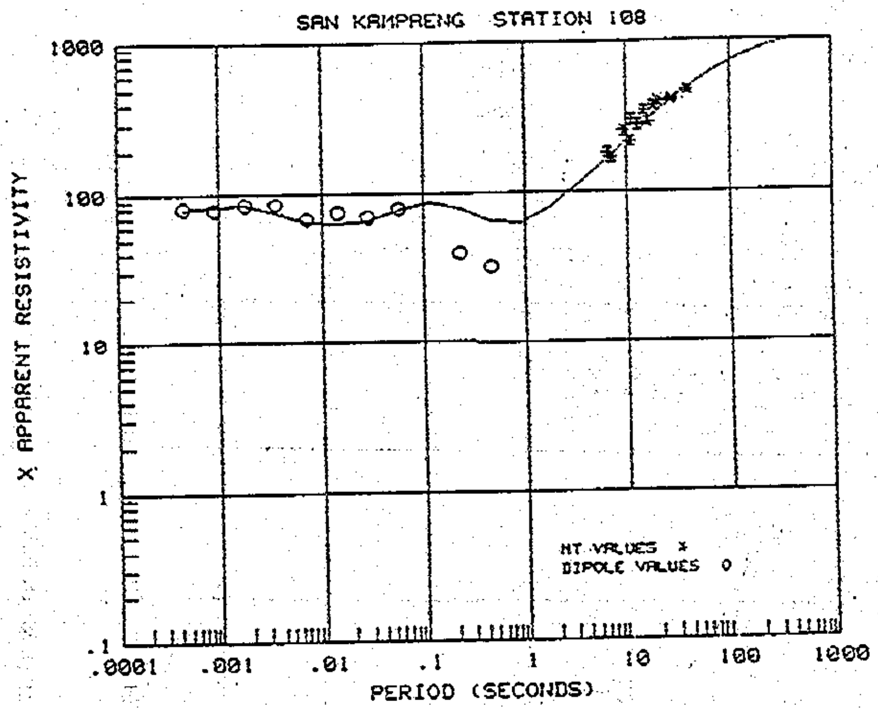
SAN KAMPAENG STATION 107

MODEL DATA

PERIOD (SECONDS)	APPARENT RESISTIVITY
.0004	416.10
.0009	238.41
.0018	133.10
.0036	82.17
.0071	64.32
.0143	66.00
.0286	74.32
.0570	77.65
.1143	73.42
.2286	65.84
.4571	59.35
.9143	53.46
1.8286	43.01
3.6571	37.90
7.3142	44.55
14.6284	68.72
29.2569	107.59
64.0000	135.51
128.0000	125.23
234.0550	109.25
468.1100	98.57
936.2244	96.29

Y-AXIS FIELD DATA

PERIOD (SECONDS)	APPARENT RESISTIVITY	
.0004	393.21	
.0009	493.96	
.0018	532.02	
.0036	98.19	
.0071	58.32	
.0143	64.67	
.0286	75.86	
.0571	70.98	
.1143	68.15	
.2283	64.20	
9.3091	52.98	+- 3.598
39.3846	110.71	+- 5.153
60.2353	129.27	+- 5.208
102.4000	122.34	+- 4.075
204.8000	112.87	+- 6.398



TOTAL CONDUCTANCE = 44.3 (MHOS) (FOR TOP 5 LAYERS)

LAYERED MODEL

RESISTIVITY	DEPTH(KM)	ALTITUDE(M)
		370.0 (SURFACE)
80.0	.250	120.0
3.0	.256	114.0
110.0	2.000	-1630.0
60.0	2.200	-1830.0
5.0	2.300	-1930.0
160.0	4.000	-3630.0
1500.0		

SAN KAMPAENG STATION 108

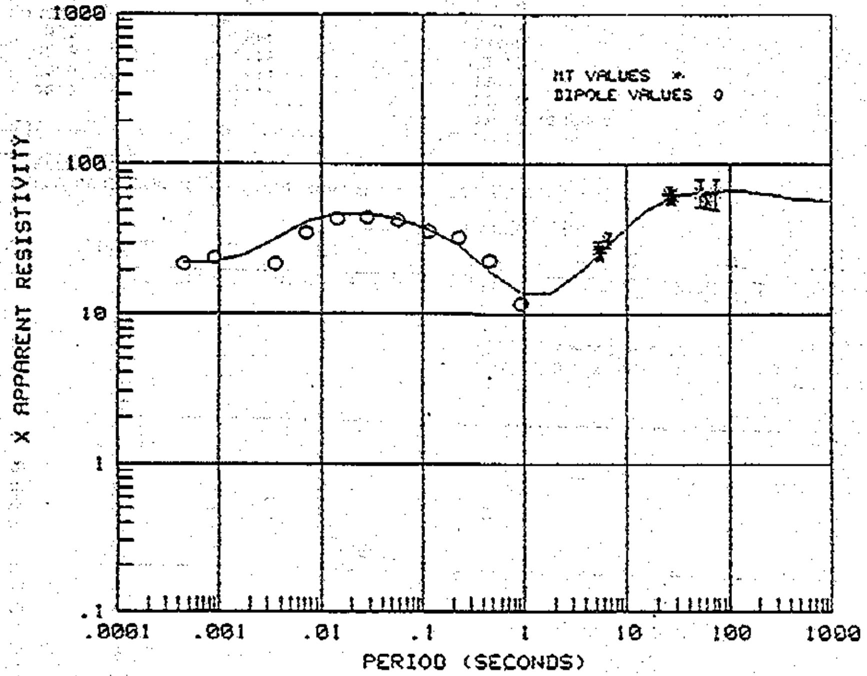
MODEL DATA

PERIOD (SECONDS)	APPARENT RESISTIVITY
.0004	79.83
.0009	83.60
.0018	84.12
.0036	74.82
.0071	65.03
.0143	63.38
.0286	66.58
.0570	77.27
.1143	87.43
.2286	79.24
.4571	64.67
.9143	63.13
1.8286	80.94
3.6571	121.67
7.3142	190.38
14.6284	291.36
29.2569	424.07
64.0000	601.36
128.0000	766.09
234.0558	902.67
468.1100	1041.58
936.2244	1156.34

X-AXIS FIELD DATA

PERIOD (SECONDS)	APPARENT RESISTIVITY	
.0004	80.73	
.0009	78.37	
.0018	85.34	
.0036	85.98	
.0071	68.88	
.0143	75.44	
.0286	78.75	
.0571	78.31	
.2283	40.52	
.4566	32.85	
6.4000	190.50	± 15.557
6.9189	174.53	± 15.133
9.3091	261.49	± 20.082
10.6667	223.14	± 16.040
11.1304	312.36	± 26.601
12.8000	288.36	± 22.224
14.8406	357.87	± 21.662
16.0000	381.06	± 16.266
18.2857	377.47	± 16.892
20.0784	408.35	± 19.837
26.9474	409.96	± 14.297
27.6757	414.62	± 16.867
39.3846	474.94	± 26.649

SAN KAMPRENG STATION 109



TOTAL CONDUCTANCE = 167.0 (MHOS) (FOR TOP 6 LAYERS)

LAYERED MODEL

RESISTIVITY	DEPTH(KM)	ALTITUDE(M)
		360.0 (SURFACE)
25.0	.050	310.0
3.0	.052	308.0
80.0	.400	-40.0
20.0	.800	-440.0
10.0	1.200	-840.0
5.0	1.700	-1340.0
5000.0	16.000	-15640.0
50.0		
-		

SAN KAMPRENG STATION 109

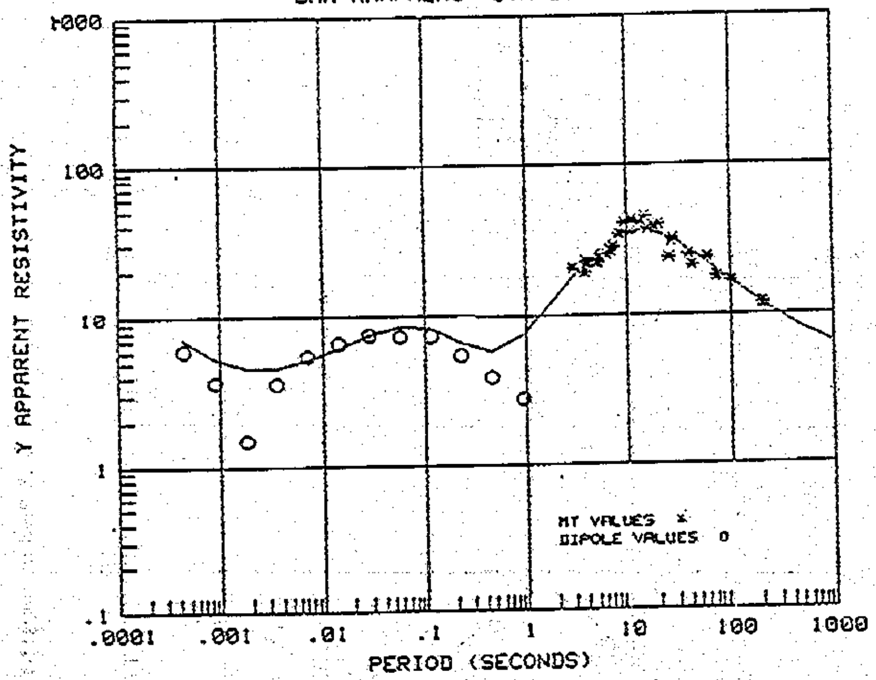
MODEL DATA

PERIOD (SECONDS)	APPARENT RESISTIVITY
.0004	22.56
.0009	22.49
.0018	25.53
.0036	32.38
.0071	41.69
.0143	47.90
.0286	48.05
.0570	43.69
.1143	37.68
.2286	29.28
.4571	19.49
.9143	13.88
1.8286	13.95
3.6571	19.90
7.3142	32.84
14.6284	48.23
29.2569	61.77
64.0000	67.49
128.0000	66.13
234.0550	63.21
468.1100	59.81
936.2244	57.05

X-AXIS FIELD DATA

PERIOD (SECONDS)	APPARENT RESISTIVITY		
.0004	21.87		
.0009	23.95		
.0036	21.95		
.0071	35.64		
.0143	44.45		
.0286	45.66		
.0571	43.62		
.1143	36.06		
.2283	32.79		
.4566	23.12		
.9124	11.72		
5.1717	27.37	±	3.077
5.3333	25.69	±	2.346
6.4000	31.75	±	4.028
25.6000	63.60	±	7.394
26.9474	57.74	±	2.759
27.6757	63.52	±	4.034
51.2000	65.38	±	12.960
60.2353	57.56	±	6.376
73.1429	64.55	±	14.060

SAN KAMPAENG STATION 110



TOTAL CONDUCTANCE = 147.3 (MHOS) (FOR TOP 4 LAYERS)

LAYERED MODEL

RESISTIVITY	DEPTH(KM)	ALTITUDE(M)
		370.0 (SURFACE)
22.0	.011	359.0
3.8	.040	330.0
12.0	.339	31.0
5.0	.900	-530.0
8000.0	2.000	-1630.0
12000.0	10.000	-9630.0
3.5		

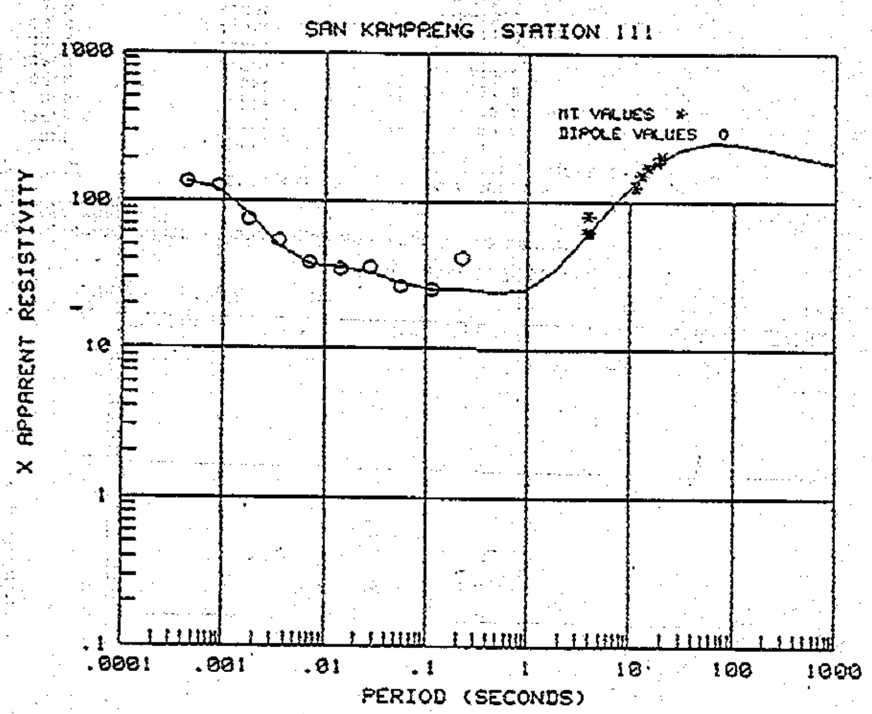
SAN KAMPAENG STATION 110

MODEL DATA

PERIOD (SECONDS)	APPARENT RESISTIVITY
.0004	7.28
.0009	5.46
.0018	4.63
.0036	4.65
.0071	5.24
.0143	6.31
.0286	7.64
.0570	8.61
.1143	8.33
.2286	6.66
.4571	5.86
.9143	7.43
1.8286	12.27
3.6571	21.31
7.3142	32.37
14.6284	36.73
29.2569	30.77
64.0000	20.96
128.0000	14.53
234.0550	10.06
468.1100	8.18
936.2244	6.53

Y-AXIS FIELD DATA

PERIOD (SECONDS)	APPARENT RESISTIVITY	
.0004	6.07	
.0009	3.76	
.0018	1.49	
.0036	3.66	
.0071	5.31	
.0143	6.77	
.0286	7.56	
.0571	7.44	
.1143	7.37	
.2283	5.52	
.4556	3.92	
.9174	2.79	
2.9257	20.54	± .654
3.7926	18.82	± .889
3.9084	22.51	± .977
4.0000	21.92	± .986
4.9231	21.73	± 1.049
5.1717	21.96	± .956
5.3333	23.64	± 1.007
6.4000	24.91	± 1.193
6.9189	26.05	± 1.113
7.3143	28.04	± 1.071
8.3934	33.97	± 1.300
9.3091	40.03	± 1.239
10.6667	34.42	± .694
11.1304	41.79	± 1.077
12.8000	40.59	± .625
14.8406	44.30	± .255
16.0000	36.25	± .628
18.2857	38.29	± .409
20.0784	38.81	± .668
25.6000	23.72	± .869
26.9474	30.29	± .587
27.6757	31.80	± .768
39.3846	24.52	± .289
42.6667	21.09	± .832
60.2353	23.78	± .958
73.1429	17.56	± 1.341
102.4000	16.59	± .738
204.8000	11.71	± .893



TOTAL CONDUCTANCE = 92.3 (MHOS) (FOR TOP 7 LAYERS)

LAYERED MODEL

RESISTIVITY	DEPTH(KM)	ALTITUDE(M)
		300.0 (SURFACE)
115.0	.144	236.0
3.0	.168	212.0
312.0	.472	-92.0
3.0	.500	-120.0
10.0	.600	-220.0
45.0	3.200	-2820.0
5.0	3.225	-2845.0
10000.0	38.000	-37620.0
150.0		

SAN KAMPAENG STATION 111

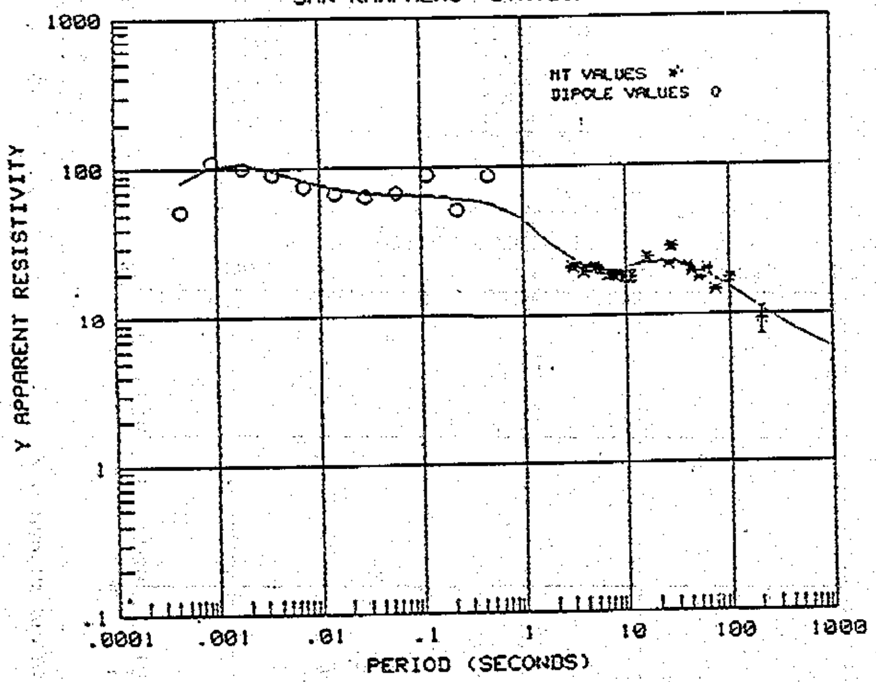
MODEL DATA

PERIOD (SECONDS)	APPARENT RESISTIVITY
.0004	139.39
.0009	122.97
.0018	81.00
.0036	50.36
.0071	37.71
.0143	35.26
.0286	32.72
.0570	28.13
.1143	25.45
.2286	25.32
.4571	24.07
.9143	24.67
1.8286	34.15
3.6571	58.33
7.3142	103.43
14.6284	168.84
29.2569	231.38
64.0000	259.23
128.0000	248.14
234.0550	228.74
468.1100	207.27
936.2244	190.45

X-AXIS FIELD DATA

PERIOD (SECONDS)	APPARENT RESISTIVITY	
.0004	136.67	
.0009	127.31	
.0018	75.11	
.0036	53.47	
.0071	38.13	
.0143	34.75	
.0286	35.46	
.0571	26.38	
.1143	25.18	
.2283	40.65	
3.7926	60.22	± 4.055
3.9084	79.74	± 4.916
4.0000	61.55	± 4.164
11.1384	129.57	± 10.189
12.8000	155.05	± 8.269
14.8406	175.20	± 9.194
18.2857	189.44	± 5.988
20.0784	207.03	± 6.594

SAN KAMPAENG STATION 112



TOTAL CONDUCTANCE = 337.5 (MHOS) (FOR TOP 8 LAYERS)

LAYERED MODEL

RESISTIVITY	DEPTH(KM)	ALTITUDE(M)
		390.0 (SURFACE)
70.0	.056	334.0
194.0	.231	159.0
3.0	.238	152.0
97.0	.353	37.0
57.0	1.589	-1199.0
10.0	1.765	-1375.0
39.0	2.648	-2258.0
5.0	4.000	-3610.0
10000.0	11.000	-10610.0
3.0		

SAN KAMPAENG STATION 112

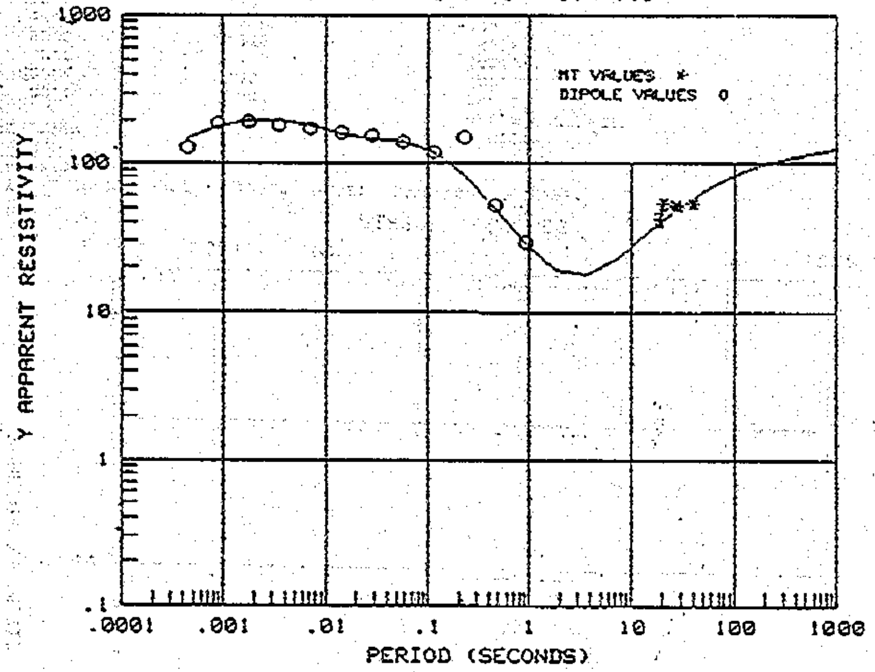
MODEL DATA

PERIOD (SECONDS)	APPARENT RESISTIVITY
.0004	81.54
.0009	103.26
.0018	108.32
.0036	95.64
.0071	82.14
.0143	73.12
.0286	67.85
.0570	67.31
.1143	65.50
.2286	61.65
.4571	57.12
.9143	46.05
1.8286	30.93
3.6571	21.74
7.3142	20.10
14.6284	22.42
29.2569	22.77
64.0000	18.31
128.0000	13.48
234.0550	10.21
460.1100	7.64
936.2244	6.01

Y-AXIS FIELD DATA

PERIOD (SECONDS)	APPARENT RESISTIVITY		
.0004	52.48		
.0009	110.57		
.0018	100.06		
.0036	91.46		
.0071	75.45		
.0143	68.61		
.0286	64.84		
.0571	68.39		
.1143	88.99		
.2283	52.60		
.4566	86.34		
2.9767	21.34	±	.938
3.0118	21.08	±	.926
3.7926	19.38	±	.949
3.9084	20.75	±	1.913
4.0000	20.98	±	.993
4.9231	21.18	±	1.229
5.1717	20.93	±	1.207
5.3333	20.21	±	1.209
6.4000	18.50	±	1.349
6.9189	19.08	±	1.373
7.3143	18.13	±	1.294
8.3934	20.35	±	1.580
9.3091	18.08	±	1.591
11.1304	18.15	±	1.587
16.0000	24.80	±	1.063
25.6000	22.10	±	.646
26.9474	28.41	±	.965
27.6757	29.51	±	1.016
39.3846	21.26	±	.596
42.6667	19.63	±	.477
51.2000	17.58	±	.429
60.2353	20.45	±	.627
73.1429	14.62	±	.477
102.4000	17.56	±	1.024
204.8000	9.16	±	1.861

SAN KAMPAENG STATION 113



TOTAL CONDUCTANCE = 215.6 (MHOS) (FOR TOP 6 LAYERS)

LAYERED MODEL

RESISTIVITY	DEPTH(KM)	ALTITUDE(M)
		420.0 (SURFACE)
129.0	.076	344.0
356.0	.313	107.0
3.0	.315	105.0
170.0	.478	-58.0
80.0	1.500	-1080.0
5.0	2.500	-2080.0
4000.0	15.000	-14580.0
150.0		

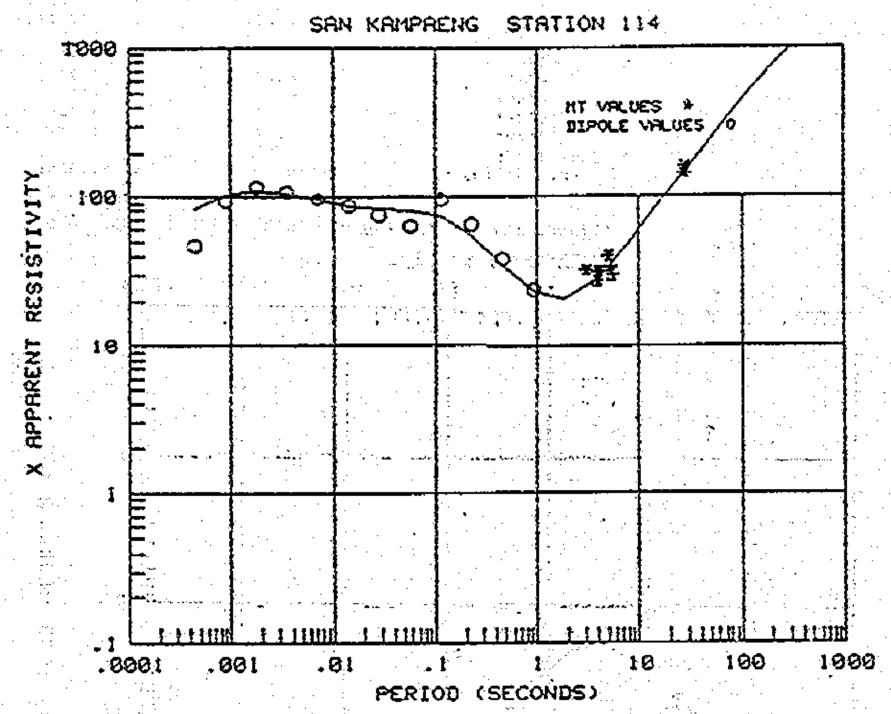
SAN KAMPAENG STATION 113

MODEL DATA

PERIOD (SECONDS)	APPARENT RESISTIVITY
.0004	147.83
.0009	180.76
.0018	199.59
.0036	199.33
.0071	183.97
.0143	161.87
.0286	148.74
.0570	142.34
.1143	118.20
.2286	82.55
.4571	49.95
.9143	28.80
1.8286	19.07
3.6571	17.74
7.3142	23.12
14.6284	34.58
29.2569	50.61
64.0000	71.34
128.0000	88.89
234.0550	102.12
468.1100	114.50
936.2244	124.03

Y-AXIS FIELD DATA

PERIOD (SECONDS)	APPARENT RESISTIVITY	
.0004	129.15	
.0009	189.70	
.0018	193.09	
.0036	183.86	
.0071	173.71	
.0143	161.84	
.0286	154.26	
.0571	142.08	
.1143	120.54	
.2283	152.76	
.4566	52.74	
.9174	29.48	
18.2857	41.84	± 4.144
20.0784	53.10	± 4.322
26.9474	52.07	± 2.684
27.6757	51.66	± 2.980
39.3846	53.16	± 2.945



TOTAL CONDUCTANCE = 139.0 (MHOS) (FOR TOP 7 LAYERS)

LAYERED MODEL

RESISTIVITY	DEPTH(KM)	ALTITUDE(M)
		420.0 (SURFACE)
70.0	.056	364.0
220.0	.231	189.0
3.0	.235	185.0
97.0	.353	67.0
57.0	1.200	-780.0
10.0	1.700	-1280.0
5.0	2.050	-1630.0
8000.0		

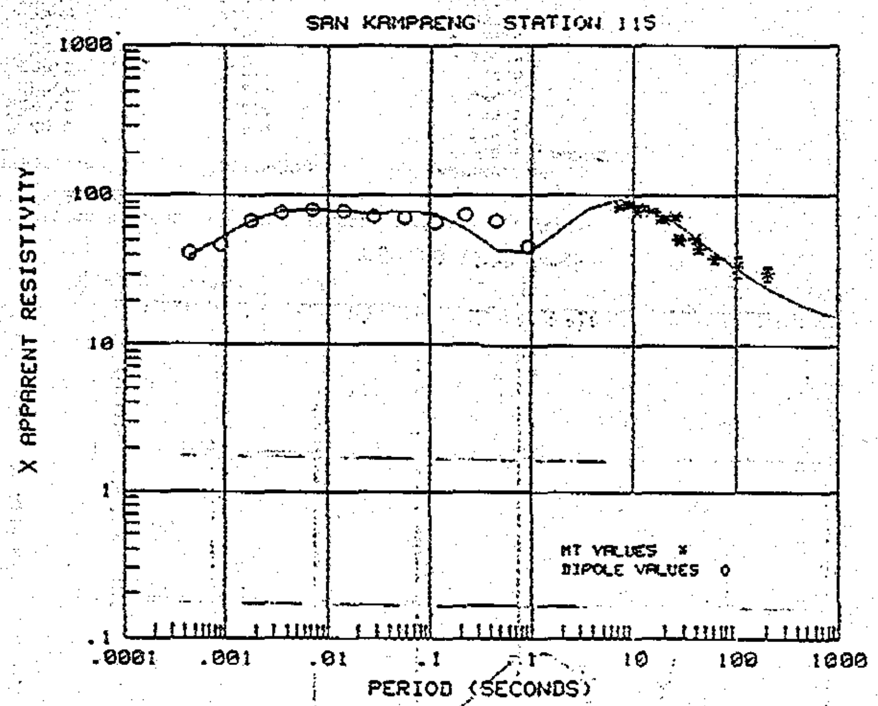
SAN KAMPAENG STATION 114

MODEL DATA

PERIOD (SECONDS)	APPARENT RESISTIVITY
.0004	82.55
.0009	103.42
.0018	111.35
.0036	105.83
.0071	96.04
.0143	86.37
.0286	82.13
.0570	80.49
.1143	73.15
.2286	55.42
.4571	35.06
.9143	23.05
1.8286	20.58
3.6571	27.45
7.3142	46.45
14.6284	85.03
29.2569	157.18
64.0000	308.22
128.0000	540.94
234.0550	851.86
468.1100	1363.47
936.2244	2047.51

X-AXIS FIELD DATA

PERIOD (SECONDS)	APPARENT RESISTIVITY
.0004	47.83
.0009	94.62
.0018	117.08
.0036	109.39
.0071	97.02
.0143	86.55
.0286	75.17
.0571	63.35
.1143	95.32 ± [illegible]
.2283	65.06 ± [illegible]
.4566	38.21 ± [illegible]
.9174	23.39
3.0118	32.03 ± 1.895
3.7926	27.00 ± 1.987
3.9084	30.49 ± 2.080
4.0000	31.72 ± 2.070
4.9231	40.37 ± 3.132
5.1717	34.26 ± 2.769
5.3333	29.76 ± 2.505
26.9474	145.12 ± 6.316
27.6757	162.48 ± 7.442



TOTAL CONDUCTANCE = 74.2 (MHOS) (FOR TOP 8 LAYERS)

LAYERED MODEL

RESISTIVITY	DEPTH(KM)	ALTITUDE(M)
		400.0 (SURFACE)
42.0	.066	334.0
272.0	.274	126.0
3.0	.280	120.0
136.0	.418	-18.0
60.0	1.500	-1100.0
14.3	1.600	-1200.0
54.0	1.800	-1400.0
5.0	2.000	-1600.0
5000.0	12.000	-11600.0
19.0		

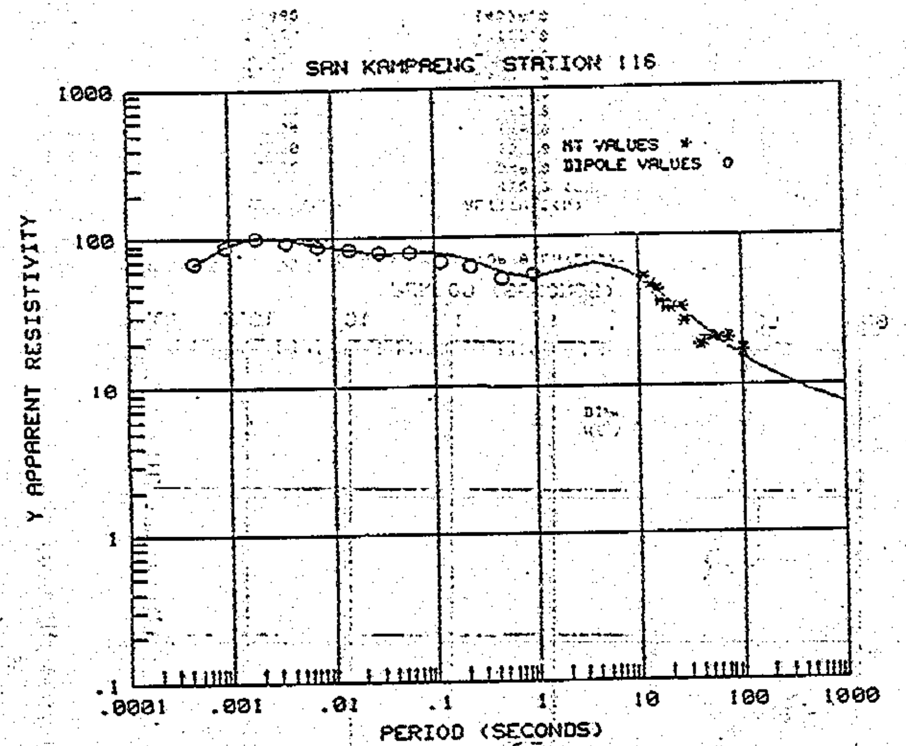
SAN KAMPAENG STATION 115

MODEL DATA

PERIOD (SECONDS)	APPARENT RESISTIVITY
.0004	39.20
.0009	50.65
.0018	66.99
.0036	76.89
.0071	79.34
.0143	77.83
.0286	75.17
.0578	76.21
.1143	74.81
.2286	58.56
.4571	43.28
.9143	41.93
1.8286	56.40
3.6571	80.71
7.3142	94.04
14.6284	82.31
29.2569	60.53
64.0000	40.70
128.0000	29.45
234.0550	23.17
468.1100	18.55
936.2244	15.64

X-AXIS FIELD DATA

PERIOD (SECONDS)	APPARENT RESISTIVITY	
.0004	41.51	
.0009	46.55	
.0018	67.21	
.0036	75.50	
.0071	78.41	
.0143	76.59	
.0286	72.55	
.0571	69.72	
.1143	64.53	
.2283	73.52	
.4566	67.01	
.9174	45.25	
7.3143	83.67	+ 3.876
8.3934	86.13	+ 4.420
9.3091	85.71	+ 3.933
10.6667	76.66	+ 2.557
11.1304	82.83	+ 3.636
12.8000	79.86	+ 2.600
14.8406	77.70	+ 2.099
16.0000	77.06	+ 2.261
18.2857	68.76	+ 2.139
20.0784	68.32	+ 2.694
25.6000	70.92	+ 2.556
26.9474	51.44	+ 2.115
27.6757	50.05	+ 2.350
39.3846	50.81	+ 1.664
42.6667	44.00	+ 2.214
60.2353	37.82	+ 2.085
102.4000	33.88	+ 5.305
204.8000	30.52	+ 3.523



TOTAL CONDUCTANCE = 61.0 (MHOS) (FOR TOP 8 LAYERS)

LAYERED MODEL

RESISTIVITY	DEPTH(KM)	ALTITUDE(M)
		440.0 (SURFACE)
62.0	.062	378.0
240.9	.258	182.0
2.7	.264	176.0
128.5	.393	47.0
78.9	1.772	-1332.0
12.4	1.969	-1529.0
47.8	2.447	-2007.0
5.0	2.500	-2060.0
95.0	8.000	-7560.0
5.0		

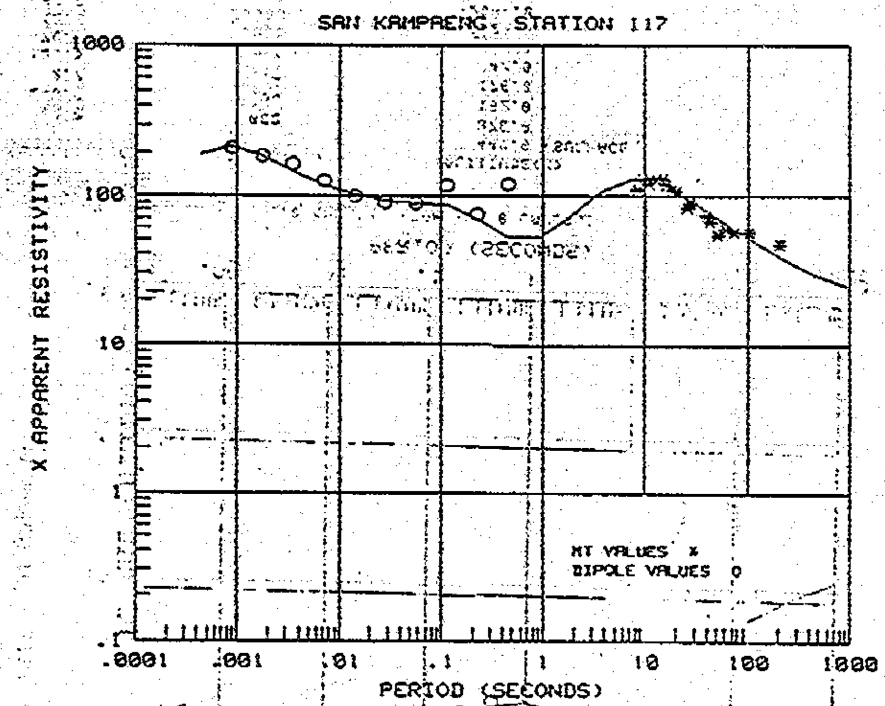
SAN KAMPAENG STATION 116

MODEL DATA

PERIOD (SECONDS)	APPARENT RESISTIVITY
.0004	66.64
.0009	98.36
.0018	102.96
.0036	99.04
.0071	89.30
.0143	82.07
.0286	78.80
.0570	79.03
.1143	79.46
.2286	78.38
.4571	57.65
.9143	52.77
1.8286	58.70
3.6571	64.44
7.3142	57.29
14.6284	42.28
29.2569	29.82
64.0000	19.17
128.0000	13.92
234.0550	11.04
468.1100	8.93
936.2244	7.60

Y-AXIS FIELD DATA

PERIOD (SECONDS)	APPARENT RESISTIVITY	
.0004	68.46	
.0009	86.85	
.0018	100.45	
.0036	93.99	
.0071	87.85	
.0143	83.13	
.0286	78.16	
.0571	78.54	
.1143	69.14	
.2283	64.00	
.4566	52.51	± [illegible]
.9174	54.36	± [illegible]
11.1304	52.99	± 2.879
12.8000	46.14	± 1.385
14.8406	43.44	± 1.526
16.0000	35.57	± 1.120
18.2857	32.54	± .914
20.0784	32.18	± .913
25.6000	33.25	± .873
26.9474	26.75	± .892
27.6757	26.73	± .987
39.3846	18.57	± 1.072
42.6667	19.52	± 1.140
51.2000	21.05	± 1.172
60.2353	20.29	± 1.100
73.1429	20.58	± 1.663
102.4000	16.89	± 1.248



TOTAL CONDUCTANCE = 65.2 MHOS (FOR TOP 8 LAYERS)

LAYERED MODEL

RESISTIVITY	DEPTH(KM)	ALTITUDE(M)
		410.0 (SURFACE)
150.0	.062	348.0
280.0	.258	152.0
3.0	.264	146.0
121.0	.393	17.0
71.0	1.772	-1362.0
12.0	1.969	-1559.0
50.0	2.447	-2037.0
5.0	2.525	-2115.0
5000.0	15.000	-14590.0
16.0		

SAN KAMPAENG STATION 117

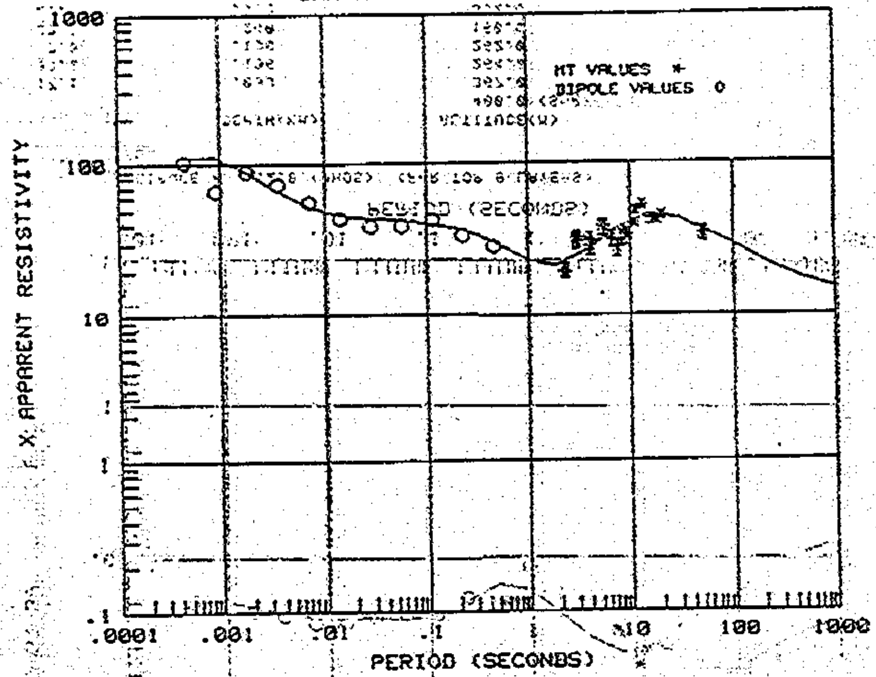
MODEL DATA

PERIOD (SECONDS)	APPARENT RESISTIVITY
.0004	193.74
.0009	216.94
.0018	190.58
.0036	149.57
.0071	120.47
.0143	102.82
.0286	92.49
.0570	90.06
.1143	87.10
.2286	69.97
.4571	52.98
.9143	52.53
1.8286	72.23
3.6571	106.96
7.3142	131.51
14.6284	121.27
29.2569	92.09
64.0000	63.06
128.0000	46.05
234.0550	36.44
468.1100	29.30
936.2244	24.00

X-AXIS FIELD DATA

PERIOD (SECONDS)	APPARENT RESISTIVITY	
.0009	215.23	
.0018	188.74	
.0036	167.21	
.0071	126.92	
.0143	101.57	
.0286	90.48	
.0571	89.29	
.1143	118.64	
.2283	76.09	
.4566	122.91	
8.3934	110.56	± 2.903
9.3091	129.87	± 2.440
10.6667	121.58	± 1.397
11.1304	132.06	± 1.616
12.8000	131.31	± 1.168
14.8406	131.63	± 1.372
16.0000	120.42	± 1.570
18.2857	111.01	± 1.647
20.0784	108.55	± 1.765
25.6000	82.36	± 1.929
26.9474	88.53	± 2.004
27.6757	89.00	± 1.279
39.3846	73.36	± 1.556
42.6667	67.00	± 1.669
51.2000	53.74	± 1.984
60.2353	59.21	± 1.762
73.1429	55.99	± 2.446
102.4000	55.78	± 2.627
204.8000	46.96	± 2.775

SAN KAMPAENG STATION 118



TOTAL CONDUCTANCE = 159.9 (MHOS) (FOR TOP 8 LAYERS)

LAYERED MODEL

RESISTIVITY	DEPTH(KM)	ALTITUDE(M)
		400.0 (SURFACE)
90.0	.045	355.0
118.0	.167	233.0
1.3	.171	229.0
51.0	.255	145.0
40.0	.800	-400.0
20.0	2.000	-1600.0
10.0	2.400	-2000.0
5.0	2.600	-2200.0
5000.0	12.000	-11600.0
10.0		

SAN KAMPAENG STATION 118

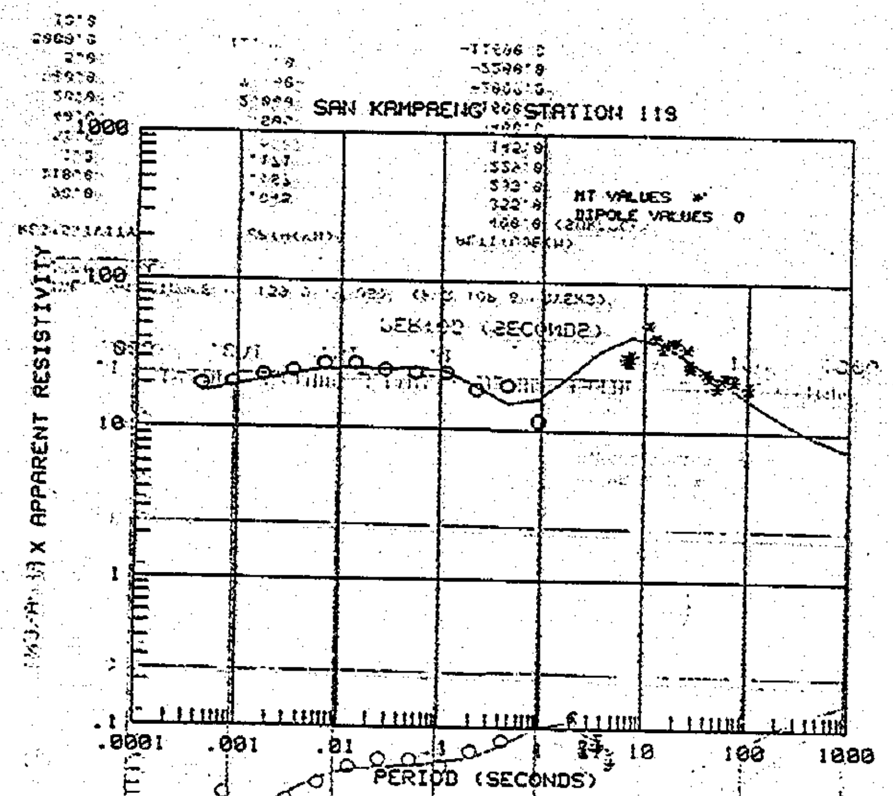
MODEL DATA

PERIOD (SECONDS)	APPARENT RESISTIVITY
.0004	110.41
.0009	112.06
.0018	89.59
.0036	66.46
.0071	52.48
.0143	45.95
.0286	44.09
.0570	42.96
.1143	40.09
.2286	37.11
.4571	31.13
.9143	23.50
1.8286	21.41
3.6571	26.92
7.3142	37.71
14.6284	43.92
29.2569	43.79
64.0000	34.05
128.0000	26.39
234.0550	21.48
468.1100	17.62
936.2244	15.09

X-AXIS FIELD DATA

PERIOD (SECONDS)	APPARENT RESISTIVITY	
.0004	104.08	
.0009	66.53	
.0018	88.98	
.0036	72.97	
.0071	55.66	
.0143	44.16	
.0286	38.93	
[illegible]	38.85	[illegible]
[illegible]	42.39	[illegible]
[illegible]	33.63	[illegible]
[illegible]	28.79	[illegible]
2.2605	19.62	2.008
2.9257	30.83	3.410
[illegible]	31.96	3.818
[illegible]	30.36	3.753
[illegible]	28.34	3.387
[illegible]	38.04	4.610
[illegible]	31.68	3.702
[illegible]	27.61	3.354
[illegible]	31.89	3.425
[illegible]	34.21	2.714
[illegible]	40.32	2.278
[illegible]	48.25	2.780
[illegible]	52.62	3.053
[illegible]	43.18	3.659
18.2057	42.58	2.687
20.0784	44.89	2.801
51.2000	34.51	3.676

SAN KAMPAENG STATION 119



TOTAL CONDUCTANCE = 412.8 (MHOS) (FOR TOP 8 LAYERS)

LAYERED MODEL

RESISTIVITY	DEPTH(KM)	ALTITUDE(M)
		400.0 (SURFACE)
17.1	.033	367.0
33.2	.136	264.0
3.0	.138	262.0
33.0	.240	160.0
20.0	.932	-532.0
3.4	1.035	-635.0
13.3	1.287	-887.0
5.0	1.388	-988.0
5000.0	8.500	-8100.0
5.0		

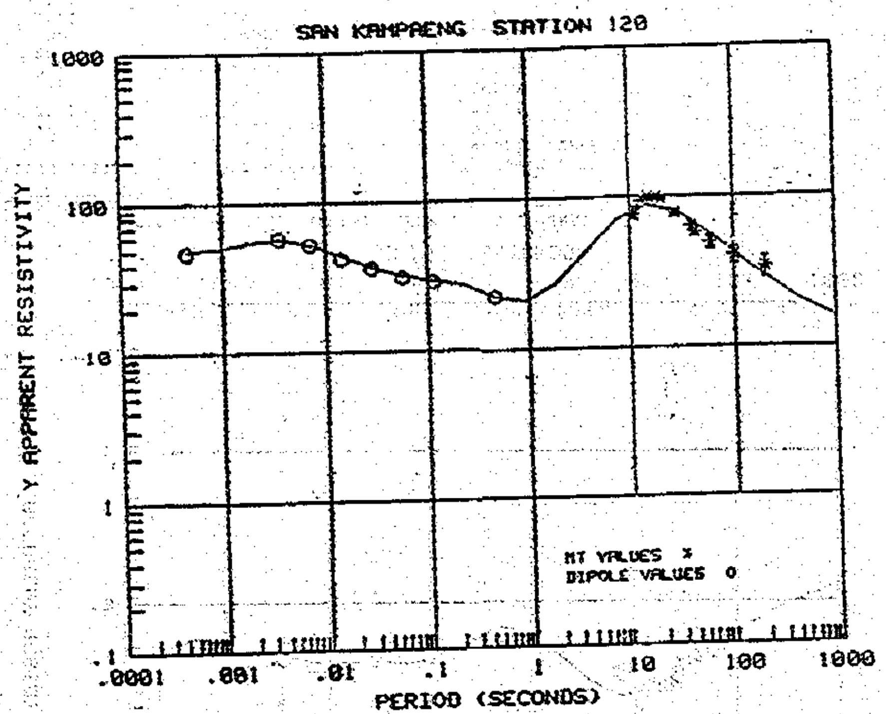
SAN KAMPAENG STATION 119

MODEL DATA

PERIOD (SECONDS)	APPARENT RESISTIVITY
.0004	17.32
.0009	19.41
.0018	21.65
.0036	23.75
.0071	25.40
.0143	25.87
.0286	25.44
.0570	25.75
.1143	24.63
.2286	19.26
.4571	15.01
.9143	16.02
1.8286	23.22
3.6571	35.01
7.3142	43.04
14.6284	39.39
29.2569	29.87
64.0000	20.17
128.0000	14.56
234.0550	11.55
468.1100	9.26
936.2244	7.81

X-AXIS FIELD DATA

PERIOD (SECONDS)	APPARENT RESISTIVITY	
.0004	20.05	
.0009	20.58	
.0018	22.86	
.0036	24.79	
.0071	27.68	
.0143	27.68	
.0286	25.51	
.0571	24.03	
.1143	24.00	
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.400
[illegible]	[illegible]	1.571
[illegible]	[illegible]	1.882
[illegible]	[illegible]	1.721



TOTAL CONDUCTANCE = 107.3 (MHOS) (FOR TOP 6 LAYERS)

LAYERED MODEL

RESISTIVITY-	DEPTH(KM)	ALTITUDE(M)
		400.0 (SURFACE)
50.0	.066	334.0
60.0	.273	127.0
3.0	.280	120.0
21.0	.415	-15.0
25.0	1.873	-1473.0
5.0	2.050	-1650.0
5000.0	17.000	-16600.0
8.0		

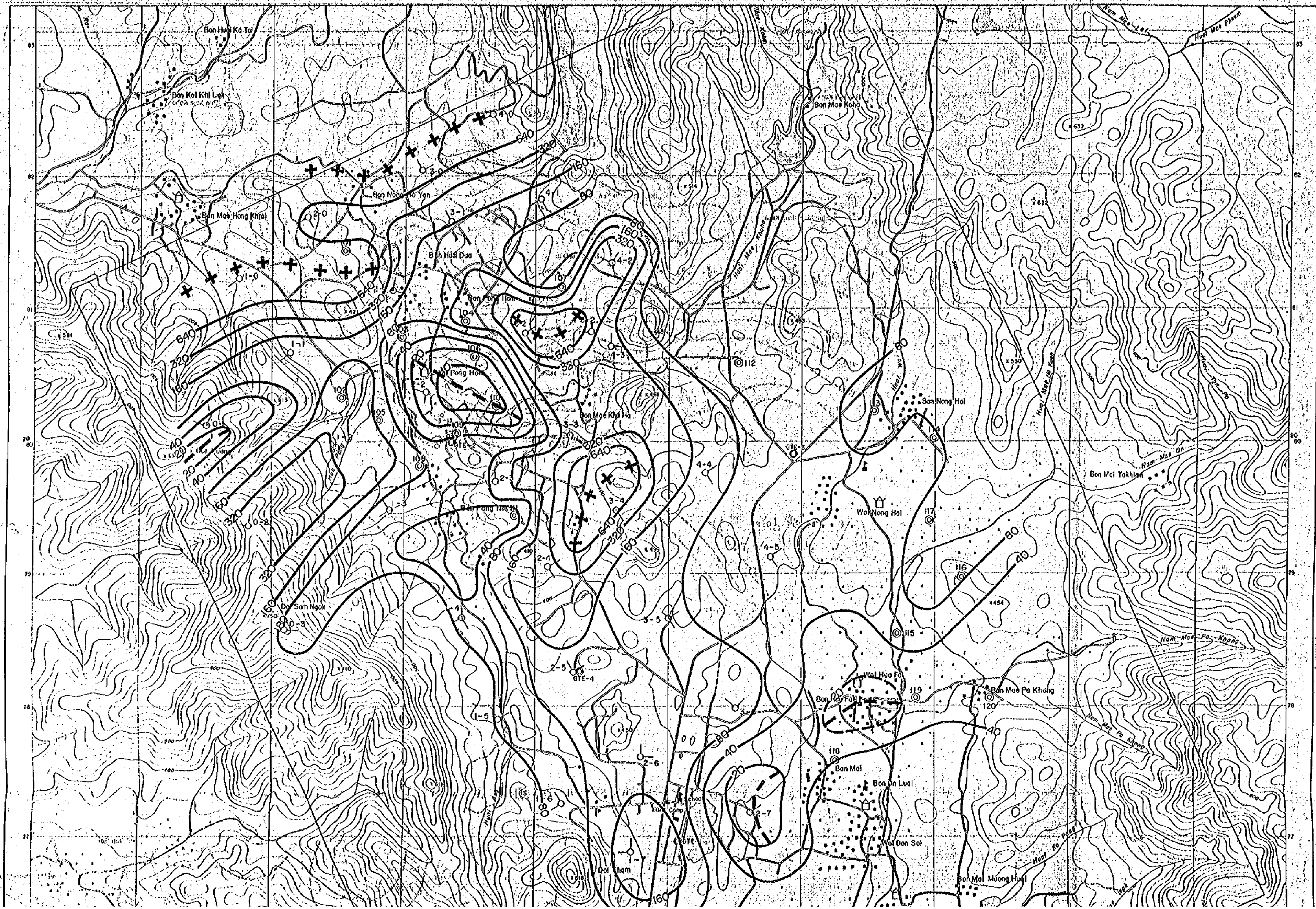
SAN KAMPAENG STATION 120

MODEL DATA

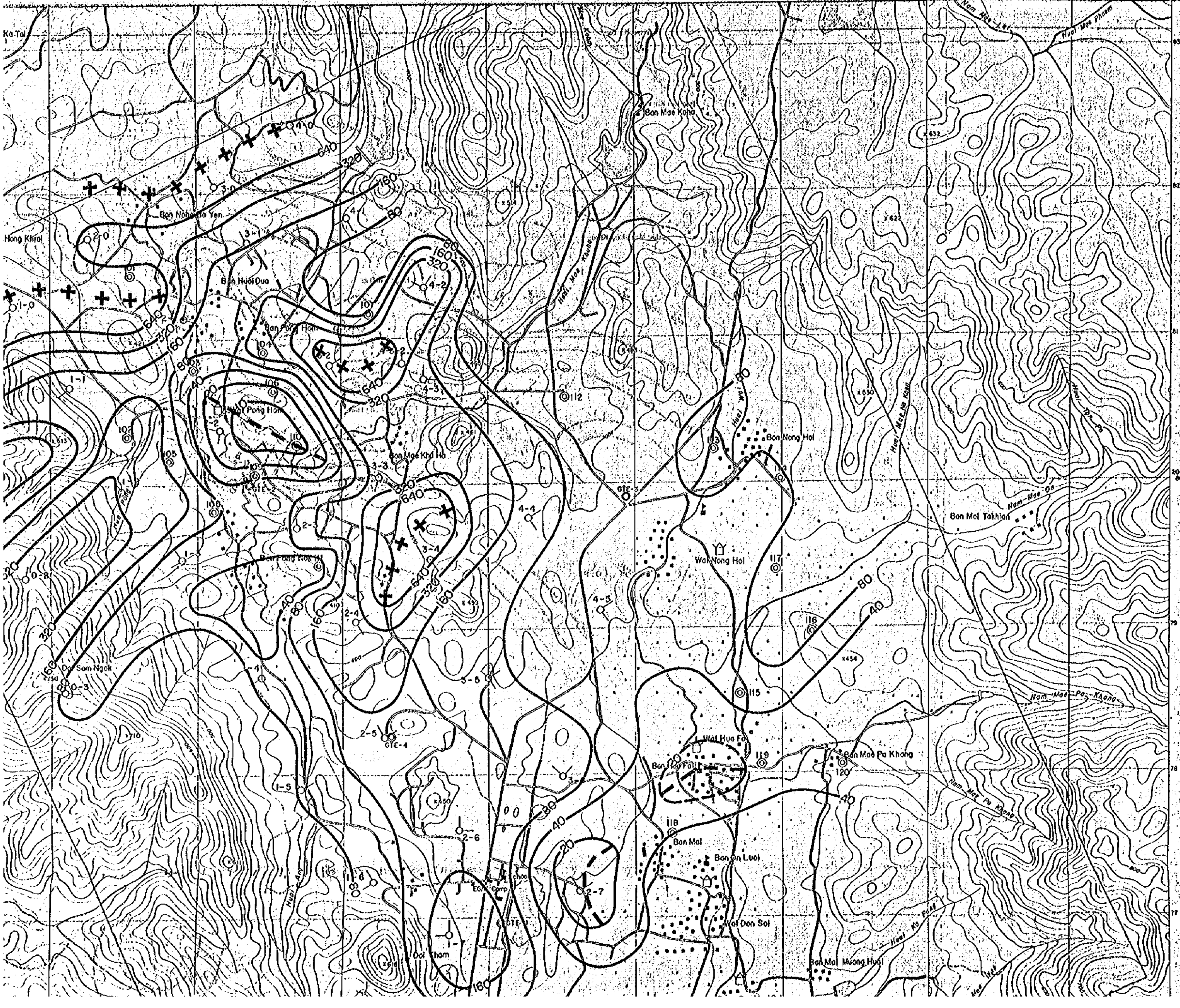
PERIOD (SECONDS)	APPARENT RESISTIVITY
.0004	49.59
.0009	50.97
.0018	55.73
.0036	58.03
.0071	54.29
.0143	45.79
.0286	38.45
.0570	33.45
.1143	31.00
.2286	28.62
.4571	23.28
.9143	21.47
1.0286	20.11
3.6571	45.47
7.3142	71.06
14.6284	87.26
29.2569	78.12
64.0000	54.34
120.0000	37.60
234.0550	27.71
468.1100	20.46
936.2244	16.01

Y-AXIS FIELD DATA

PERIOD (SECONDS)	APPARENT RESISTIVITY	
.0004	48.25	
.0036	58.69	
.0071	54.20	
.0143	43.50	
.0286	36.96	
.0571	32.28	
.1143	30.39	
.4566	23.02	
10.6667	74.89 ±	2.782
11.1304	80.67 ±	3.953
12.0000	94.64 ±	3.233
14.0406	100.52 ±	3.071
16.0000	94.02 ±	2.247
18.2857	101.02 ±	2.107
20.0784	95.30 ±	1.962
26.9474	77.69 ±	2.859
27.6757	77.27 ±	3.369
39.3846	63.11 ±	3.307
42.6667	57.93 ±	3.306
60.2353	50.16 ±	4.934
102.4000	41.47 ±	5.003
204.8000	34.81 ±	5.547



Ban Huai Ko Tai
Ban Mae Hong Khrai
Ban Huai Dua
Ban Mae Koho
Ban Nong Hai
Wat Nong Hai
Ban Mae Pa Khang
Ban Mai
Wat Don Sai
Doi Sam Ngok



THE PRE-FEASIBILITY STUDY
ON
THE SAN KAMPAENG GEOTHERMAL DEVELOPMENT PROJECT
IN THE KINGDOM OF THAILAND

APPARENT RESISTIVITY ISOCONTOURS
Period: .1143s

unit: ohm.meter

JAPAN INTERNATIONAL COOPERATION AGENCY
ELECTRICITY GENERATING AUTHORITY OF THAILAND
DEPARTMENT OF MINERAL RESOURCES
CHIANG MAI UNIVERSITY

P.N. 178/84 MARCH 1984 SH/1

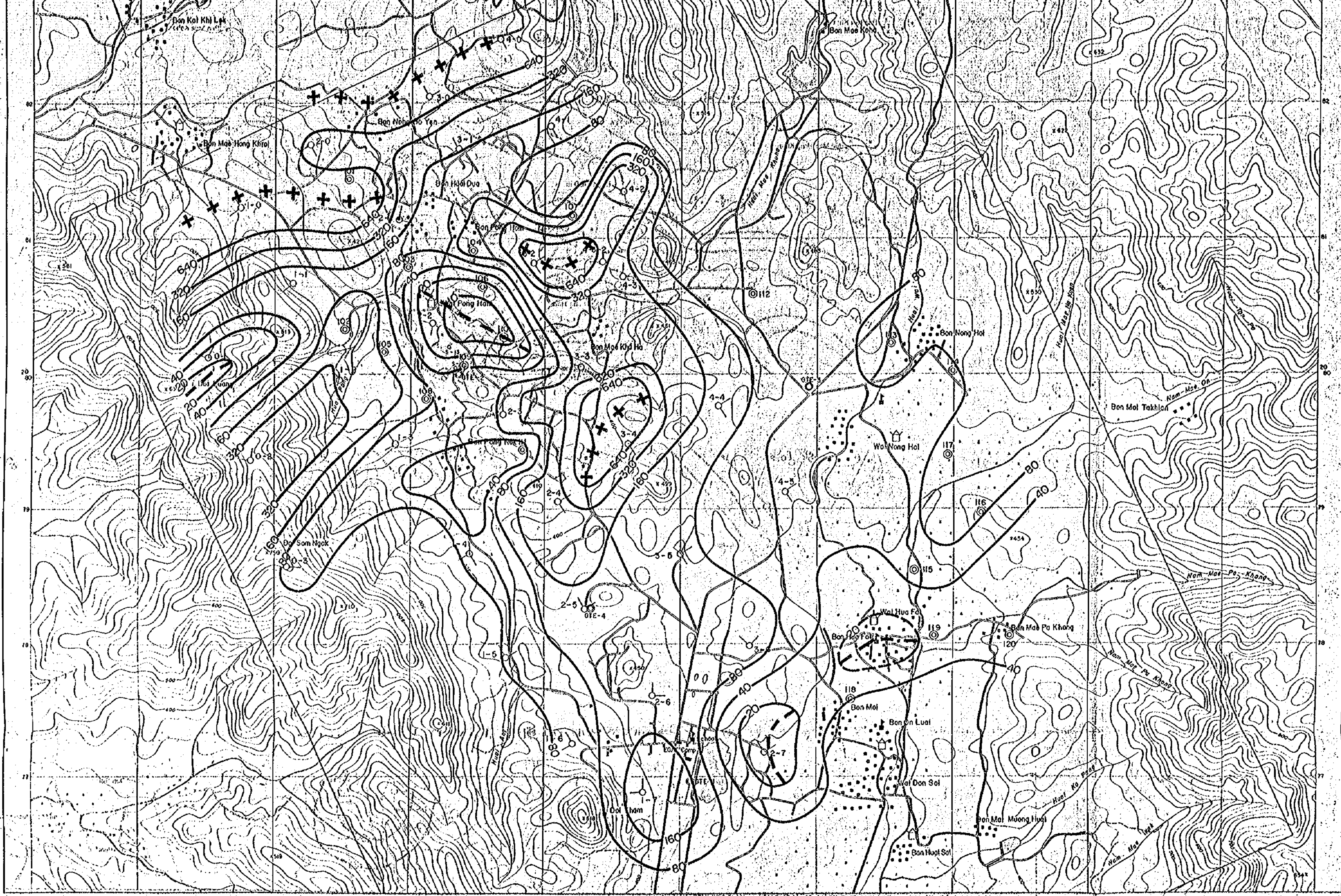
0 500 1000m

LEGEND

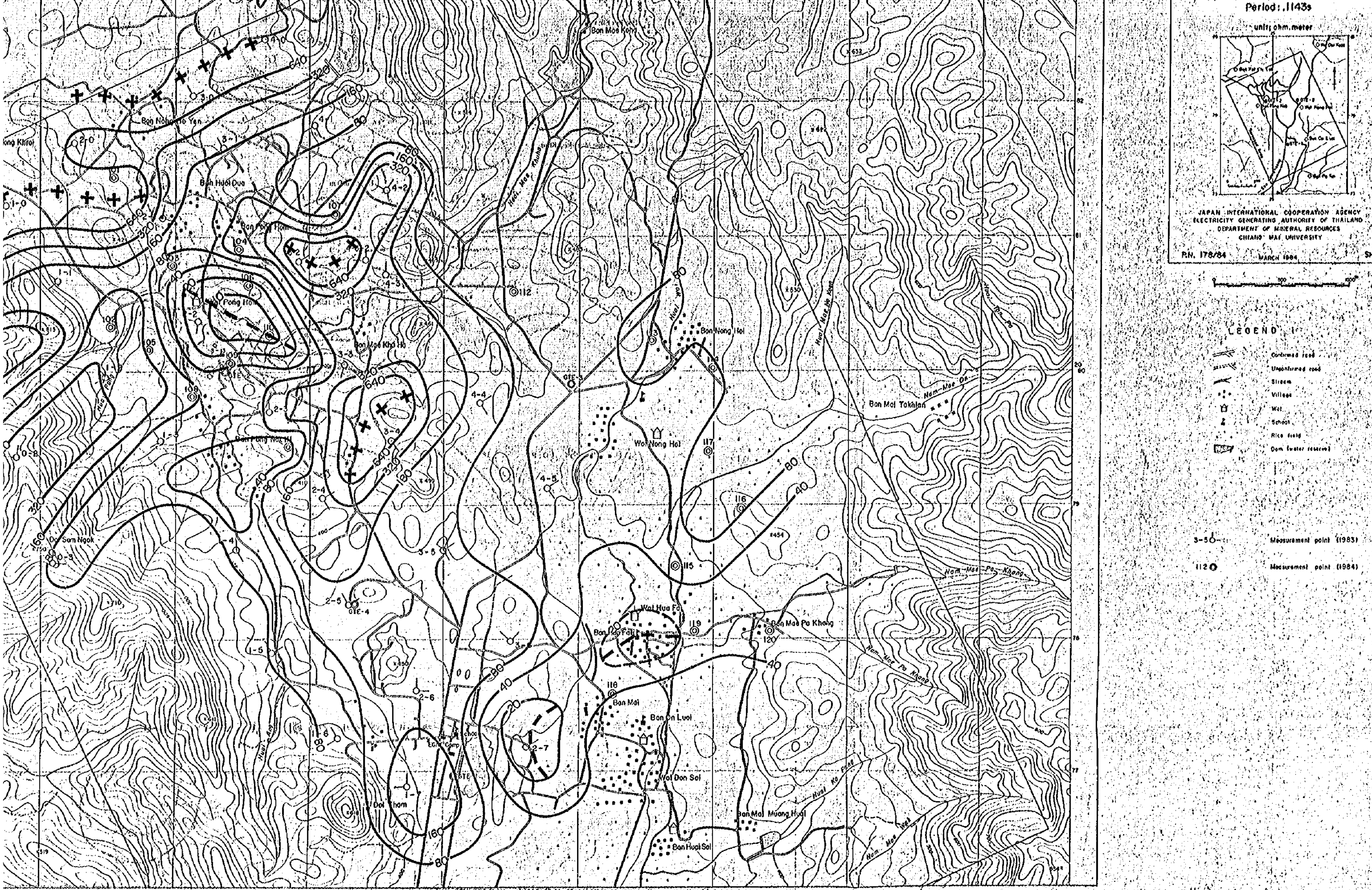
- Confirmed road
- Unconfirmed road
- Stream
- Village
- Wat
- School
- Rice field
- Dam (water reserve)

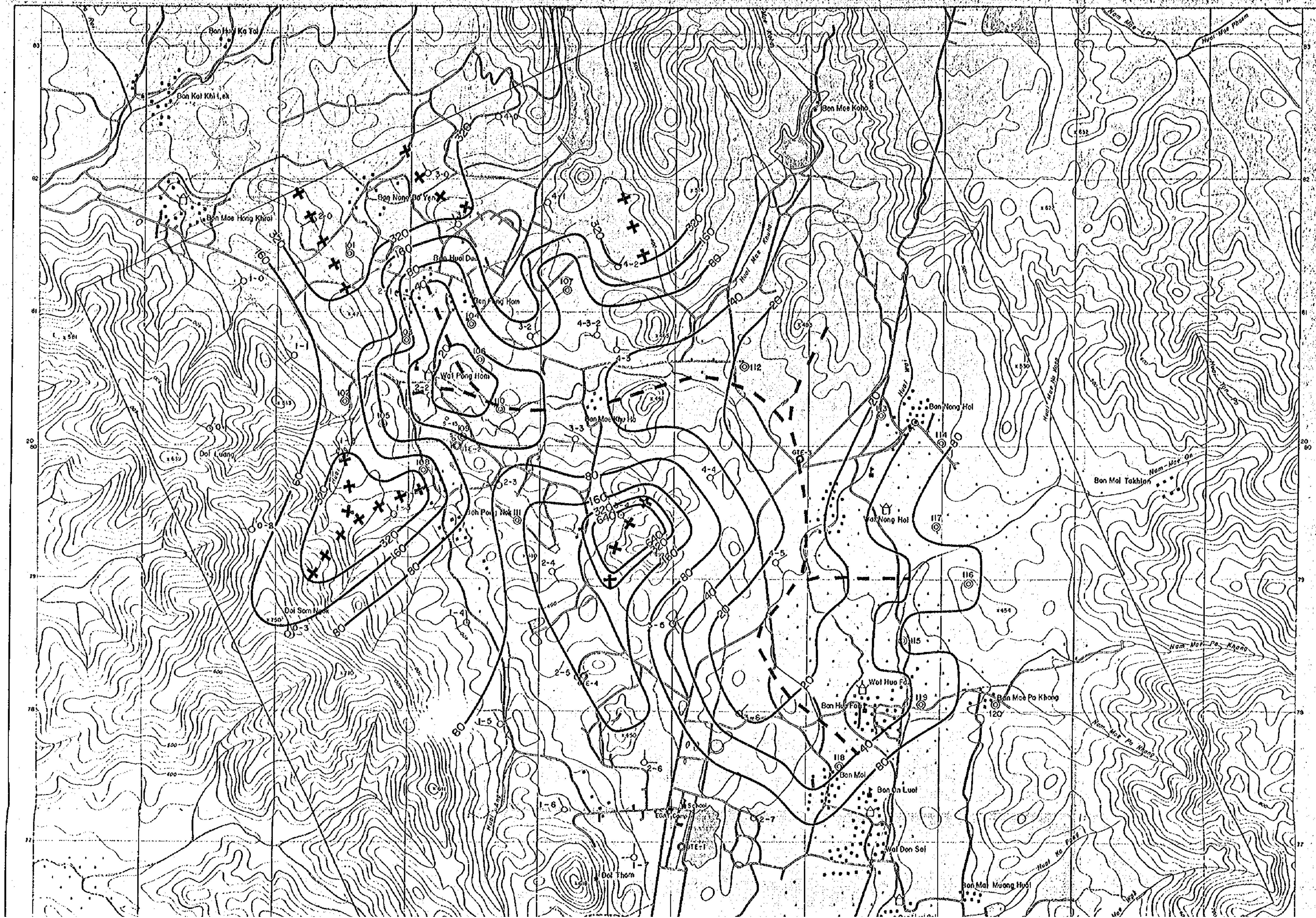
3-5 Measurement point (1983)

112 Measurement point (1984)

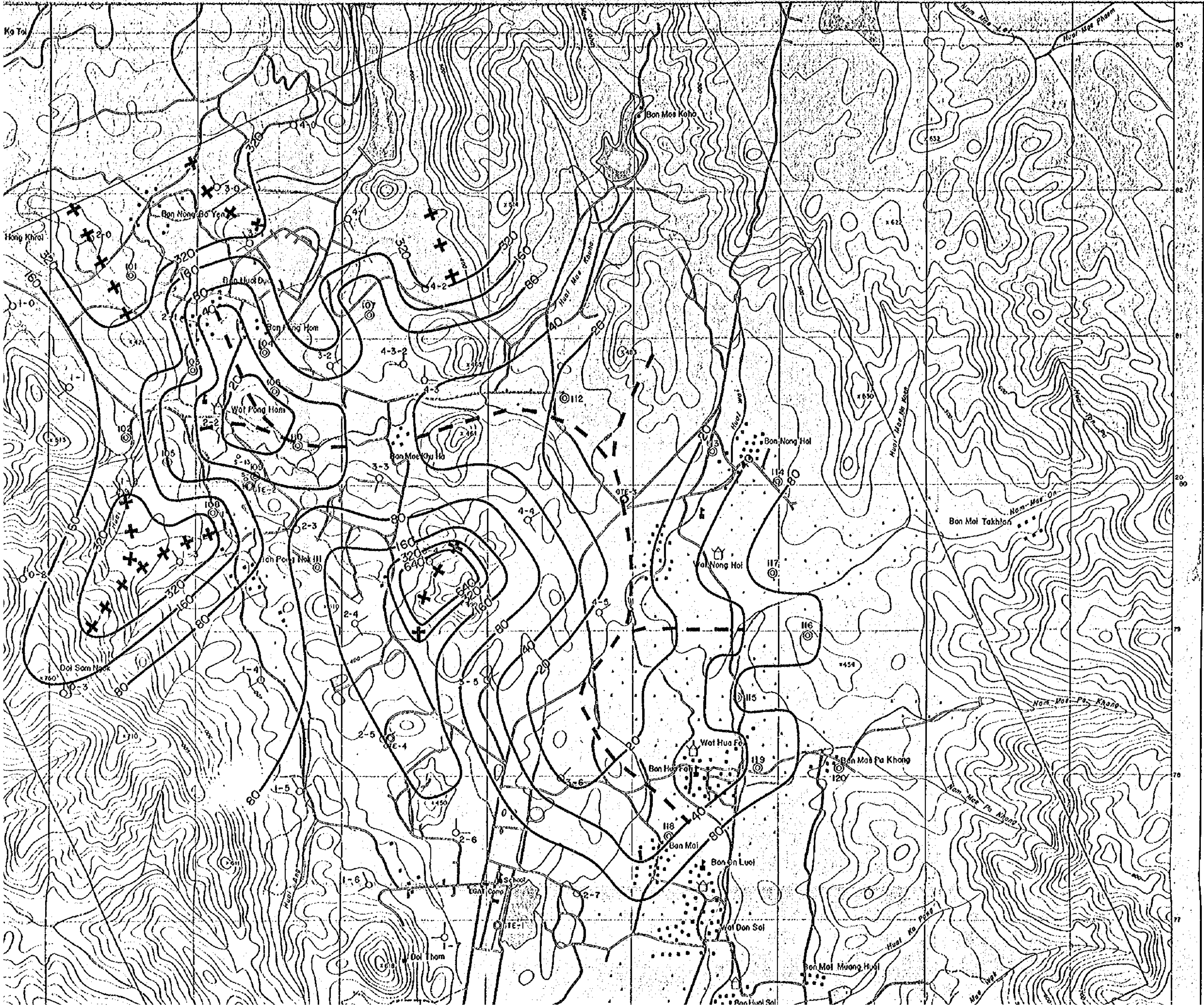


Bon Mae Kong
Bon Mae Hong Khrai
Bon Huai Dua
Pong Han
Bon Mae Kha Ha
Bon Nong Hoi
Bon Mai Takhian
Nam Mae On
Wat Nong Hoi
Nam Mae Pa Khang
Wat Hua Fai
Bon Mae Pa Khang
Bon Mai
Wat Don Sai
Bon Huai Sai
640
320
160
80
40
20


Period: .1143s
unit: ohm.meter
JAPAN INTERNATIONAL COOPERATION AGENCY
ELECTRICITY GENERATING AUTHORITY OF THAILAND
DEPARTMENT OF MINERAL RESOURCES
CHIANG MAI UNIVERSITY
P.N. 178/84
MARCH 1984
SH/1
LEGEND
Confirmed road
Unconfirmed road
Stream
Village
Wat
School
Rice field
Dam (water reserve)
Measurement point (1983)
Measurement point (1984)
Bon Mae Kong
Bon Nong Ho Yen
Bon Huai Dua
Bon Pong Hom
Bon Pong Hai
Bon Mae Kha Ho
Bon Nong Hoi
Wat Nong Hoi
Bon Mai Toknian
Doi Som Ngok
Wat Hua Fai
Bon Hua Fai
Bon Mae Pa Khang
Bon Mai
Bon On Luai
Wat Don Sai
Doi Thom
Bon Mai Muang Huai
Bon Huai Sai
Nam Mae Pa Khong
Nam Mae On
Huai Mae Khong
Huai Mae Ho Kam



Ban Huai Ka Toi
Ban Mae Koho
Ban Nong Bo Yen
Ban Mae Hong Khrai
Ban Huai Dua
Ban Pong Hom
Wat Pong Hom
Ban Mae Khu Ha
Doi Luang
Doi Som Nook
Wat Nong Hoi
Ban Nong Hoi
Ban Mai Takhian
Ban Mae Pa Khong
Nam Mae Pa Khong
Ban Mai
Ban On Luai
Wat Don Sai
Ban Mai Muang Huai
Doi Thom
School



THE PRE-FEASIBILITY STUDY
ON
THE SAN KAMPAENG GEOTHERMAL DEVELOPMENT PROJECT
IN THE KINGDOM OF THAILAND

APPARENT RESISTIVITY ISOCONTOURS
Period: 11.1304s

UNIT: ohm.meter

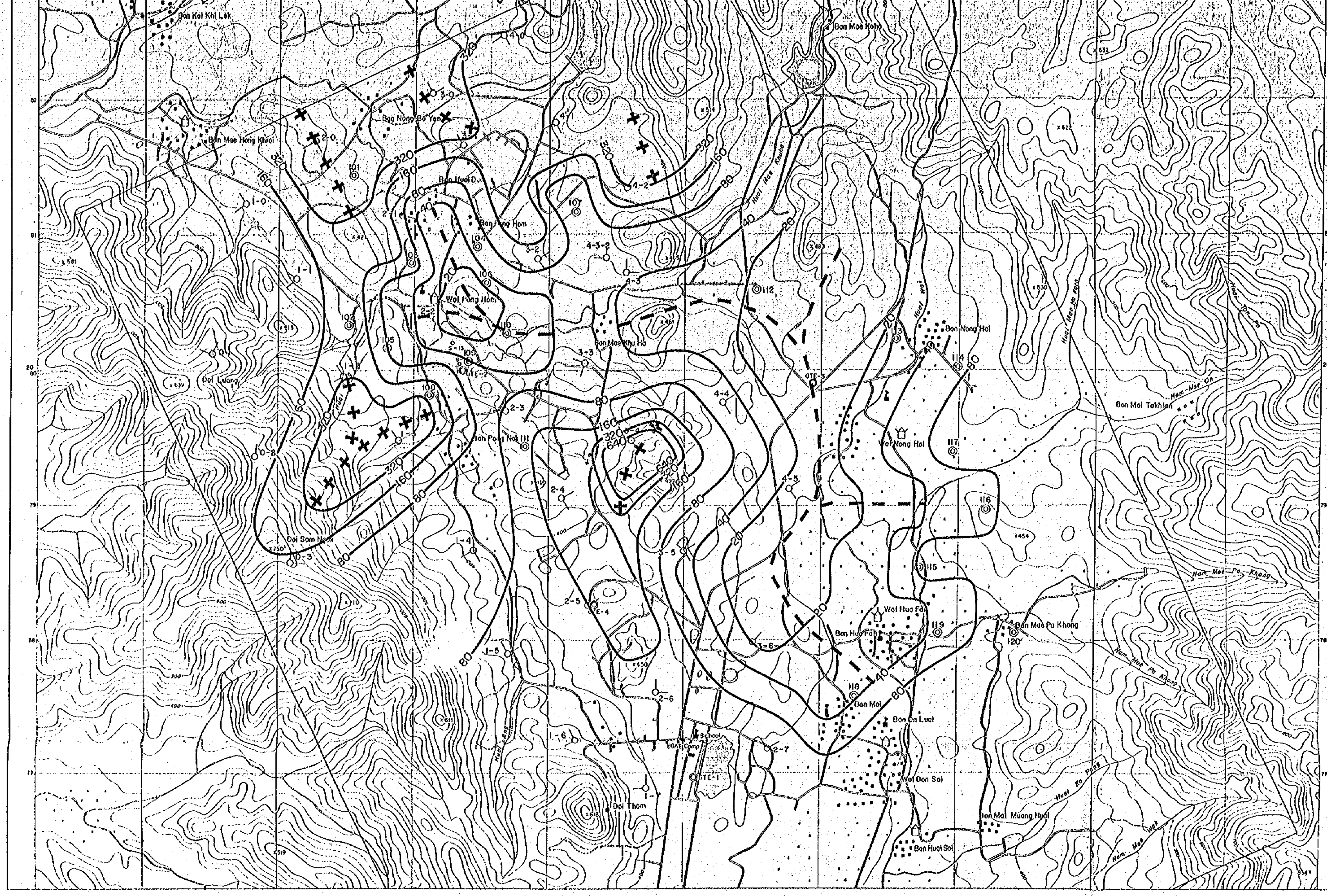
JAPAN INTERNATIONAL COOPERATION AGENCY
ELECTRICITY GENERATING AUTHORITY OF THAILAND
DEPARTMENT OF MINERAL RESOURCES
CHIANG MAI UNIVERSITY

P.N. 178/84 MARCH 1984 SH#2

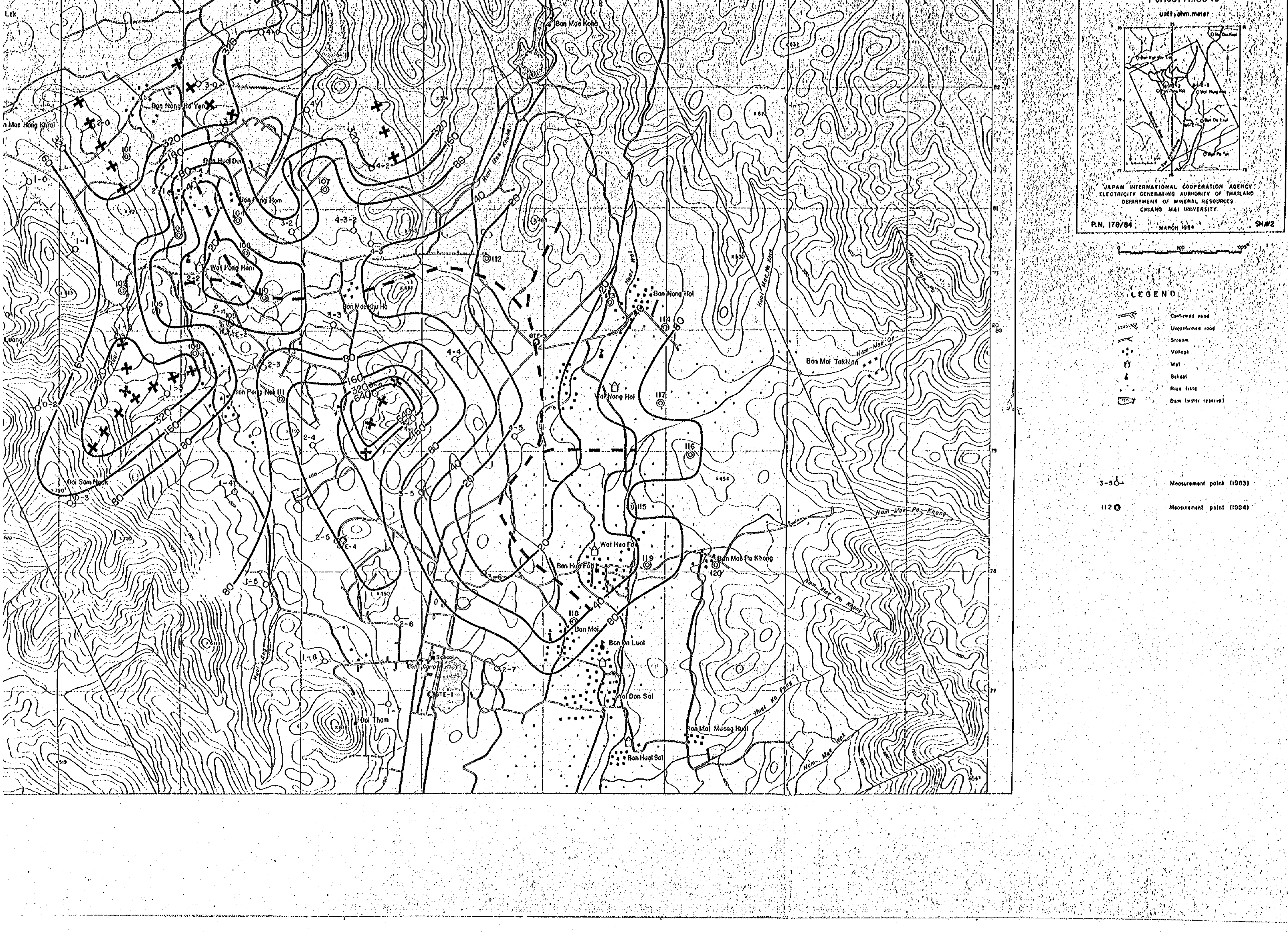
0 500 1000m

LEGEND

- Confirmed road
- Unconfirmed road
- Stream
- Village
- Wat
- School
- Rice field
- Dam (water reserve)
- 3-5 Measurement point (1983)
- 112 Measurement point (1984)



Ban Nong Bo Yen
Ban Mae Hong Khrai
Ban Pong Hom
Wat Pong Hom
Ban Nong Hoi
Doi Luang
Wat Nong Hoi
Ban Mai Takhian
Nam Mae On
Ban Mae Pa Khong
Nam Mae Pa Khong
Ban Mai
Ban On Luai
Wat Don Sai
Doi Tham
Ban Mai Muang Huai
Ban Huai Sai
School


unit: ohm.meter
JAPAN INTERNATIONAL COOPERATION AGENCY
ELECTRICITY GENERATING AUTHORITY OF THAILAND
DEPARTMENT OF MINERAL RESOURCES
CHIANG MAI UNIVERSITY
P.N. 178/84
MARCH 1984
SH#2
LEGEND
Confirmed road
Unconfirmed road
Stream
Village
Wat
School
Rice field
Dam (water reserve)
Measurement point (1983)
Measurement point (1984)
Ban Mae Koha
Ban Nong Bo Yen
Ban Huai Dua
Ban Pong Hom
Wat Pong Hom
Ban Mae Khu Ha
Ban Nong Hoi
Ban Mai Takhlon
Wat Nong Hoi
Ban Pong Nok
Doi Sam Nack
Wat Hua Fai
Ban Hua Fai
Ban Mae Pa Khong
Ban Mai
Ban On Luai
Wat Don Sai
Ban Mai Muong Huai
Ban Huai Sai
Doi Thom
Nam Mae Pa Khong
Nam Mae Wat
Huai Ka Pong