a: 2, 4, 7, 10, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100 meters,

and that in other sites as below;

a: 2, 4, 6, 8, 10, 13, 15, 16, 20, 24, 25, 30, 35, 40, 50 meters.

The measurement equipment employed was YEW 3244 (made in Japan) in Gesang, Kloposawit and Kertosari, ABEM SAS 300 (made in Sweden) in K. Lengkong Fan.

In the measurement, because of the ground surface of these field sites was covered with many gravels (mean diameter 1 to 50 cm) with very dry sand and silt, it was very difficult for electric current to pass underground. Accordingly, some ρ -a curves based on the field data may include some measurement errors.

All the values of apparent resistivity were plotted immediately on the full-logarithmic section paper and recorded on the "MEASUREMENT NOTE OF RESISTIVITY". The figures and notes are attached as Supplement Report D-2 with the calculated resistivity-depth column.

3.4.3 RESULTS OF ANALYSIS

(1) Method of Analysis

The resistivity (ρ) calculated from the field data is an apparent resistivity (2π a ρ) by the Wenner's Method and is expressed in terms of (ρ a).

By measuring the values of (ρ a) at several electrode spacings (a), it is possible to find the influence of the deeper layers on the apparent specific resistivity (ρ a). In the case of a simple two-layer model, the relationship between electrode spacing (a) and apparent specific resistivity is shown in Fig.-3.4.5. Therefore, if the relationships between (a) and (ρa) in various thicknesses of upper layers are calculated beforehand, by comparing the calculated relationship and the field data the electric resistivity structure can be determined.

These theoretical ρa-a curves of the two layer model are shown in Fig.-3.4.6 called "Stndard Curves" or "Master Curves".

In the case of a three or more layer structure, using "Auxiliary Curves", the upper layers can be regarded as one homegeneous layer.

Accordingly, in a complicated multi-layer structure, the field data can be analyzed completely.

Fig.-3.4.7 shows the auxiliary curves computed by Mr. Ono.

(2) Results of Analysis

The analysis of the field data was carried out exclusively by superimposing a ρ-a curve on the "Standard Curves" computed by the "Wenner" theory.

The ρ-a curves with the determined resistivity depth column are attached in Supplement Report D-2.

The results of analysis of the findings of electric sounding are given below.

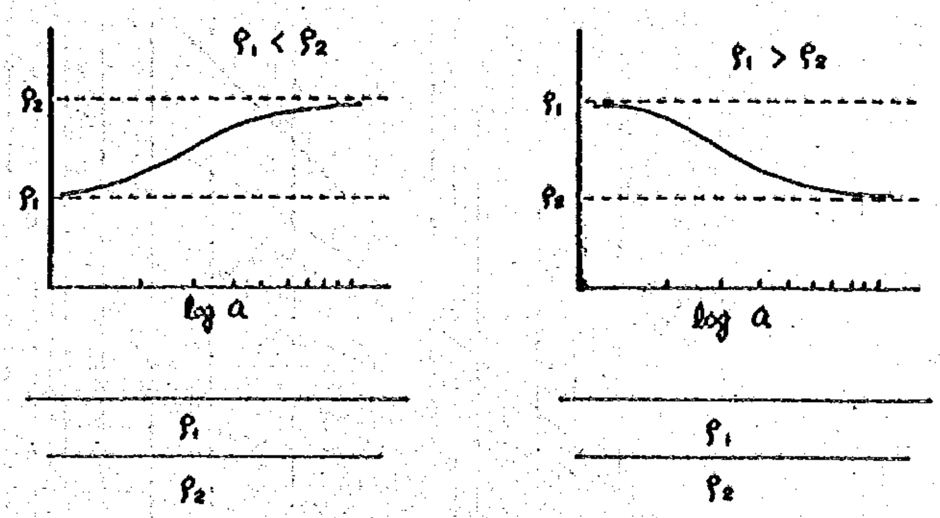


Fig.- 3.4.5 Relationship ρa-a in Two Layers Model

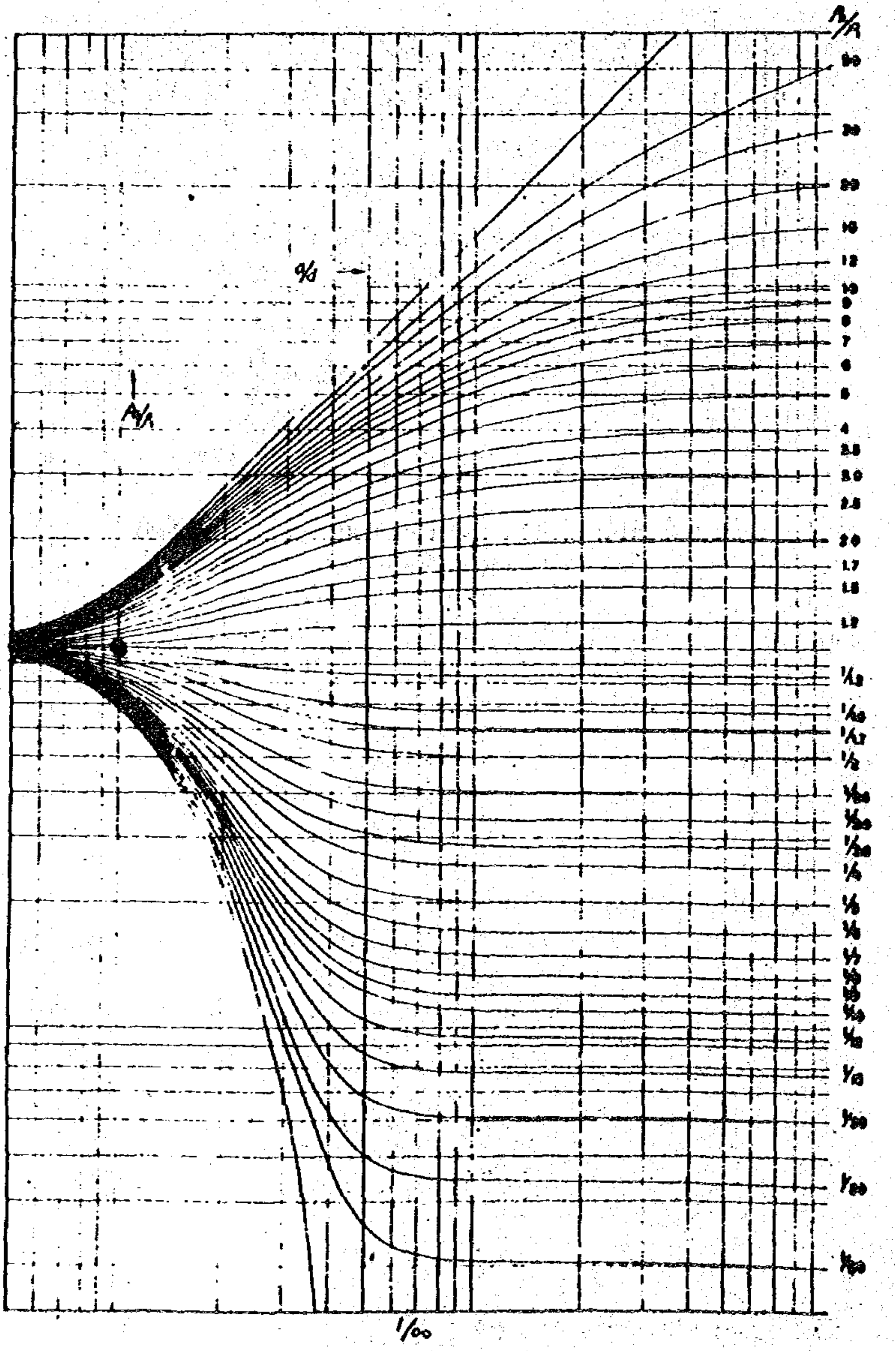


Fig.- 3.4.6 Standard Curves

垂直探査解析用補助曲線図(小野式)

ES-DI 直流電気探査装置用

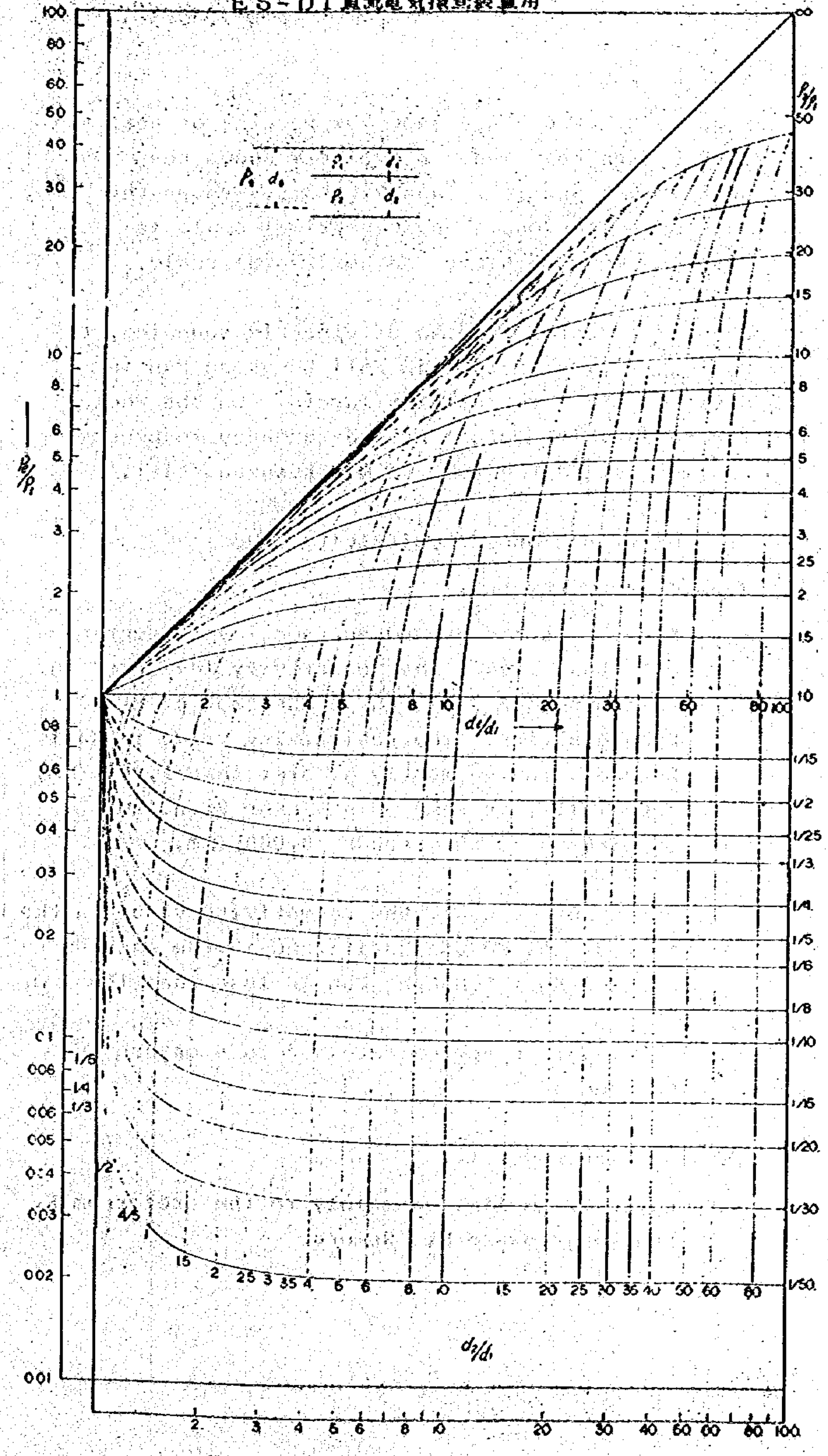


Fig.- 3.4.7 Auxiliary Curves

i) Kali Lengkong Fan

Figs. 3.4.8 and 3.4.9 show the results of analysis in Kali Lengkong Fan. Fig.-3.4.8 shows the north-south sections, and Fig.-3.4.9 shows the east-west sections. Their vertical scale is exaggerated to 5 times the horizontal scale.

According to the results of electric sounding, the resisitivity structure in Kali Lengkong Fan is divided into 6 resistivity layers. On the whole, the resistivity values have a tendency to become smaller toward the foot of Mt. Kukusanseriti.

-: Distribution of Resistivity Layer

(Resistivity Layer I)

Layer I is the ground surface layer covering the study area. The resistivity is larger in Kali Lengkong Fan than in the foot of Mt. Kukusanseriti. The resistivity value in Kali Lengkong Fan is mostly greater than 2,000 Ω m, especially, at some points near Pronojiwo Damsite where it exceeds 10,000 Ω m.

On the other hand, the resistivity value in the foot of Mt. Kukusanseriti and in the eastern area of Kali Lengkong Fan is less than 100 Ω m.

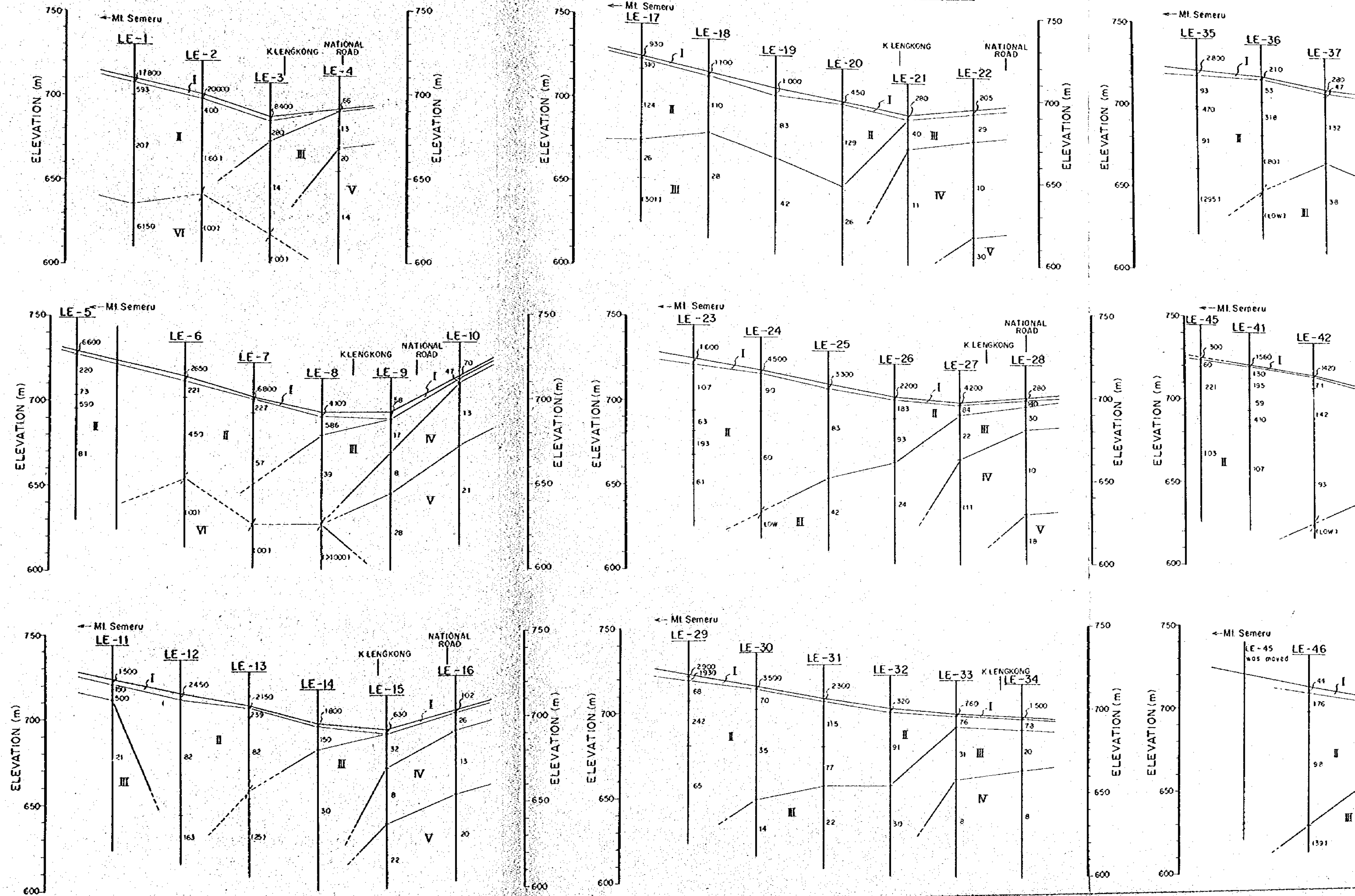
The layer is approximately 2 to 5 meters in thickness.

(Resistivity Layer II)

Layer II is limited mainly to the area from K. Lengkong toward Mt. Semeru.

RESISTIVITY LAYER SECTION (NORTH-SOUTH DIRECTION)

KALI LENGKONG FAN



CTION (NORTH-SOUTH DIRECTION)
GKONG FAN

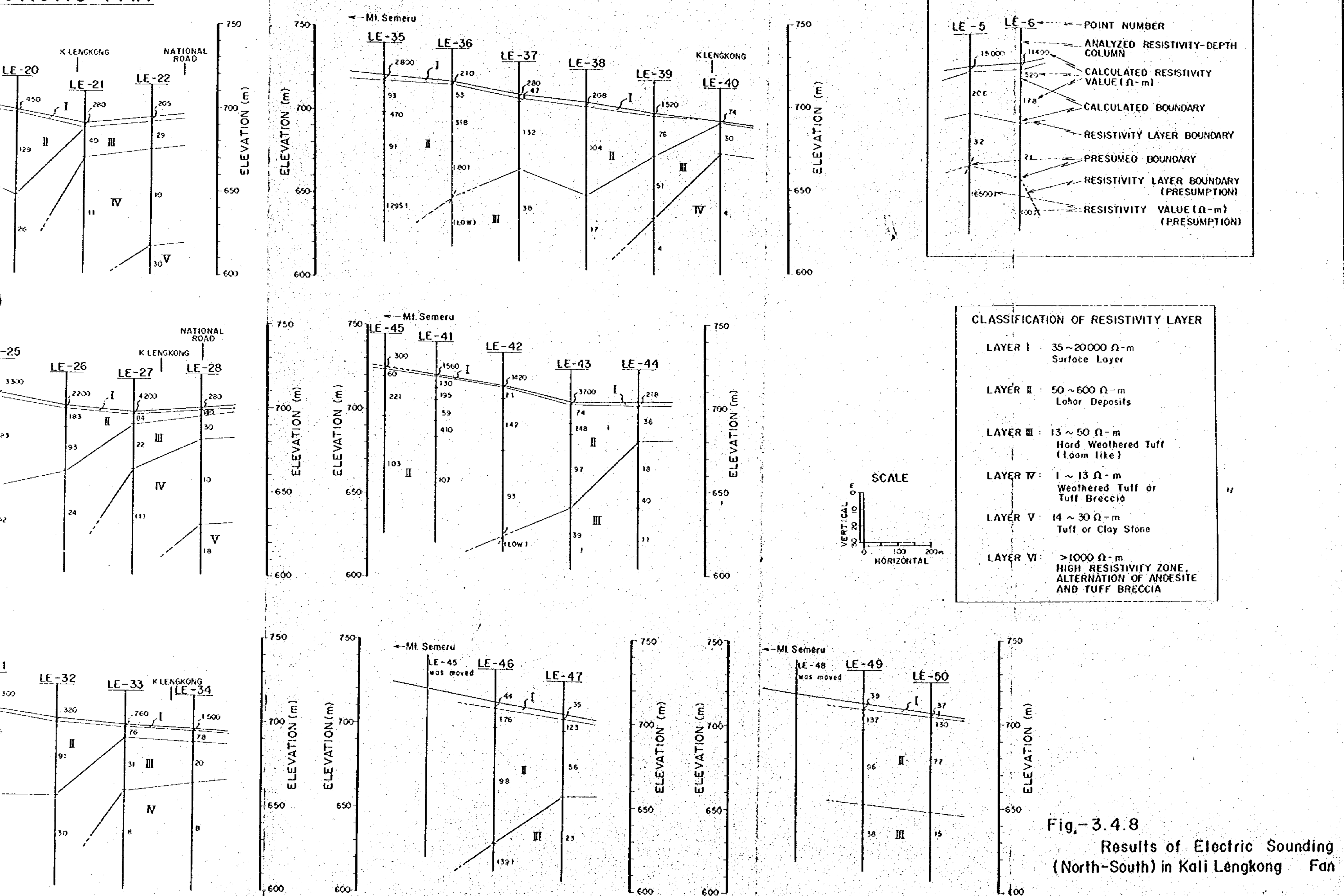
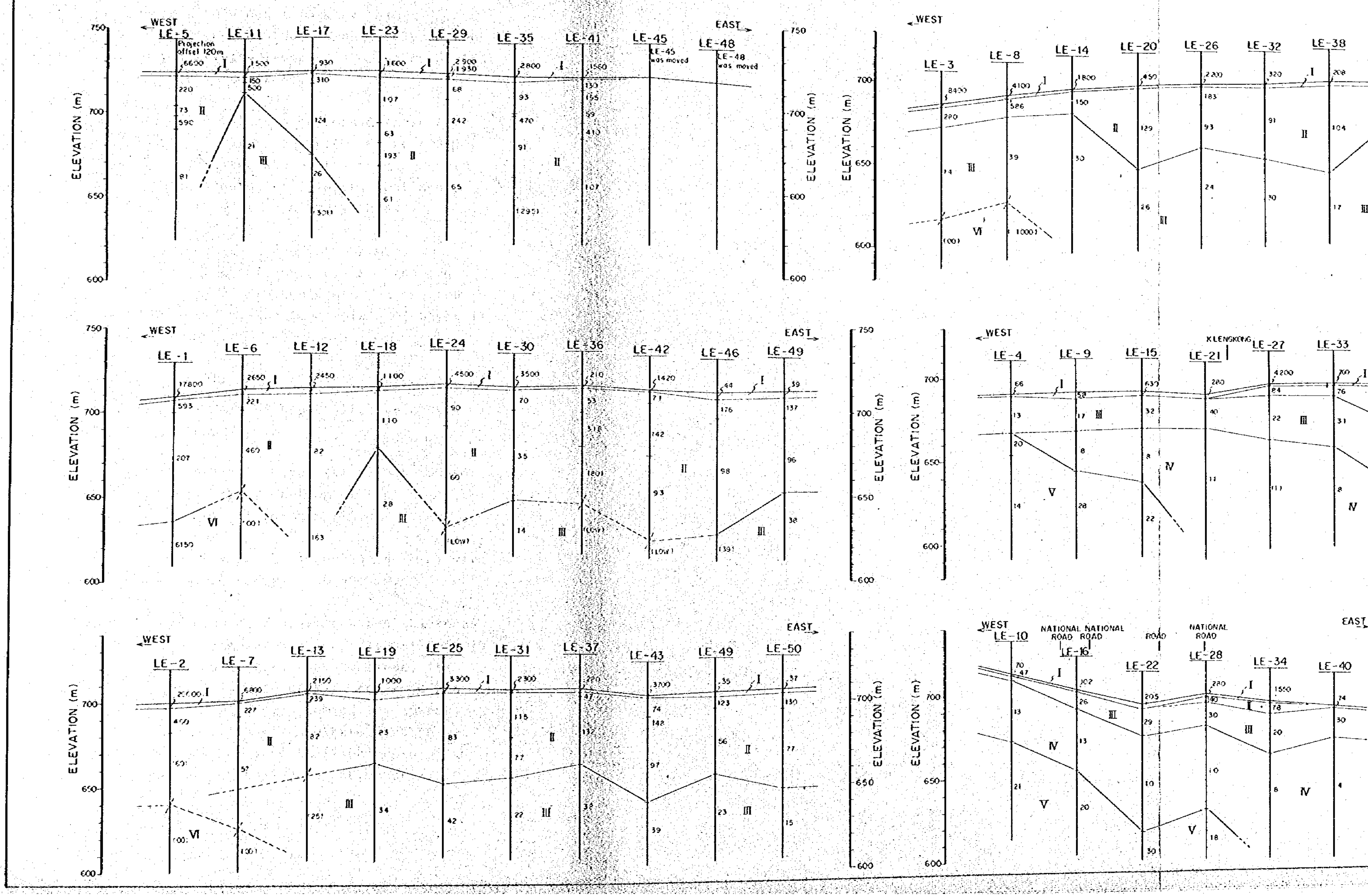
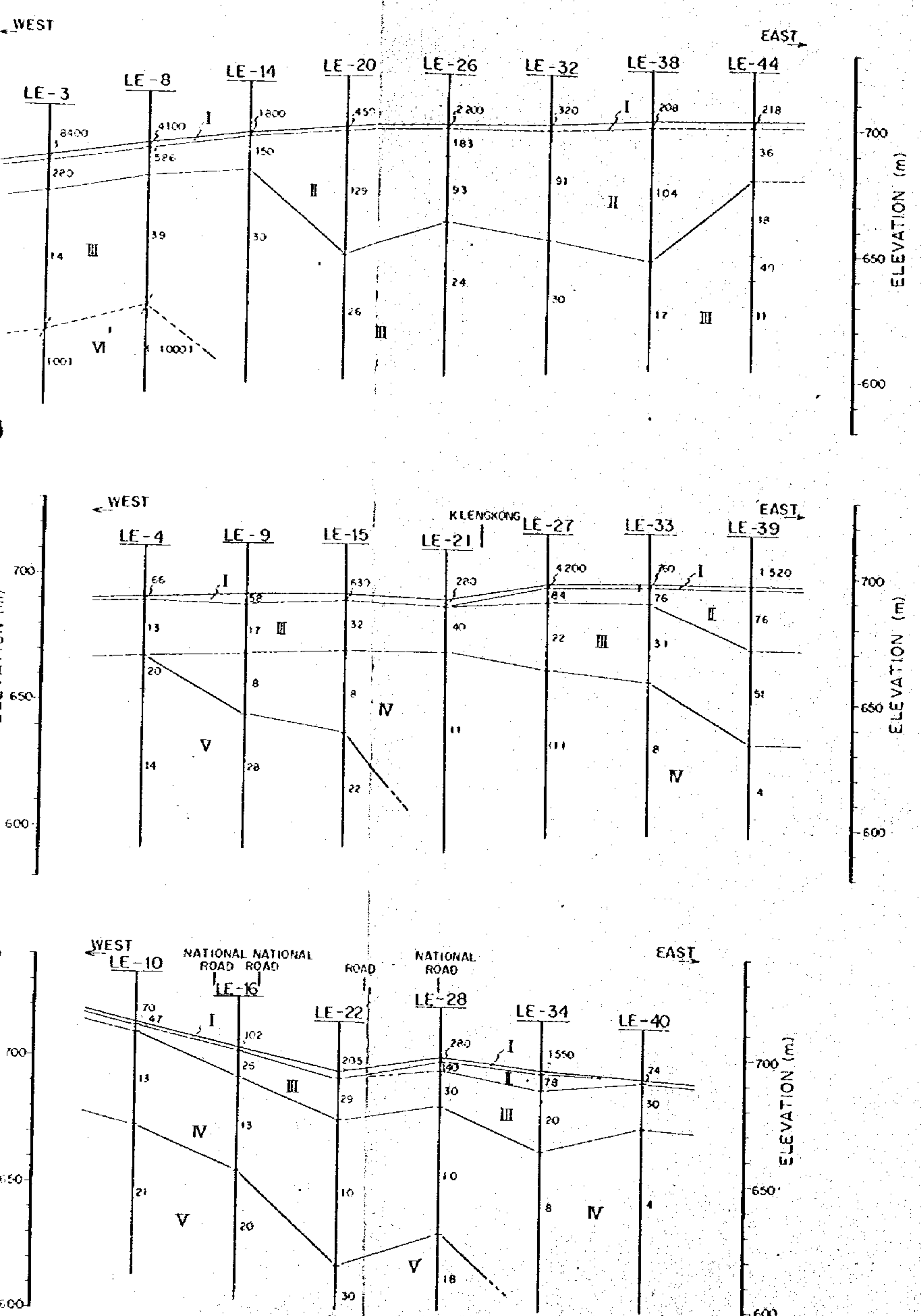


Fig.-3.4.8 Results of Electric Sounding (North-South) in Kali Lengkong Fan

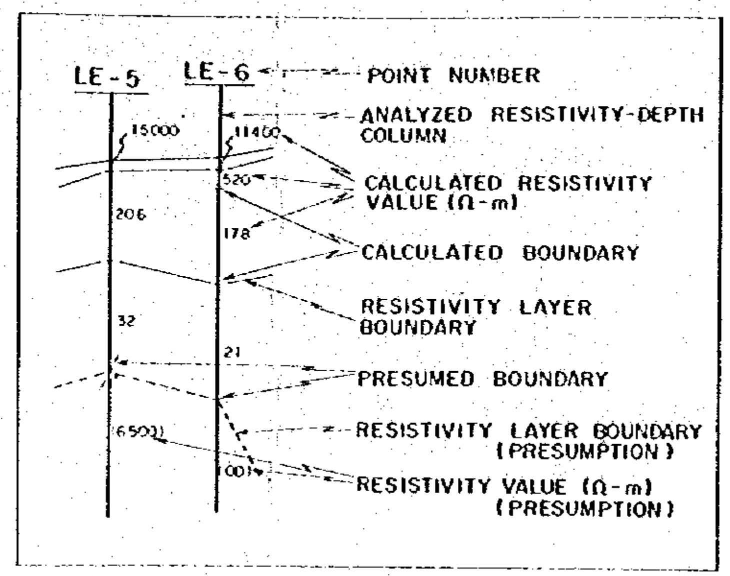
RESISTIVITY LAYER SECTION (EAST - WEST DIRECTION)
KALI LENGKONG FAN



– WEST DIRECTION)



LEGEND



CLASSIFICATION OF RESISTIVITY LAYER

LAYER I	35~20000 Ω-m	Surface Layer
LAYER II	50~600 Ω-m	Lahar Deposits
LAYER III	13~50 Ω-m	Hard Weathered Tuff (Loam like)
LAYER IV	1~13 Ω-m	Weathered Tuff or Tuff Breccia
LAYER V	14~30 Ω-m	Tuff or Clay Stone
LAYER VI	>1000 Ω-m	HIGH RESISTIVITY ZONE, ALTERNATION OF ANDESITE AND TUFF BRECCIA

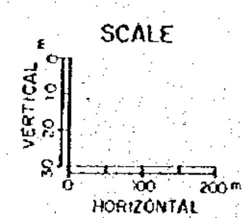


Fig.- 3.4.9 Results of Electric Sounding (East-West) in Kali Lengkong

Layer II is subdivided into many thin resistivity layers by the computed columns, but the thin resistivity layers cannot be connected to each other in Layer II.

The resistivity values show considerable variation from approximately 60 Ωm to 600 Ωm. Nevertheless, on the whole, the thickness of the subdivided resistivity layers that show more than 300 Ωm is relatively thin.

Layer II is absent in the foot of Mt. Kukusanseriti but thickens from K. Lengkong toward Mt. Semeru. In the east-west section nearest Mt. Semeru, the lower plain of Layer II cannot be found.

(Resistivity Layer III)

Layer III, overlain by Layer II, lies above Layers IV, V and VI.

The overlain plain of Layer III slopes toward Mt. Semeru with the exception of the neighborhood area of point LE-11.

The resistivity value is less than 50 Ωm, with the mean value of about 20 to 30 Ωm.

From the results of measurement the thickness of Layer III in and around the national road is approximately 15 meters. Nevertheless, its thickness in the middle of Kali Lengkong Fan increases to 50 meters, becoming the lowest resistivity layer in the southern section. This is because the investigation depth of the measurement is about - 70 to -80 meters.

(Resistivity Layer IV)

Layer IV, situated under Layer III, is limited to the area in and around the foot of Mt. Kukusanseriti.

The resistivity value is 4 to 13 Ω m. Layer IV has a tendency to become thin toward K. Lengkong and Pronojiwo Damsite (west). It seems that the maximum thickness is approximately 50 to 60 meters.

(Resistivity Layer V)

Layer V is also limited to the area in the foot of Mt. Kukusanseriti. That is to say, Layer V is distributed within the southwest area of Kali Lengkong Fan, and underlies Layer IV.

The resistivity value is about 15 to 30 Ω m, but the thickness cannot be estimated. This is because in the southwest area of Kali Lengkong Fan, Layer V is situated deeper.

(Resistivity Layer VI)

In Kali Lengkong Fan, excluding Layer I, Layer VI has the highest resistivity values in excess of 1,000 to 6,000 Ω m.

In addition, Layer VI is limited to the western area of Kali Lengkong Fan. That is to say, at points LE-1, LE-2, LE-3, LE-6, LE-7 and LE-8 resistivity values of more than 1,000 Ω m are detected. The elevation of the upper plain is approximately EL. 640 meters.

-: Geological Interpretation of Resistivity Layers

The following is a brief geological interpretation of the results of electric sounding in Kali Lengkong Fan.

(Resistivity Layer I)

Layer I corresponds to younger Lahar deposits or top soil of cultivated land.

The classification can be established to compare the resistivity values. That is to say, the high resistivity area is younger Lahar deposits. The cultivated land area has a lower resistivity value.

The thickness of younger Lahar deposits is about 2 to 5 meters.

(Resistivity Layer II)

Layer II corresponds to relatively older Lahar deposits at the height of the resistivity value.

According to the results of electric sounding, older Lahar deposits looked as if they had been deposited many times on the study field.

Layer II is mostly situated under the ground water table.

(Resistivity Layer III)

Layer III corresponds to the highly weathereed zone of Tertiiary bedrock or its deposits.

According to the specific resistivity, Layer III having a loam-like appearance consists of argillaceous silts.

This layer is situated under the ground water table, and these resistivity values support the idea that it is an impervious layer. However, this point must be confirmed in the later investigations.

(Resistivity layer IV)

Layer IV corresponds to the Tertiary bedrock consisting of tuff and clayey mudstone. At the height of these resistivity values, it is richer in clay mineral than the overlying resistivity Layer III.

Layer IV is regarded as an impervious layer.

(Resistivity Layer V)

Layer V is similar in property to the overlying Layer IV. The highest resistivity value is more than that of Layer IV. Layer V also corresponds to the Tertiary bedrock thought to be consisted of silt and mudstone. The resistivity value suggests that it is an impervious layer.

(Resistivity Layer VI)

This layer corresponds to alternation of adesite lava volcanic breccia. The high resistivity values indicate that it is an impervious layer.

ii) Gesang Consolidation Damsite and Sand Pocket Site in Kloposawit and Kertosari

The above-mentioned 3 sites are located in the upper and middle reaches of K. Mujur.

Fig.-3.4.10 shows the results of analysis of the 3 sites. Their vertical scale is exaggerated to 5 times the horizontal scale.

According to the results of electric sounding, the resistivity structure along K. Mujur is divided into 3 resistivity layers.

Nevertheless, when comparing each resistivity layer profiling, the resistivity values show a tendency to become lower toward the upper reaches of K. Mujur with the structure becoming more complex. For example, resistivity Layer II detected in Gesang is absent in Kertosari. The boundary plain of the resistivity layers in the 2 sites of K. Mujur slants toward the downstream.

-: Distribution of Resistivity Layers

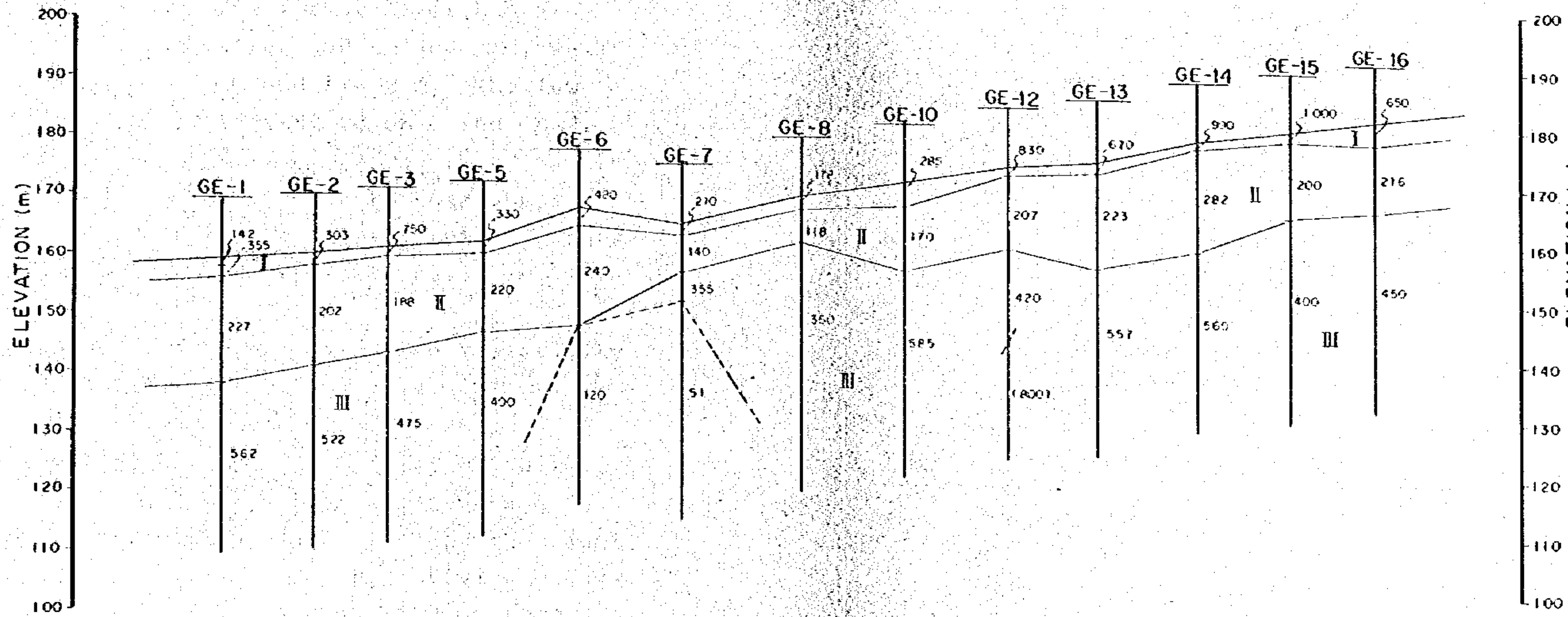
In Gesang consolidation damsite, the resistivity structure is divided into 3 layers.

Layer I has resistivity values of 140 to 1,000 Ω m. Its thickness 1.5 to 4 meters.

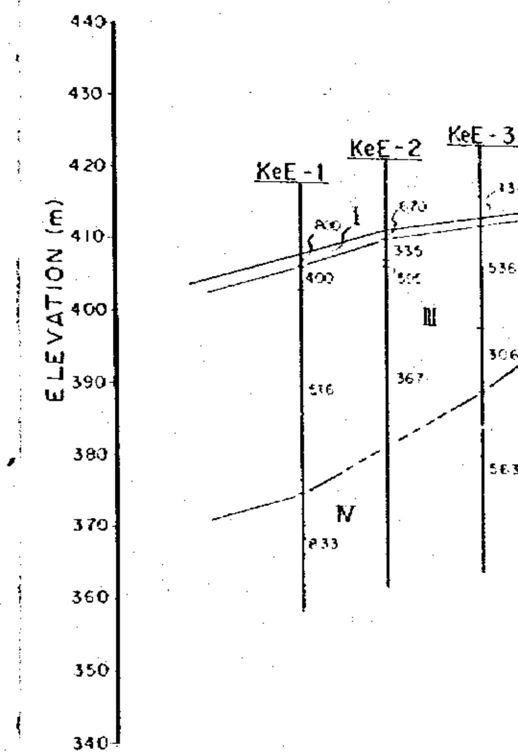
Layer II has nearly a constant resistivity value (120 to 280 Ω m) ranging in thickness from 5.5 to 18 meters. Especially, the most striking feature of this layer is that it is very thin at GE-7 and GE-8.

RESISTIVITY LAYER SECTION
ALONG K. MUJUR AND K.B TUNGGENG

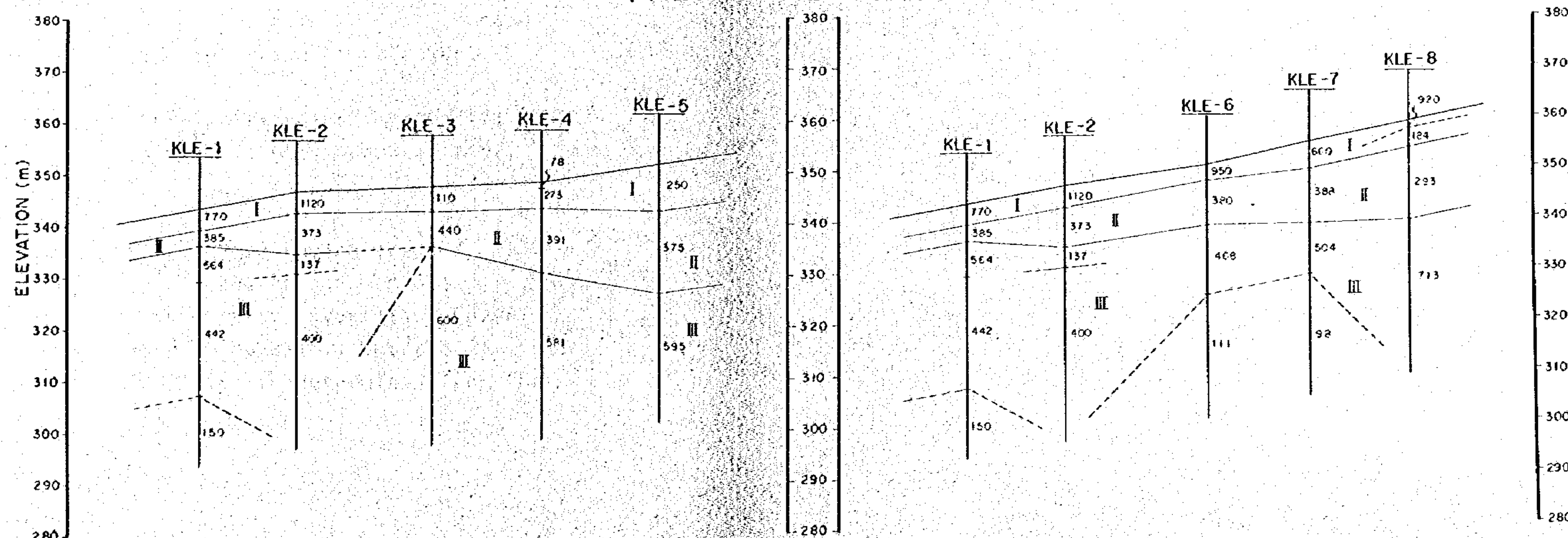
GESANG CONSOLIDATION DAMSITE
(ALONG K. MUJUR)



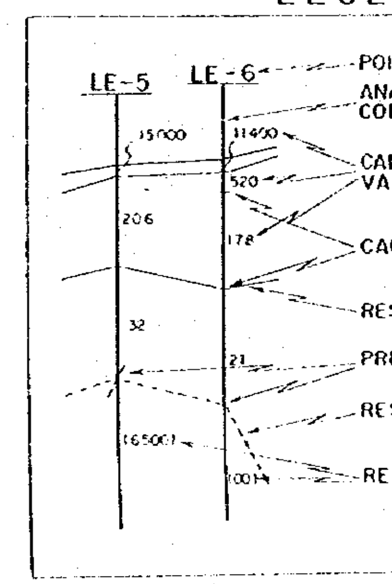
KERTOSARI
(ALONG



KLOPOSAWIT SAND POCKET
(ALONG K.B. TUNGGENG)



LEGE



CLASSIFICATION OF RESISTIVIT

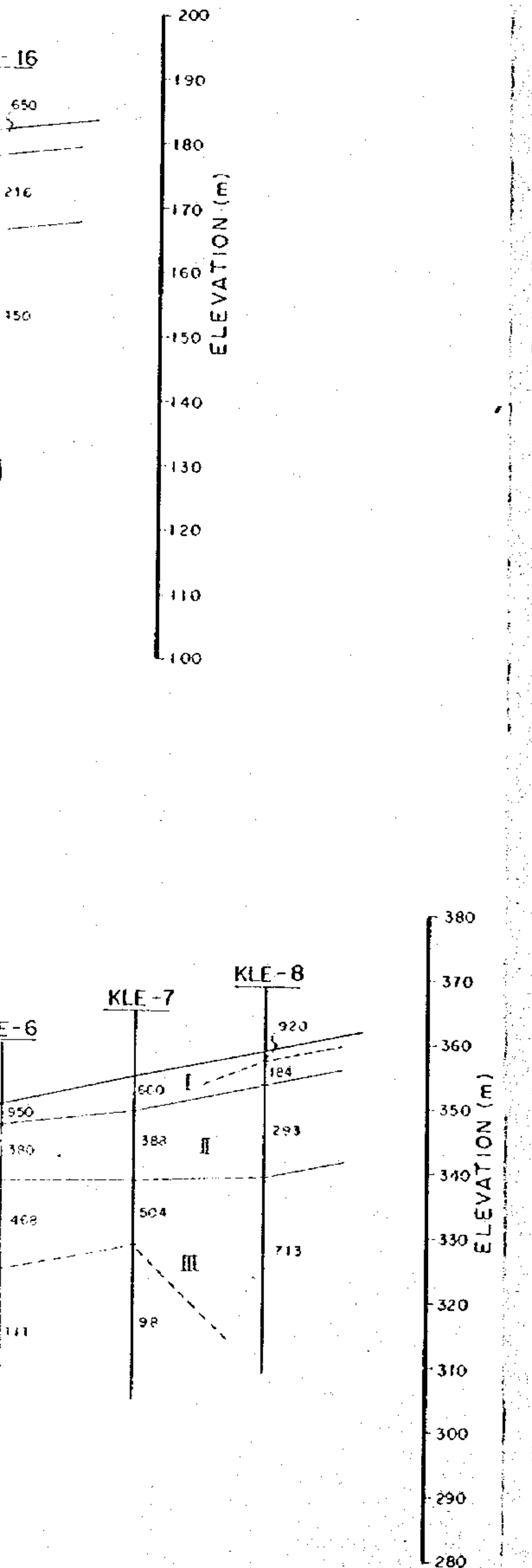
LAYER I : 80 ~ 1200 Ω-m
Surface

LAYER II : 200 ~ 400 Ω-m
Upper Layer

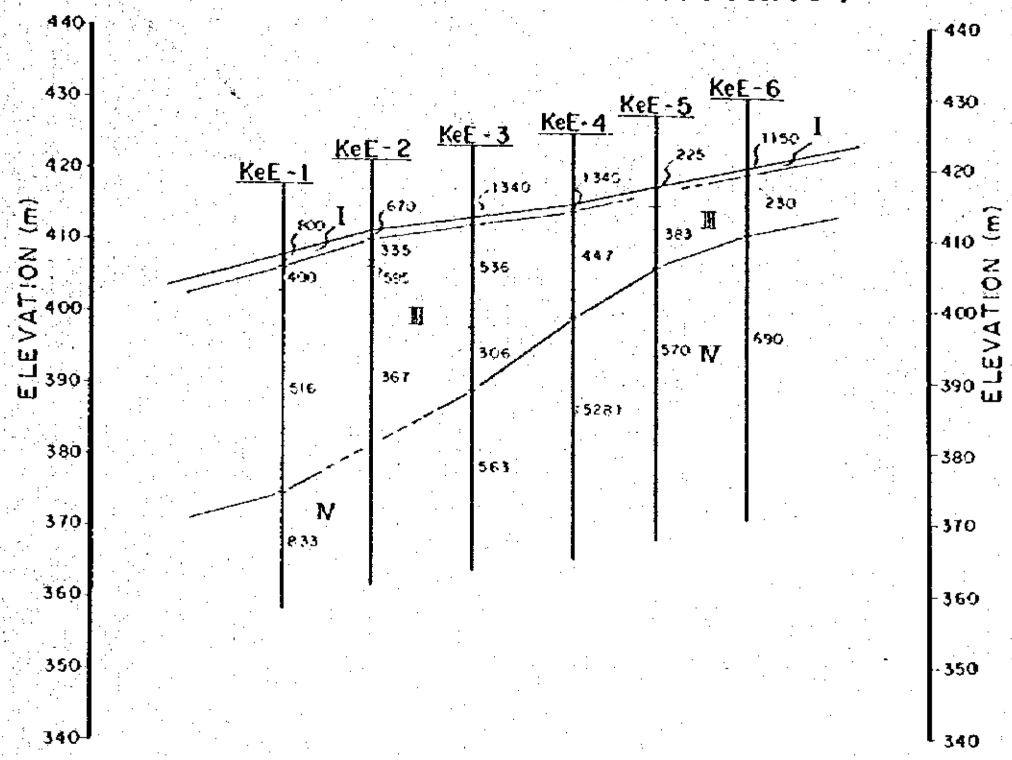
LAYER III : 300 ~ 600 (50 ~ 150)
Lower Layer

LAYER IV : 500 ~ 800 Ω-m
Lower Layer

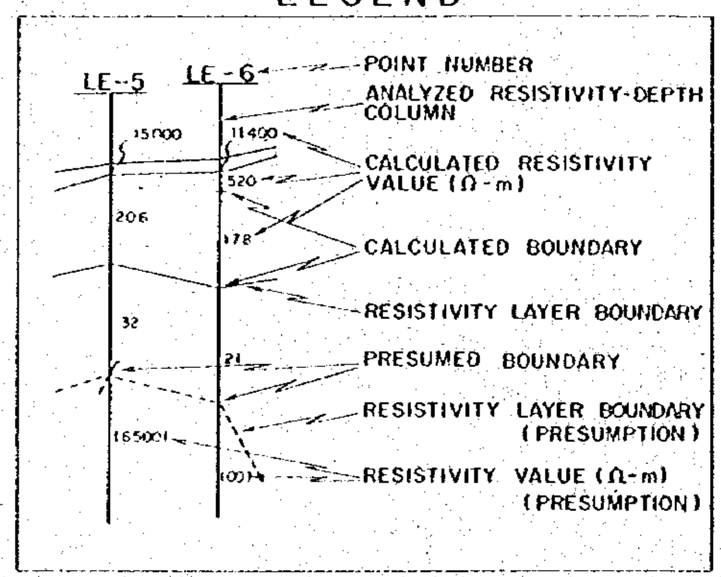
CTION
UNGGENG



KERTOSARI SAND POCKET
(ALONG K.B. TUNGGENG)



LEGEND



CLASSIFICATION OF RESISTIVITY LAYER

LAYER I : 80～1200 Ω-m
Surface

LAYER II : 200～400 Ω-m
Upper Layer

LAYER III : 300～600 (50～150) Ω-m
Lower Layer

LAYER IV : 500～800 Ω-m
Lower Layer

SCALE

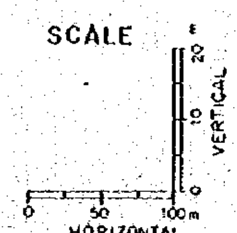


Fig-3.4.10 Results of Electric Sounding in K. Mujar.

Layer III is subdivided into high and low resistivity zones. The former layer has a resistivity value between 350 to 580 Ωm, while the latter have 50 Ωm and 120 Ωm. The low resistivity zone is limited to GE-6 and GE-7.

The depth from ground surface to this upper plain is about -18 to -21 meters, but at points GE-7 and GE-8 it is about -7 meters.

In Kloposawit Sand Pocket Site, the resistivity structure is divided into 3 layers.

Resistivity Layer I has resistivity of 80 to 1,120 Ωm and is about 5 meters in average thickness. Especially, Layer I along the right channel has relatively lower resistivity values (80 to 270 Ωm) and is thicker than that along the main channel of K. Mujur.

Resistivity Layer II has about a 290 to 440 Ωm resistivity value. Resistivity Layer III has about 400 to 710 Ωm resistivity value. Resistivitiy Layer II has a tendency to become thinner toward the downstream of K. Mujur.

When comparing resistivity values, Layer III in Kloposawit is believed to correspond to Layer III in Gesang.

The low resistivity layers having the resistivity values of 100 to 140 Ωm are intercalated in resistivity Layer III. These layers are presumed to be silty, but the continuity is indefinite as determined from the results.

In Kertosari Sand Pocket Site, the resistivity structure can be divided into 3 layers.

Resistivity Layer I has resistivity of 230 to 1,340 Ωm. It is 1 to 2.5 meters in thickness.

Layer II (200 to 400 Ωm) cannot be detected in this site. Resistivity Layers III and IV are detected in this site, however. The boundary plain between them is not distinct. Accordingly, in view of the resistivity values, these two layers can be generally regarded as one layer. Layer III shows 230 to 540 Ωm and Layer IV shows a 530 to 830 Ωm resistivity value.

This Layer III corresponds to the Resistivity Layer III in Kloposawit and Layer III in Gesang.

Resistivity Layer IV (530 to 830 Ωm) is not distributed in Gesang and Kloposawit sites.

: Geological Interpretation of Resistivity Layers

Layer I in the upper and middle reaches of K. Mujur generally corresponds to the riverbed deposits.

It consists of sand, gravels and boulders. Its permeability is very high.

Resistivity Layer II consists of sand, silt and grvels. The resistivity values are higher than that in Kloposawit in the upper reaches of the K. Mujur, and if anything, it is similar to that of Layer II in Kali Lengkong Fan. Layer

II in Gesang corresponds to loose younger Lahar deposits, and the permeability, compared with other sites, is higher.

Layer III in Gesang, and Layer III in Kloposawit and Kertosari all have the same electric resistivity characteristics, but the sedimentary environment in Gesang is simpler than in other 2 sites.

It is presumed that resistivity Layer II in Kloposawit corresponds to weathered older Lahar deposits while resistivity Layer IV in Kertosari corresponds to well compacted older Lahar deposits.

These layers consist of gravely sand and silt. The low resistivity layer (50 to 140 Ωm) detected in Gesang and Kloposawit is presumed to be rich in silt.

The resistivity value of older Lahar deposits (resistivity Layer III and IV) in K. Mujur and K.B. Tunggeng is higher than that in K. Lengkong Fan. That is, older Lahar deposits in K. Mujur and K.B. Tunggeng have a more than 200 Ωm resistivity value. Conversely, greater part of older Lahar deposits in K. Lengkong Fan have a low resistivity value of less than 200 Ωm. In view of this fact, the component of older Lahar deposits in K. Mujur and K.B. Tunggeng is assumed to be coarser than that in K. Lengkong Fan.

THE REPUBLIC OF INDONESIA

THE FEASIBILITY STUDY ON THE VOLCANIC DEBRIS CONTROL AND WATER CONSERVATION PROJECT IN THE SOUTHEASTERN SLOPE OF MT. SEMERU

SUPPORTING REPORT (5)

PART - E

LAND USE

FEBRUARY, 1984

JAPAN INTERNATIONAL COOPERATION AGENCY

E. LAND USE

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LIST OF TABLES

1. INTRODUCTION

1.1 OUTLINE OF STUDY AREA

Mt. Semeru, 3,676 m, is located in East Java, about 100 km southeast of Surabaya and about 30 km west of Lumajang. The studies cover the southeastern piedmont to the south of the mountain with an area of about 730 km^2.

Mt. Semeru is one of the most active volcanoes on the island of Java, noted for volcanic activity, and is a very young strato-volcano. The Semeru volcano is found to the south of the Jambangan complex volcano and has wide well-developed skirts stretching toward the southeastern piedmont. A range of mountains consisting of Tertiary rocks stands to the south of the Semeru volcano, preventing the southward development of the piedmont.

A formation of volcanic fans is seen in the piedmont at below EL. 1,500 m; these fans are divided into the upper and lower fans at EL. 750 - 800 m. The upper fans consist of Nuee Ardente and lava flow or deposits of lahar, while the lower fans mainly consist of lahar deposits reaching points near EL. 150 m. Flat land is observed outside these fans as if to form the periphery of the volcano and extends to the Indonesian Ocean. The piedmont of the Semeru volcano has been subject to frequent and extensive disasters brought about by the outflow of debris resulting from dissection of the volcanic mountain and eruptions.

Climatologically, the area belongs to the tropical monsoon zone, in which the year is divided into dry and rainy seasons; the warm weather, further, will enable intensive cultivation of rice only if a supply of water can be obtained.

In general, it is difficult to procure water inside the fans, however, irrigation utilizing water from rivers and springs at the ends of the ladu fans is practiced and cultivation of rice is undertaken over vast stretches of land even during the dry season within the study area. The Lumajang Plains, the alluvial fan of the Bondoyudo river, also provide stable rice paddies.

As can be learned, utilization of the rivers dissecting the volcanic piedmont in all directions is conducted inside these volcanic fans; in other words, the outflow of the debris accompanying lahar or Nuee Ardente brings disasters not only to areas along the river courses but also to a wide expanse of land.

The favorable relations between the topography and the mode of land use in the south and southeast of the piedmont can be attributed to the topography facilitating at the procurement of water. As far as the study area is concerned, it may be safety stated that crops compatible to the area, i.e., topography and the supply of water, are being cultivated. In other words, the main part of the volcanic cone area generally has trees; ladu fans, plantation crops and field crops such as sugarcane; lahar fans, rice; volcanic periphery, field crops; old volcanic piedmont, field crops and coffee; Tertiary mountains, plantation crops consisting mainly of coffee; and alluvial plain, rice.

Despite such expensive utilization of land, a wide stretch of devastated land is left unattended in areas along the B. Semut and Rejali rivers; these areas include those ignored after frequent disasters brought about by lahar and those unable to provide water due to the change in the river courses.

1.2 PURPOSE OF STUDIES

These studies on land use were undertaken with a view to comprehending the actual conditions of land use inside the study area (see Fig.-1.1) and, at the same time, to correcting the existing land use maps drawn on the scale of 1/50,000 with reference to the present conditions. The results of these studies will serve as basic data to be used for the estimation of economic effect and for the determination of the effect of disasters caused by the outflow of debris.

1.3 METHOD OF STUDIES

The studies were carried out through field investigations and interpretation of aerial photographs; the flow of work is shown in Fig.-1.2. The field investigations were performed in August and September, 1982.

(1) Field Investigation

Inquiries into the changes in land use attributable to disasters and the present conditions of land use, in addition to filed observations, were made using a land use study map (see Table-1.1). The number of land use study points amounted to 139, and the study locations and a list of study points are shown in Fig.-1.3 and Table-1.2, respectively.

(2) Interpretation of Aerial Photographs

Land use was interpreted according to the aerial photographs taken in July 1981. Since the existing land use map, prepared in 1977, did not clearly indicate the distinction between singleand double-harvesting, distinction was attempted based upon the results of inquiries. Further, distinction regarding plantation crops and forests was also undertaken.

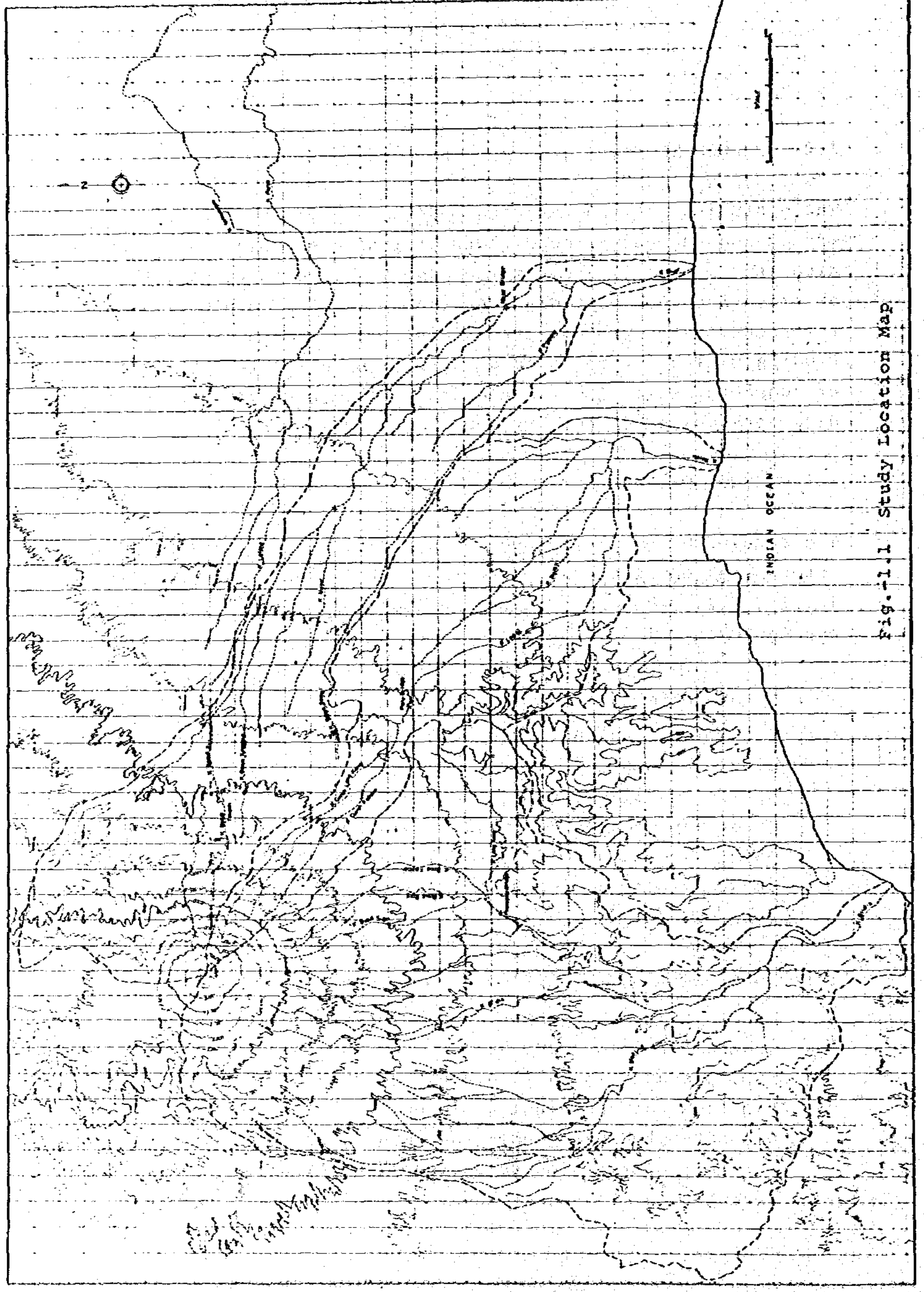

Fig. 1.1 Study Location Map

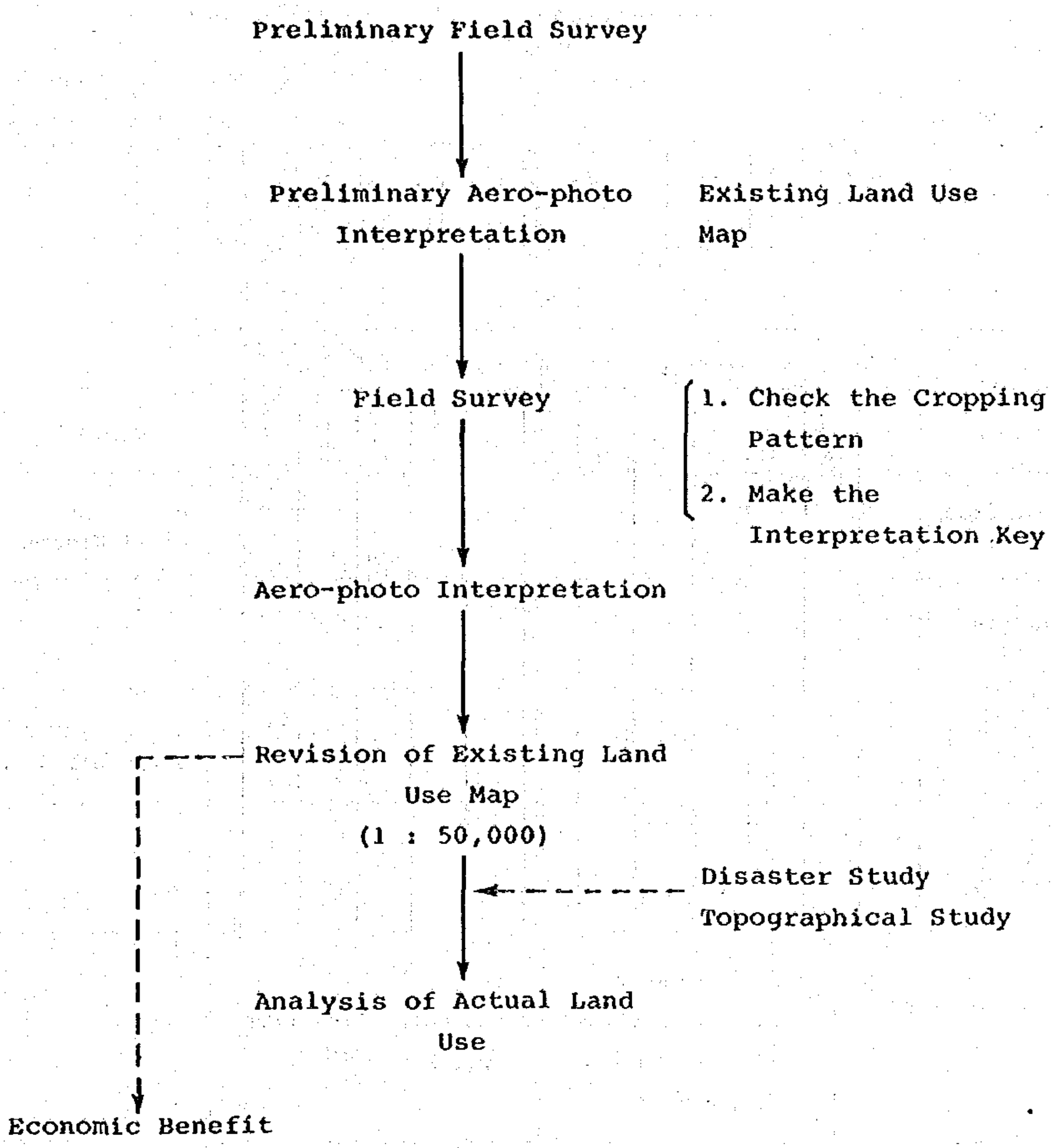

Fig. - 1.2 Flow of Work

Table - 1.1 Questionnaire for Land Use study   No.:

Day/Month/Year		Name of surveyor	
Name of village			
Answerd by: M / F	Age		How long have yoy lived here?

What crops did you plant around July, 1981?

Table of crops planted during the past year

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Comments
Kind of crops													Before or after disaster
Irrigation conditions													
Kind of crops													Before or after disaster
Irrigation conditions													

Factors preventing planting of rice	1. No water 2. Not permited to use water from river 3. Could not obtain water 4. Unknown
Factors preventing use of irrigation water	1. River course water height changeable 2. Land was too high 3. Water soure was too far away
Production of primary crops for each ha	

Table - 1.2 Liste of Study Points

Day/Month	No.	Location	Day/Month	No.	Location
7/7	1	Tunggeng	14/7	1	Pandan Wangi
	2	Gelapan		2	Rekesan Kidul
	3-1	Sumber Sari		3	Pandan Wangi
	3-2	Sumber Sari		4	Pandan Wangi
	4	Sumber Sari		5	Pandan Wangi
	5	Sumber Sari		6	Tempeh Kidul
	6	Wonorenggo		7	Tempeh Kidul
	7	Sumber Mujur	15/7	1	Tempeh Kidul
	8	Sumger Mujur		2	Tempeh Kidul
	9	Penanggal		3	Lempeni
10/7	1	Kerto Sari		4	Lempeni
	2	Kerto Sari		5	Kemamang, Tambahrejo
	3	Kerto Sari	17/7	1	Hutan Bago
	4	Kerto Sari		2	Bango Rekesan
13/7	1	Klopo Sawit - Pancut		3	Bango Rekesan
	2	Klopo Sawit		4	Bango Rekesan
	3	Besuk Tumpeng		5	Tengah Kali Rejali
	4	Sembon		6	Bago Rekesan
	5	Jokarto		7	Bago Rekesan
	6	Jokarto			
	7	Pulo			

Day/Month	No.	Location	Day/maonth	No.	Location
29/7	1	Kebondeli, Sb.Wuluh	11/8	1	Gandoroso
	2	Sb.Wuluh		2	Ringinponh-Danurejo
	3	Panggunglomlook Kidul		3	Danurejo
7/8	1	Kamar Kajang-Sb.Wuluh		4	Gondoruso
	2	Kebondeli-Sb.Wuluh		5	Danurejo-Gondoruso
	3	Kebondeli		6	Sumberrejo, Gondoroso
	4	Sb.Wungkal-Sb.Wuluh		7	Ringinpojor, Gondoruso
	5	Kamp Renteng-Sb.Wuluh		8	Sudimoro-Kalibendo
10/8	1	Jugo Sari	12/8	1-1	Tegalbanteng-Buyeng
	2	Jugo Sari		1-2	Tegalrejo-Bulurejo
	3	Jugo Sari-Jugo,Cd.Puro		1-3	Tegalrejo
	4	Jugo sari-Jugo,Cd.Puro		2	Wareng-Tempursari
	5	Jugo Sari-Laharan		3	Purorejo
	6	Urang-Ganrung		4	Tempurrejo

Day/Month	No.	Location	Day/Month	No.	Location
20/8	1	Curah Kobo'an	16/9	1	Bulak Klakah Japit
	2	Sumber Wuluh		2	Japit Candipupo
	3	Sumber Wuluh		3	Nguer Pasirian
	4	Curah Kobo'an		4	Nguer
21/8	1	Suniber Vrip		5	Nguer Pasirian
	2	Kamara(Supit Urang)		6	Komplangan Pasirian
27/8	1-1	Jugaton Pronojiwo		7	Formely Kalikemaron
	1-2	Sidomulyo Ampelgadive		8	Pasirian
	2	Sumber Rowd	17/9	1	Gaplek
	3	Pronojiwo		2	Karangan Yar-Japit
15/9	1	Sumberurip		3	Karangan Yar
	2	Supit Urang		4	Legongjambe Selokawar
	3-1	Gumukmas Supiturang		5	Legongjambe Selokawar
	3-2	Gumukas Supiturang		6	Selok Ke Bonan
	4	Supiturang Pronojiwo		7	Lempeni
	5	Supiturang		8	Madurejo
	6	Kloposawit		9	Semumu
	7-1	Selorejo Klopo Sawit		10	Madurejo
	7-2	Selorejo		11	Semumu
	8-1	Sumberrejo Candipuro		12	Semumu Darungan
	8-2	Sumberrejo Candipuro			
	9	Japit Candipuro			

Day/Month	No.	Location	Day/Month	No.	Location
20/9	1	Karangbendo	23/9	1	Tulungrejo Pasrujambe
	2	Karanganyar Jarit		2	Pasrujambe Semduro
	3	Uranggantung-Jarit		3	Pasrujambe Semduro
	4	Bangun Sari	24/9	1	Sumber Suko
	5	Bades Purut		2	Sumber Suko Tempeh
	6-1	Bagokrajan Kidul		3	Sumber Suko
	6-2	Bagokrajan Kidul		4	Mojosari
	7	Bago		5	Laban Labruk Lor
	8	Gesang		6	Purwosono
	9	Pulo		7	Bayemam Citro Trunan
	10-1	Sukorejo Tempen Tengah		8	Suko Purwosono
	10-2	Sukopejote			
	11	Tempeh Lor			
	12	Tempeh Lor			
	13-1	Besuk Tempeh			
	13-2	Besuk Tempeh			
	14	Curahjero Labruk			

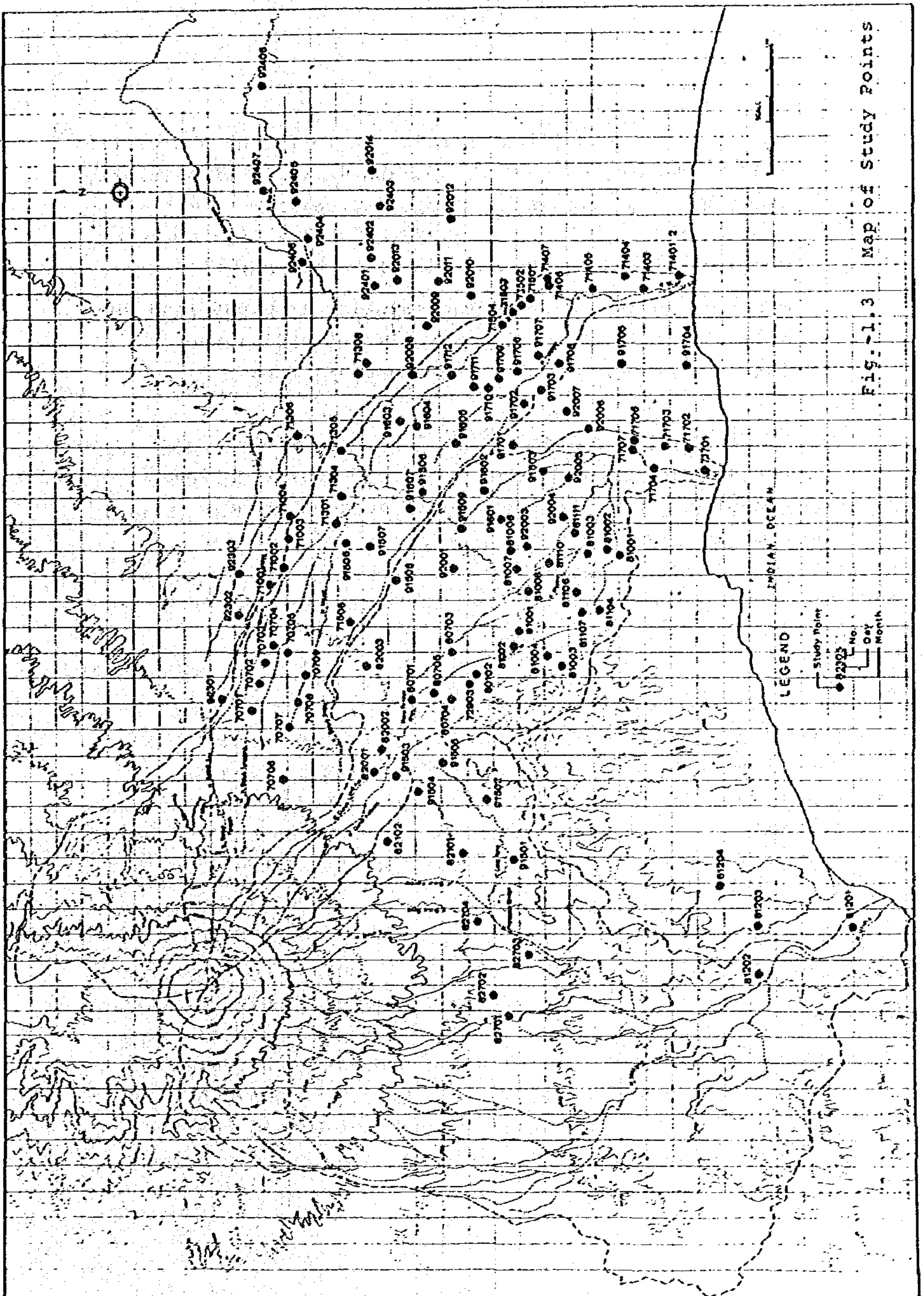

Fig.-1.3 Map of Study Points

Forests were classified in relation to the height of trees and the density of tree crowns and in terms of naturally growing and artificially planted trees.

(3) Correction of 1/50,000 Existing Land Use Map

Corrections were made to the existing 1/50,000 land use maps with reference to the results of aerial-photo interpretation to prepare new land use maps.

(4) Compilation of Cropping Patterns

Based upon the results of the field investigations, cropping patterns were compiled in good order.

(5) Changes in Land Use Inside the K. Rejali Fan

Changes in land use regarding the K. Rejali fan were studied with reference to existing topographical maps (1923), existing land use maps (1977) and the land use maps newly prepared during the study (1982).

2. RESULTS OF STUDIES ON LAND USE

2.1 PRESENT CONDITIONS OF LAND USE

A rough sketch of land use is shown in Fig.-2.1; in addition, a reduction of the 1/50,000 land use map prepared during the study is given in Fig.-2.7. The present conditions of land use inside the study area as agricultural land are noticeably compatible with the topography of the area. The following are descriptions of the relationship between land use and topography.

Volcanic Cone

The area is the volcanic slopes on Mt. Semeru at EL. 1,500 m and above. Sections at EL. 1,500 - 2,500 m have densely and naturally growing tall trees, and sections above EL. 2,500 m are exposed and bare. The lahar which flowed down the B. Sat and B. Tunggeng in May 1981 originated from a collapse which had occurred inside this forest belt.

Ladu Fans

The area is sections at EL. 800 - 1,500 m. Topographically speaking, the area consists of that made of an accumulation of lava and that of ejecta. The area of lava accumulation has shrubs and a forest of tall trees, while the ladu fans, where ejecta accumulated, are planted with field and plantation crops. Such field crops mainly consist of sugarcane and plantation crops, coffee and

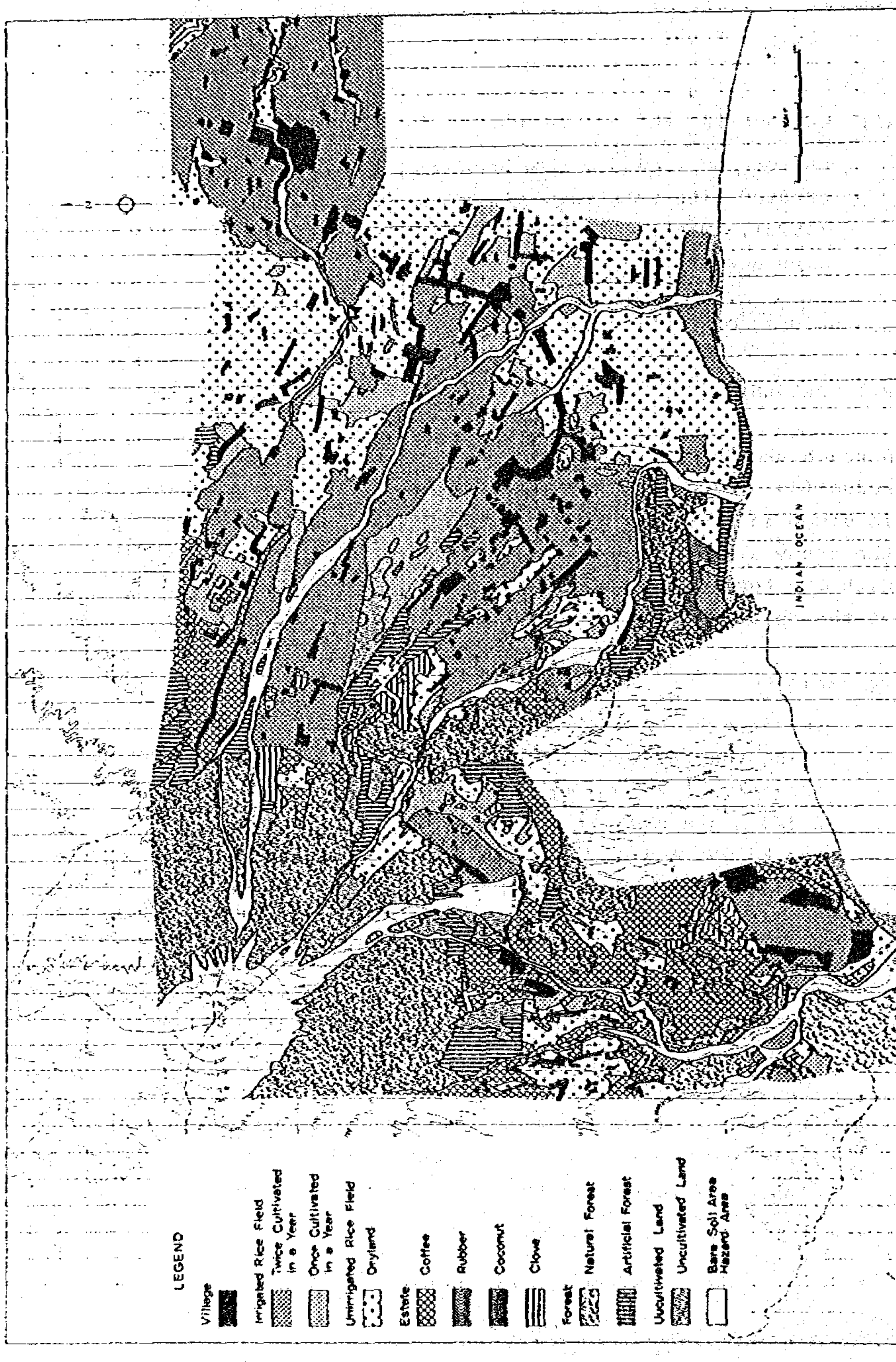

Fig.-2.1 A Rough Sketch of Land Use

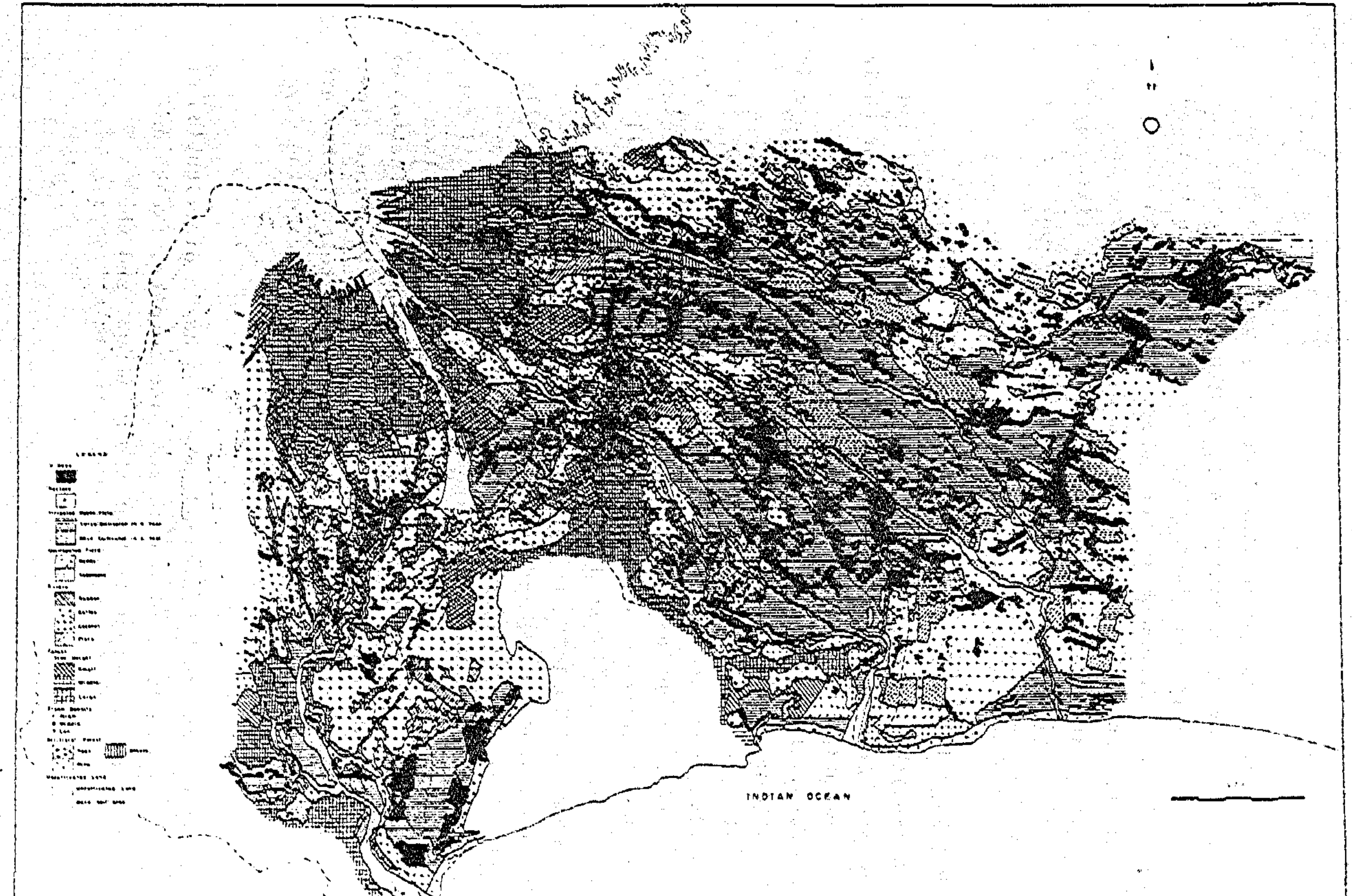

Fig.-2.2 Land Use Map

cloves. Furthermore, the ladu fans, present a special difficulty in obtaining water, owing to the presence of deep valleys and rivers which flow eroding the fans and which are the channels for lahar. Sugarcane is found mostly on the right bank of the B. Kobo'an river and coffee is being cultivated near Sumber Mujur Village; cultivation of cloves is practiced on the right bank of the B. Tuggeng river.

Lahar Fans (Steep Slope)

The lahar fans are divided into the steep-slope fan and the gentle-slope fan; and depending on the period of their formation, they are further divided into old and new fans. A zone of springs, of which Sumber Mujur Village is typical, exists at the end of ladu fans. Due to the absence of appreciable supplies of debris and change in river courses at present, the old fans provide stable rice paddies (double-harvesting) through irrigation utilizing these springs. On the other hand, the new fans still possess uncultivated land, centering around the fan top. The land is left unattended and the growth of weeds is conspicuous; such areas of land are extensive especially in the B. Semut fan and encompasses most of the steep-slope fans. Wasteland also spreads in the K. Rejali fan; and in the K. Lengkong fan, most thereof is bare land covered with grass. This is also applicable to the top of the B. Sat fan. Although there are narrowly formed rice paddies inside shallow valleys of the wasteland, they are far from stable due to the lack of water during the dry season.

Apart from such wasteland, the area has a distribution of artificially planted teak and pine forests. Teaks are seen on the right bank of the B. Semut, and the former area of lahar accumulation is now made into a teak forest. Further, the western end of the B. Semut fan has a wide expansion of clove fields.

Lahar Fans (Gentle Slope)

Rice paddies are conspicuous in areas at EL. 250 - 150 m. These areas are subject to disasters with a decreased frequency and procurement of stable rice paddies is a matter of water supply. Although irrigation is being carried out by the utilizion of the rivers and springs, use of part of land for only field crops is inevitable due to the limited amount of water for irrigation and lack of facilities (see Fig.-2.3). Moreover, the overall lack of water during the dry season necessitates the planting of field crops consisting mainly of corn and tobacco. Cultivation of tobacco is seen over a wide area extending between western Pasilian and the K. Rejali fan.

A wide area of wasteland is also seen in the gentle-slope fans within the K. Rejali fan (see Fig.-2.4). The land is a result of the frequent disasters in recent years and considerable change in the river courses in the K. Rejali fan, which in turn resulted in the absence of stable supplies of water. A number of wide, dry fields exist in the area surrounding B. Sat Lama. This is due to the presence of an accumulation of sand and gravel in thick layers around B. Sat Lama with a poor performance of water retention and also due to the scarcity of water from B. Sat Lama during the dry season.

Periphery

This is the area covering the section from EL 150 m to the coastal plains. Although rice paddies can be seen around the irrigation channels, the area mostly consists of dry fields.

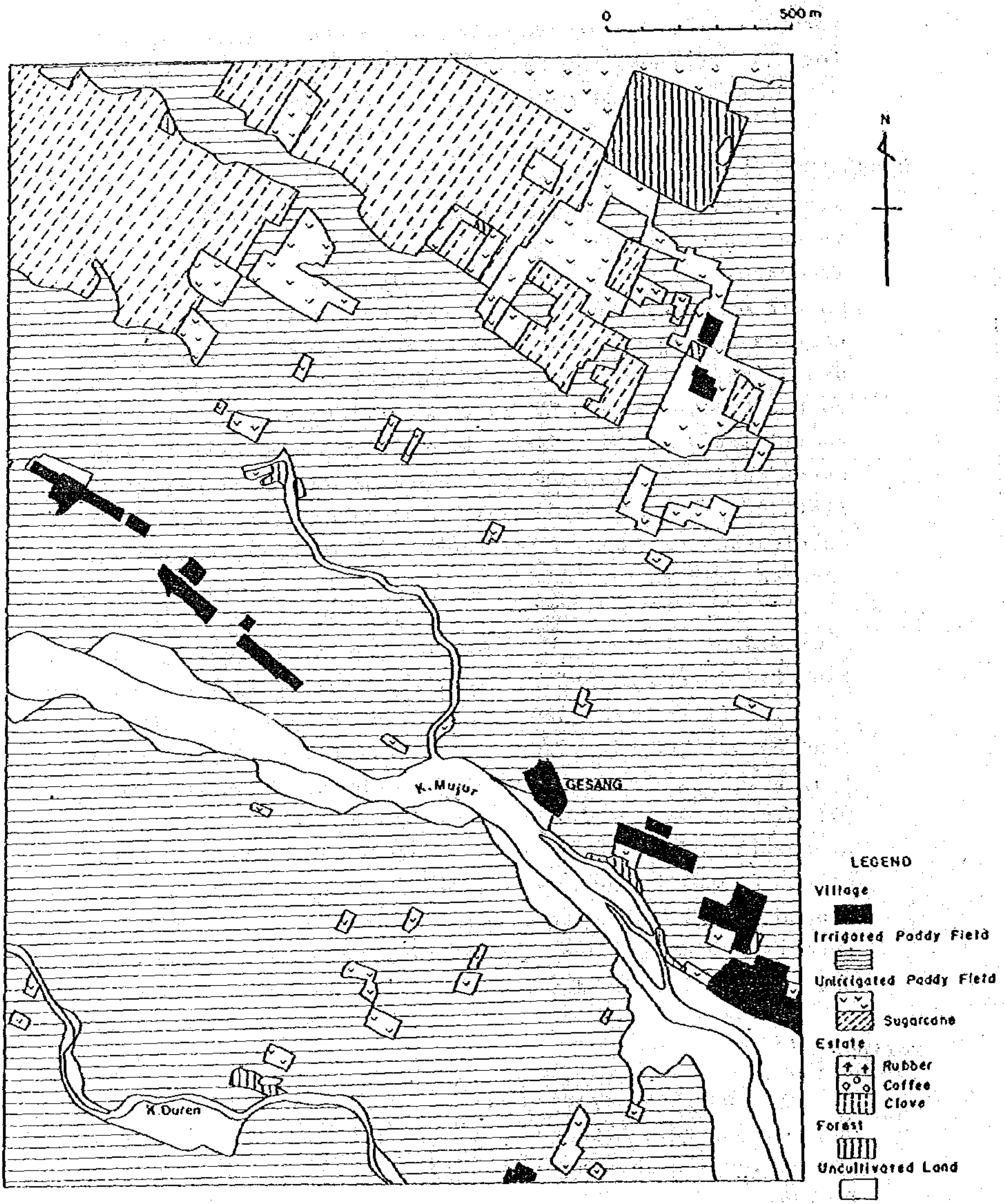

Fig.-2.3 Actual Land Use in B. Sat Fan Area in 1982

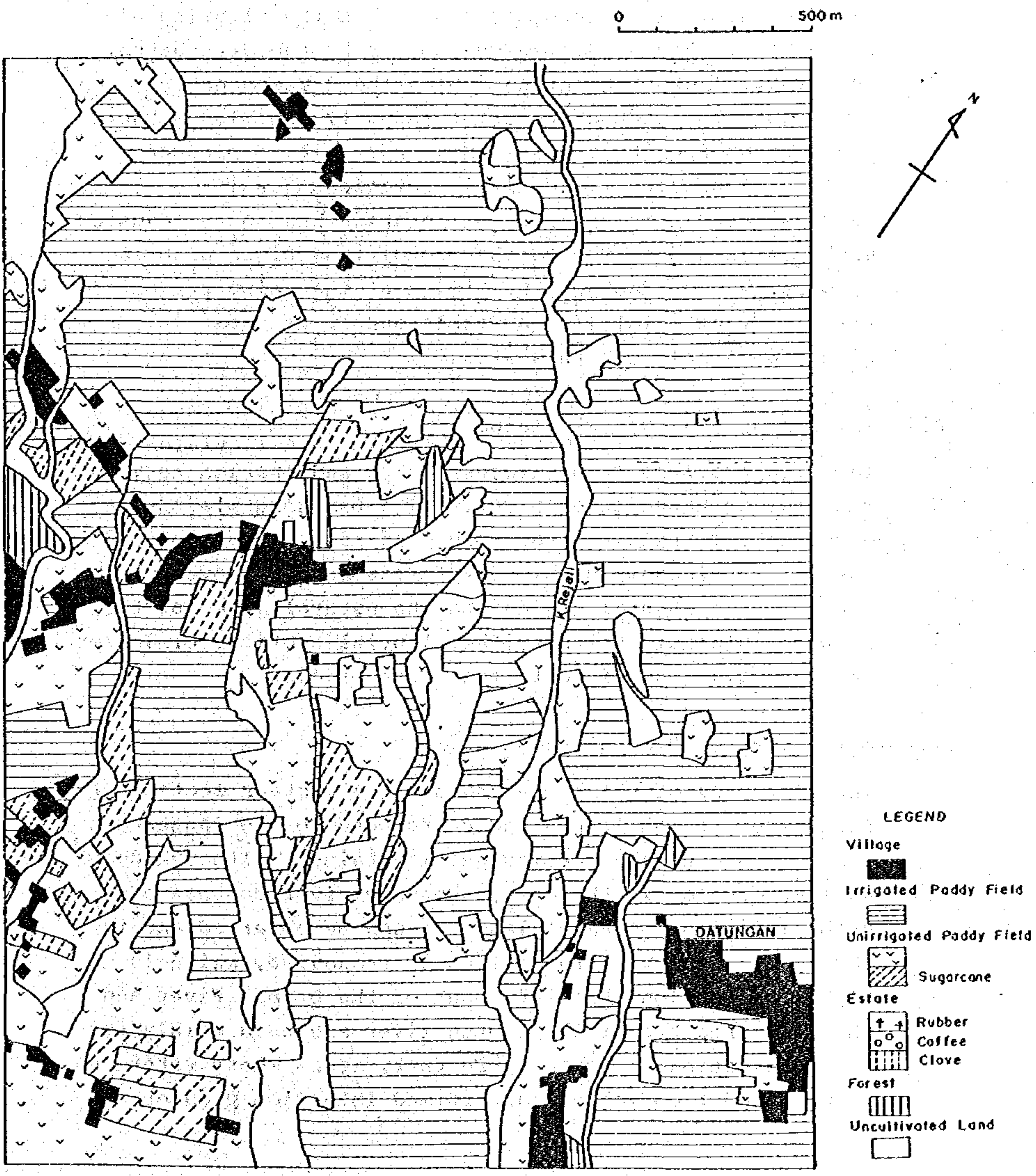

Fig.-2.4 Actual Land Use in K. Rejali Fan Area in 1982

The field crops mainly include corn, sugarcane, beans and tobacco, etc. There are sections where the planting of crops has to be entirely given up during the dry season. The sections where planting during the dry season is impossible to produce two crops annually and places where planting during the dry season is possible to produce three or four crops annually in rotation. It is inevitable that the pattern of rotation has to be adjusted each year based on the weather conditions since planting is greatly dependent on the timing of the rainy season and the amount of rainfall. A stable supply of water is highly desirable for this area.

Alluvial Plains and Coastal Plains

The area provides stable rice paddies and enables harvesting two or three times a year. The Lumajang plains are especially fertile and the volume of rice crops produced there is noticeably high. Dry fields are seen over the dunes in the coastal plains and the natural levee of the Lumajang plains. Further, the alluvial sections of Sumber Sari are also made into fertile rice paddies.

Piedmont Slopes of Old Volcanoes

The left bank of the K. Lateng and the western section of Pronojiwo are tablelands and correspond to the Jangbangan complex volcano and the Tenggat mountains. Although deep valleys develop in the area, the very river courses are stable; various modes of land use can be observed and in particular, the western section of Pronojiwo, which is high in elevation, the left bank of the B. Sat river and the upper reaches of the Lanteg river are used mainly for the cultivation of coffee. Further, areas where water can be obtained from valleys are formed into rice paddies, which are capable of single- and double-harvesting. Areas for which procurement of water is difficult are used as dry fields for the cultivation of sugarcane, corn and beans. Cassavas are also commonly seen in the west of Pronojiwo.

Tertiary Mountains

The Tertiary mountains between the K. Rejali and K. Glidik have a wide expanse of forest; the part of the mountains between Pronojiwo and Tempur Sari, on the other hand, is used as coffee plantations. The latter has forests only over steep cliffs along the river course, steep slopes and areas with exposed rocks. Some sections are used for the cultivation of cloves. Despite its mountainous topography, the area can be described as relatively fertile land.

Table - 2.1 Conceptual Relationships of Topography and Land use

Topography			Land use
Main part of volcanic cone	2500m and over		Bare soil
	2500m and under		Forest (natural)
Ladu Fan			Forest (natural/artifical), Dry field (mainly sugarcane), Cloves, Coffee.
Lahar Fan	Steep Slope	B. Sat Fan	Rice paddy (single- and double-harvesting), Dry field
		B. Semut fan	Wasteland, Artifical forest, Rice paddy (single- and double-harvesting) Dry field, Cloves
		K. Rejali fan	Rice paddy (double-harvesting), Wasteland
		K. Lengkong fan	Wasteland
		K. Poh fan (old fan)	Stable rice paddy (double-harvesting), Tobacco, Corn
	Gentle-slope		Rice paddy (double-harvesting); half of B. sat fan, dry field.
Volcanic periphery			Dry field (considerable area of land where planting during dry season is not possible)
Alluvial plain			Rice paddy (double-harvesting)
Tertiary mountains			Forest (natural/artificial), Coffee, Cloves, Cassava
Old volcanic piedmont	Pronojiwo		Coffee, Dry field
	Left bank of B. Sat and K. Lateng		Coffee, Dry field, Rice paddy (single-harvesting)

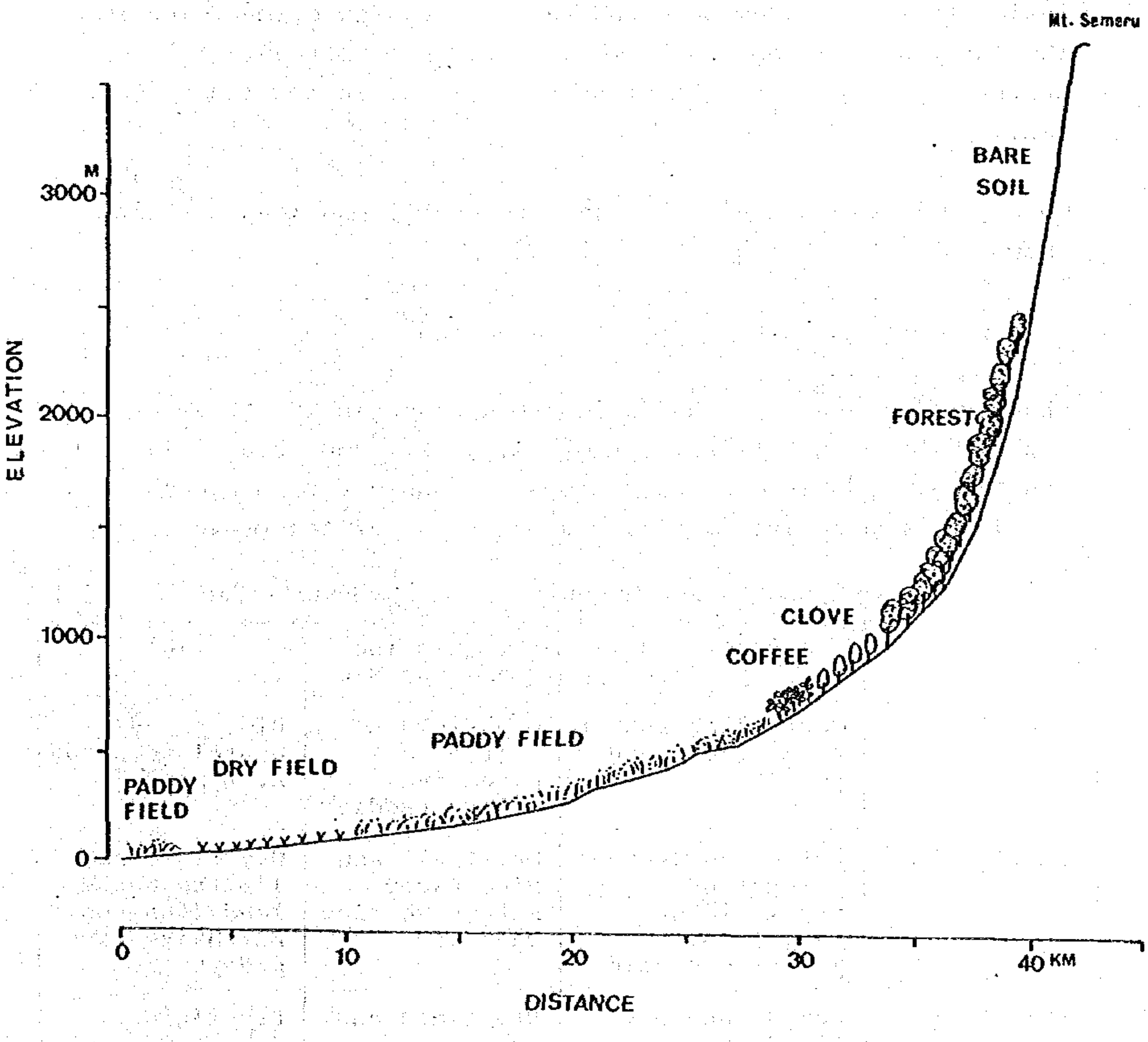

Fig.-2.5 Conceptual Relationship of Topography and Land Use

In addition to those discussed so far, in terms of land use, the study area includes agricultural communities, downtown districts and houses and factories. The downtown and housing districts are limited to Lumajang, Tempe and Pasilian; the downtown district of Lumajang being the largest. Factories are seen along the national highway betweeen Lumajang and Tempe.

As for agricultural communities, a dense distribution is noted inside the rice paddy zone and there are a few communities in the lahar steep-slope fans, where wasteland spreads. Conversely, there are almost no communities inside the B. Semut fan.

Conceptual relationships between topography and land use are shown in Fig.-2.5 and Table-2.1.

2.2 CHANGES IN LAND USE IN K. REJALI FAN

Changes in the use of land which took place in the K. Rejali fan are shown in Table-2.2, Figs.-2.6, -2.7 and -2.8. Fig.-2.6 and Fig.-2.7 depict the conditions of land use seen around 1923 and 1977, respectively; Fig.-2.8 are those of the present, 1981.

Table-2.2 Change in Land Use in K. Rejali Fan

	Around 1923	By existing Land Use Map	1981
Steep-slope fan	Coffee and rubber plantations and Forest	Dry field (fan top) Extensive rice paddies	Rice paddy Wasteland along K. Leprak
Gentle-slope fan	Coffee and rubber plantations Dry field or wasteland? Few rice paddies	Dry field and Rice paddy Extensive rice paddies	Dry field and limited waste-land (fan top) Extensive rice paddy
Periphery	Forest and Dry field	Dry field and Forest	Dry field

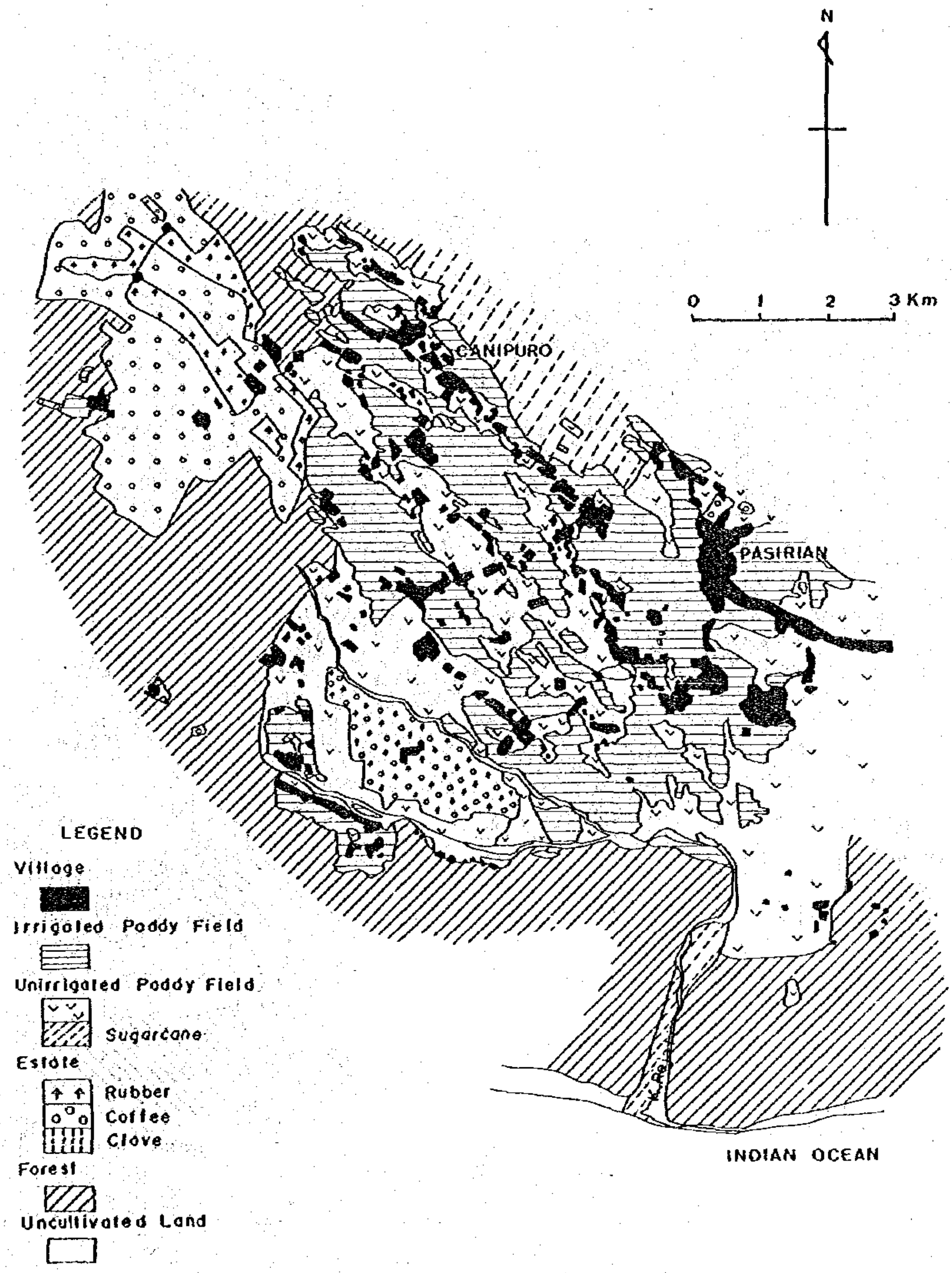

Fig.-2.6 Land Use in K. Rejali Fan around 1923

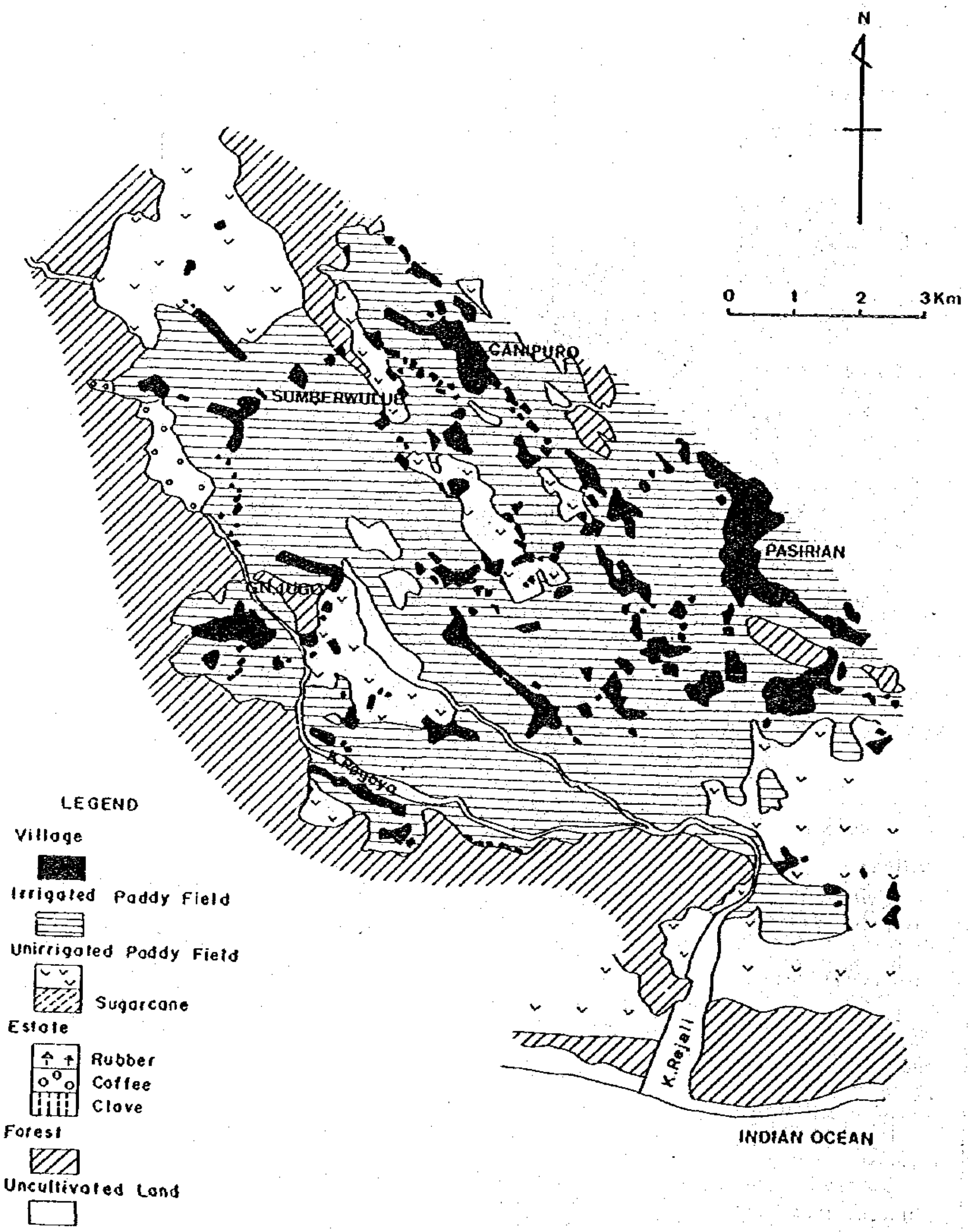

Fig.-2.7 Land Use in K. Rejali Fan around 1977

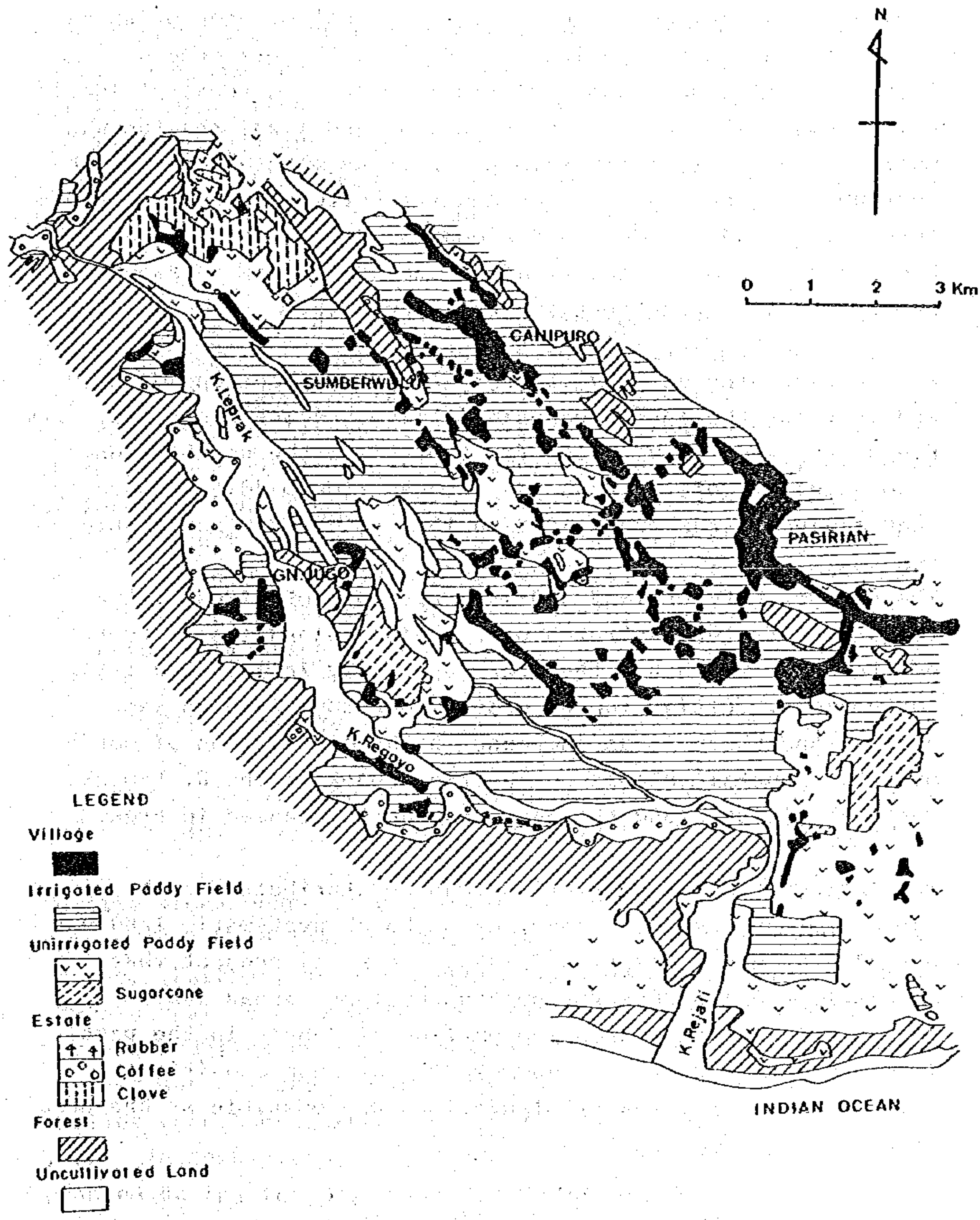

Fig.-2.8 Land Use in K. Rejali Fan in 1981

Table-2.2 summarizes the conditions typical of each of these periods. During the period around 1923, the presence of forests, coffee and rubber plantations and sugarcane fields is noticeable. It can be assumed that around 1923, the fan was utilized in a relatively stable manner as plantations, which took up wide areas at the top and the bottom of the fan, the forests, around Gn. Jugo and along the coast. An increase in the occurrence of disasters after the 1940's can be assumed from field investigations and existing data.

At the beginning of 1977, forest land decreased considerably and in turn, the land area used as rice paddies increased. Dry fields are seen only at the fan top and in the south of Gn. Jugo, and most of the area was used as rice paddies. Development advanced from about 1923 to 1977 is clearly noticeable.

The changes between 1977 and 1981 are characterized by the formation of a vast stretch of wasteland along the K. Leprak due to lahar which hit the area repeatedly in 1978 and 1981. Furthermore, cultivation of cloves near Sumber Wuluh was started and there is an increase in the cultivation of coffee over the mountain slopes on the right bank of the K. Leprak. The teak forest along the coast further decreased in area.

The introduction of plantations can be attributed to the wide expanse of undeveloped areas, even though systematic land use was already under way around 1923. This may suggest that sophisticated land use for such undeveloped areas was not possible due to the extensive outflow of debris in the past, (the present Semut fan is one example of such conditions). However, the formation of plantations was possible at the same time.

Furthermore, the fact that the increase in the area of rice paddies despite the frequent disasters as exemplified by data for 1977 is a direct result of active development of land for paddies advanced in relation to the increase in population; sophistication of land use in this area fundamentally calls for a decrease in disasters and the provision of a stable water supply.

As of 1981, areas left uncultivated include those subjected to disasters brought about by lahar between 1977 and 1981 and those where lahar deposits, especially boulders, accumulated in the past and still remain. This suggests that areas where there is an accumulation of boulders cannot be easily restored by farmers alone. Such examples can be observed at the areas subjected to the disaster of 1909 (B. Sat fan and also B. Semut fan). Not only the presence of boulders but also deposits of gravel with poor water retention can also be a factor which prevents cultivation of the land.

2.3 CROPPING PATTERN

Cropping patterns made known during field investigations are shown in Fig.-2.9; Fig.-2.10 gives typical cropping patterns.

Fertile areas possessing a stable supply of water are used as rice paddies and enable harvesting three times in about 14 months. Further, in areas where the harvesting of rice two times a year is possible, the growing of rice for a single harvest requires an appreciable period of time; and therefore, it does not necessarily mean that the volume harvests are smaller than those expected from harvesting 2.5 to 3 times a year. In some areas, crops such as tobacco and corn are planted during the dry season and rice is harvested twice during the rainy season; still in some areas the planting of rice once during the rainy season and field crops twice during

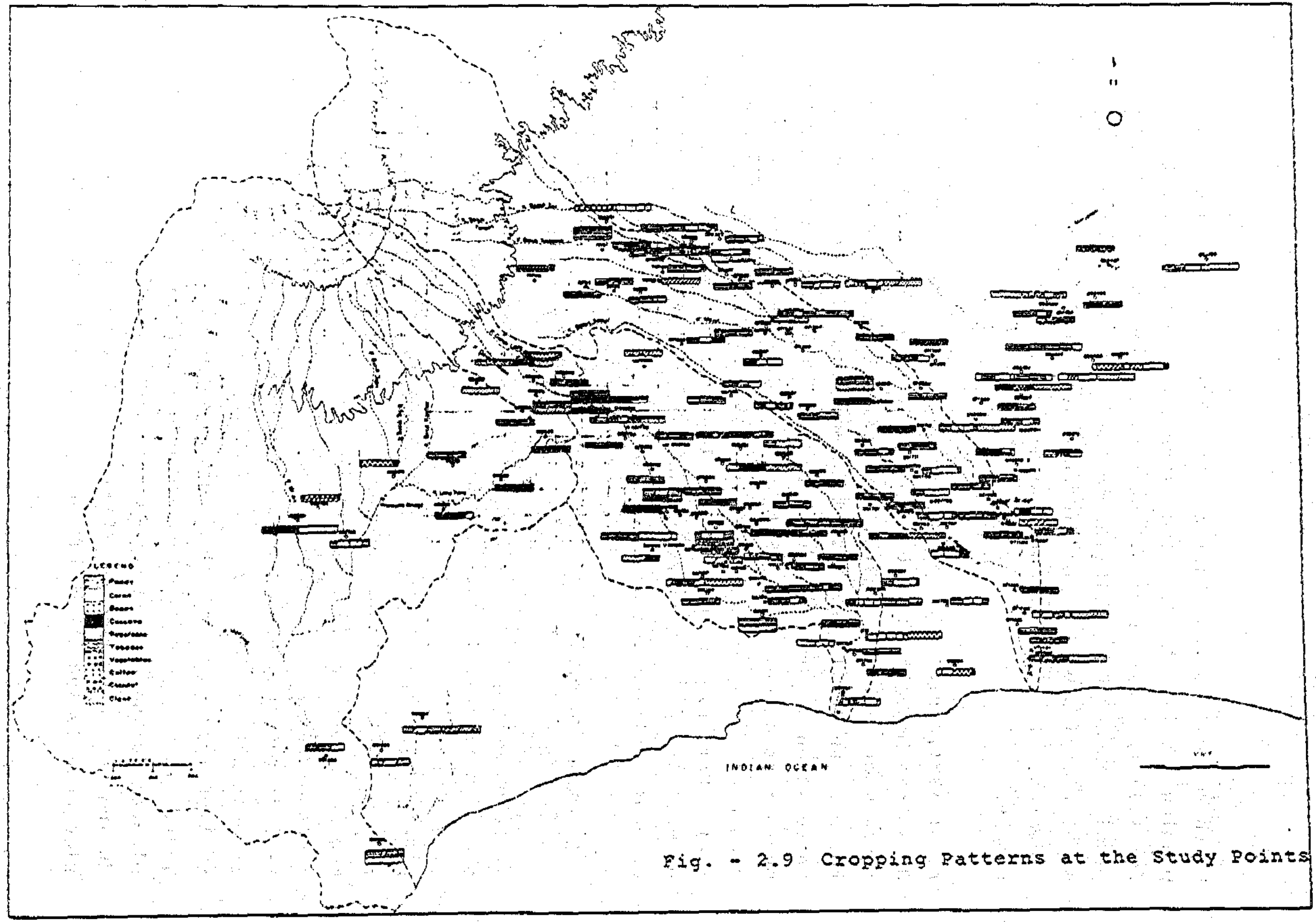

Fig. - 2.9 Cropping Patterns at the Study Points

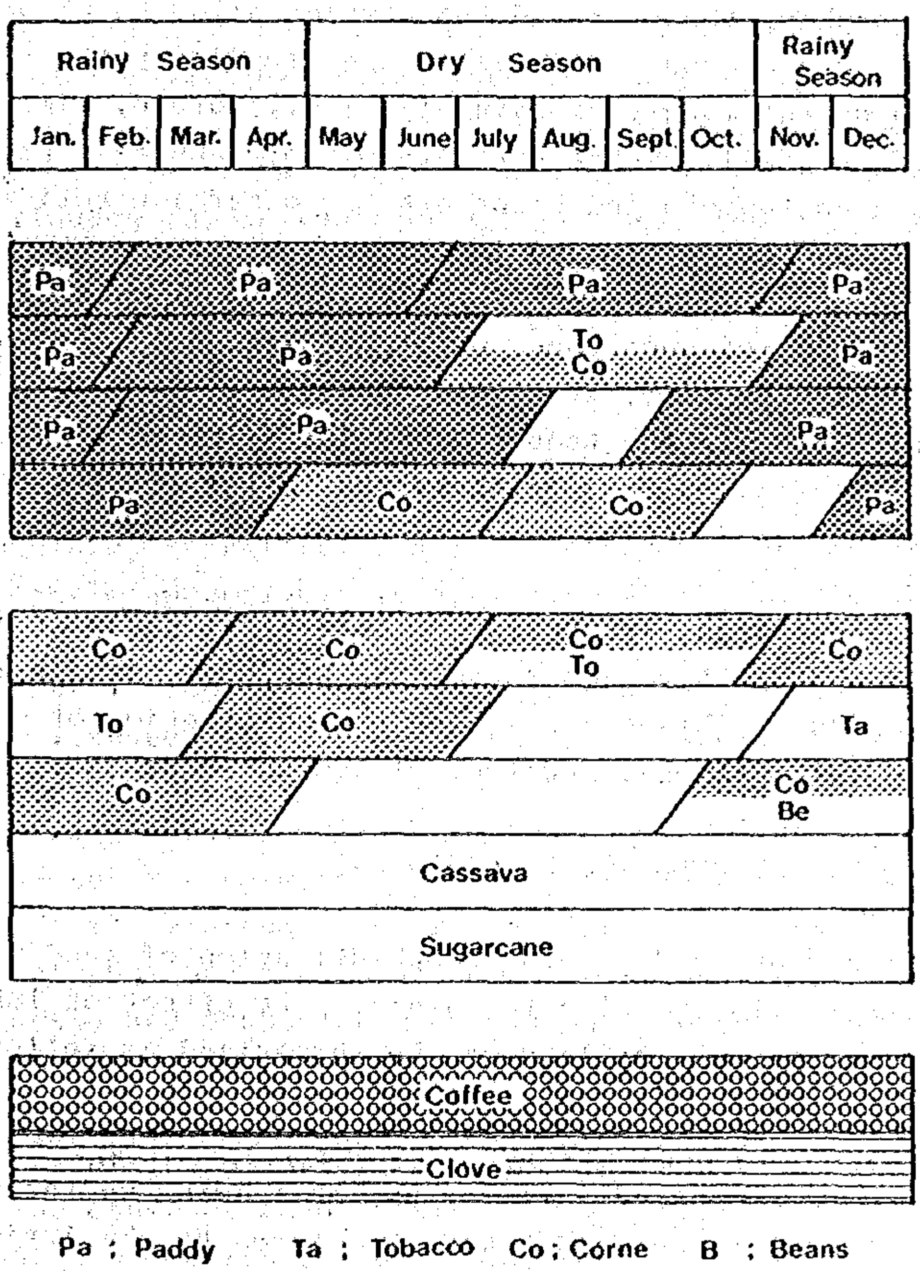

Fig.- 2.10 Typical Cropping Patterns in the Study Area the dry season are carried out. These variations in the cropping patterns depend on the manner of rainfall, i.e. volume, time and period of rainfall.

On the other hand, there are areas where rice planting is impossible. These areas include those which allow planting of other crops throughout the year and those which allow no planting during the dry season. Here also, the cropping patterns vary depending on the manner of rainfall, i.e., volume, time and period of rainfall. Three harvests of corn annually plus other crops such as tobacco and beans are the general practice and cassava is widely cultivated in the mountain areas.

The cultivation of sugarcane, which requires a lot of water for a short period of time, is classified into two types; extensive sugarcane fields in the Ladu fan and intensive sugarcane fields in the Lahar fan, on the periphery and in the coastal plains where irrigation facilities are available.

Plantation crops mainly consist of coffee, although an increase in the area of cultivation for cloves has been seen in recent years. Areas may be used only for the cultivation of coffee or the mixed cultivation of coffee, cloves and bananas.

2.4 LAND USE IN RELATION TO DISASTER

As has been mentioned already, sophistication of land use is being hindered in the disaster areas. The effect of lahar disasters on the use of land can be summarized as follows in relation to the changes in topography.

(1) The procurement of water is unstable owing to the changes in the river bed height and the damage to the irrigation facilities caused by Lahar.

(2) Procurement of water supplies is difficult owing to the changes in the river courses.

(3) Debris being supplied consists of coarse particles and the land is not suitable for cultivation.

(4) Accumulation of soil consisting mainly of sand and gravel in thick layers decreases water retention.

(5) The presence of vast wasteland in the B. Semut fan can be attributed to, in addition to the above factors, the decrease in the flow volume brought about by the decrease in the catchment area of the upper reaches caused by the changes in the river courses which occurred during the lava flow of 1941 and 1942.

Lahar is likely to flow downstream along the old river course and accumulate; therefore, the river course within the lahar fan has debris appreciable in diameter. This means that rice paddies along the old river course do not always produce good harvests, as is the case with alluvial fans in Japan. Conversely, there are places where cultivation is considerably difficult because of boulders. However, there are many examples where shallow valleys along the old river course and inside the fan are used as rice paddies, since the procurement of water in these areas is easy. As far as the effects of the disaster of 1981 on land use is concerned, the areas where debris passed and accumulated were subjected to the direct effects of the disaster. The field investigation of 1982 confirmed that most of these areas were still left unattended. The effects of the disaster were noticed in a wide area in the form of the destruction of water intake facilities and an accumulation of debris inside channels for irrigation water. In these areas, the absence of water supplies has necessitated the convertion of crops from paddy rice to field crops.

Since the studies under discussion at present fell short of comprehending the extent of effects brought about by damage to the irrigation facilities, discussion thereof has to wait until later studies are conducted. However, the presence of such damage is as mentioned and when temporary damage is additionally considered, the area should cover a wide expanse of land.

3. SUMMARY

The results of the studies on land use enabled the comprehension of the present land use conditions in the study area and of the effects of Lahar disasters on land use in terms of their characteristics.

The extensive wasteland and uncultivated land at the top of the Lahar fans, which is subject to frequent disasters, are not very satisfactory for use as paddy fields, although some paddy fields do exist. Despite the passage of 40 years, during which the Semut fan has been more or less free from disasters, the fan has still land unattended. This may be fundamentally attributed to the lack of water. Furthermore, the Rejali fan still remains uncultivated even though the land could be used as rice paddies. This is closely connected to the direct effects of disasters.

As mentioned above, the effect of disasters clearly reflects on the type of land use and operates as a restricting force to nature. Land use sophistication, i.e. the replacement of these areas by agricultural land, will require the stabilization of river course, stable water procurement and supply, the removal of boulders which hinder cultivation and the elimination of soil with poor water retention along with efforts to increase the various disaster prevention functions

THE REPUBLIC OF INDONESIA

THE FEASIBILITY STUDY ON THE VOLCANIC DEBRIS CONTROL AND WATER CONSERVATION PROJECT IN THE SOUTHEASTERN SLOPE OF MT. SEMERU

SUPPORTING REPORT (5)

PART - F
WATER USE

FEBRUARY, 1984

JAPAN INTERNATIONAL COOPERATION AGENCY

F. WATER USE INVESTIGATION

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APPENDIX

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1. CONTENTS OF REPORT

This report shows the investigation results on the river water use conditions in the areas surrounding the intakes along the K. Mujur and K.Rejali which run to the south-east of Mt. Semeru.

The purposes of the investigation are as follows:

(i) To study the relation between the river discharge at the intake points and the intake rates, based on their respective data, and to understand the intake fluctuation tendency.

(ii) To study the actual condition of the rivers (channels) in the non-irrigated areas in terms of water intake and conveyance, and to study the main crops in the areas, including their yields and cropping patterns. This data will provide vital information when the effect of the land development is to be determined by the calculation of its socio-economic effects.

K. Glidik, one of the major rivers in the study area, is omitted from the study on intake rate simply because there is no intake facility along the river.