

APPENDIX V

**RESULT OF GEOLOGICAL
RECONNAISSANCE SURVEY**

LIST OF TABLES

Table No.	Page
V. 1 Geology at Sekrang-1	V-1
V. 2 Geology at Sekrang-2	V-2
V. 3 Geology at Kanowit	V-3
V. 4 Geology at Medamit-2	V-4
V. 5 Geology at Pasia	V-5
V. 6 Geology at Ayat	V-6
V. 7 Geology at Bangkit	V-7
V. 8 Geology at Kapit-2	V-8
V. 9 Geology at Mukoh	V-9
V.10 Geology at Kapit-1	V-10
V.11 Geology at Ibau	V-11
V.12 Geology at Quarry Sites	V-12

LIST OF FIGURES

Fig.No.		Page
V. 1	Geological Map of SRI AMAN Area	V-13
V. 2	Geological Map of SARIKEI Area	V-14
V. 3	Geological Map of LIMBANG Area	V-15
V. 4	Geological Map of KAPIT Area	V-16
V. 5	Geological profile of Sekrang-1	V-17
V. 6	Geological profile of Sekrang-2	V-18
V. 7	Geological profile of Kanowit	V-19
V. 8	Geological profile of Medamit-2	V-20
V. 9	Geological profile of Pasia	V-21
V.10	Geological profile of Ayat	V-22
V.11	Geological profile of Bangkit	V-23
V.12	Geological profile of Kapit-2	V-24
V.13	Geological profile of Mukoh	V-25
V.14	Geological profile of Kapit-1	V-26
V.15	Geological profile of Ibau	V-27

TABLE V. 1 GEOLOGY AT SEKRANG-1

Site		SEKRANG-1		
Geological formation and age		Stage I of the Belaga Formation Upper Cretaceous		
	Left bank	River bed	Right bank	
Geologic structure	N 50 W 78 SE (dips toward upstream)			
Classification of bed rock	Slate	Slate	Slate	
Rock quality	Soft	Soft	Soft	
Weathering condition (Thickness)	Clayey slate (10 m)	Soft slate (1 - 3 m)	Clayey slate (2 - 5 m) Soft slate (5 - 6 m)	
Condition of fissure	Schistosity at intervals of 2 - 10 cm, oxidization	-	Schistosity at intervals of 2 - 5 cm, oxidization	
Overburden (Thickness)	Talus deposit (3 m) Clay and silt, soft	River deposit (7 - 8 m) sand and gravel dia:3-10 cm ave.: 5 cm rounded-well rounded, mainly hard graywacke, loose	-	
Permeability of bed rock	Clayey zone: low Rock zone:middle	Soft rock zone: middle Rock zone:middle	Clayey zone: low Soft rock zone: middle Rock zone: middle	

TABLE V. 2 GEOLOGY AT SEKRANG-2

Site		SEKRANG-2		
Geological formation and age		Stage I of the Belaga Formation Upper Cretaceous		
	Left bank	River bed	Right bank	
Geologic structure	N 30 W 50 SW (dips toward upstream)			
Classification of bed rock	Graywacke	Graywacke	Graywacke	
Rock quality	Very hard	Very hard	Hard	
Weathering condition (Thickness)	Sand and rubble due to weathering (10 m)	(0)	Sand and rubble due to weathering (10 - 20 m)	
Condition of fissure	Joint at intervals of more than 20 - 30 cm, tight	-	Joint at intervals of less than 15 - 30 cm cracky; oxidization	
Overburden (Thickness)	Alluvial terrace (2 - 3 m) Fine sand and silt. Soft	River deposit (1 - 2 m) sand and gravel dia: mainly 3-5cm max. 150 cm rounded-well rounded, mainly graywacke, loose	Talus deposit (5 - 7 m) clay and silt; Soft	
Permeability of bed rock	Weathered zone: high Rock zone: low-middle	Rock zone: low-middle	Weathered zone: high Rock zone: high	

TABLE V. 3 GEOLOGY AT KANOWIT

Site		KANOWIT		
Geological formation and age		Stage II of the Belaga Formation Lower Eocene		
	Left bank	River bed	Right bank	
Geologic structure	N 60 W 80 SW (dips toward up stream)			
Classification of bed rock	Phyllite	Phyllite	Phyllite	
Rock quality	Soft	Soft - hard	Soft	
Weathering condition (Thickness)	Clayey phyllite (15 - 20 m)	Soft phyllite (1 - 2 m)	Clayey phyllite (15 - 20 m)	
Condition of fissure	Schistosity at intervals of 1 - 2 mm Joint at intervals of 3-10 cm, Cracky	-	Schistosity at intervals of 1 - 2 mm	
Overburden (Thickness)	Talus deposit (3 - 5 m) sand and silt soft	River deposit (2 - 4 m) sand and gravel dia: 5-7 cm, max: 10 cm, well rounded-rounded mainly hard gray-wacke, loose	Alluvial terrace (1 - 4 m) fine sand, soft Talus deposit. (5 - 6 m) clayey soil, soft	
Permeability of bed rock	Clayey zone: low Rock zone: middle - high	Rock zone: middle	Clayey zone: low Rock zone: middle	

TABLE V. 4 GEOLOGY AT MEDAMIT-2

Site		MEDAMIT-2		
Geological formation and age		Setap Shale Formation Oligocene - Miocene		
	Left bank	River bed	Right bank	
Geologic structure	N 30 W 50 NE (dips toward down stream)			
Classification of bed rock	Graywacke	Shale Graywacke	Shale	
Rock quality	very hard	Hard very hard	Hard	
Weathering condition (Thickness)	Looseness zone (1 - 2 m)	(0)	Weathered shale (5 m)	
Condition of fissure	Low dip joint at intervals of 15-20 cm, tight - open	-	Schistosity at intervals of 1-5 cm, tight - oxidization	
Overburden (Thickness)	Top soil (less than 1 m) loose	River deposit (2 m) Sand and gravel dia: 5-15 cm, max. 70 cm hard graywacke, shale, rounded- subrounded, loose	Top soil clayey soil (5 m) Soft	
Permeability of bed rock	High	Middle - high	Middle	

TABLE V. 5 GEOLOGY AT PASIA

Site	PASIA		
Geological formation and age	Meligan Formation Miocene		
	Left bank	River bed	Right bank
Geologic structure	NS - N20W 40 - 80NE (dips toward left bank)		
Classification of bed rock	Graywacke	Graywacke	Graywacke
Rock quality	very hard and massive	very hard and massive	very hard and massive
Weathering condition (Thickness)	Assumed to be thin	Assumed to be fresh	Assumed to be thin
Condition of fissure	Assumed to be massive and tight	Assumed to be tight	Assumed to be tight - open
Overburden (Thickness)	Exposed graywacke	River deposit (1 - 2 m)	Exposed graywacke
Permeability of bed rock	Assumed to be low - middle	Assumed to be low - middle	Assumed to be middle - high

TABLE V. 6 GEOLOGY AT AYAT

Site	AYAT		
Geological formation and age	Stage II of the Belaga Formation Lower Eocene - Paleocene		
	Left bank	River bed	Right bank
Geologic structure	N 70 W 85 NE (dips toward downstream)		
Classification of bed rock	Alternation of siliceous sandstone and slate	Alternation of graywacke and slate	Alternation of graywacke and slate
Rock quality	Siliceous sandstone: very hard Slate: hard	Hard	Hard - soft
Weathering condition (Thickness)	Clayey slate and sandstone-rubble (5-10 m).	-	Clayey slate, sand and rubble (5-10 m)
Condition of fissure	Joint at intervals of 15-20 cm in parallel with heading	Tight bedding planes at intervals of 5-10 cm	Oxidized and open bedding at intervals of 20-40 cm. release joint at intervals of 15-30 cm
Overburden (Thickness)	Alluvial terrace deposit (3-4 m) sand and gravel Clayey zone (2-3 m)	-	Top soil (3-4 m)
Permeability of bed rock	Middle	Middle - low	Middle - high

TABLE V. 7 GEOLOGY AT BANGKIT

Site	BANGKIT		
Geological formation and age	Stage II of the Belaga Formation Lower Eocene - Paleocene		
	Left bank	River bed	Right bank
Geologic structure	N 53 W 85 NE (dips toward downstream)		
Classification of bed rock	Alternation of argillite and slate	Alternation of argillite and slate	Alternation of argillite and slate
Rock quality	Soft - hard	Soft - hard	Soft - hard
Weathering condition (Thickness)	Clayey soil (about 10 m)	Soft rocks (2-3 m)	Soft rocks (5-10 m)
Condition of fissure	Joints at intervals of a 1-5 cm in parallel with bedding	-	-
Overburden (Thickness)	Top soil (2 m)	River deposit (1-2 m) dia: mainly 2-4 cm max. 40 cm, subangular - sub-rounded, graywacke slate, loose	Alluvial terrace deposit (5-6 m)
Permeability of bed rock	Middle	Middle	Middle

TABLE V. 8 GEOLOGY AT KAPIT-2

Site		KAPIT-2		
Geological formation and age		Stage II of the Belaga Formation Lower Eocene - Paleocene		
	Left bank	River bed	Right bank	
Geologic structure	EW 80 N-S (approximately vertical)			
Classification of bed rock	Slate / Alternation of graywacke and slate	Alternation of graywacke and slate	Alternation / Slate of graywacke and slate	
Rock quality	Soft - hard	Hard	Soft - hard	
Weathering condition (Thickness)	Clayey slate (5-10 m)	-	Clayey slate (5-10 m)	
Condition of fissure	Slate:Schistosity at intervals of 2 - 3 mm Bedding plane: tight (altn.)	Slate:Schistosity at intervals of 2 - 3 mm Bedding plane : tight	Slate:Schistosity at the intervals 2 - 3 mm Bedding plane : tight(altn.)	
Overburden (Thickness)	Alluvial terrace (4-5 m) sand and gravel	-	-	
Permeability of bed rock	Clayey zone : Low Rock zone: middle	Rock zone: middle	Clayey zone : Low Rock zone: middle	

TABLE V. 9 GEOLOGY AT MUKOH

Site	MUKOH		
Geological formation and age	Stage II of the Belaga Formation Lower Eocene - Paleocene		
	Left bank	River bed	Right bank
Geologic structure	N 88 W 75-80 SW (dips toward upstream)		
Classification of bed rock	Graywacke	Graywacke	Graywacke
Rock quality	Very hard	Very hard	Very hard
Weathering condition (Thickness)	Looseness zone (2-3 m)	(0)	Looseness zone (4-5 m)
Condition of fissure	Vertical joint at intervals of 15-20 cm open, oxidation Flat-lying joint at intervals of 10-20 cm, open	Vertical joint at intervals of 15 - 20 cm, tight	Vertical joint at intervals of 15 - 20 cm, open Flat-lying joint at intervals of 10-20 cm, open
Overburden (Thickness)	-	-	-
Permeability of bed rock	High	Middle - low	High

TABLE V. 10 GEOLOGY AT KAPIT-1

Site		KAPIT-1		
Geological formation and age		Stage III of the Belaga Formation Middle Eocene - Upper Eocene		
	Left bank	River bed	Right bank	
Geologic structure	N 60 W 40 NE (dips toward right bank)			
Classification of bed rock	Slate	graywacke Slate	slate graywacke	
Rock quality	Soft	Soft - Loose	Soft - hard	
Weathering condition (Thickness)	Clayey slate	Graywacke : Looseness zone (4-5 m) Soft slate : (5-10 m)	Graywacke : Looseness zone (5-10 m) Clayey slate : (10-15 m)	
Condition of fissure	Schistosity at intervals of 1-2 mm Joint at intervals of 5-10 cm	-	Graywacke : open joint at intervals of 15-30 cm	
Overburden (Thickness)	-	River deposit (2-3 m) sand and gravel, dia: 3-10 cm max. 15 cm, subangular-subrounded, graywacke, slate, loose	-	
Permeability of bed rock	Clayey zone: Low Rock zone : Middle	middle - high	Graywacke : high Slate : low - middle	

TABLE V. 11 GEOLOGY AT IBAU

Site		IBAU		
Geological formation and age		Stage III of the Belaga Formation Middle Eocene - Upper Eocene		
	Left bank	River bed	Right bank	
Geologic structure	EW - N 80 W 80 N (dips toward upstream)			
Classification of bed rock	Slate	Slate	Slate	
Rock quality	Soft	Soft - hard	Soft	
Weathering condition (Thickness)	Clayey slate (10 - 15 m)	Soft slate (5 - 6 m)	Clayey slate (10 - 15 m)	
Condition of fissure	-	-	Joint at intervals of 5-10 cm	
Overburden (Thickness)	Alluvial terrace deposit (5 m) sand and gravel	River deposit (2-3 m) dia: 3-7 cm, max. 20 cm, subangular - subrounded, graywacke	-	
Permeability of bed rock	Clayey zone : Low Rock zone: middle	Rock zone: middle	Clayey zone : Low Rock zone: middle	

TABLE V. 12 GEOLOGY- AT QUARRY SITES

SITE	GEOLOGY	LOCATION	REMARKS
SEKRANG-1	Alternation of graywacke and slate	2 km to the north-northwest of the damsite	-
SEKRANG-2	Graywacke	1 km to the north of the damsite	-
KANOWIT	Sandstone	20 km to the south-southeast of the damsite	-
MEDAMIT-2	Shale	-	No quarry
PASIA	Graywacke	2 km to the north-east of the damsite	-
AYAT	Graywacke	1.5 km to the north of the damsite.	-
BANGKIT	Alternation of slate and argillite	-	No quarry
KAPIT-2	Slate	4 km to the north of the damsite	-
MUKOH	Graywacke	1 km to the east of the damsite	-
KAPIT-1	Slate	-	No quarry
IBAU	Slate	-	No quarry

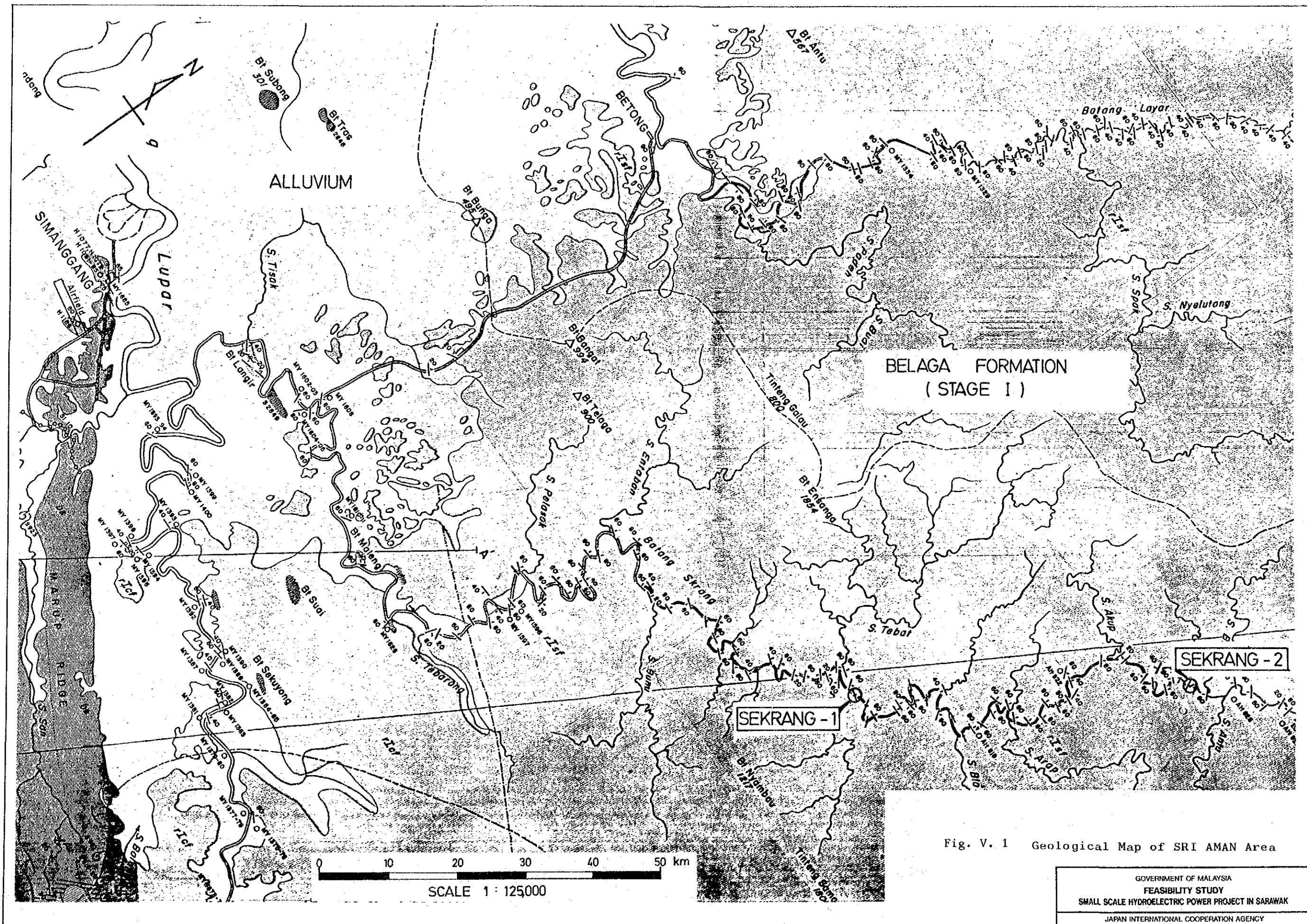


Fig. V. 1 Geological Map of SRI AMAN Area

GOVERNMENT OF MALAYSIA
 FEASIBILITY STUDY
 SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
 JAPAN INTERNATIONAL COOPERATION AGENCY

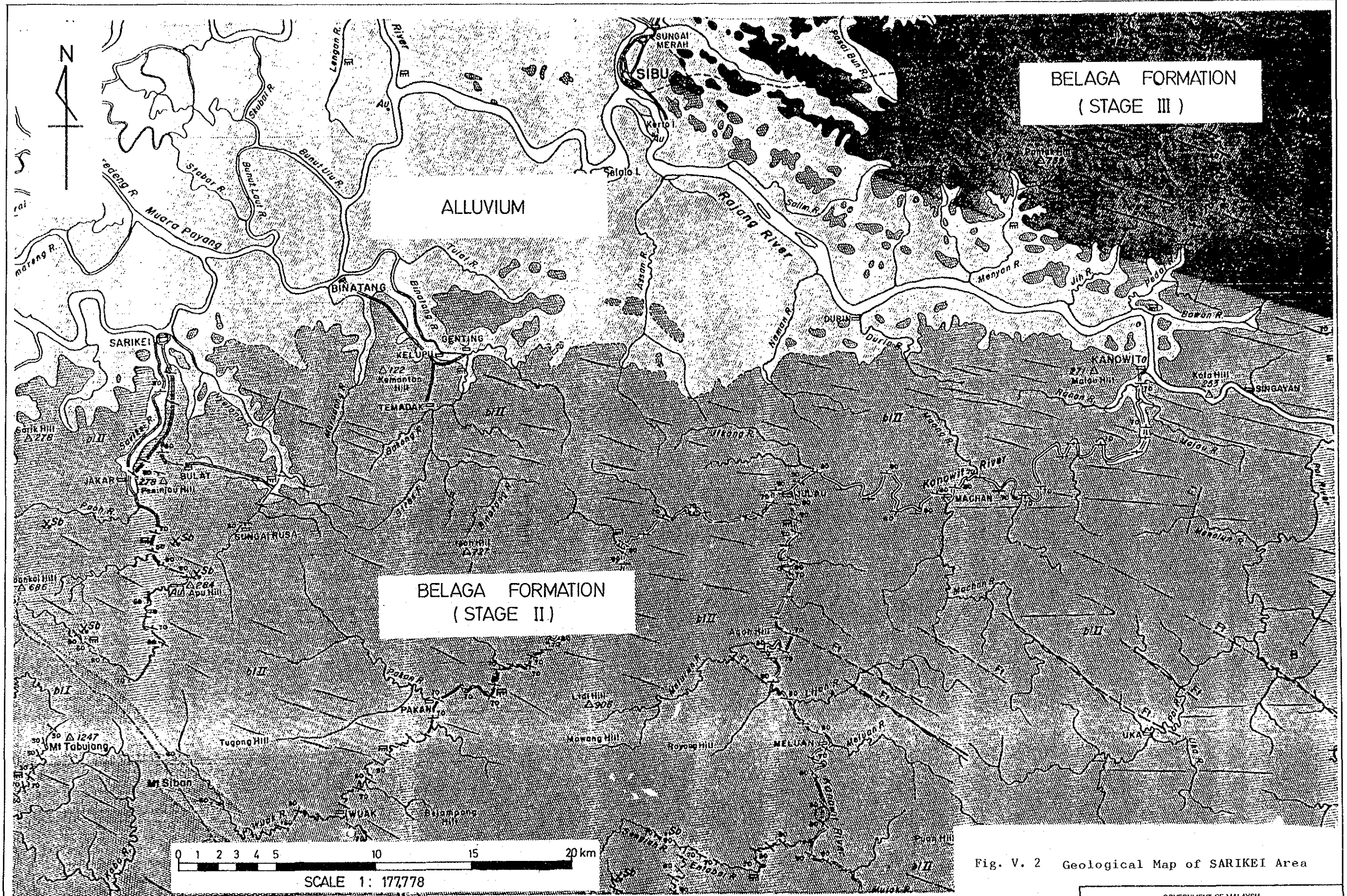


Fig. V. 2 Geological Map of SARIKEI Area

GOVERNMENT OF MALAYSIA
 FEASIBILITY STUDY
 SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
 JAPAN INTERNATIONAL COOPERATION AGENCY

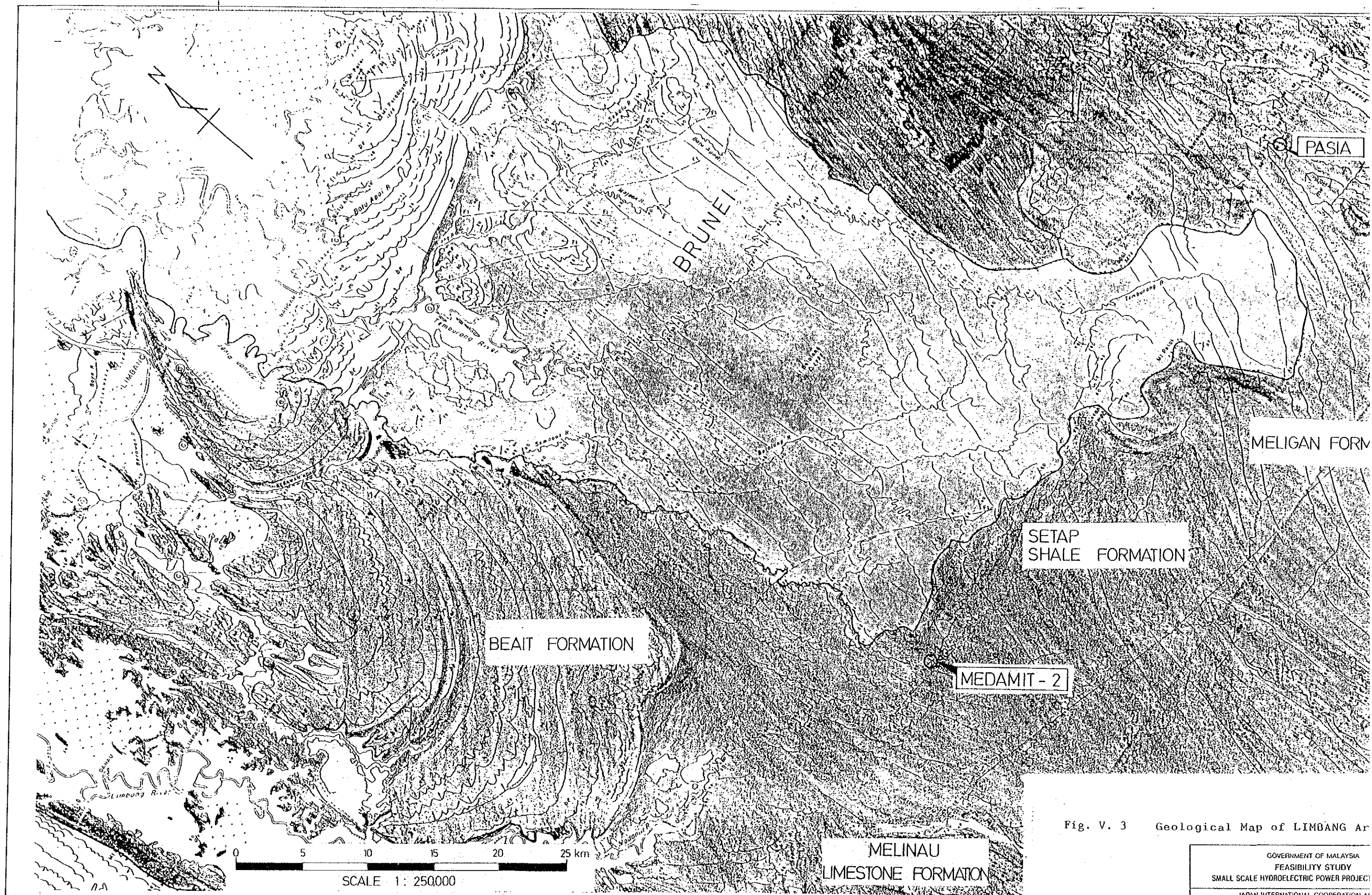


Fig. V. 3 Geological Map of LIMBANG Ar

GOVERNMENT OF MALAYSIA
 FEASIBILITY STUDY
 SMALL SCALE HYDROELECTRIC POWER PROJECT
 JAPAN INTERNATIONAL COOPERATION AI

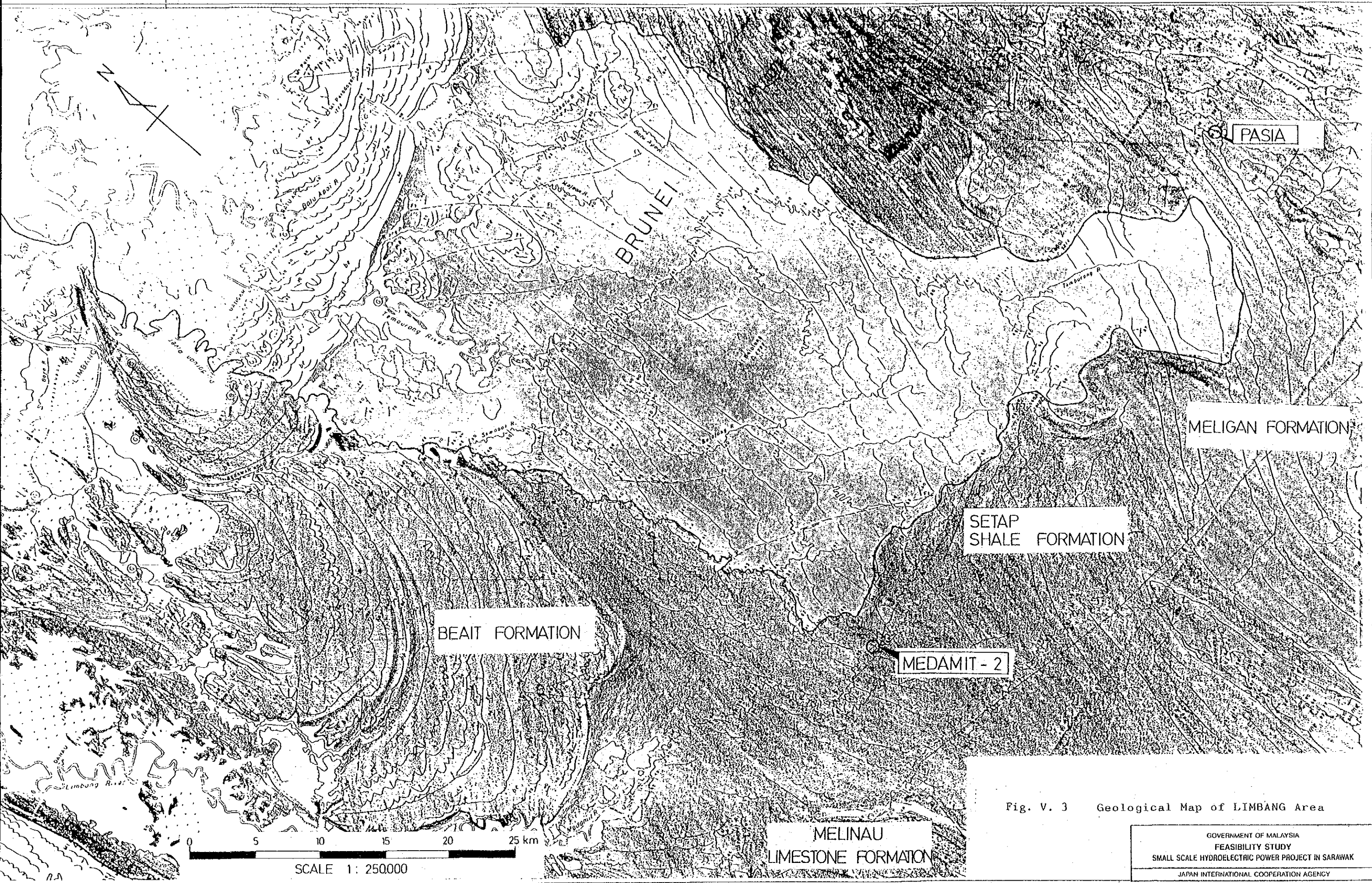
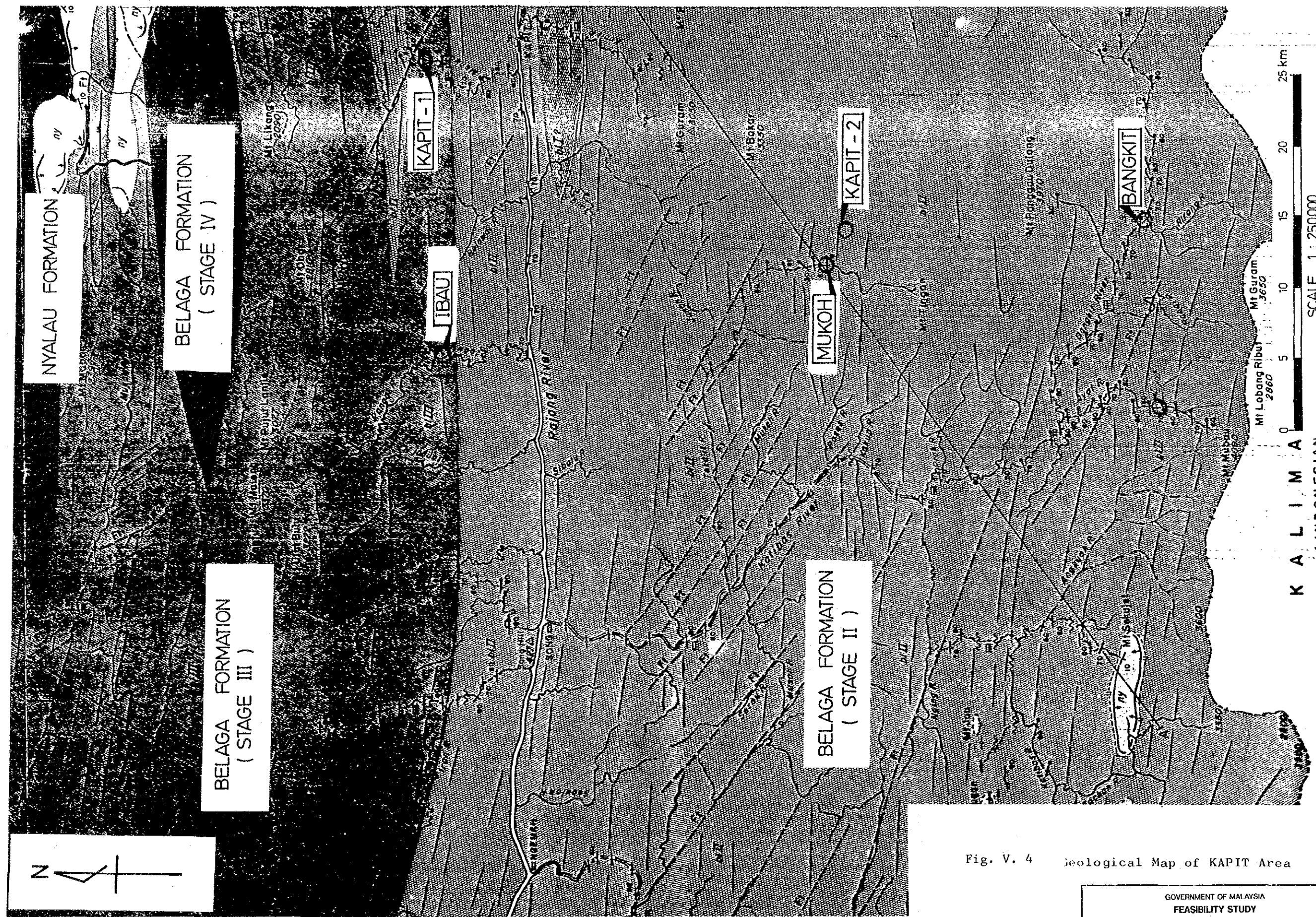


Fig. V. 3 Geological Map of LIMBANG Area

GOVERNMENT OF MALAYSIA
 FEASIBILITY STUDY
 SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
 JAPAN INTERNATIONAL COOPERATION AGENCY



NYALAU FORMATION

BELAGA FORMATION
(STAGE IV)

BELAGA FORMATION
(STAGE III)

[KAPIT-1]

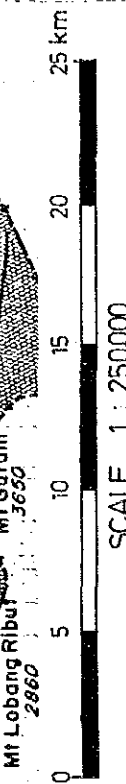
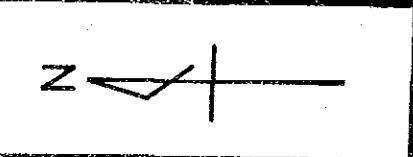
[IBAUI]

BELAGA FORMATION
(STAGE II)

[MUKOH]

[KAPIT-2]

[BANGKIT]



SCALE 1 : 250000

K A L I M A
(I N D O N E S I A)

Fig. V. 4 Geological Map of KAPIT Area

GOVERNMENT OF MALAYSIA
FEASIBILITY STUDY
SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
JAPAN INTERNATIONAL COOPERATION AGENCY

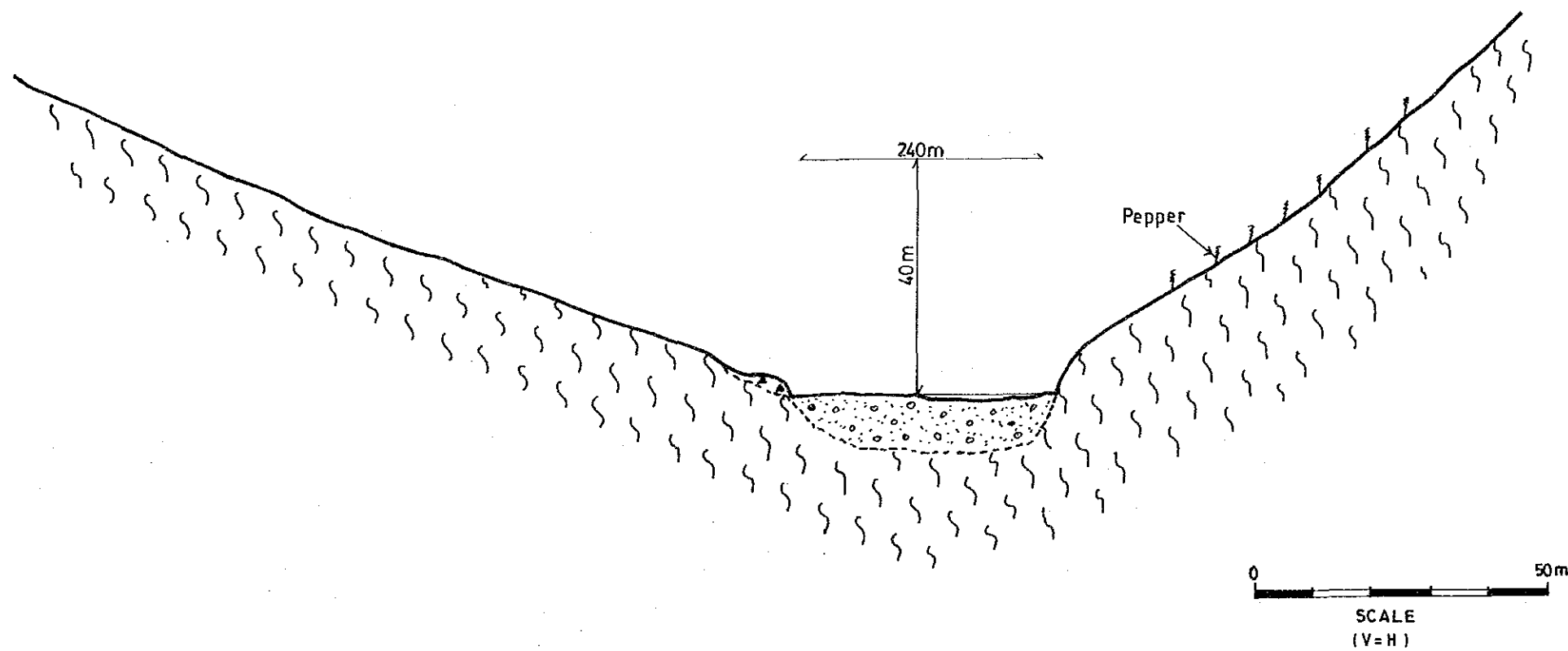
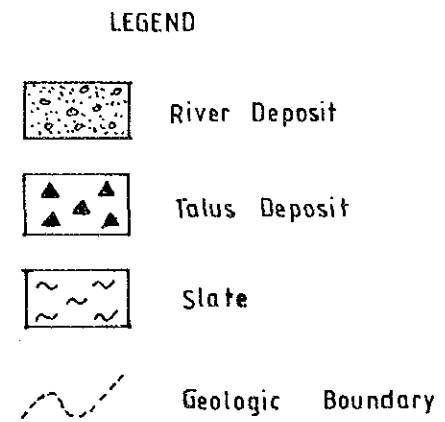
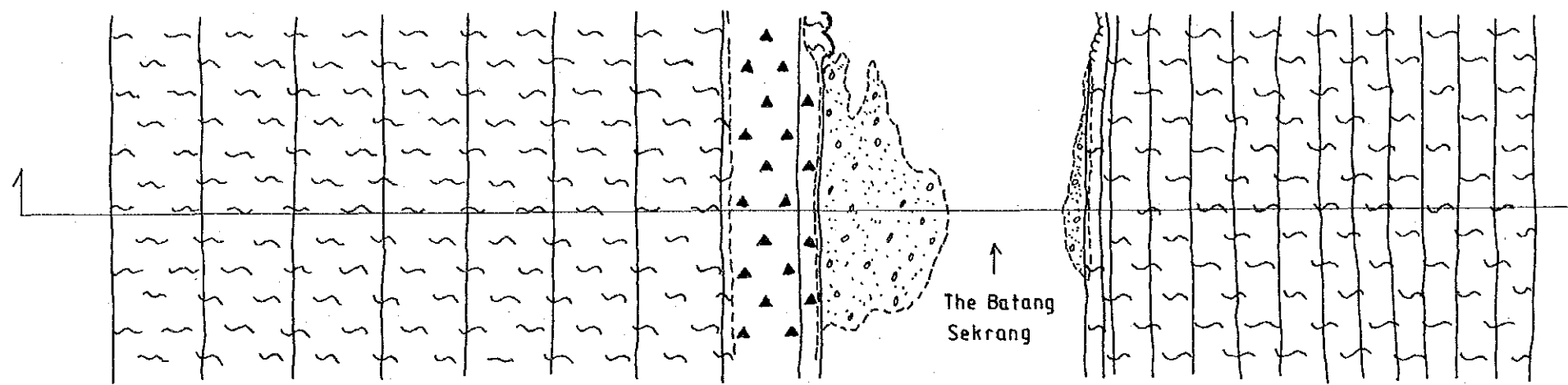
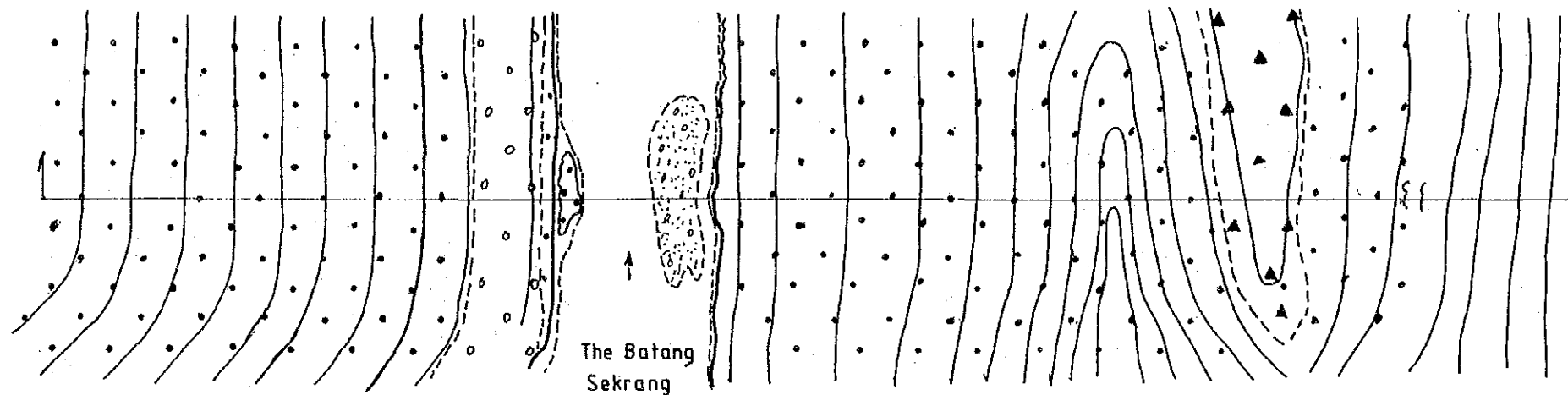


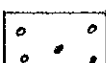
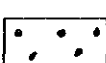



Fig. V.5 Geological profile of Sekrang-1

GOVERNMENT OF MALAYSIA
 FEASIBILITY STUDY
 SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
 JAPAN INTERNATIONAL COOPERATION AGENCY



LEGEND

-  River Deposit
-  Talus Deposit
-  Terrace Deposit
-  Graywacke
-  Geologic Boundary

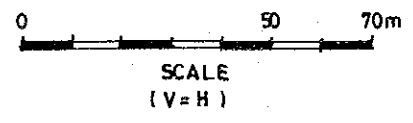
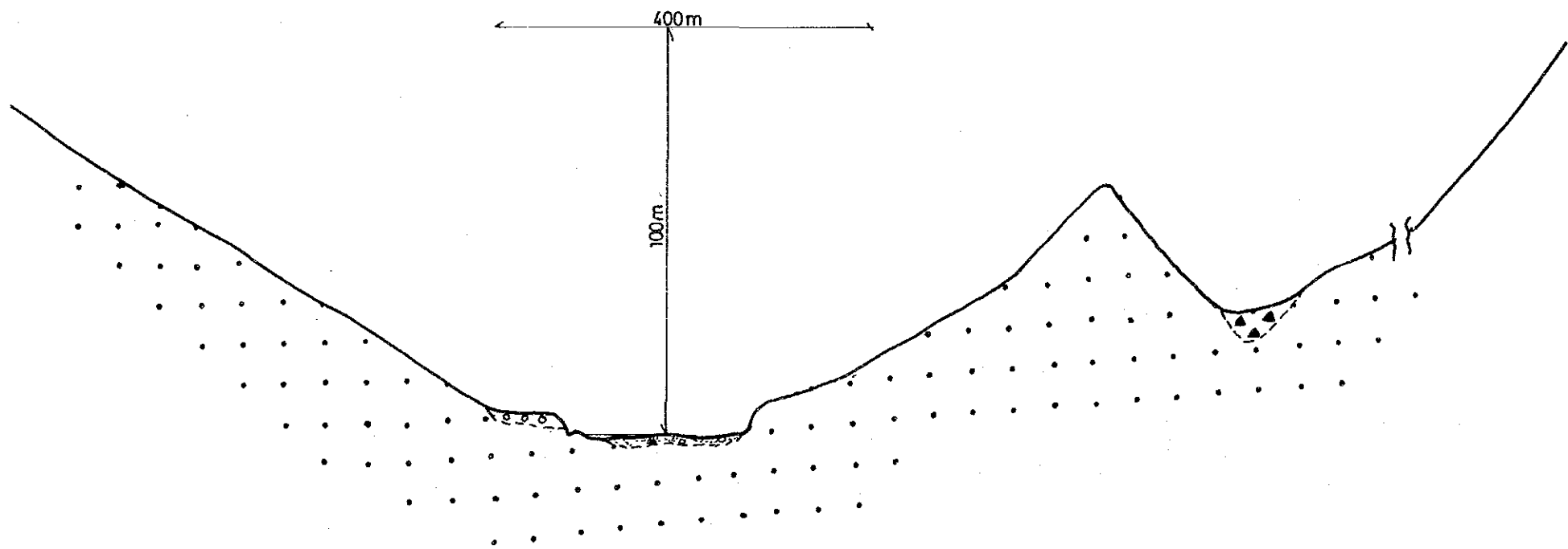
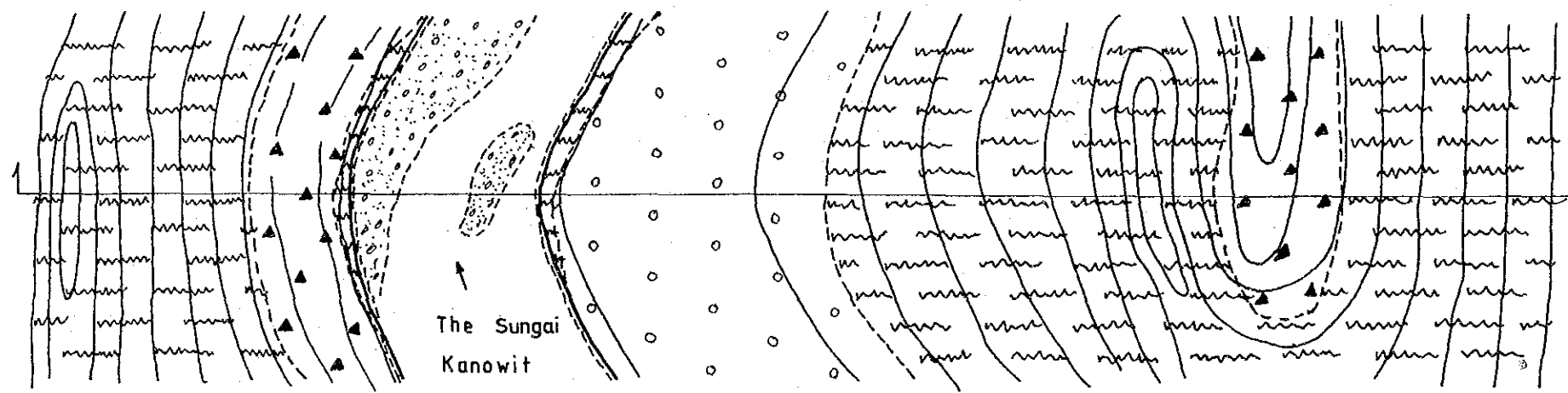
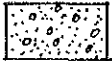


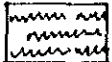
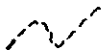


Fig. V. 6 Geological profile of Sekrang-2

GOVERNMENT OF MALAYSIA
 FEASIBILITY STUDY
 SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
 JAPAN INTERNATIONAL COOPERATION AGENCY



LEGEND

-  River Deposit
-  Talus Deposit
-  Terrace Deposit
-  Phyllite
-  Geologic Boundary

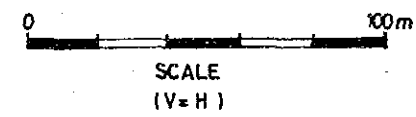
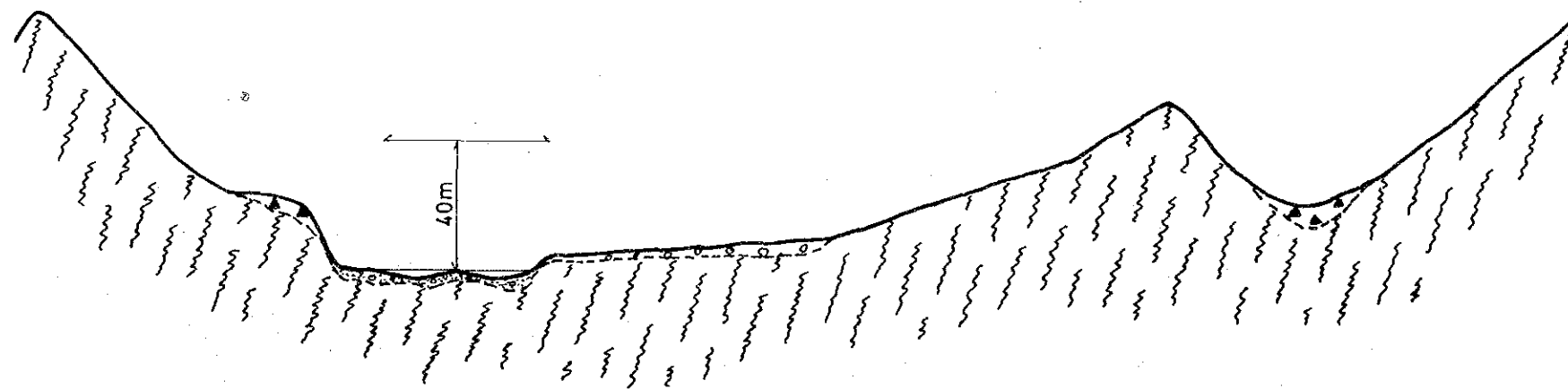
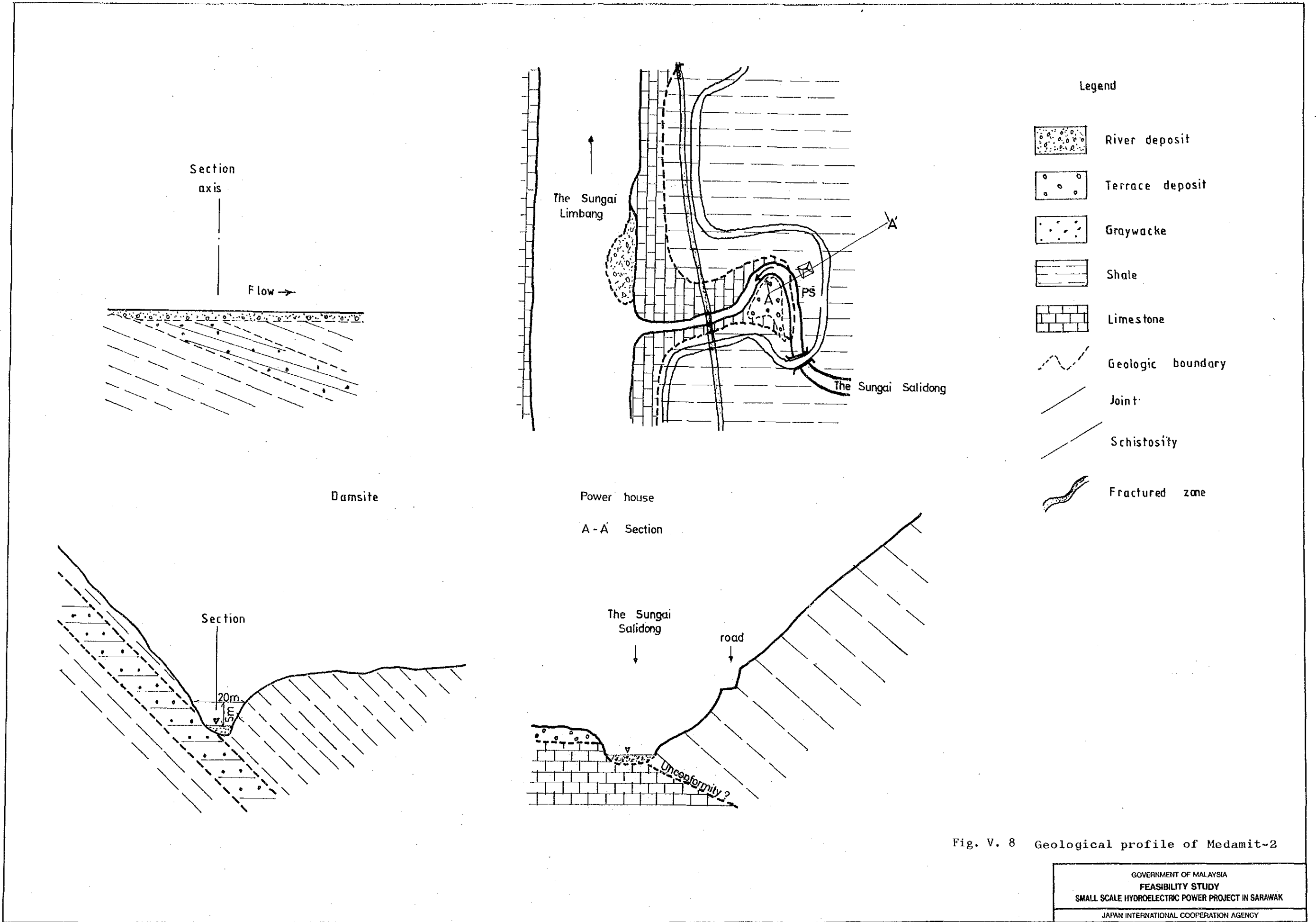


Fig. V. 7 Geological profile of Kanowit

GOVERNMENT OF MALAYSIA
 FEASIBILITY STUDY
 SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
 JAPAN INTERNATIONAL COOPERATION AGENCY



Legend

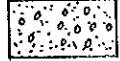
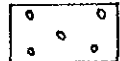
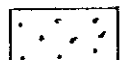
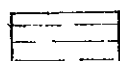
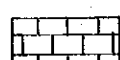




-  River deposit
-  Terrace deposit
-  Graywacke
-  Shale
-  Limestone
-  Geologic boundary
-  Joint
-  Schistosity
-  Fractured zone

Fig. V. 8 Geological profile of Medamit-2

GOVERNMENT OF MALAYSIA
 FEASIBILITY STUDY
 SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
 JAPAN INTERNATIONAL COOPERATION AGENCY

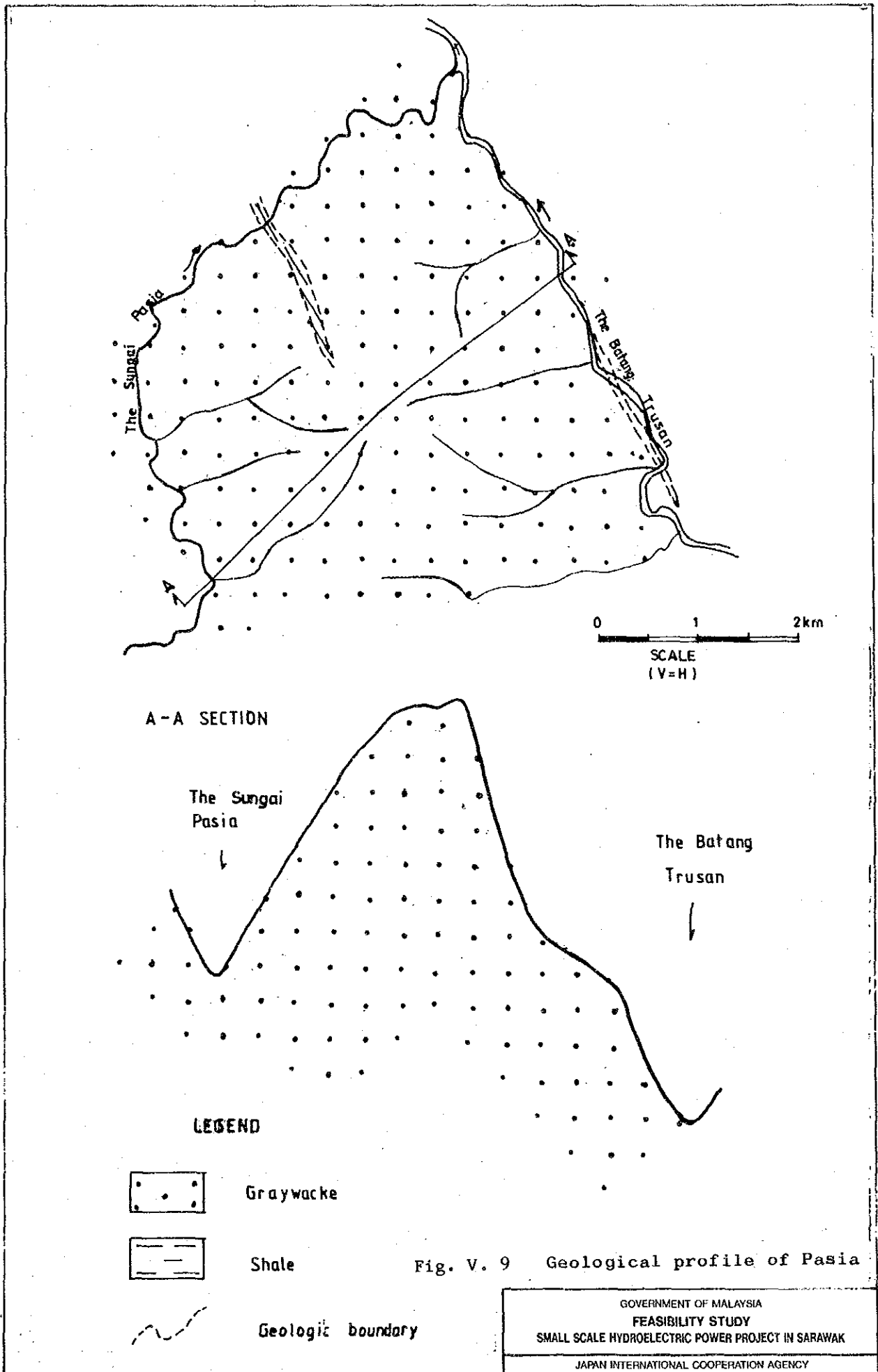
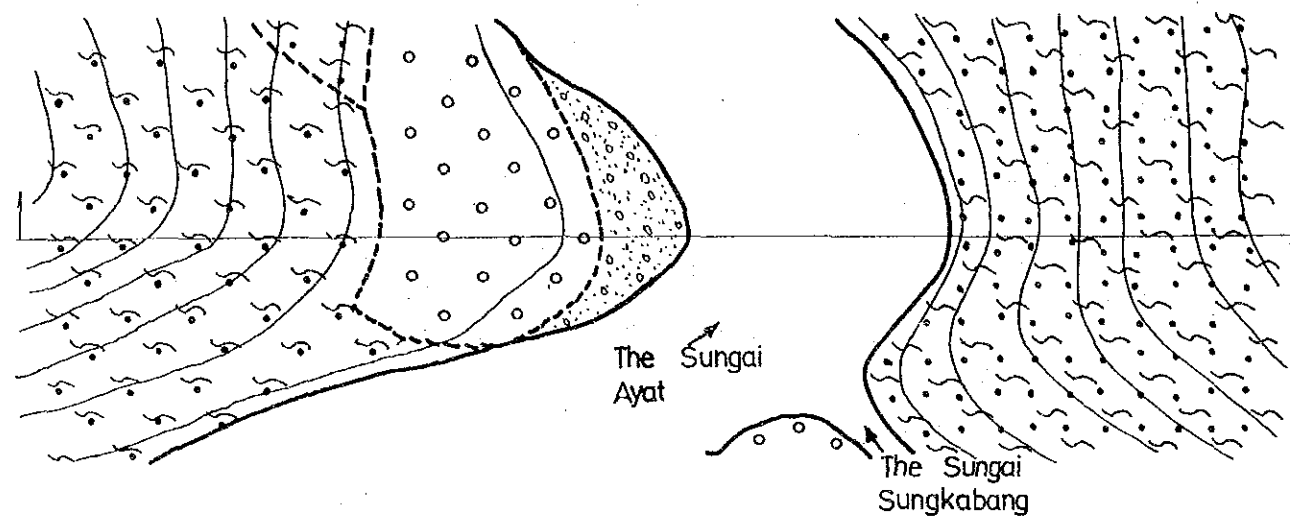



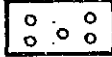

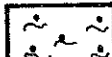

Fig. V. 9 Geological profile of Pasia

GOVERNMENT OF MALAYSIA
 FEASIBILITY STUDY
 SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK

JAPAN INTERNATIONAL COOPERATION AGENCY



LEGEND

-  River deposit
-  Terrace deposit
-  Alternation of graywacke and slate
-  Alternation of fine sandstone and slate
- 

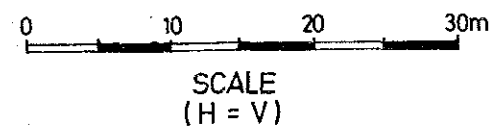
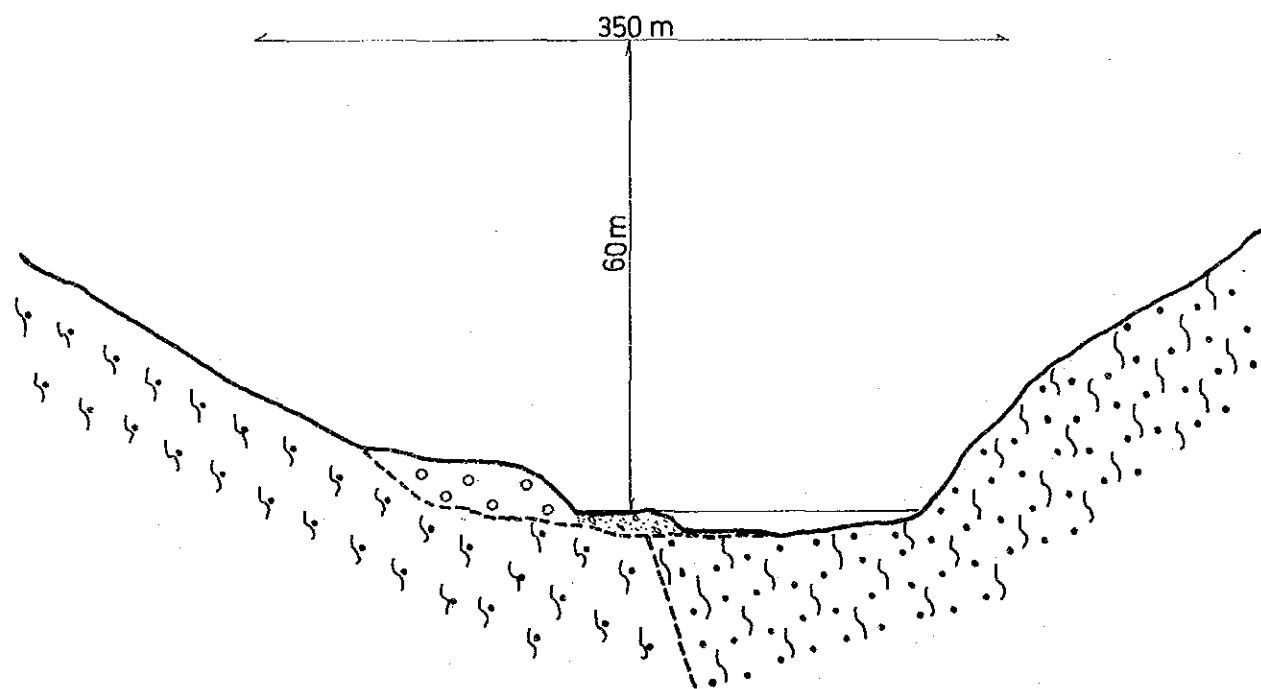
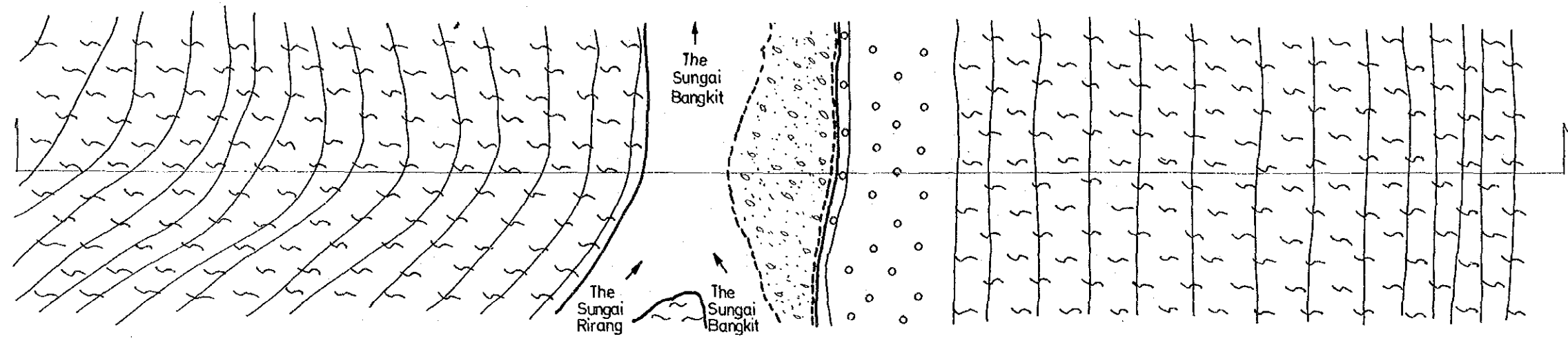
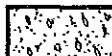
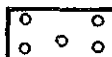
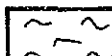



Fig. V. 10 Geological profile of Ayat

GOVERNMENT OF MALAYSIA
 FEASIBILITY STUDY
 SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
 JAPAN INTERNATIONAL COOPERATION AGENCY



- LEGEND**
-  River deposit
 -  Terrace deposit
 -  Alternation of argillite and slate
 -  Geologic boundary

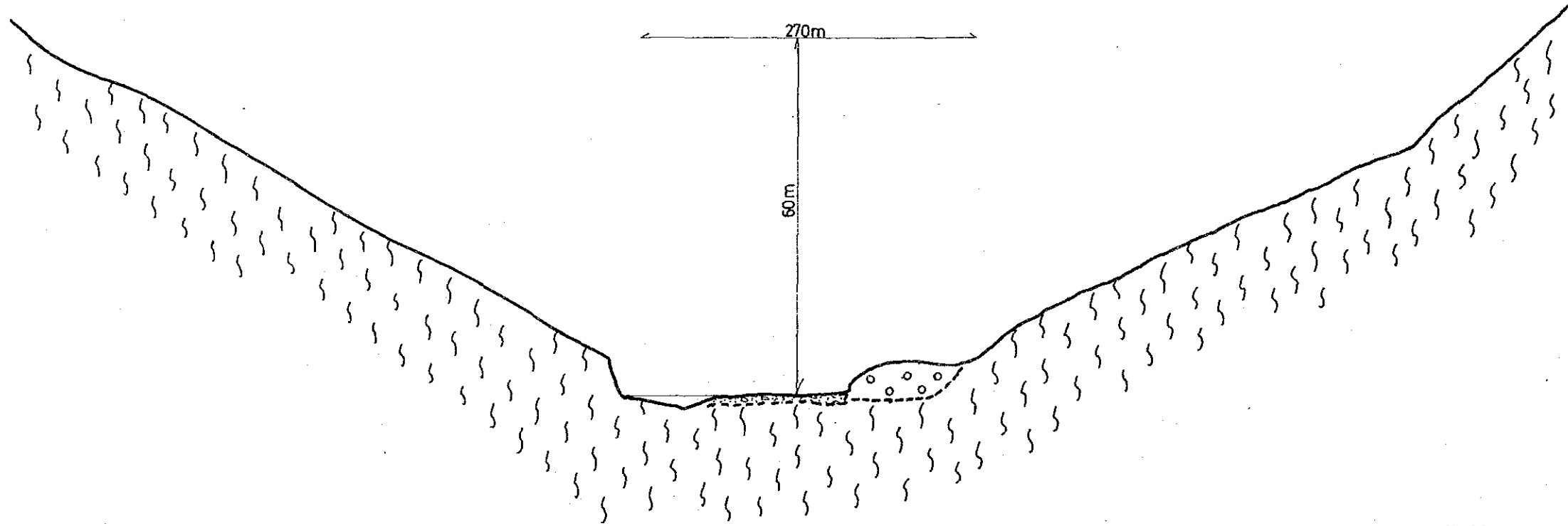
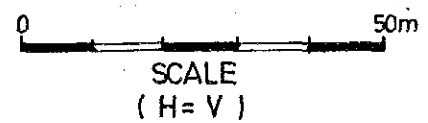
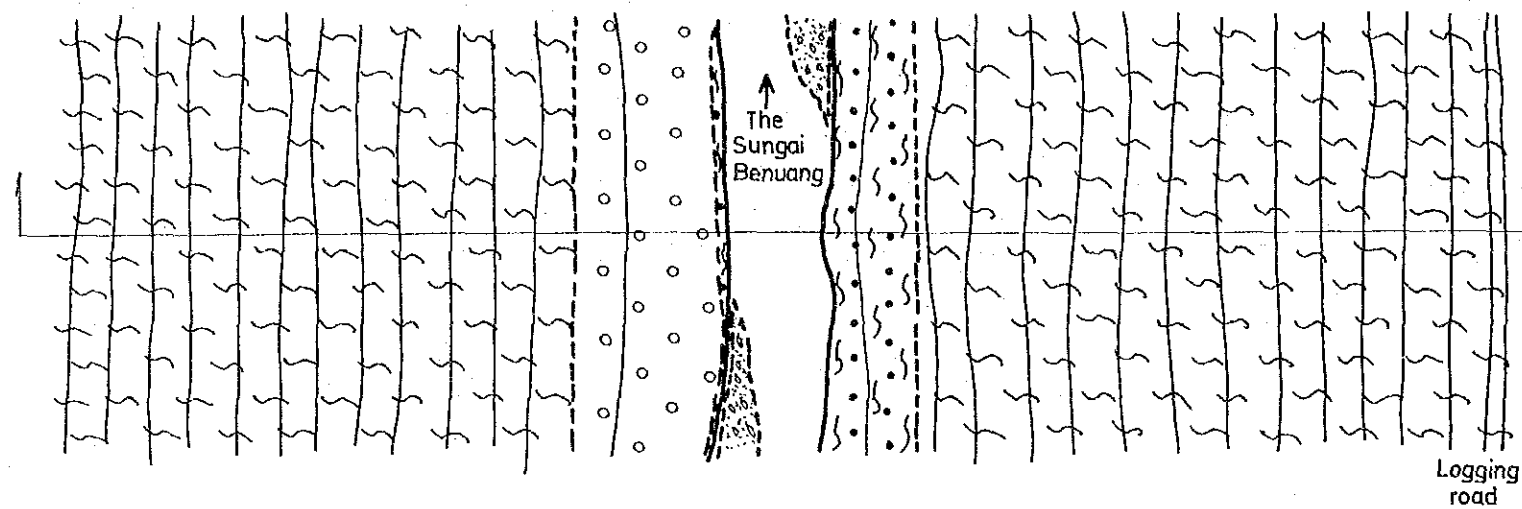



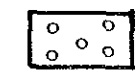



Fig. V.11 Geological profile of Bangkit



GOVERNMENT OF MALAYSIA
FEASIBILITY STUDY
SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
JAPAN INTERNATIONAL COOPERATION AGENCY



Legend

-  River deposit
-  Terrace deposit
-  Alternation of graywacke and slate
-  Slate
-  Geologic boundary

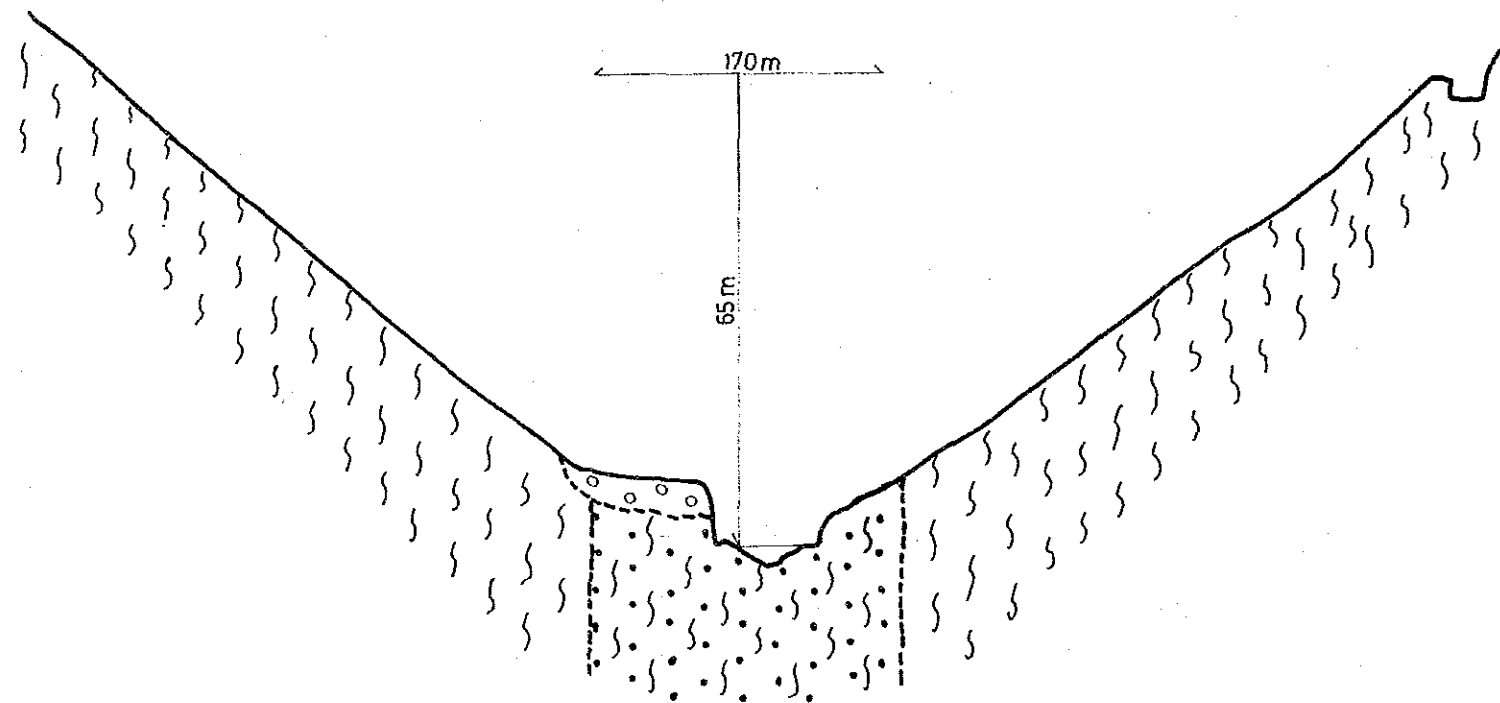
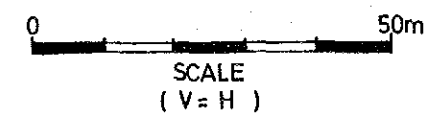
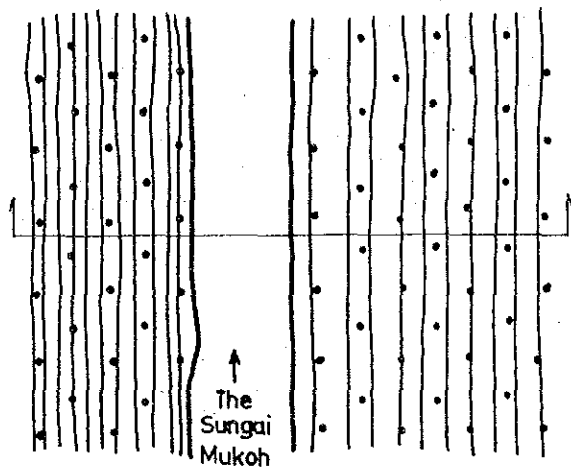


Fig. V.12

Geological profile of Kapit-2



GOVERNMENT OF MALAYSIA
 FEASIBILITY STUDY
 SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
 JAPAN INTERNATIONAL COOPERATION AGENCY



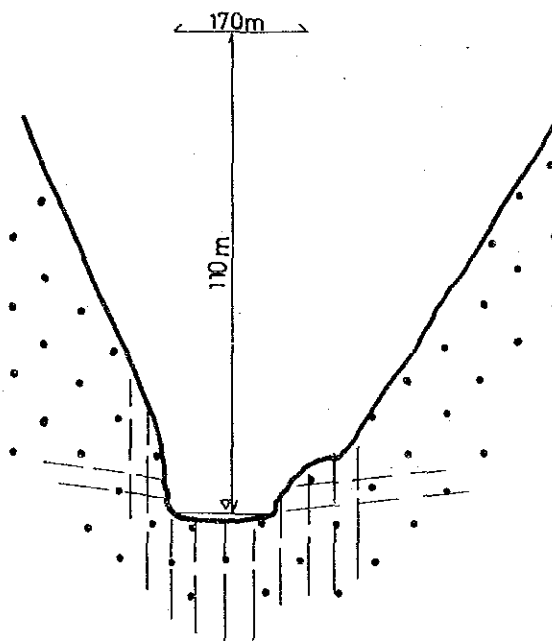
Legend



Graywacke



Joint

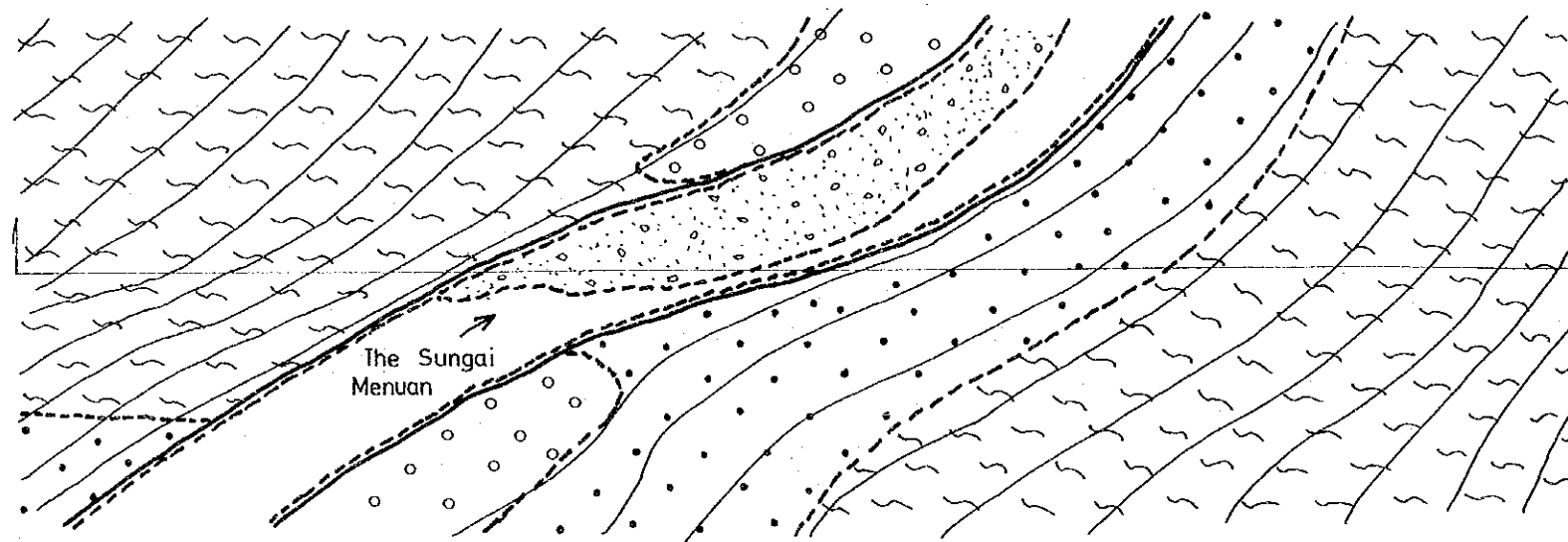


SCALE
(V = H)

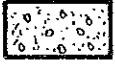


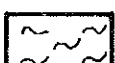
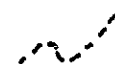
Fig. V.13 Geological profile of Mukoh

GOVERNMENT OF MALAYSIA
FEASIBILITY STUDY
SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK

JAPAN INTERNATIONAL COOPERATION AGENCY



Legend

-  River deposit
-  Terrace deposit
-  Graywacke
-  Slate
-  Geologic boundary

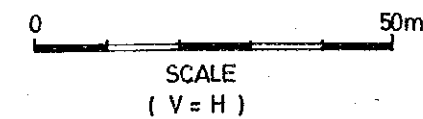
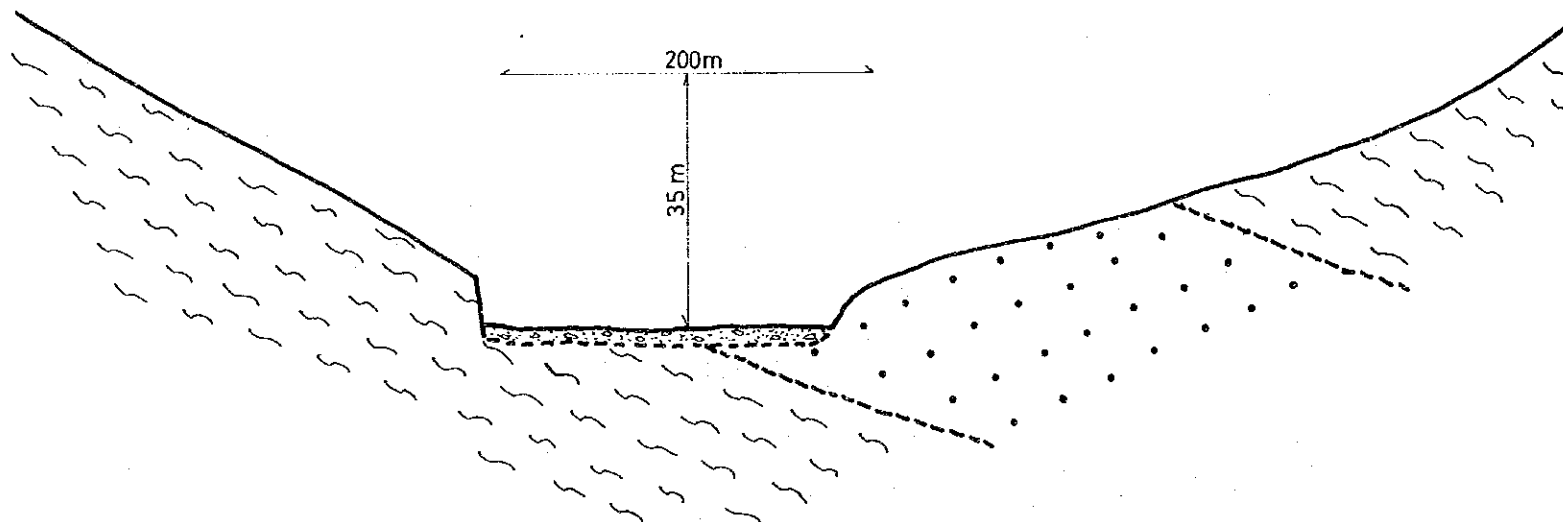
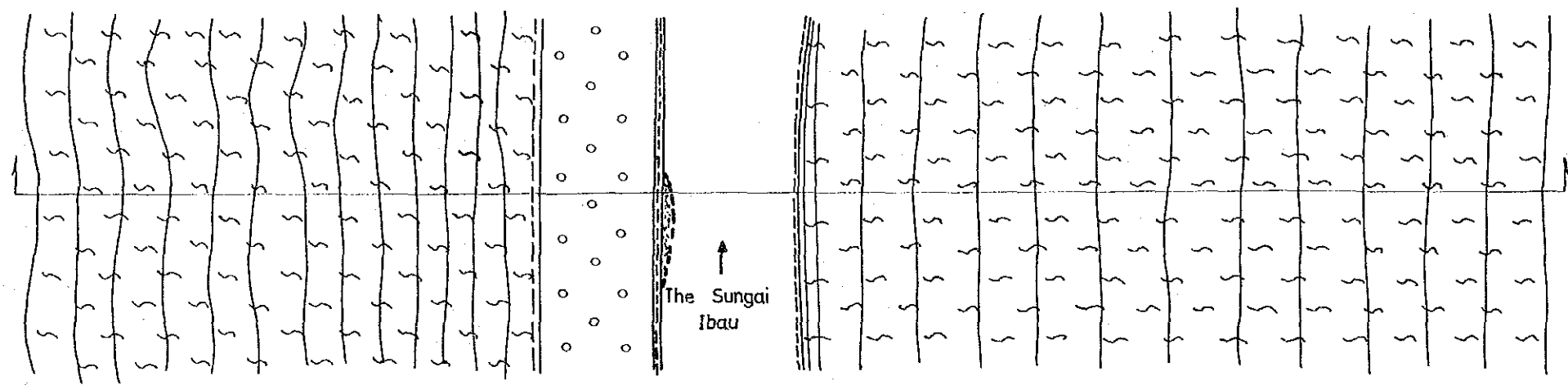

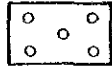
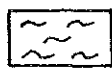



Fig. V. 14 Geological profile of Kapit-1

GOVERNMENT OF MALAYSIA
 FEASIBILITY STUDY
 SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
 JAPAN INTERNATIONAL COOPERATION AGENCY



- Legend
-  River deposit
 -  Terrace deposit
 -  Slate
 -  Geologic boundary

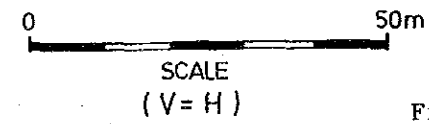
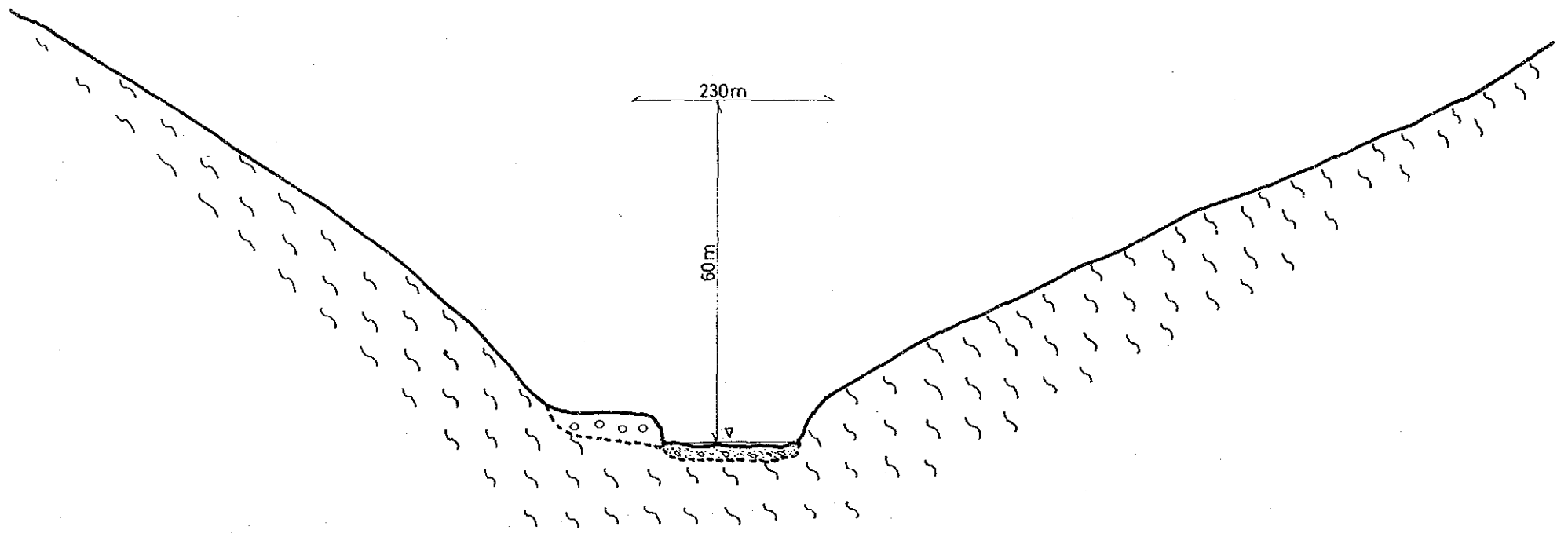


Fig. V. 15 Geological profile of Ibau

GOVERNMENT OF MALAYSIA
 FEASIBILITY STUDY
 SMALL SCALE HYDROELECTRIC POWER PROJECT IN SARAWAK
 JAPAN INTERNATIONAL COOPERATION AGENCY

