DRAINAGE AND IRRIGATION DEPARTMENT
MINISTRY OF AGRICULTURE
GOVERNMENT OF MALAYSIA

JABATAN PARIT DAN TALIAIR
KEMENTERIAN PERTANIAN
KERAJAAN MALAYSIA

GROUNDWATER RESOURCES FOR AGRICULTURAL USE IN MALAYSIA

PADANG TERAP
Supplementary Report
August, 1982.

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Summary

The groundwater potential of the Semanggol Formation rocks underlying the Gula Padang Terap estate has been investigated by means of surface resistivity surveys and by borehole drilling and testing.

The Semanggol consists of thin bedded shale, siltstone and greywacke sandstones which have been faulted and highly folded. Intergranular porosity is negligible and the aquifer is developed in open joints and fractures in the more weathered rocks down to 40 m.

The aquifer zone is impersistent and thin and generally low yielding. Of 18 bores drilled and tested by JPT and earlier by Renardet, only one would be likely to sustain discharge appropriate to an irrigation bore (i.e. $>$20 l/s).

This low success rate dictates that a very large number of sites would have to be drilled, on an extensive grid, to detect any further successful boreholes. Such boreholes are expected to occur almost at random at sites inappropriate to irrigation system designs; an extensive conveyance system would be required.

Because of the low potential of the aquifer and the likely high costs associated with extensive drilling and conveyance works, it is concluded that no significant part of Gula Padang Terap could be irrigated from groundwater.

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FIGURES

APPENDIX

1. Introduction and Previous Work

An investigation of the groundwater resources of the Padang Terap Gula (PTG) estate in Kedah was carried out by the JPT groundwater group as part of an appraisal of groundwater resources for agricultural use in Malaysia. The investigation extended from October 1981 to February 1982.

The estate cultivates some 6,500 ha of rain fed continuous sugar which is ratooned several times. The whole area experiences intermittent water shortages consequent upon irregular rainfall, and these shortages may interfere with and delay land cultivation and re-planting.

However, although irrigation is essential for increasing yields, other factors such as poor soils and labour shortages are involved. In addition, a poor dissected terrain may somewhat limit the area which could be successfully irrigated.

The management of PTG have considered both the development of surface water supplies held in reservoirs and the development of groundwater. The area was therefore given a high priority for investigation since a groundwater assessment was essential in determining a policy for future development of the estate.

In 1979, Renardet and Yussoff Ibrahim carried out investigations in PTG, using geophysical resistivity techniques. These were used to detect subsurface water bearing zones or aquifers amongst the underlying Semanggol Formation which is a series of highly folded and rather altered sandstones, siltstones and shales.

Six exploratory boreholes were later drilled upon targets located by geophysical methods (Figure 2.2).

Their results were inconclusive but several boreholes indicated that the Semanggol Formation rocks had some promise as an aquifer. They concluded that drilling boreholes on relatively high resistivity zones (thought to represent sandstone beds) could give yields of 3-6 litres per second.

Details of the Renardet-Yussoff Ibrahim boreholes are given later (Table 2.2).

2. JPT Investigation Programme.

2.1 General

In order to test and amplify the conclusions of the previous investigation by Renardet, JPT carried out an exploratory geophysical investigation with concurrent exploratory drilling; 12 bores were drilled. Geophysical results were later tested by drilling.

Where discharges were adequate, exploratory bores were yield tested by means of an air lift pump.

2.2 Geology and Geophysics

2.2.1 Geology

Padang Terap and the mountain areas to the north-west and east are underlain by the Triassic Semanggol Formation, a rapidly changing sequence of shales, siltstones, and coarse, ill-sorted, sandstones; no cherts or true conglomerates have yet been observed. After deposition, these rocks were tightly folded along a roughly north-south axis and then further deformed into a series of larger amplitude anticlines and synclines; faulting with associated with the folding. Most of the rocks have near vertical dips with a strike ranging from 330 to 20 degrees. Several outcrops in Padang Terap exhibit such tight folding.

The sediments of the Semanggol Formation are thinly bedded. The lithologies in extreme examples change from black shales, through siltstones to coarse sandstones within a space of 20 centimetres. These rapid changes have important implications for surface and borehole geophysics and for the hydrogeology of the area.

The maximum bed thicknesses observed to date is about 1 metre, but often there are zones of predominantly sandstone or predominantly shale/siltstone which have a thickness of around 20 metres.

The shales are finely laminated and soft in weathered exposures but at depth they are harder and fissile. The siltstones are a light grey colour in surface exposures but black at depth. They are often highly fractured. The sandstones are not true sandstones. They are an ill-sorted assemblage of angular, fine and coarse material typical of a greywacke. In surface exposures the sandstones are light brown to deep red in colour. Highly weathered examples have an intergranular porosity caused by the weathering and leaching out of unstable minerals. At depth the sandstones are black and very hard with no intergranular porosity.

All the lithologies are fractured but often the fractures have been sealed by either the deposition of fine clay particles or the precipitation of quartz or metallic oxides.

2.2.2 Geophysics

Twenty six resistivity traverses or profiles and nine soundings were carried out by the JPT geophysics team using, initially, borrowed ABEM Terrameter equipment and later, Scintrex RSP-6 equipment.

It was realised that the application of resistivity soundings to thin bedded vertically dipping slightly metamorphosed sediments is theoretically suspect; sound resistivity interpretation ideally uses earth models of horizontal isotropic layers with good resistivity contrast. Under the subsurface conditions at Padang Terap, resistivity traverses were more appropriate that soundings.

Figure 2.1 shows the position of the resistivity soundings and profiles and some details of the geological exposures in Padang Terap; some geophysical measurements carried out by Renardet in 1979 are also shown.

The results of the work were as follows:-

- It was not possible, because of the sparse outcrop, to map individual beds or horizons within the Semanggol Formation. Similarly because the beds were so thin, it is not possible to trace them using resistivity.

- It was possible to distinguish areas underlain predominantly by sandstone; this showed up as relative high points on the resistivity profiles.

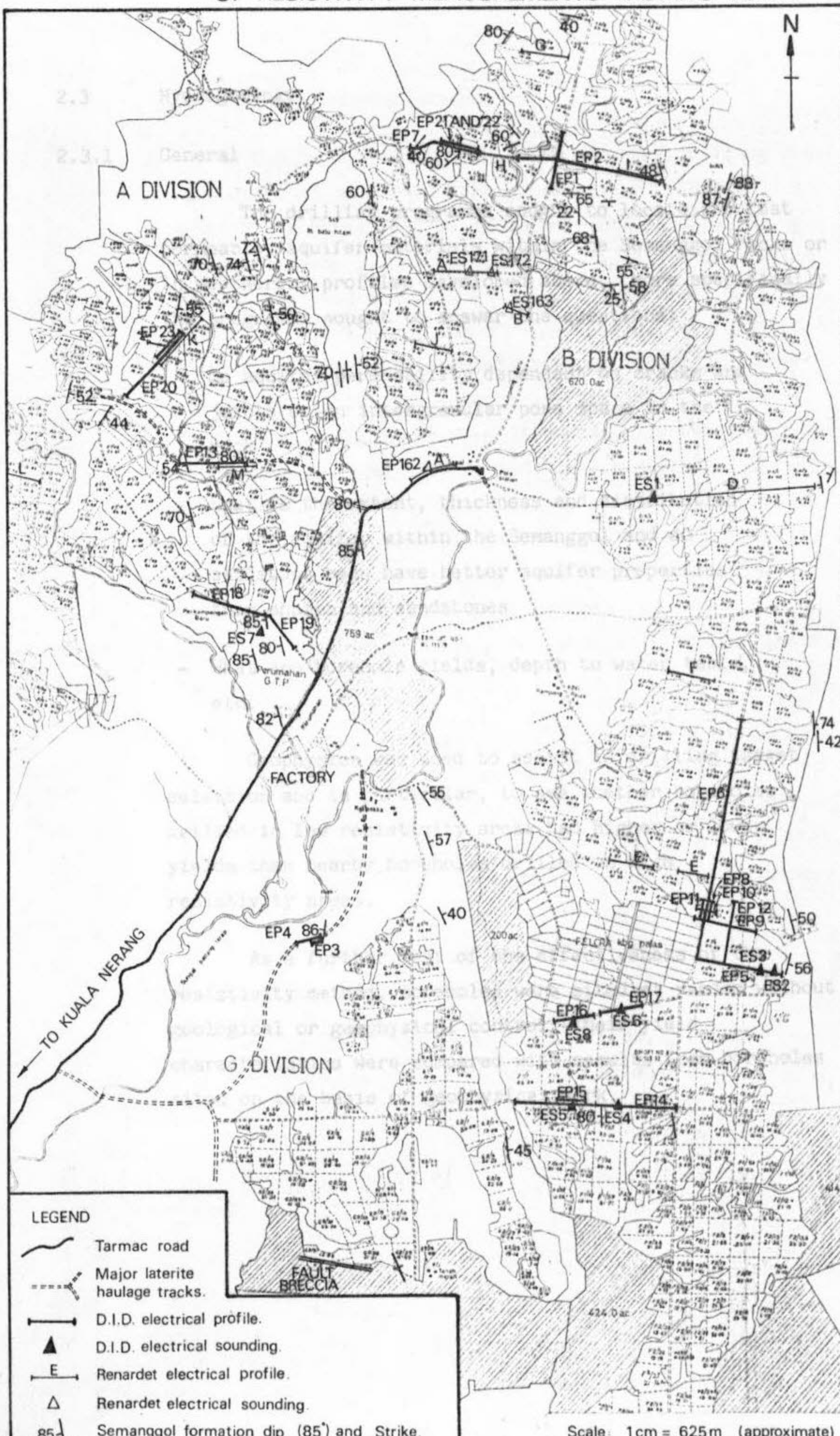
- Resistivity soundings and the study of rock exposures indicate that the process of soil formation and deep sub-aerial weathering has created a crude horizontal zonation in the rocks. However, the lateral variation in rock lithology and the variations in the thickness of the weathering zones made positive lithological identification impossible and therefore, without borehole or surface outcrop control, the method can only suggest a restricted range of alternatives.

- Evidently, the resistivity method cannot predict, with any certainty, subsurface rock types within the Semanggol Formation in Padang Terap. In any case, lithology in these rocks is not directly related to permeability or bore yield; the latter is dependent upon the incidence of interconnected fractures and cracks.

- the success rate or yield of boreholes sited on resistivity targets was no better than that from boreholes sited on a random basis (but on flat irrigable land blocks).

- In view of the low groundwater potential of these rocks as revealed by concurrent borehole drilling, no further resistivity work was justified.

Figure 2.1 GEOLOGICAL DATA, AND LOCATION OF RESISTIVITY MEASUREMENTS PADANG TERAP



2.3 Hydrogeology

2.3.1 General

The drilling programme sought to locate and test permeable, aquifer materials within the Semanggol rocks or in weathering profiles developed above. More specifically the programme sought to answer the questions:

- Is aquifer permeability dependant on cracks and joints or on intergranular pore space in the rock
- What is the extent, thickness and distribution of the aquifer within the Semanggol and do sandstone beds have better aquifer properties than shales and sandstones
- What are borehole yields, depth to water table, etc.

Geophysics was used to assist in drilling target selection and in particular, to see whether boreholes drilled in low resistivity areas had higher or lower yields than nearby boreholes drilled on high resistivity areas.

As a further test of the effectiveness of the resistivity method, boreholes were sited at random without geological or geophysical control; their yield characteristics were compared with results from boreholes sited on the basis of geophysical work.

2.3.2 Drilling and Testing Results

Two Tone 750A hydraulic drive rotary drilling rigs were operated by JPT in Padang Terap Gula. Twelve exploratory bores (PT1 to PT12) were drilled, either on geological/geophysical targets or in a random grid sited on flat land blocks (Figure 2.2). Two bores (PT2 and PT10, depths 151 m and 135 m respectively) were drilled to investigate deep rock permeability and lithology; other boreholes were drilled to 65 m average depth. Drill cuttings from the bores were lithologically examined and bores were geophysically logged. Where justified by the discharge of water during drilling, air lift yield tests were carried out, both at intermediate and sometimes at final bore depth. Lithologic and borehole geophysical logs were used, together with drilling data, to construct composite bore logs. These logs are given in the Appendix to this report.

Typical lithological profiles showed a transition from tough black unweathered Semanggol meta shale or sandstone into deeply weathered rock and clays; surface layers were usually composed of soil and laterite-clays (Table 2.1). Lithologic samples indicated the following:-

- unweathered sandstone beds within the Semanggol show no visible intergranular porosity

- meta shale-siltstone blocks, with clean joint faces can be recovered from the unweathered zone

Figure 2.2 LOCATION OF BOREHOLES PADANG TERAP.

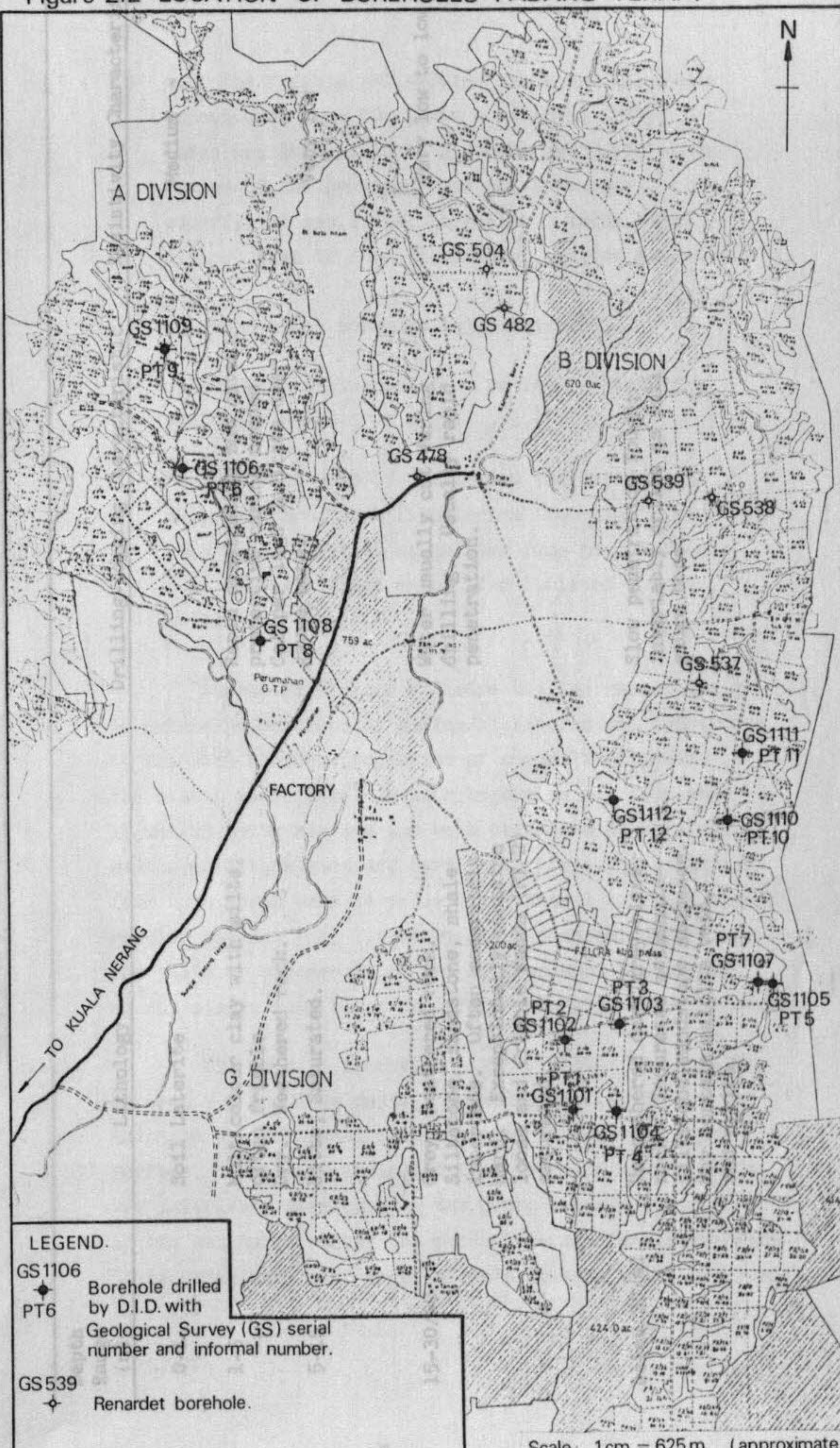


Table 2.1

SEMANGGOL FORMATION - TYPICAL VERTICAL SEQUENCE IN PADANG TERAP

Depth Range (n)	Lithology	Drilling-logging Characteristic	Resistivity Characteristic
0-1	Soil Laterite	-	Medium
1-5	Multicolour clay with silts; often friable. Dry. Weathered rock.	Rapid penetration but caves; protective casing needed. Caliper logs indicate over gauge bore.	
5-15	Ditto; Saturated.		Very low
15-30/40	Grey, weathered rock. Siltstone, sandstone, shale interbeds. Often moderately hard. Exceptionally contains loose and friable sands (PT 2); saturated.	Water usually cut during drilling. Usually rapid penetration.	Very low to low
below 30/40	Unweathered dark grey-black rock. Indurated metashale-siltstone-sandstone sequence. May contain calcite vein, and pyrite.	Slow penetration Tough; invariably drills as full gauge bore.	

- soft and friable well-sorted sands are sometimes encountered from the 15-40 m interval (PT2); these are thought to be a deeply weathered sandy facies of the Semanggol and not a younger superficial geological formation. These sands did not seem to form significant aquifer material.

Geophysical borehole logs indicated:

- alternating shale-sandstone or less resistive - resistive beds (SP-R logs)

- caliper logs clearly delineated the upper soft clay-weathered rock lithologies from tight, hard rock below about 40 m; caliper logs here indicate full borehole gauge except for isolated joints (PT9).

Boreholes PT6 and PT8 were drilled respectively on extensive outcrops of shales/siltstones and sandstones, to test the aquifer properties of these lithologies. The static water level in both boreholes was less than 10 metres below surface and both boreholes penetrated weathered lithologies and hard rock. Drilling discharges from both bores were very low (less than 1 l/s) and the results suggest that lithology alone does not determine the yield of a borehole or put another way, sandstones do not always form better aquifers than shales or siltstones.

The zone of saturation (water table) was usually between 2 m and 10 m depth. Superficial clay layers can maintain an additional perched water table at or near surface. Drilling indicated that the main aquifer zone was invariably developed in the depth interval 15 m to 40 m, in the weathered rocks; the productive aquifer seems often to be coincident with rock hardness changes which are likely to reflect a rock permeability change. Such changes typically occur at the junction of tough unweathered deep rocks and the grey weathered rocks of the profile (Table 2.1). The evidence suggests that aquifer permeability is developed only in open cracks and joints largely above 40 m, and not within intergranular pore spaces. Softer weathered or sandy materials encountered in the profiles (e.g. PT2, PT8) do not contain a significant aquifer.

During drilling, water flows produced from the borehole were measured in order to locate productive horizons. Where the discharge of water during drilling exceeded 1 or 2 l/s, the borehole was later tested by air lift. Seven such tests have been carried out. The air lift test allows a rough discharge/drawdown estimate which allows later decisions about borehole completion and the necessity for standard pumping tests using borehole turbine pumps, such pumps were not available during the period of the investigation.

The discharge-drawdown data obtained by airlift together with similar data obtained by Renardet is shown (Table 2.2). A crude borehole productivity index called specific capacity has been derived from this data. The frequency of boreholes in Padang Terap having various specific capacity values is shown below (Table 2.3).

The results indicate a poor aquifer which is generally capable of only low yields to boreholes. In only 6 out of 12 completed JPT bores is the sustained yield (i.e. yield which could be sustained by a production turbine pump) likely to exceed 3-4 l/s.

TABLE 2.2

YIELD TEST DATA - PADANG TERAP

Borehole No.	Total depth (M)	Target	Static Water ground surface (M)	Test Date	Discharge Q (1/s)	Drawdown SW (M)	Specific Capacity (1/s/m)	Remarks, bore status
PT 1	60	F block grid	8.8	18.11.81	*5.2	0.59	8.81	To be converted to TP bore bore with 10" slotted csg.
PT 2	151	"	1.71	4.12.81	*2.3	10.49	0.22	Deep test.
PT 3	77	"	5.61	17.12.81	*4.0	14.51	0.28	Completed with 6" dia. slotted casing. Obs.
PT 4	60	"	2.9		*5	10.85	0.46	
PT 5	66	Resistivity low			(1.5)			Not tested
PT 6	66	Shale lithology	4.08		(0.5)			Not tested
PT 7	62.5	Resistivity high	8.0	2.3.82	3.0	12.3	0.24	
PT 8	66	Sandstone lithology			(0)			Dry bore
PT 9	61	Resistivity high	1.9	27.1.82	*4.5	12.04	0.37	Completed with 6" dia. slotted casing.
PT 10	135	E block grid	5.3		(0.7)			Not tested
PT 11	60	"	4.9		(0.15)			Not tested
PT 12	60	"	5.6	16.2.82	6.3	10.36	0.61	Obs.
GS 478	36		1.9	4.8.79	6.4	17.06	0.38	Padang Sanai
GS 482	36		-	28.6.79	(3.75)			Padang Terap; collapsed.
GS 537	33		4.5	28.10.79	(6.25)	16.5	0.13	Padang Terap
GS 539	50		1.97	-	7.5	9.64	0.78	Padang Terap
GS 540	50		5.83	26.12.79	5.9	-	0.4	"

Note:

* discharge from 2-3 hour airlift tests

(1.5) drilling discharge only; no test justified.

GS 478 etc. Renardet boreholes

Obs. Suggested observation bore.

Table 2.3

Distribution of Specific Capacities

Air lift Specific Capacity Interval (l/s/m)	Possible bore yield for 10 m drawdown (l/s)	No. of bores in Padang Terap having stated specific capacity		
		This project	Renardet	All bores
0 - 0.1	1.0	5	0	5
0.1 - 0.3	2.0	3	1	4
0.3 - 0.7	5.0	3	2	5
0.7 - 1.5	11.0	0	1	1
>1.5	?>40*	1	0	1
Totals		12	4	16

(i) Severe discontinuities in drawdown-discharge behaviour can be anticipated at higher discharges in a crack aquifer with thin yielding section. Therefore specific capacities derived from crude low discharge airlift tests cannot be used to extrapolate drawdown-discharge behaviour at high discharge.

(ii) * PT1 air lift data only; SC = 8.81 l/s/m. PT1 requires rigorous pump test.

Permeable horizons within the interval 15-40 m are likely to comprise thin open cracks or joints and the vertical extent of such yielding sections is small. In such, a drawdown limit (in this case of about 10 m) has to be imposed to avoid evacuation of the yielding section. For a 10 m drawdown limit, only specific capacities exceeding about 2 l/s/m can give bore yields appropriate to irrigation use (i.e. 20 l/s or greater). Only PT1 has a specific capacity which justifies bore conversion to test-production bore status! Possible maximum bore yields, for a 10 m drawdown, are given (Table 2.3). These, it can be seen, are invariably very low.

Borehole completions are shown on the composite bore logs in the Appendix. Bores PT3 and PT9 have been equipped with slotted steel casings opposite the weathered rock producing zone. It is intended that PT1 should be pump tested with a turbine pump following enlargement to a test-production status with a 10" inch slotted steel casing set opposite the producing zone. Pump testing with a turbine borehole pump, might also be carried out on PT3 and PT9. Following satisfactory pump testing, PT1, at least, could later be used as a field water supply point for the sugar estate. It is suggested that PT12 and PT3 are used by the JPT for groundwater observation bores.

All other bores are equipped with 6" steel casings set through any unstable soil weathered zones.

Water quality appears good, with electrical conductivity values between 150 and 300 micromhos. During any later pump testing, water samples should be tested with portable chemistry laboratory equipment and sent for standard lab analysis.

2.4 Conclusions

The conclusions of the current investigation can be summarised as follows:-

- resistivity methods in Padang Terap, whilst they may be able to identify likely rock lithologies, cannot identify permeability and hence borehole yield.

- in Padang Terap, rock permeability is not directly related to lithology, but appears to be related to the incidence of inter-connected open fractures in the rock. Such incidence, it appears, can only be detected by drilling.

It is unlikely that geologic/hydrogeologic methods will be any more successful than geophysics in locating permeable zones in Padang Terap and direct methods (i.e. drilling) seem most appropriate.

Drilling has indicated an impersistent low yielding unconfined aquifer, probably developed in open joints and cracks to depths of about 40 m. Because the aquifer is developed in joints, its specific yield (or unconfined storage) is likely to be low.

3. Groundwater Potential in Padang Terap

On the criterion that significant scale groundwater irrigation in Padang Terap, by whatever means, is unlikely to be feasible unless a number of wells with yields over 20 l/sec can be obtained, the prospects look decidedly poor. The success rate of exploration bores in these terms has been only one in 12 or one in 18 if the Renardet results are included; the air lift yield and capacity of PT1 appear to be quite exceptional.

Indirect studies, of a geological or geophysical nature, have not been found to significantly improve borehole success rate, implying that the interpretable features are not directly related to water bearing properties (e.g. a fault may be open and water bearing or else completely closed by secondary deposition and cementation of rock fragments). In fact the best results seem to have come from a semi-random approach, where boreholes have been sited in locations which are most appropriate to their end-use, that is, on the flat irrigable lands in Blocks E and F (See Table 2.2).

The borehole yields seem to be extremely sensitive to small location differences which may suggest the higher yielding crack-fissure systems are near vertical. Because yielding crack-fissures are unlikely to be extensive, existing air lift yields must be confirmed by long term pump tests.

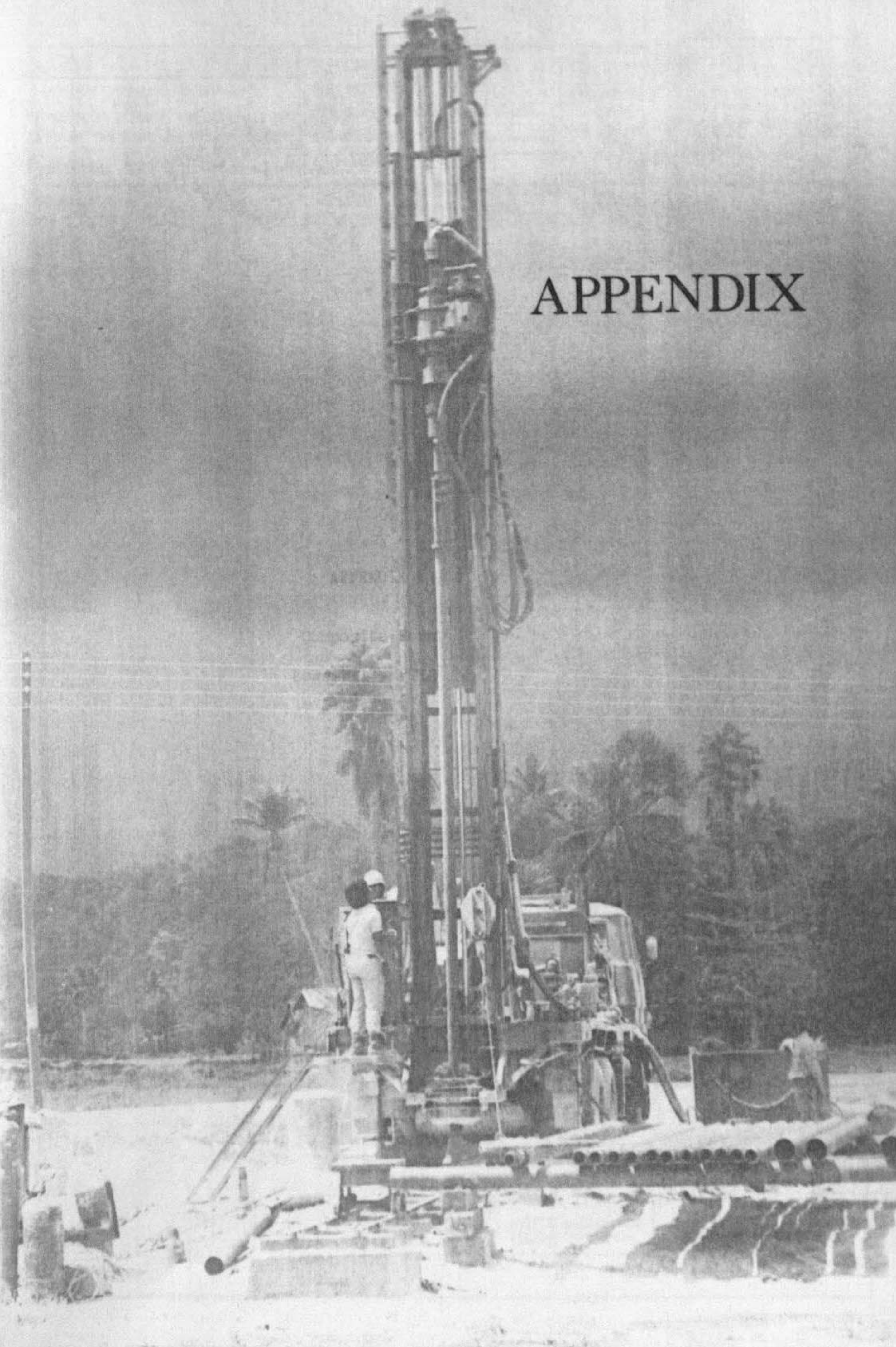
On the basis of the existing groundwater potential assessment, no further extensive works seem justfified in Padang Terap.

However, if it decided that studies should proceed further, then the recommended method would be the rapid drilling and air lift testing of a large number of very slim exploratory boreholes, mainly on a 'grid' pattern actually in the irrigable areas, but with a proportion sited on targets based on geological/geophysical interpretation, near the irrigable areas. Suitable bores could then be reamed-out to production status.

A large number of slim exploration boreholes would inevitably be required as a consequence of the low success rate mentioned earlier. An estimate of borehole numbers can be made. The total area of Padang Terap Gula is 6,500 ha and the estimated groundwater requirement at the production bore head is 0.5 l/s/ha; this assumes that sprinkler irrigation is used and that irrigation efficiency is 80%. The irrigation from groundwater of say 1,000 ha in Padang Terap could require 25 production bores of 20 l/s and hence, given a 1 in 18 success rate, some 450 exploratory bores could be required!

The consequence of the grid drilling of large numbers of exploratory bores is likely to be a random distribution of suitable production bores, with some areas having more than required for local requirements, but most areas less. To re-distribute irrigation water in the terrain typical of the area, a closed pipe system would be needed. Because such a system has high capital costs, a stringent economic analysis would be required before committing such costs. In economic terms however, the initial costs of such a collecting system may be regarded as sunk costs once a decision has been taken to install it. The development cost of connecting nearby lower-discharge wells to the system then becomes one of marginal costs and it is probable that a few wells with much lower yields than 20 l/s might be connected.

APPENDIX



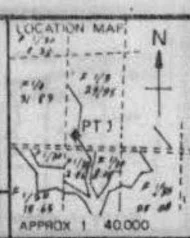
APPENDIX

Composite Bore

Logs PT1 - PT12

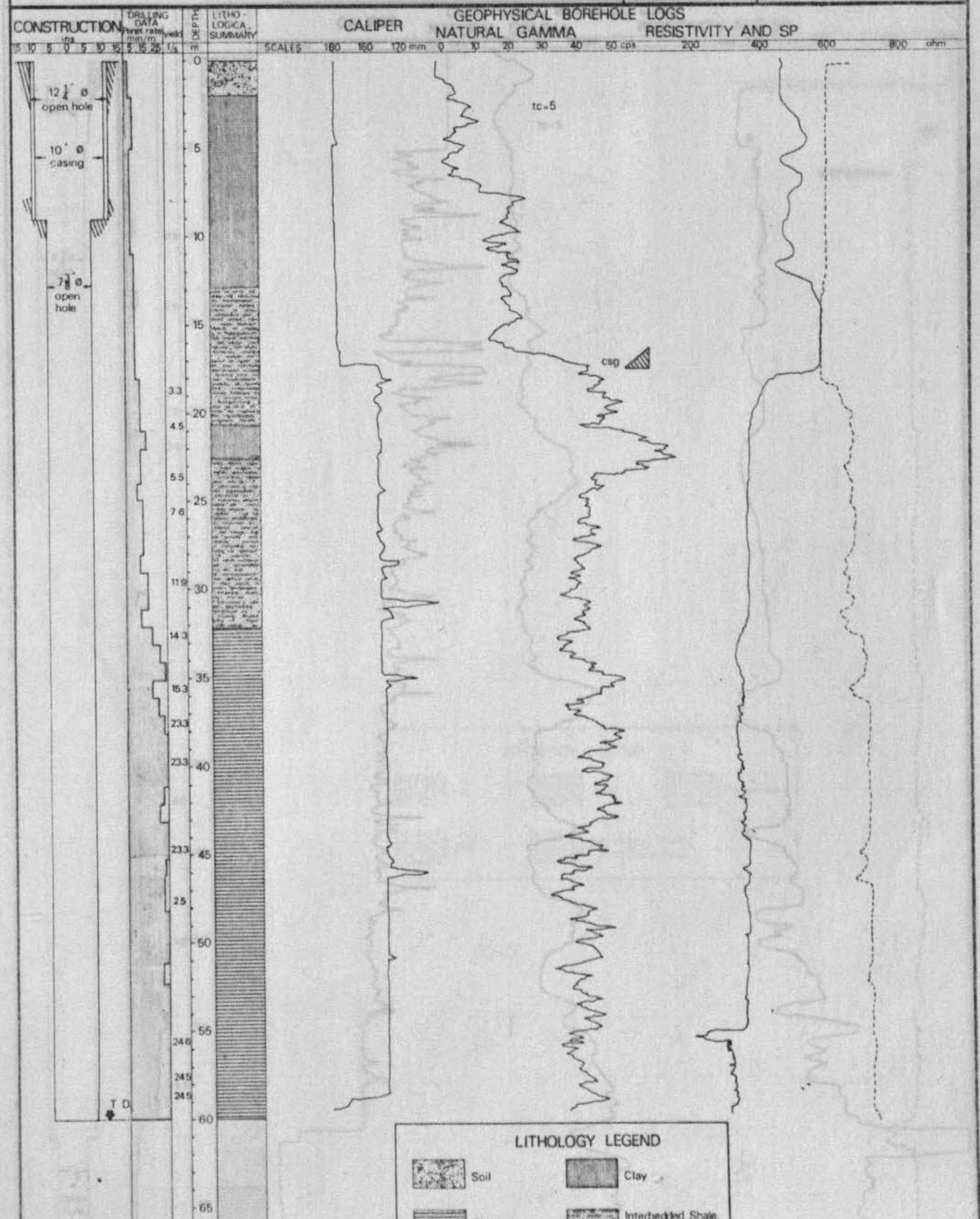
COMPOSITE BORE LOG

LOCATION: PADANG TERAP, KEDAH BLOCK	TOPO SHEET: KUALA NERANG
STARTED 13.11.1981, COMPLETED 18.11.1981	GRID REFERENCE: 018 953
DRILLING METHOD: ROTARY AIR FLUSH	REFERENCE POINT (R.P.) RIG FLOOR
YIELD TEST: DATE 18.11.1981. METHOD: AIR LIFT	R.P. ELEVATION: m (above ground level)



(PT 1) GS1101

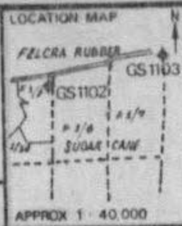
TOTAL DEPTH: 60 m	SWL 10.02 m
YIELD 5.2 l/s	EC: 480 micromhos at 25°C
REMARKS	



COMPOSITE BORE LOG

LOCATION: PADANG TERAP, KEDAH
BLOCK F 1/3
STARTED 5.11.1981, COMPLETED 19.12.1981
DRILLING METHOD: AIR ROTARY 0-60m, 105-110m.
AIR HAMMER 60-105m, 110-151m.

TOPO SHEET: 1 KUALA NARANG
GRID REFERENCE: 018 960
REFERENCE POINT (R.P) TOP CASING
R.P. ELEVATION: ≏ 145 m (above ground level)

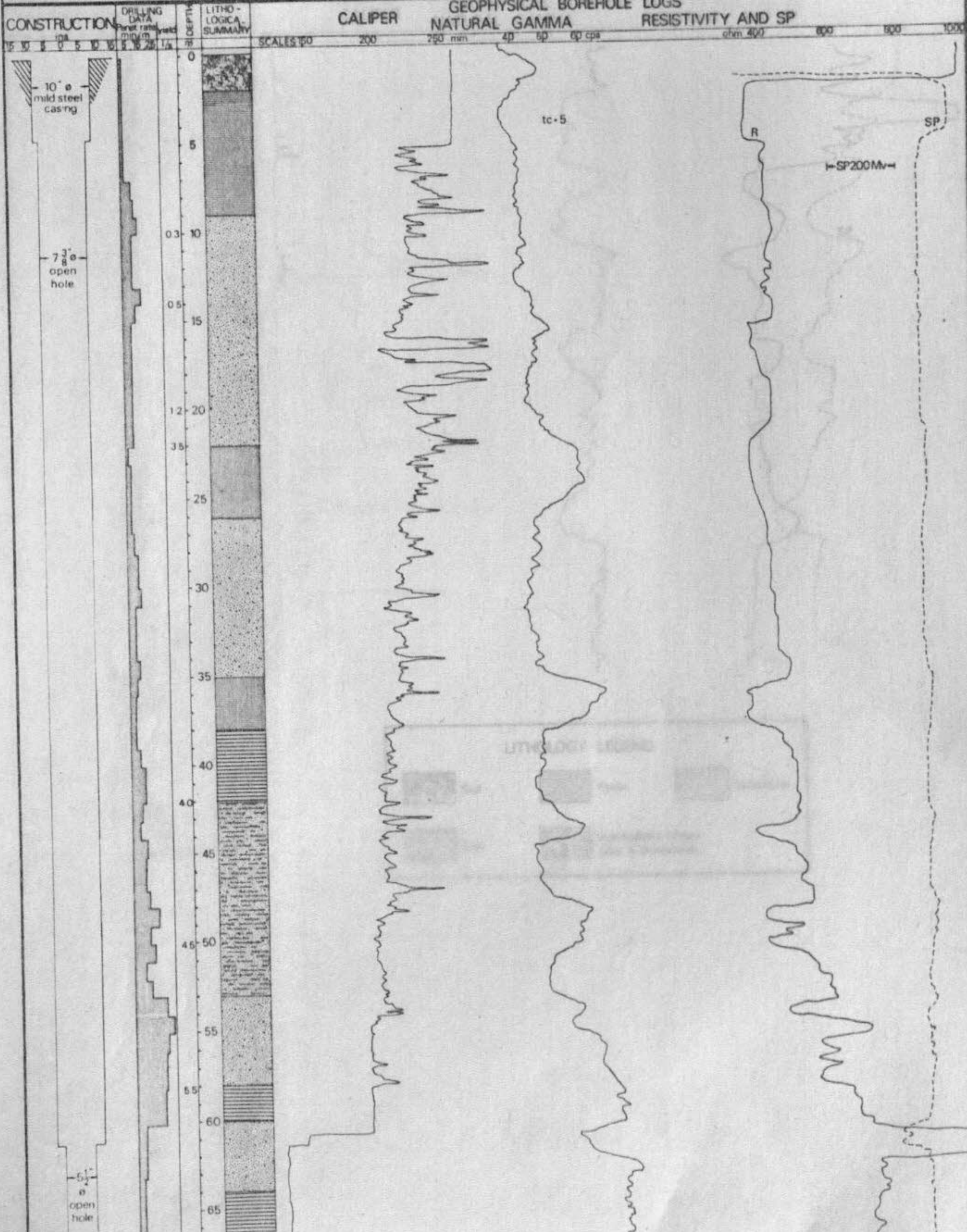


(PT2) GS1102

TOTAL DEPTH	151 m	SWL	2.37 m
YIELD	2.3 l/s	EC	160 micro mhos at 25°C

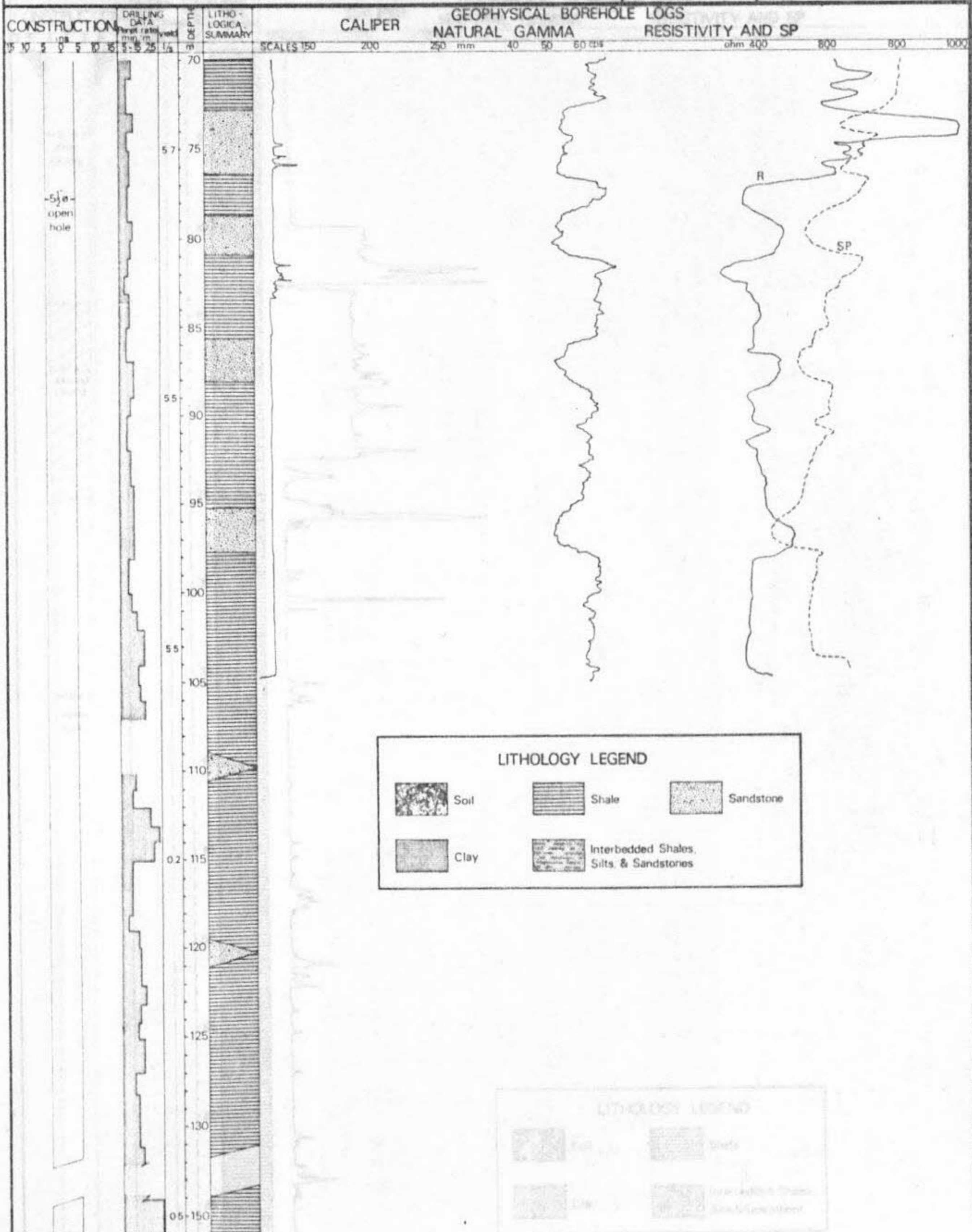
REMARKS:

YIELD TEST: AIRLIFT, 4.12.1981; DURATION 270 min.



COMPOSITE BORE LOG

LOCATION	TOPO SHEET:	LOCATION MAP	Cont'd **GS1102**
STARTED: 1982 COMPLETED: 1982	GRID REFERENCE:	APPROX 1	TOTAL DEPTH: 151 m · SWL 2.37 m
DRILLING METHOD	REFERENCE POINT (R P)		YIELD 2.3 l/s · EC 160 micro mhos at 25°C
YIELD TEST:	R P. ELEVATION: m (above ground level)		REMARKS:



COMPOSITE BORE LOG

LOCATION: PADANG TERAP, KEDAH
BLOCK F 1/7
STARTED 9.12.1982, COMPLETED 18.12.1982
DRILLING METHOD: ROTARY AIR FLUSH 0-42 m, 72-77 m, AIR HAMMER 42-72 m.
YIELD TEST: AIR LIFT at 4 l/s 17.12.81.

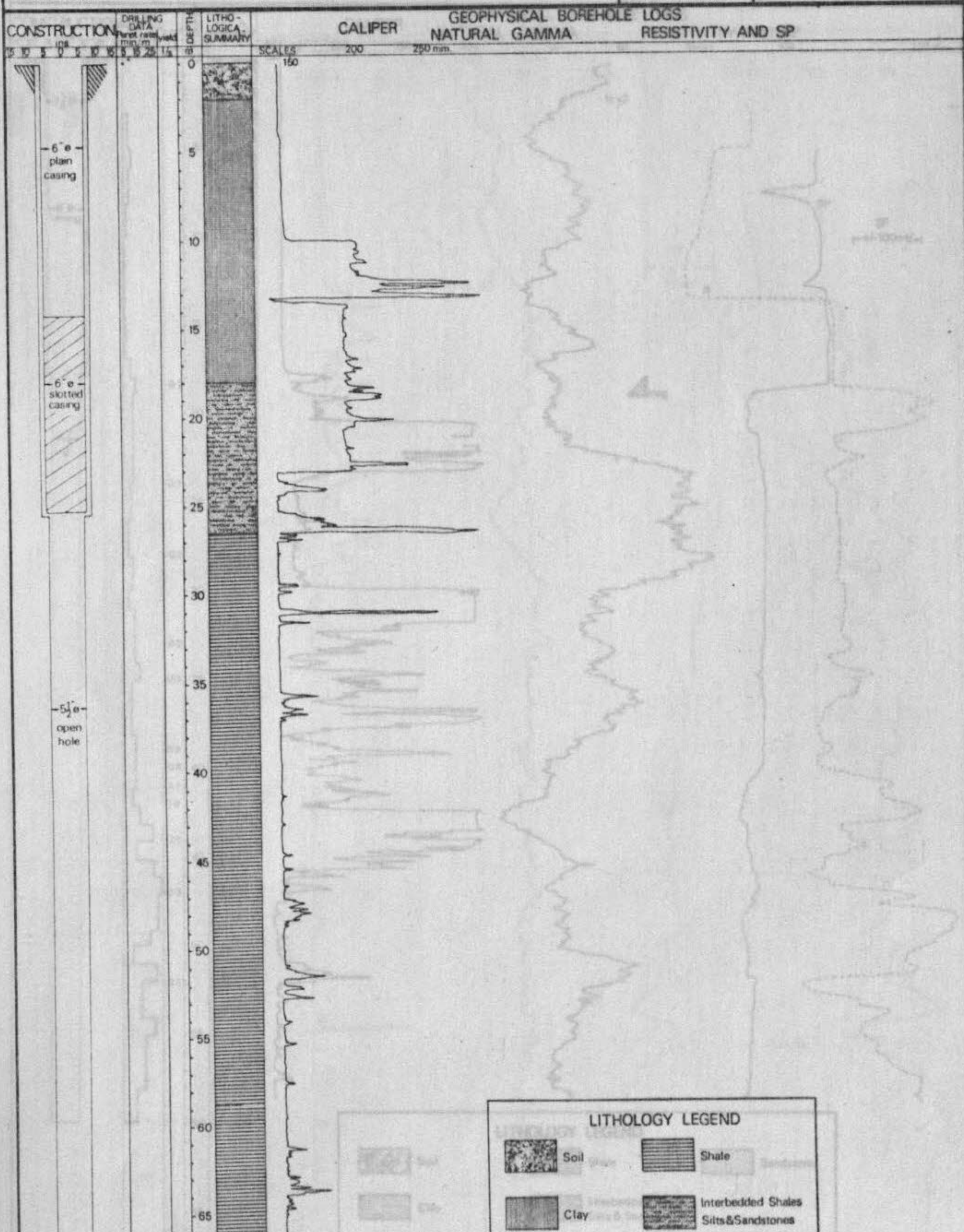
TOPO SHEET: 1 KUALA NERANG
GRID REFERENCE: 022 961
REFERENCE POINT (R.P.) CASING TOP
R.P. ELEVATION: m (above ground level)

LOCATION MAP
APPROX 1 : 40000

(PT 3) GS 1103

TOTAL DEPTH 77 m	SWL 6.81 m
YIELD 4 l/s	EC: 290 micromhos at 25°C

REMARKS: air lift discharge declined from 7 to 4 l/s



COMPOSITE BORE LOG

LOCATION: PADANG TERAP, KEDAH. BLOCK F 1/8
STARTED 19.12.1982, COMPLETED 6.1.1982
DRILLING METHOD: AIR ROTARY

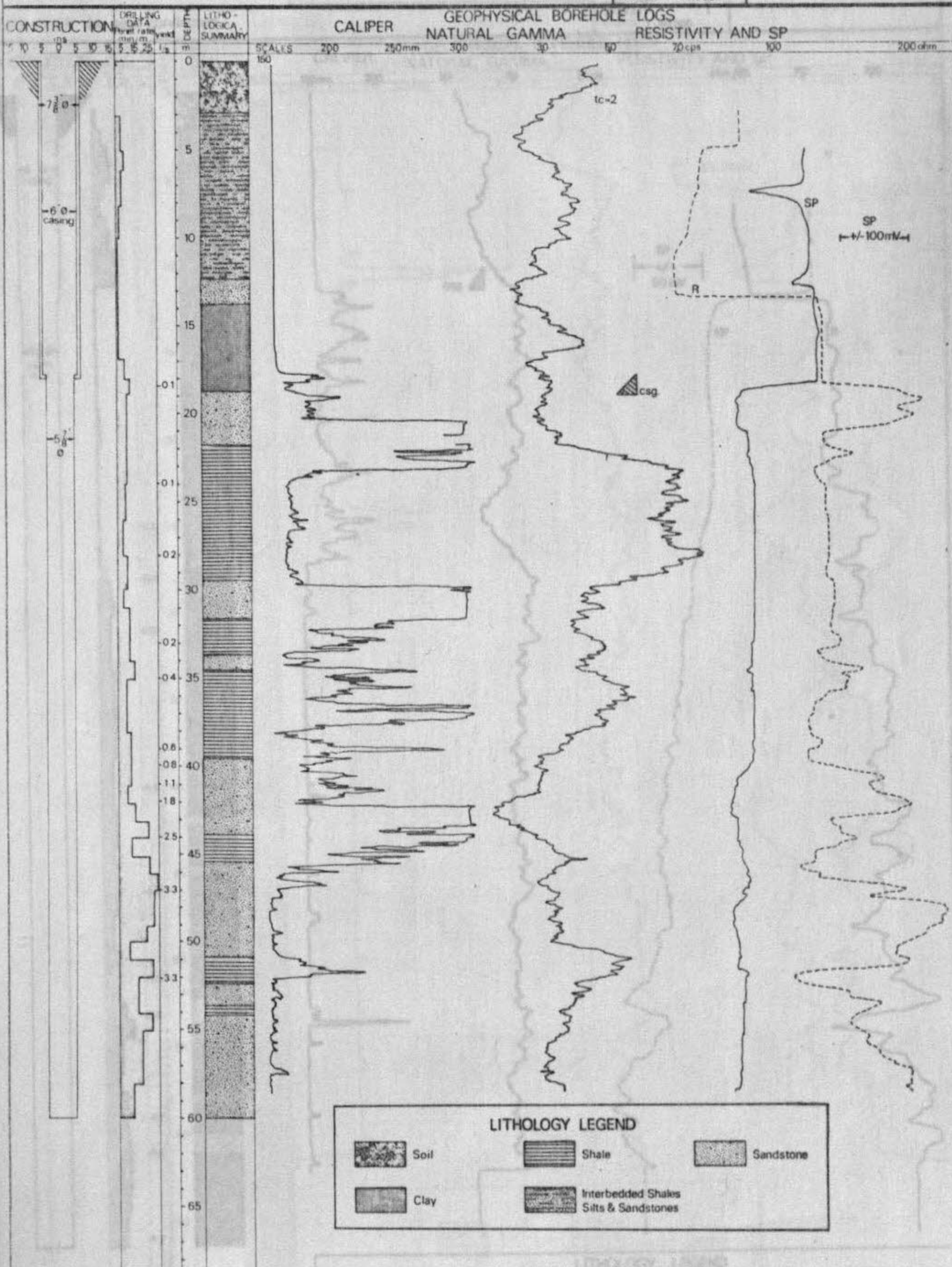
YIELD TEST: AIR LIFT, 3 HRS ON 5.1.82.

TOPO SHEET: 1 KUALA NERANG.
GRID REFERENCE: 023 954.
REFERENCE POINT (R.P.) CASING TOP.
R.P. ELEVATION: m (above ground level)

LOCATION MAP

(PT4) GS1104

TOTAL DEPTH	60 m	SWL	3.2 m
YIELD	5 l/s	EC	micro mhos at 25°C
REMARKS			



COMPOSITE BORE LOG

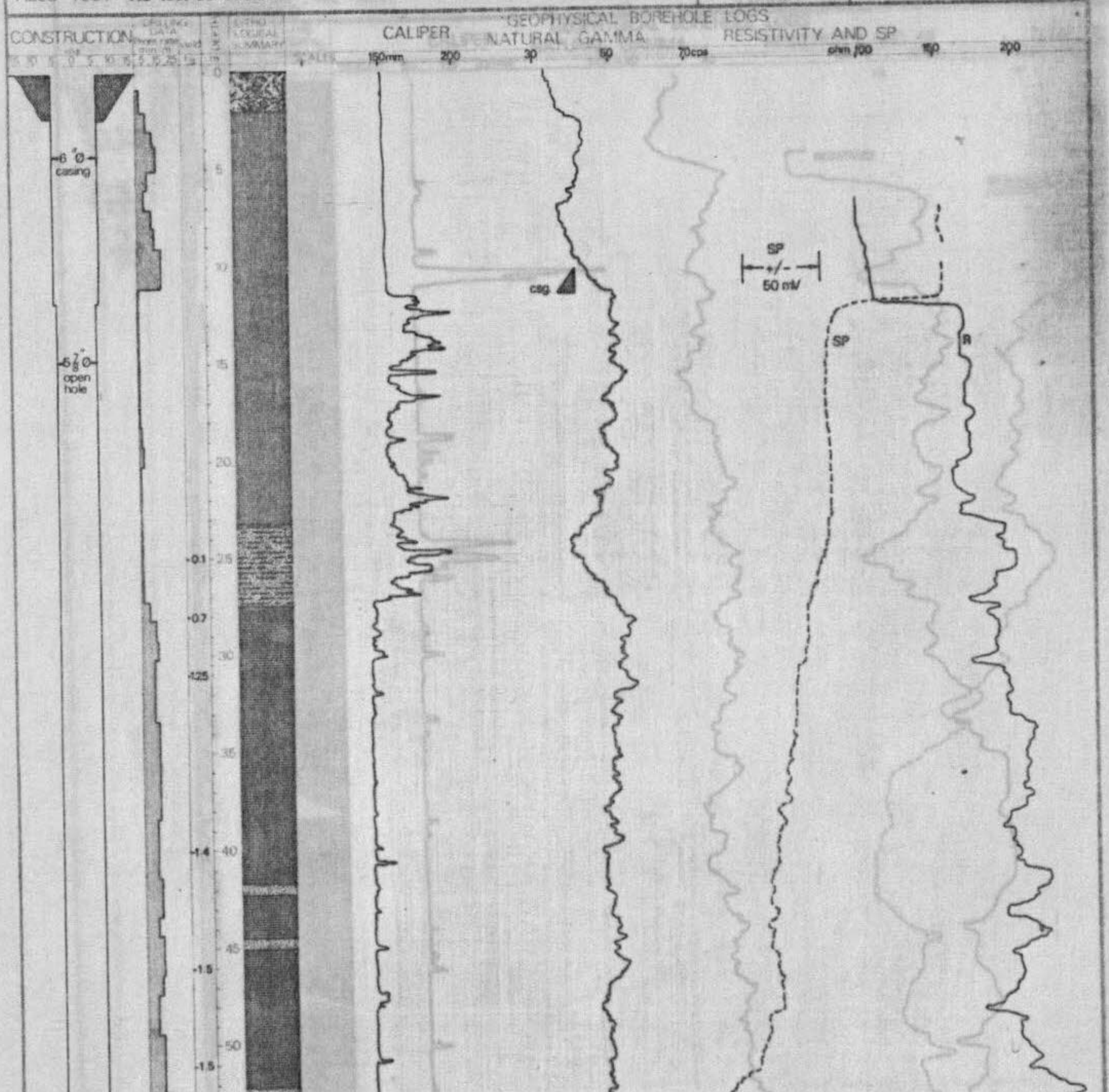
LOCATION PADANG TERAP, KEDAH
BLOCK E 1/6
STARTED 4 1 1982 COMPLETED 7 1 1982
DRILLING METHOD AIR ROTARY.
YIELD TEST No test conducted.

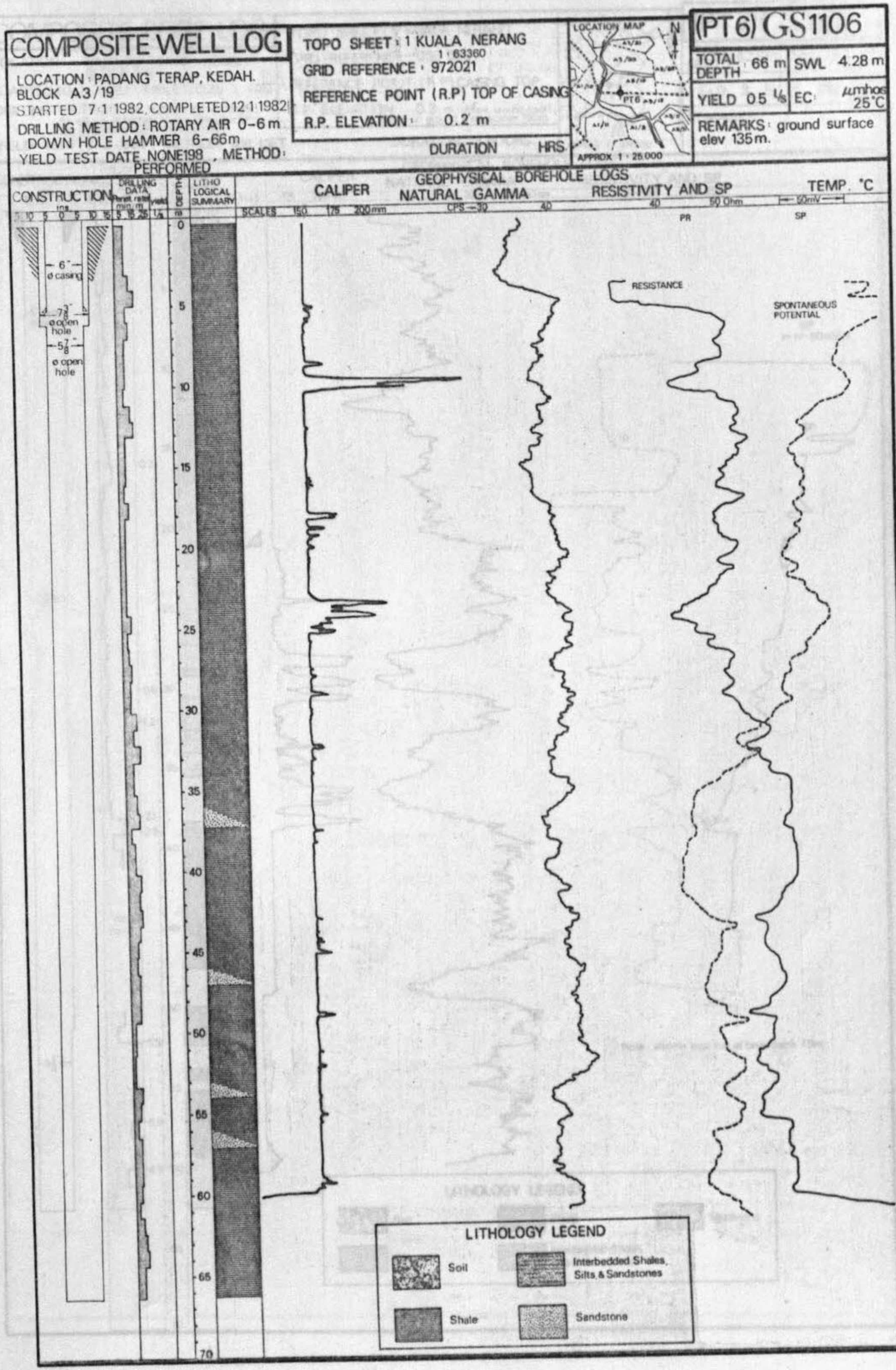
TOPO SHEET KUALA NERANG.
GRID REFERENCE 037 966.
REFERENCE POINT (R.P.) CASING TOP.
R.P. ELEVATION m (above ground level)

PT5 GS1105

TOTAL DEPTH	66 m	SWL	m
YIELD	<2.0 l/s	EC	micro mhos at 25 C

REMARKS




COMPOSITE WELL LOG
LOCATION : PADANG TERAP, KEDAH.
BLOCK A3/19
STARTED 7 1 1982, COMPLETED 12 1 1982
DRILLING METHOD : ROTARY AIR 0-6 m
DOWN HOLE HAMMER 6-66m
YIELD TEST DATE NONE 198 , METHOD :
PERFORMED
TOPO SHEET : 1 KUALA NERANG
1 : 63360
GRID REFERENCE : 972021
REFERENCE POINT (R.P) TOP OF CASING
R.P. ELEVATION : 0.2 m
DURATION HRS
LOCATION MAP
N
APPROX 1 : 25 000
(PT6) GS1106
TOTAL DEPTH 66 m
SWL 4.28 m
YIELD 0.5 l/s
EC : µmhos 25°C
REMARKS : ground surface elev 135 m.
CONSTRUCTION
DRILLING DATA
DEPTH m
LITHOLOGICAL SUMMARY
GEOPHYSICAL BOREHOLE LOGS
CALIPER
NATURAL GAMMA
RESISTIVITY AND SP
TEMP. °C
SCALES 150 175 200 mm
CPS — 30 40
40 50 Ohm
50mV
PR
SP
6" ø casing
7 3/8" ø open hole
5 7/8" ø open hole
RESISTANCE
SPONTANEOUS POTENTIAL
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
LITHOLOGY LEGEND
Soil
Interbedded Shales, Silts & Sandstones
Shale
Sandstone

COMPOSITE BORE LOG

LOCATION PADANG TERAP, KEDAH BLOCK 1/6

STARTED 10 1 1982 COMPLETED 25 2 1982

DRILLING METHOD AIR ROTARY AIR HAMMER 51-62 5m INTERVAL 0 19m DRILLED BY RIG [], BORE COMPLETED BY RIG]

YIELD TEST 2 3 1982 METHOD AIR LIFT DURATION 3 HOURS

TOPO SHEET 1 KUALA NERANG

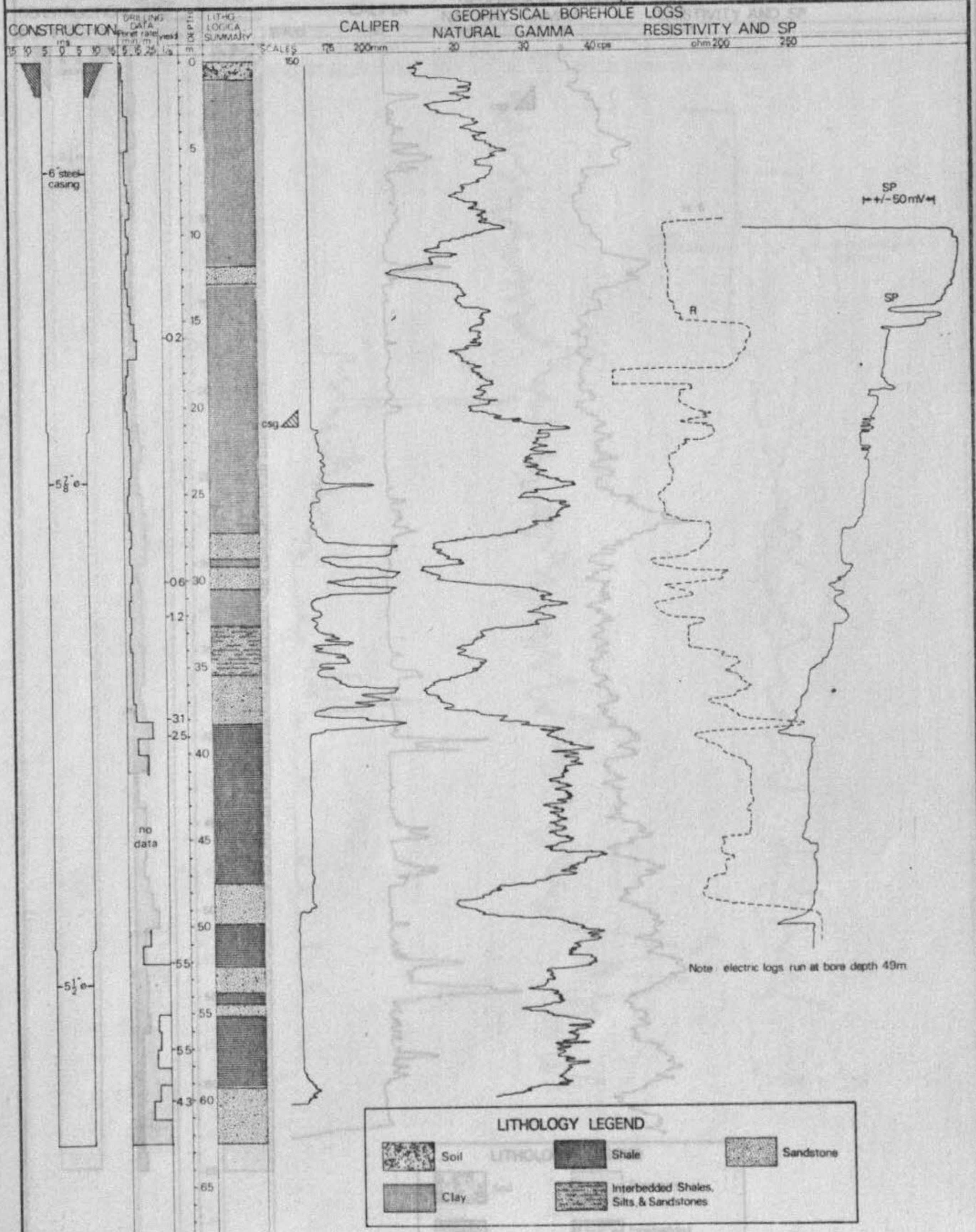
GRID REFERENCE 036 966

REFERENCE POINT (R.P.) CASING TOP.

R.P. ELEVATION 0.3 m (above ground level) elevation ground level approx 190m.

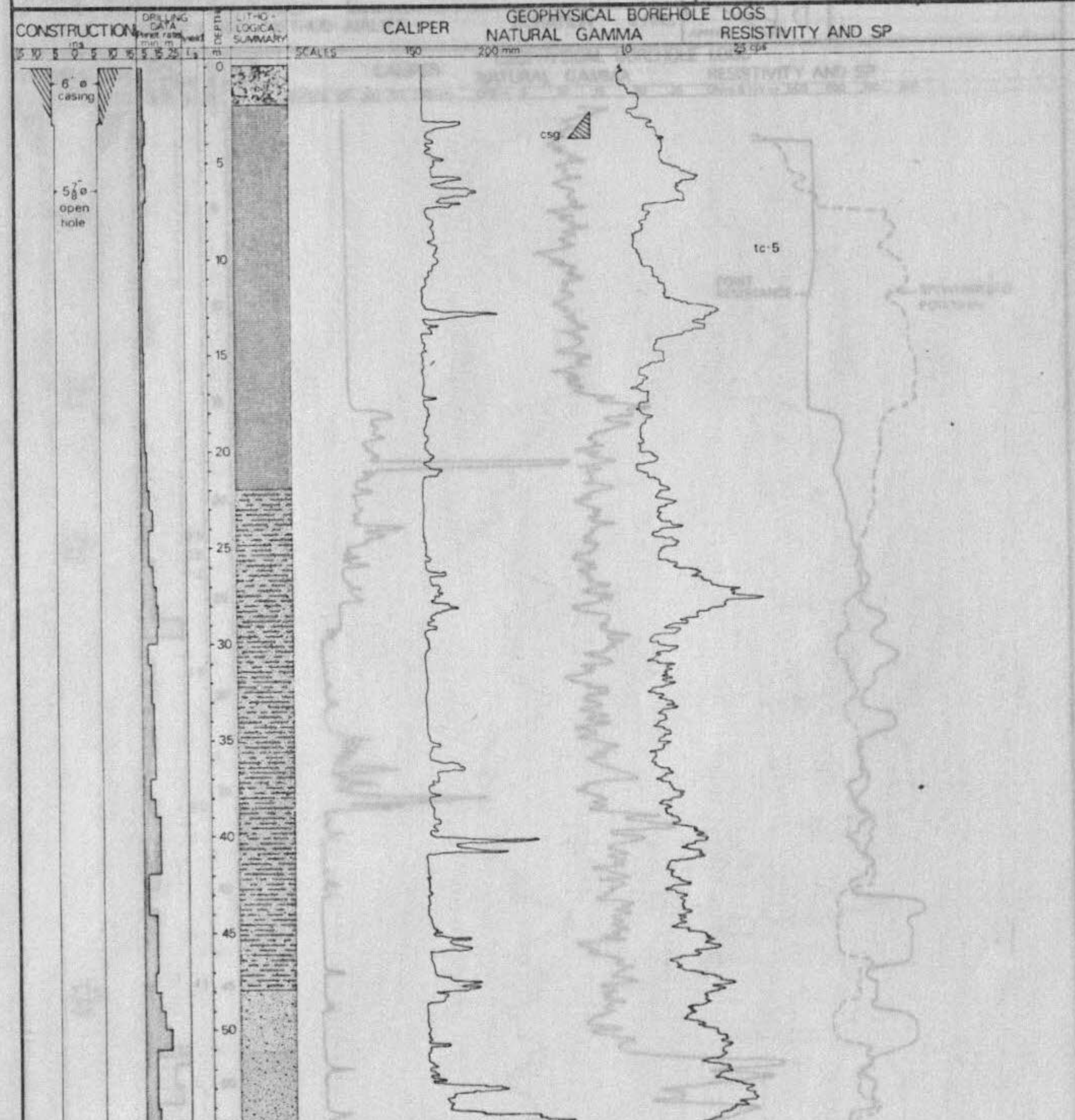
(PT 7) GS 1107

TOTAL DEPTH 62.5 m	SWL 8.3 m
YIELD 3 l/s	EC 390 micromhos at 25°C
REMARKS	



COMPOSITE BORE LOG

LOCATION PADANG TERAP, KEDAH HOUSING COMPOUND	TOPO SHEET 1 KUALA NERANG	(PT8) GS1108
STARTED 13 1 1982, COMPLETED 18 1 1982	GRID REFERENCE 981 992	TOTAL DEPTH 65 m · SWL m
DRILLING METHOD ROTARY AIR HAMMER	REFERENCE POINT (R P) TO OF CASING	YIELD l/s · EC micro mhos at 25°C
YIELD TEST DRY BORE	R P ELEVATION m (above ground level)	REMARKS



COMPOSITE WELL LOG

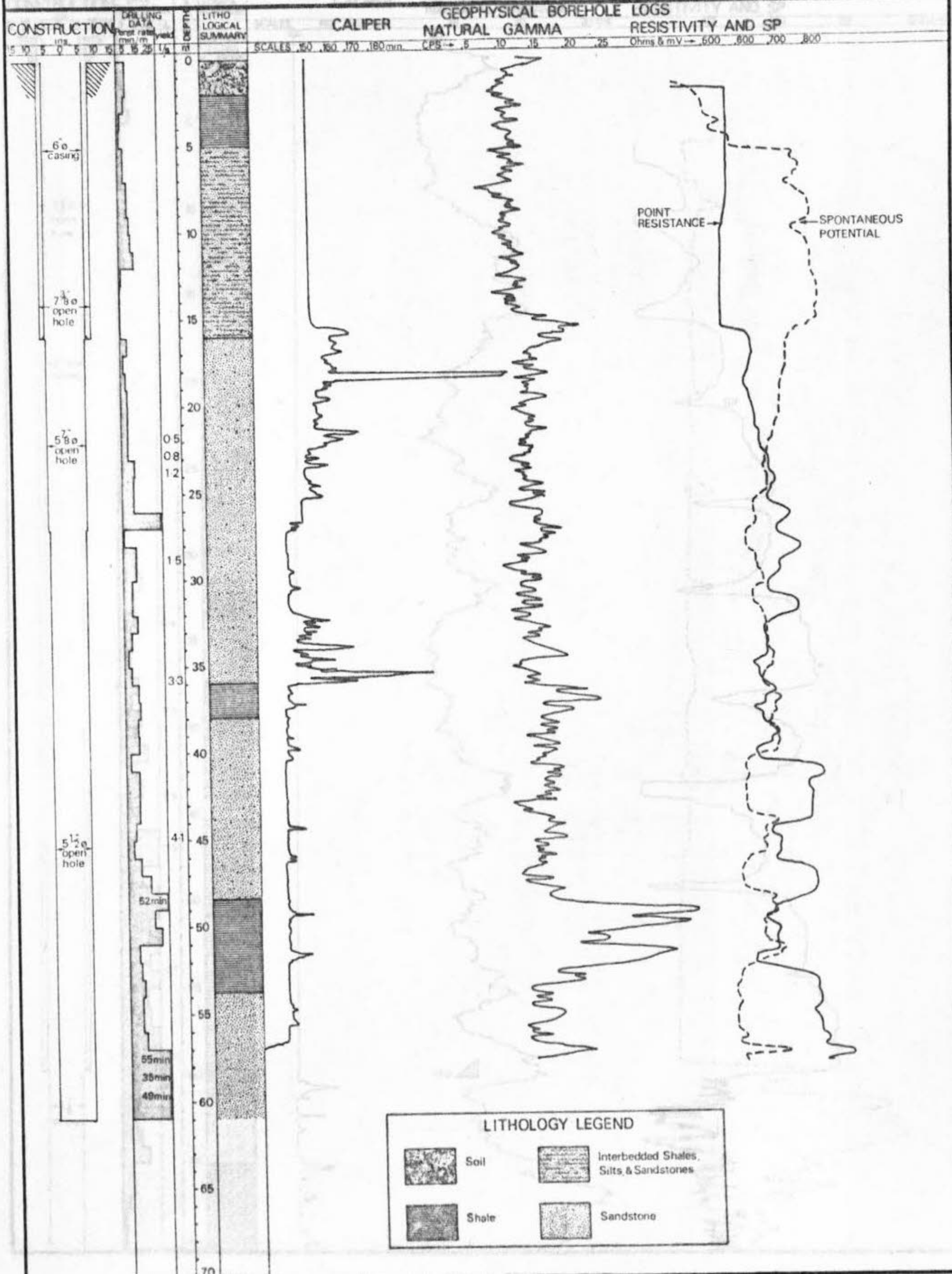
LOCATION: PADANG TERAP, KEDAH BLOCK A2/43
STARTED 19·1·1982, COMPLETED 21·1·1982
DRILLING METHOD: ROTARY AIR FLUSH, 0-27m ROCK BIT, 27-61m D-H HAMMER
YIELD TEST DATE 27·1·1982, METHOD: AIRLIFT

TOPO SHEET: 1 KUALA NERANG
GRID REFERENCE: 968 035
REFERENCE POINT (R.P.) TOP OF CASING
R.P. ELEVATION: 0·2 m(above g.l.)
DURATION 4 HRS.

LOCATION MAP (APPROX 1:25000)

(PT9) GS 1109

TOTAL DEPTH 61 m	SWL 2·10 m
YIELD 4·5 l/s	EC 320 µmhos 25°C
REMARKS	



COMPOSITE BORE LOG

LOCATION: PADANG TERAP, KEDAH BLOCK E 1/28

STARTED 31 1 1982, COMPLETED 5 2 1982

DRILLING METHOD: ROTARY AIR FLUSH
0 - 60 m ROCK BIT, 60 - 135 m D.H. HAMMER

YIELD TEST: Not Conducted - low yield

TOPO SHEET: 1 KUALA NERANG

GRID REFERENCE: 034 981

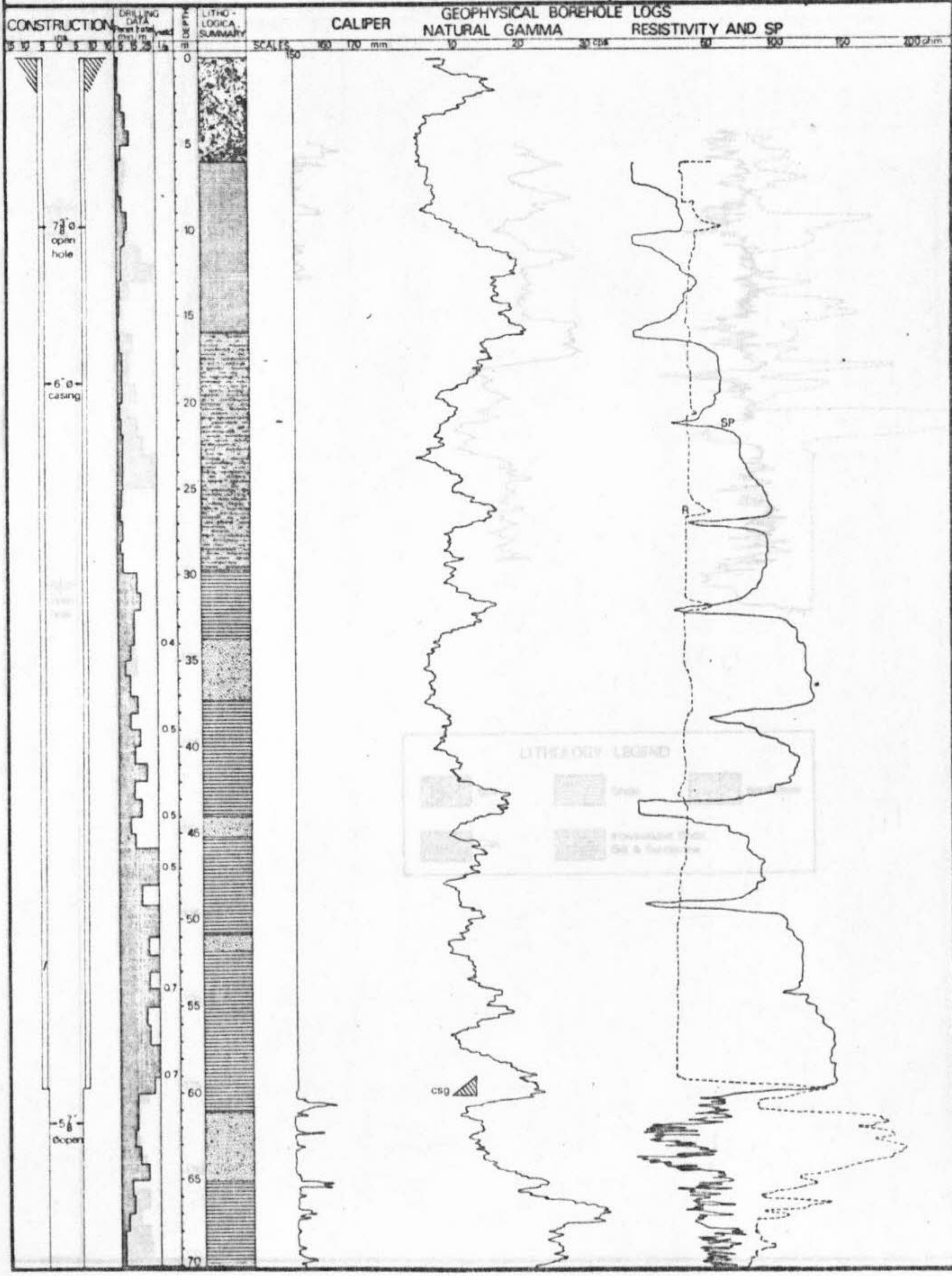
REFERENCE POINT (R.P) CASING TOP

R.P. ELEVATION: m (above ground level)

(PT10) GS1110

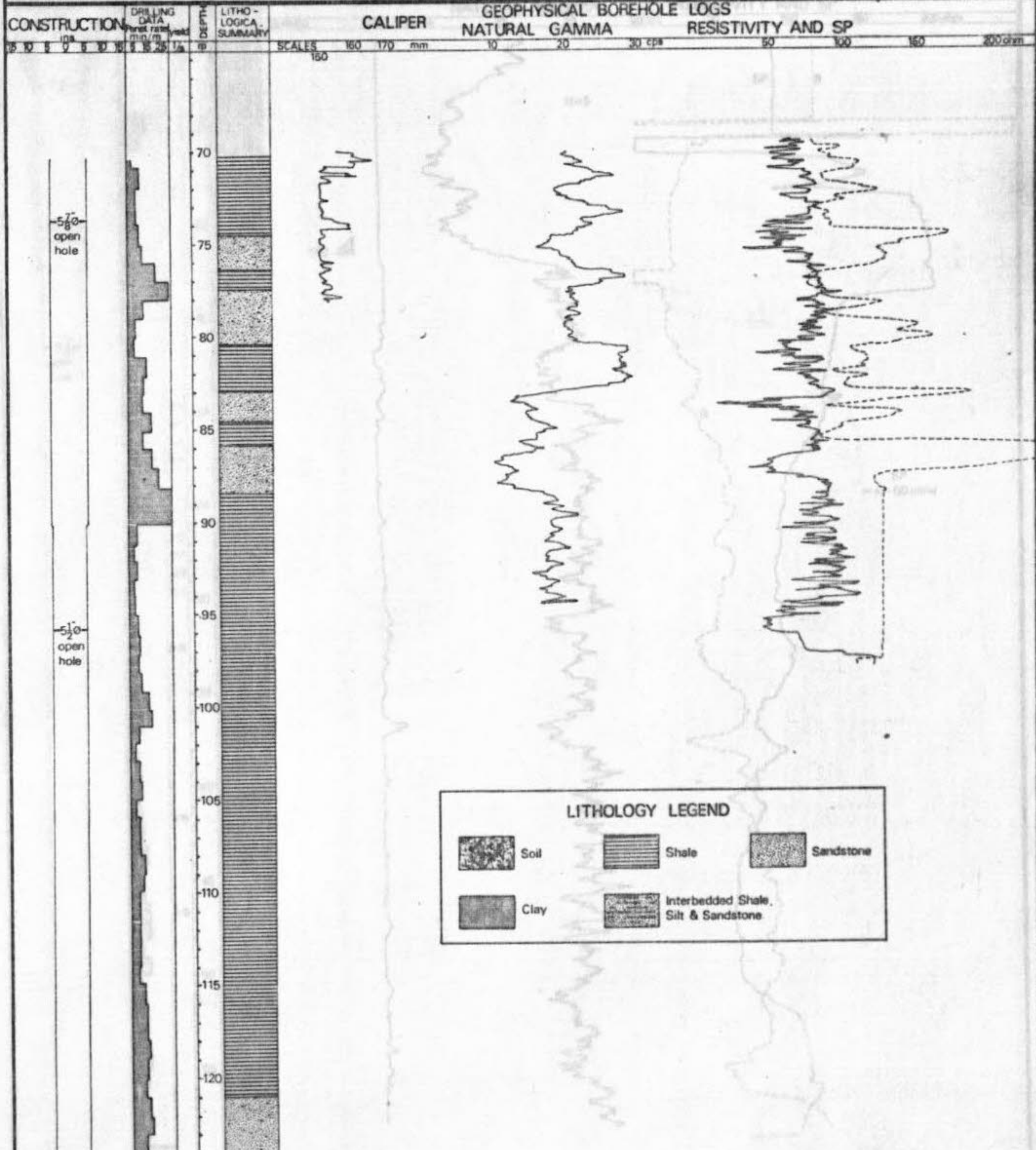
TOTAL DEPTH 135 m	SWL 5.3 m
YIELD < 0.7 l/s	EC micro mhos at 25°C

REMARKS:



COMPOSITE BORE LOG

LOCATION:	TOPO SHEET:	LOCATION MAP	Cont'd **GS1110**
STARTED: 1982, COMPLETED: 1982	GRID REFERENCE:		TOTAL DEPTH: m · SWL: m
DRILLING METHOD:	REFERENCE POINT (R.P)		YIELD: l/s · EC: micro mhos at 25°C
YIELD TEST:	R.P. ELEVATION: m (above ground level)	APPROX 1:	REMARKS:



COMPOSITE BORE LOG

(PT11)GS 1111

LOCATION PADANG TERAP, KEDAH BLOCK E 2/18

STARTED 8 2 1982, COMPLETED 10 2 1982

DRILLING METHOD: ROTARY AIR FLUSH 0–12m (7 3/8) ROCK BIT, 12–60m (5 7/8) ROCK BIT.

YIELD TEST :– NOT CONDUCTED (VERY LOW YIELD).

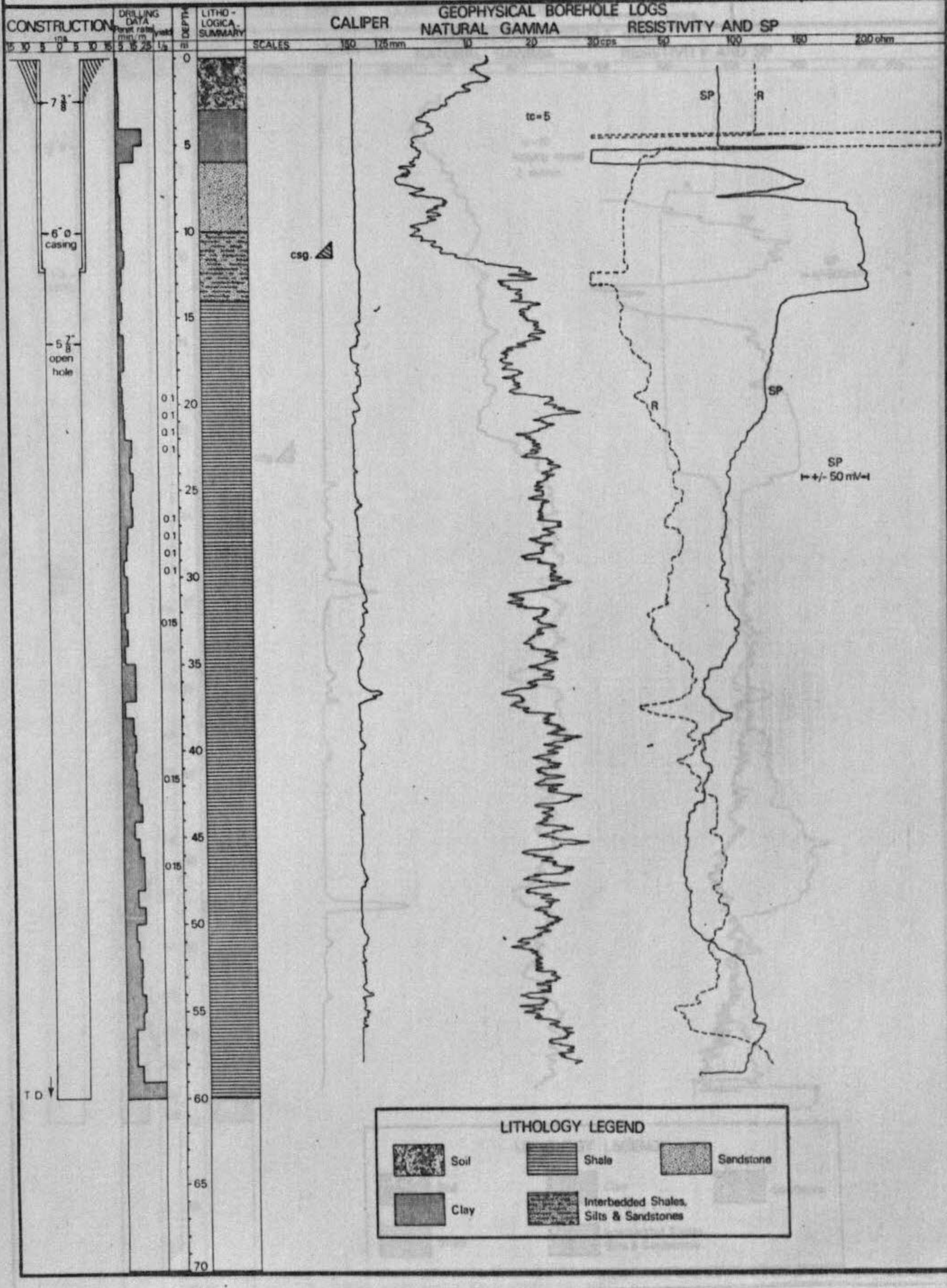
TOPO SHEET 1 KUALA NERANG

GRID REFERENCE : 055 992

REFERENCE POINT (R.P) TOP OF CASING

R.P. ELEVATION : m (above ground level)

TOTAL DEPTH 60 m	SWL 4.90 m
YIELD 0.15 l/s	EC micro mhos at 25°C
REMARKS.	



COMPOSITE BORE LOG

OCATION: PADANG TERAP, KEDAH
BLOCK E1/37
TARTED 12: 2:1982, COMPLETED 15: 2:1982
RILLING METHOD: ROTARY AIR FLUSH
0.22 m 7⅞" ROCK BIT 22-60 m 5⅞" ROCK BIT.
IELD TEST: DATE 16.2.82 METHOD: AIRLIFT. DURATION: 5½ HOURS.

TOPO SHEET: 1 KUALA NERANG
GRID REFERENCE: 018 986
REFERENCE POINT (R.P.) TOP OF CASING
R.P. ELEVATION: 0.22 m (above ground level)

LOCATION MAP
APPROX 1:40,000

(PT 12) GS1112

TOTAL DEPTH 6.0 m	SWL 5.82 m
YIELD 6.3 l/s	EC 380 micro mhos at 25°C
REMARKS: