CHAPTER III

HYDROGEOLOGICAL INVESTIGATION

The hydrogeological investigation was carried out in this study to understand the background knowledge of water condition, especially of the groundwater. The knowledge is to be employed in slope stability analysis.

In order to obtain knowledge, the investigation were carried out in three methods, namely meteorological study, seepage observation and electric resistivity survey.

Unfortunately, the hydrogeological investigation was not very conclusive thus, the analysis to be followed is based on the hydrologic property of an assumed condition rather than the observed one.

3.1 Meteorological Study

A record of seven years of rainfall was collected by EGAT and the Royal Irrigation Department (Table 4). The data indicate that the rainy season normally occurs here from May to October while the rest of the year is relatively dry. The heaviest rainfall generally occurs during the months of August and September with average monthly rainfall of 200 to 260 mm. This precipitation is to make up the annual mean rainfall of more than 1,000 mm.

Table 4. Rainfall data of Mae Moh Area, Lampang (after EGAT and Royal Irrigational Dept., 1981).

Month \ Year	1973	1974	1975	1976	1977	1978	1979	1980	average/month
April	na	147.6	2.0	122.0	96.5	77.5	120.0	50.9	88.10
May	na	180.0	167.8	143.0	170.6	260.1	183.2	102.1	172.40
June	na	142.2	189.0	64.5	35.9	104.0	149.4	242.5	132.50
July	na	198.7	207.3	69.3	177.0	256.1	128.0	227.2	180.50
August	na	263.3	306.1	192.5	274.1	239.5	164.6	70.6	215.80
September	na	150.0	202.3	222.3	301.4	186.8	217.8	241.0	217.40
October	na	124.1	75.0	92.0	172.3	90.6	45.0	25.0	89.10
November	na	110.7	33.5	11.0	2.3	0.0	0.0	0.0	22.50
December	na	34.5	0.0	0.0	13.9	0.0	0.0	0.0	6.90
January	0.0	59.3	0.0	0.0	17.9	0.0	na	na	32.60
February	0.0	1.2	0.0	0.0	31.7	0.0	na	na	5.50
March	85.4	10.0	0.0	64.5	8.0	0.0	na	na	28.00
Total/year	-	1421.6	1183.0	981.1	1301.1	1214.6	-	-	

Rainfall is in millimeter.

3.2 Seepage Observation

A large amount of rain water flows as a surface runoff on the ground and the slope face. Part of it seeps into the ground to a shallow depth perched (?) aquifer to seep out along the cracks on the slopes. After the rainfall decrease, as being observed in this study, water seepage was still noticed at the upper part of the slope, especially of the northwestern one. The water seeped out along the contact between the gravel bed of Mae Taeng Formation and the lower-lying Red Beds sequences. Other seepage was also noticed along the discontinuities at the lower bench slope.

3.3 Electric Resistivity Survey

In order to detect the groundwater table and the effect of pore water pressure in the subareas of study, the installation of piezometers in the bore holes for such purpose is essential. Unfortunately, neither bore holes nor the installation of piezometers in the study area is available. Therefore, the electric resistivity survey was attempted to find the groundwater table within the subareas of study to be used later in the stability calculation.

Ten localities with known surface elevation where the resistivity survey were performed are shown in Figure 21. The resistivity meter, Terrameter-ABEM AB 5310, was used to measure the vertical change in the resistivity by means of 'electrical drilling' or 'depth sounding' method. The electrodes were placed in a straight line at a certain distance apart according to Schlumberger's configuration (Figure 22). For each measurement,

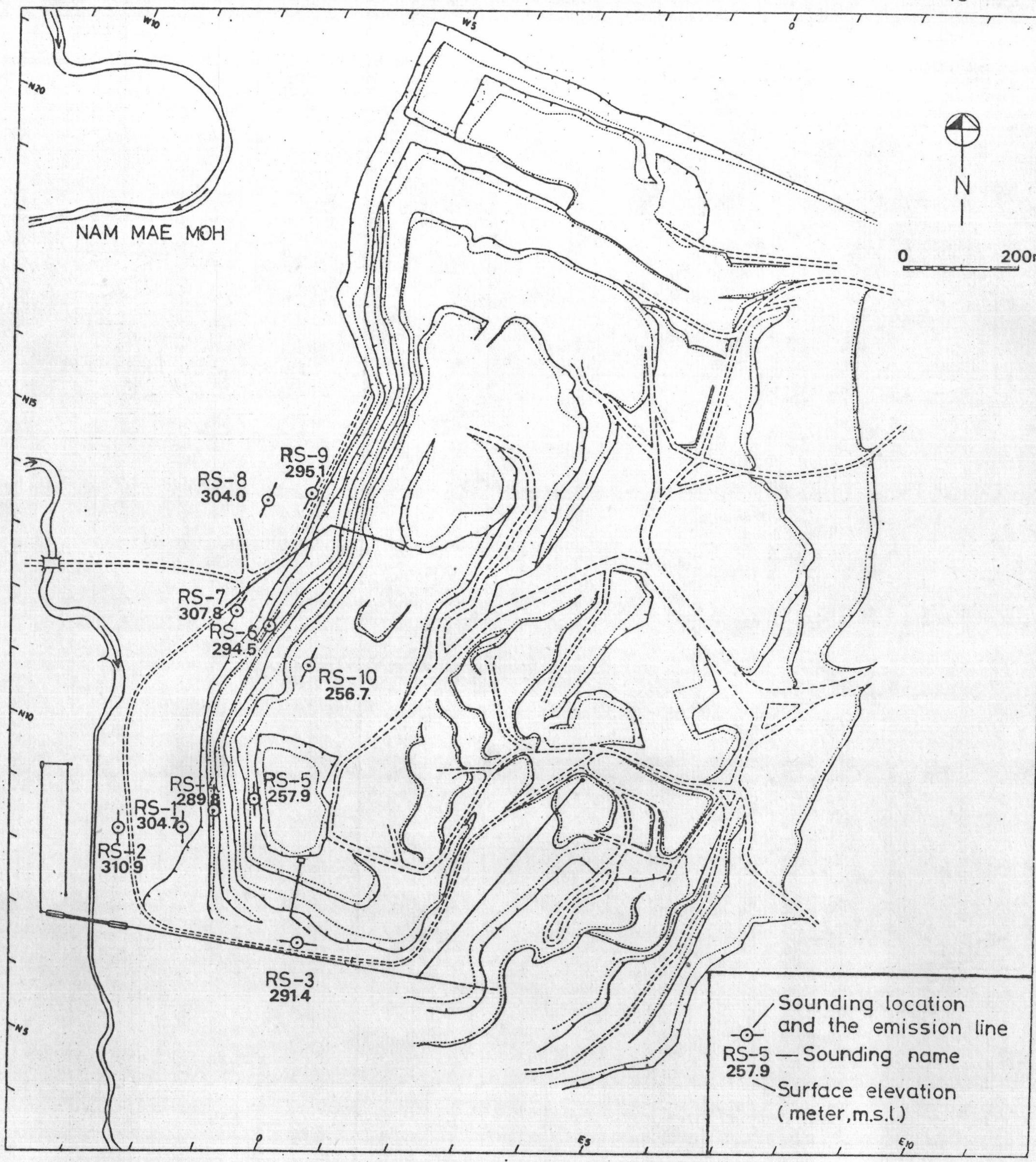
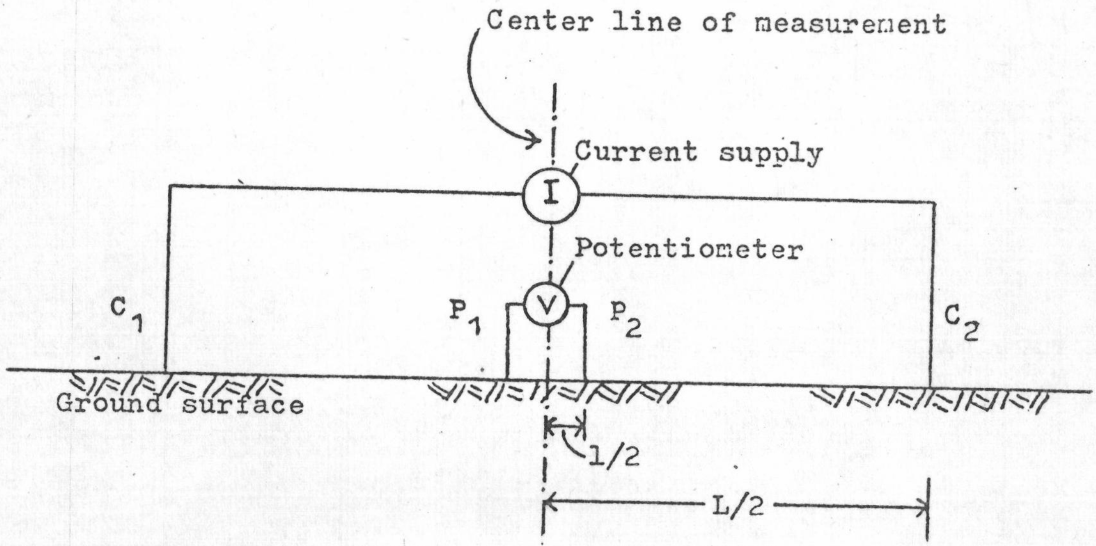


Figure 21. Location of the resistivity survey.



C_1 , C_2 - Current electrode

P_1 , P_2 - Potential electrode

Figure 22. Schlumberger's configuration for the electric resistivity survey.

the distance between the electrodes was increased. By multiplying the resistance obtained at each measurement by a factor appropriate to the electrode configuration and separation, a series of apparent resistivities is obtained. The graphs of apparent resistivity versus electrode spacing were plotted and the interpretation of the resulting curve yields an estimate of the thickness and resistivities of the subsurface layers.

3.3.1 Interpretation procedure

The interpretation of the resistivity measurement is necessarily based on the assumption that the strata are thick, homogeneous and strongly contrasted between the fully - and partly saturated layers. The two parameters, thickness and resistivity, which characterize each layer are often related, and the form of the curve depends mainly on either their ratio or product.

The interpretation was carried out into two methods as follows :-

a) Partial curve matching. This method requires matching of small segments of the field profile with theoretical curves for two horizontal layers, together with an aid of Ebert Auxiliary Graph (Orellana and Mooney, 1966). By this method, an estimate thickness (t_n) and resistivity (ρ_n) of the subsurface layers, so called 'earth model', were obtained.

b) Model matching by HP-85 microcomputer. A further interpretation was done using the program package named SCHT/K of the Department of Geology, Chulalongkorn University (Somchai Sriisraporn, 1981, personal communication). The input data are composing of the current-electrode spacing over two (L/2), apparent resistivity (ρ_a) and the estimate earth model (ρ_n and t_n) are loaded into the program. The theoretical schlumberger profile of a given estimate earth model was computed by convolution of resistivity transforms with Ghosh filter coefficients, and then, plotting of the observed points (from the field measurements) on the computed profile was shown on the CRT (cathod ray tube). If the theoretical profile is not fit to the field profile, the thickness and resistivity values are modified and the theoretical profile recomputed. The process will be repeated until the fitness is acceptable. Hence, the subsurface structure is assume to be identical with the theoretical structure. The computation is thus cally 'current model'.

For a groundwater evaluation, it is reasonably to use a basic assumption that the resistivity of the uniformed materials partially or fully saturated with water is lower than that in a dry condition. The evaluation also depends on the comparison of subsurface resistivity to subsurface geology. Thus, if the detailed subsurface geology is known and the comparison results in a good agreement, the aquifer layers and the groundwater level can possibly be inferred.

3.3.2 Results and discussion

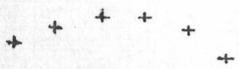
The results of the quantitative interpretation are shown in Figure 23 (a to j). Two to four subsurface layers with varying thickness were detected in this method of study. The upper part is composed of one to two thin layers (0.7 to 3.7 m thick) of rather high resistivity

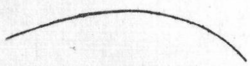
Figure 23. Results of the resistivity interpretation of 10 localities.

Explanation

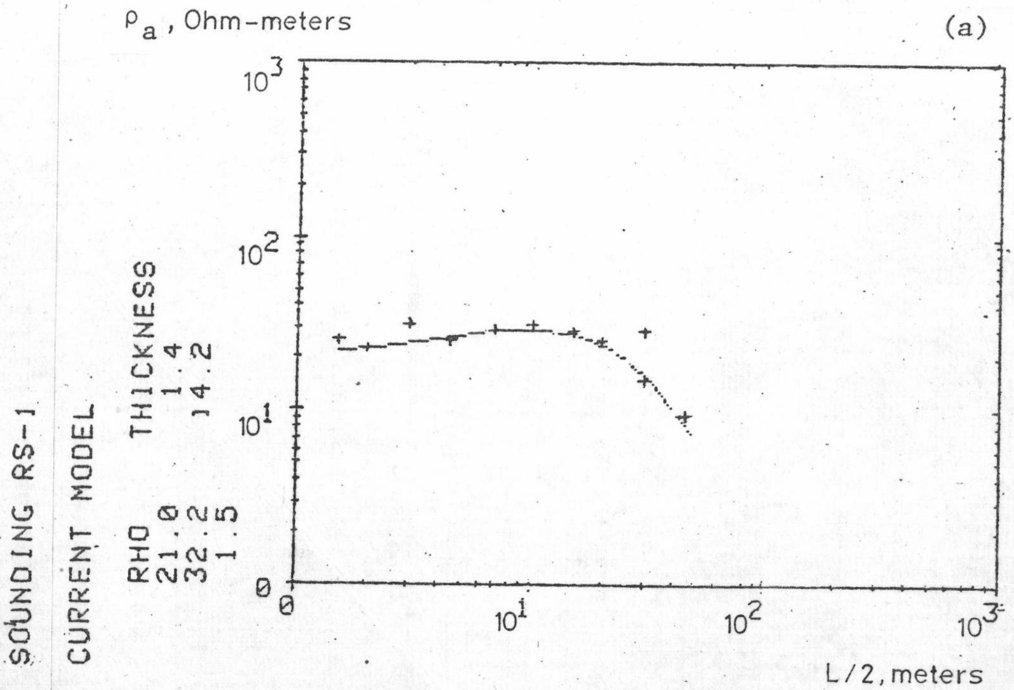
ρ_a = apparent resistivity, ohm-meters.

L/2 = current electrode spacing, meters.

 = field profile.

 = computed or theoretical profile.

Current model are expressed as true resistivity (RHO or ρ_n) and thickness (t_n) of each subsurface layer.



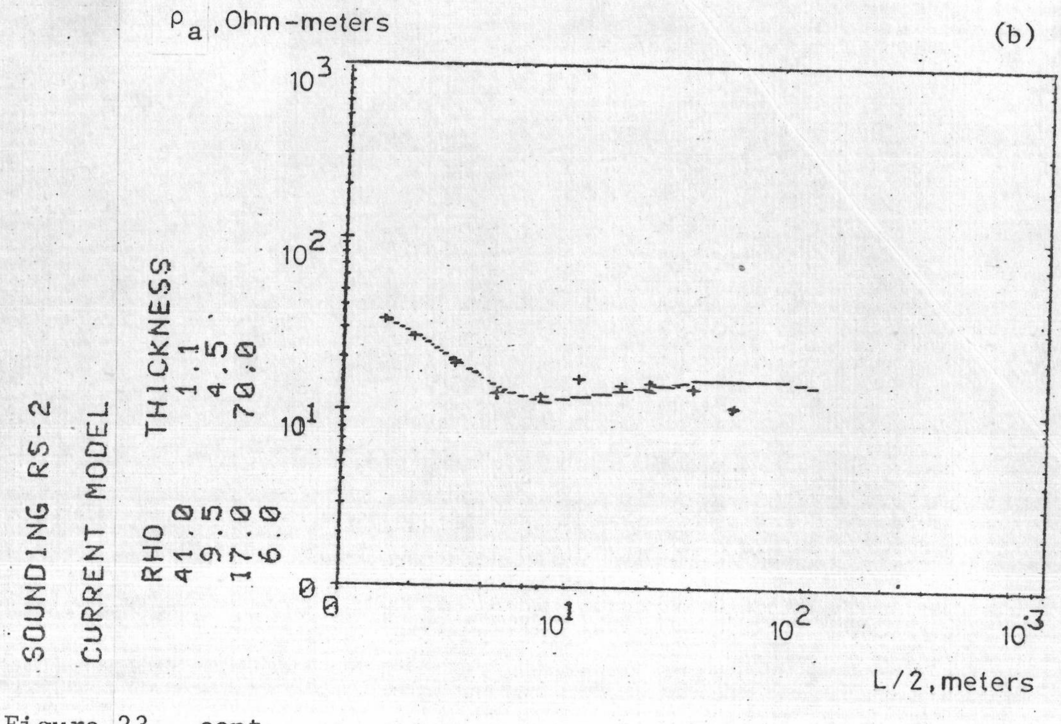
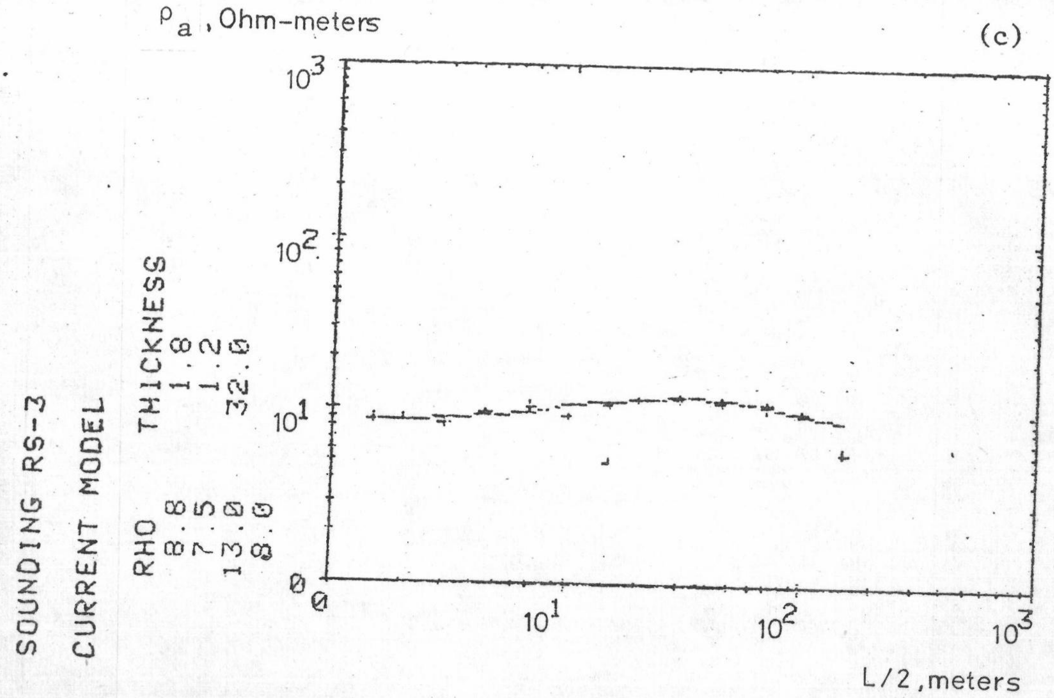
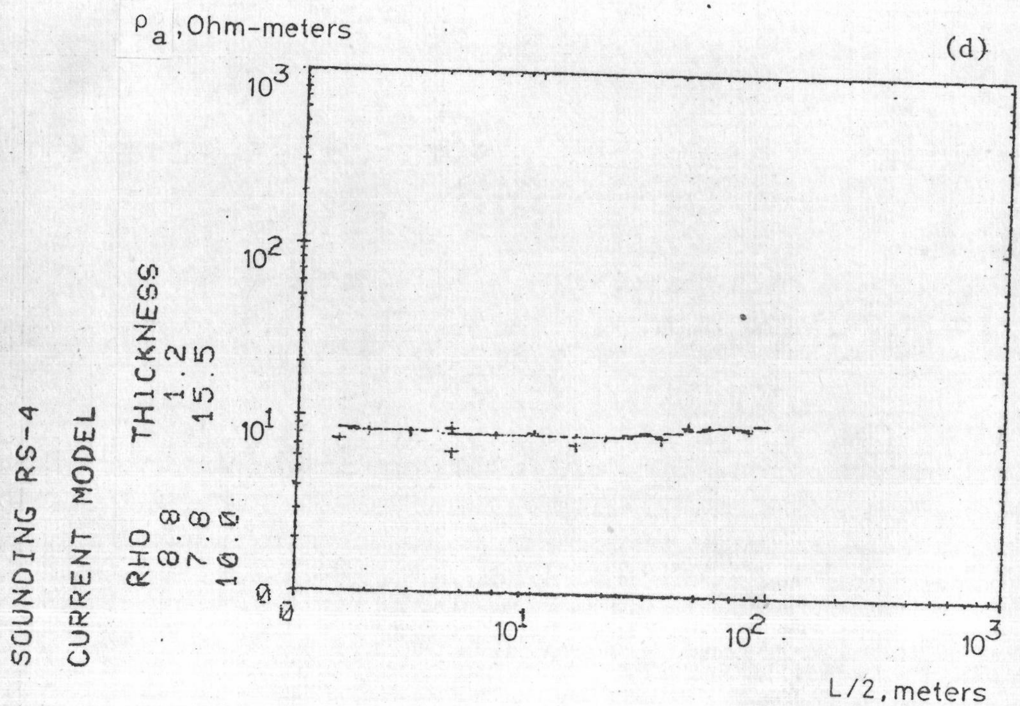


Figure 23. cont.





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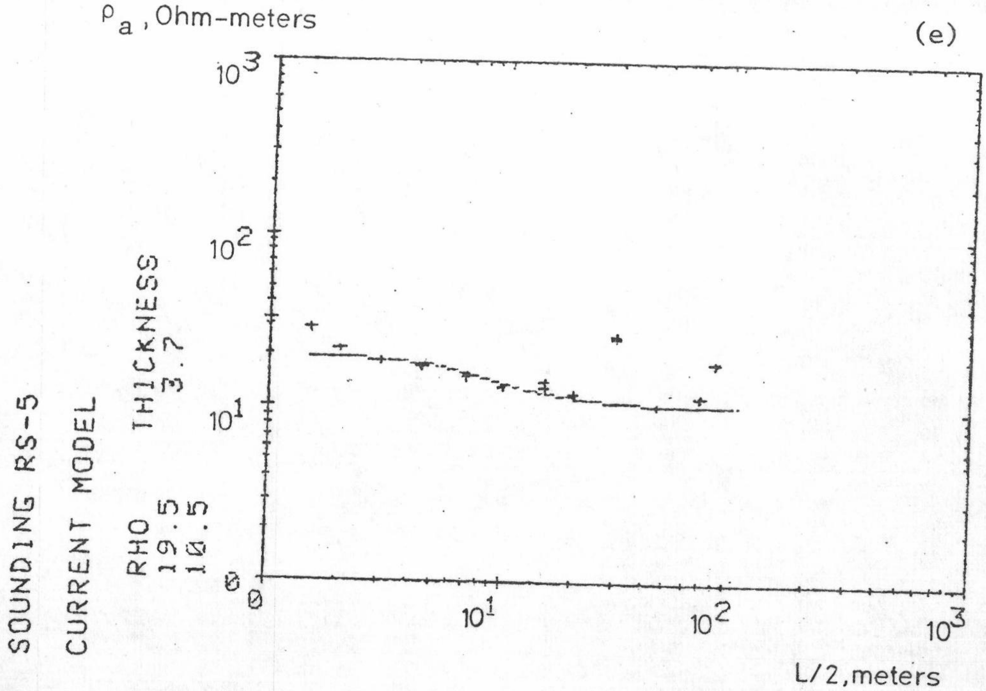

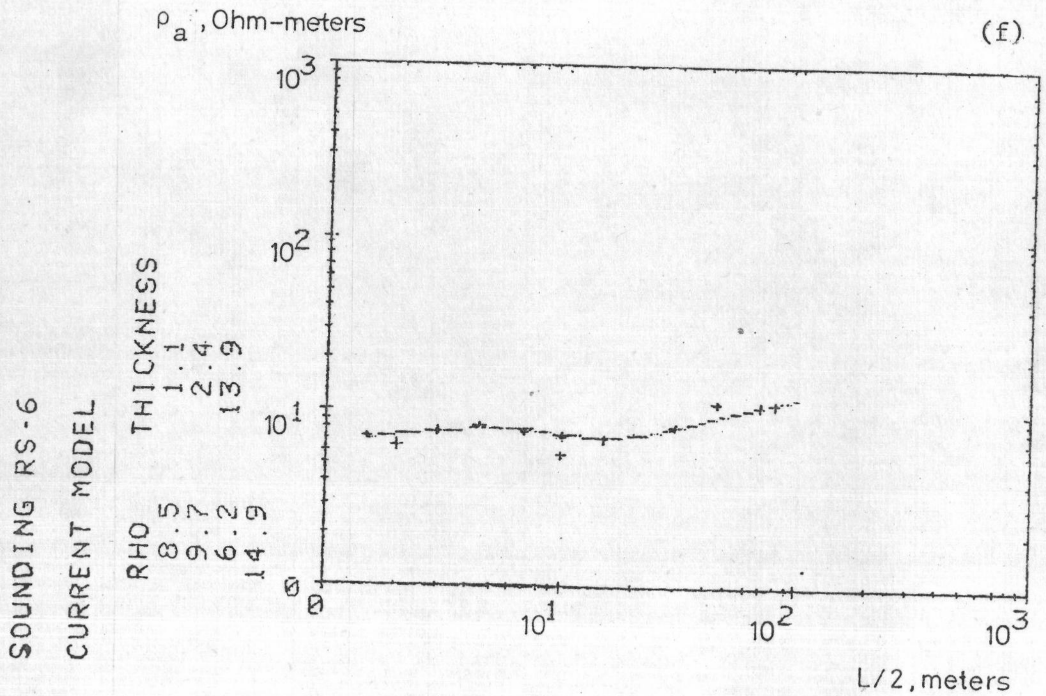

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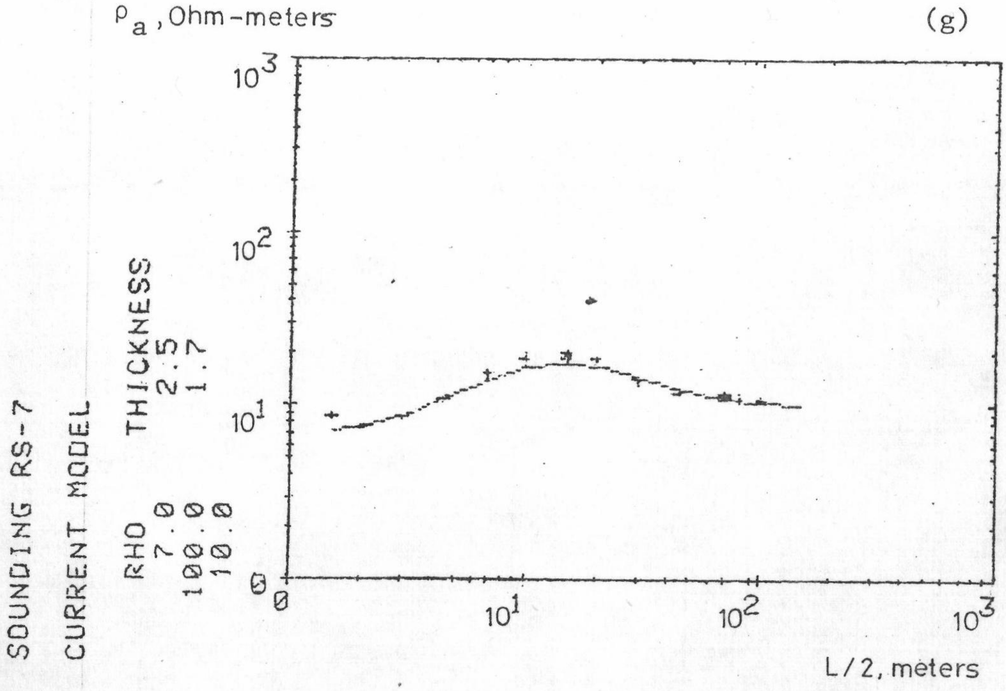

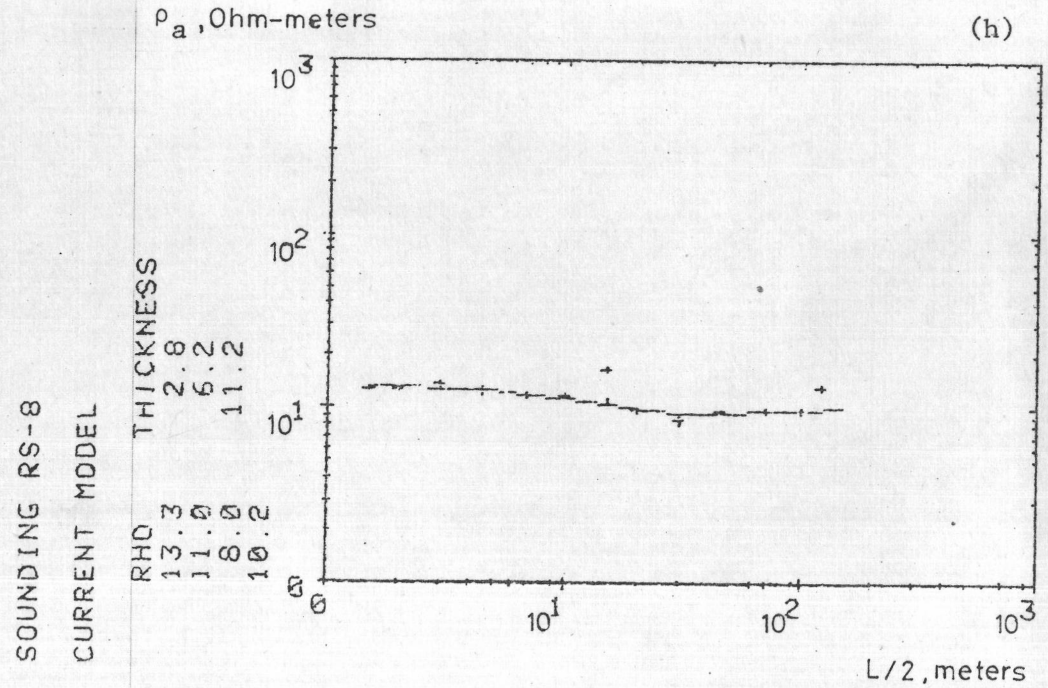

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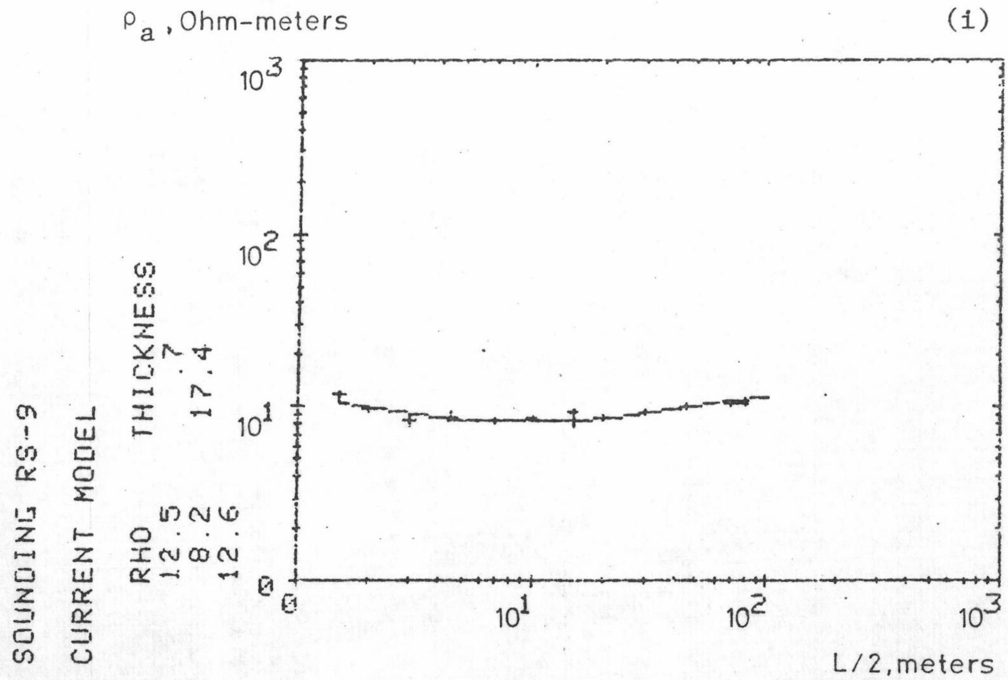

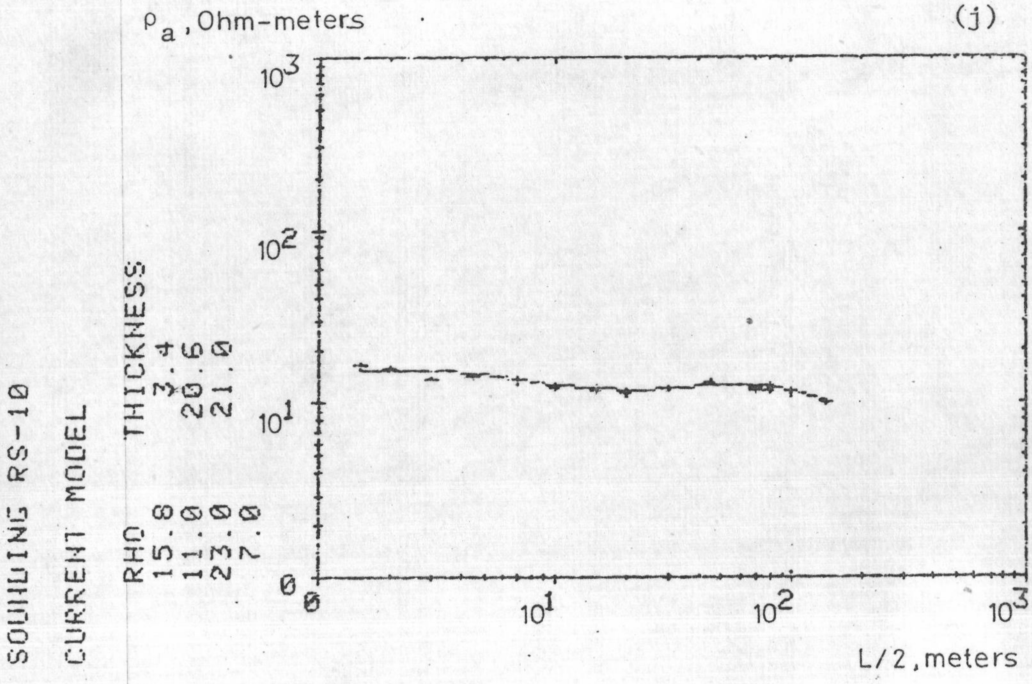

Figure 23. cont.

values ranging from 7.0 to 110.0 ohm-meters. The other layers are thicker than these upper layers. Their thickness are greater than 6.2 meters. The resistivity values of the lower layers which is expected to be in a range of true resistivity of claystones, both dry and saturated condition, are ranging from 6.2 to 15 ohm-meters thus meets the expectation. However, the resistivity contrast between dry and saturated claystones comes in a very low range, thus the moisture-content condition can not be clearly defined.

The comparison between the subsurface geology, including water level, to the theoretical model can not be set up because no bore hole data adjacent to any sounding point are available. Thus, the qualitative interpretation for groundwater level determination is still incomplete. But the raw data obtained in the present work can be used for a further interpretation when the detailed subsurface geology, including water table measurement, are available later on.

The errors in the resistivity measurement were also noted to cause the incompatible variation of the resistivities when all of the resistivities data are correlated. The errors are caused by the unknown splits or partings of lignite beds which extend inside the slope at various levels. It may be noted, on the other hand, that the lithology is not truly homogeneous through out the slope. Other cause of error may be occurred during the measurements by which the emission line (traverse line of measurement) which was laid adjacent to the slope face created the 'air contact' effect (Figure 24). This effect distorts a flow of current through the earth from one current-electrode to the other at a high separation.

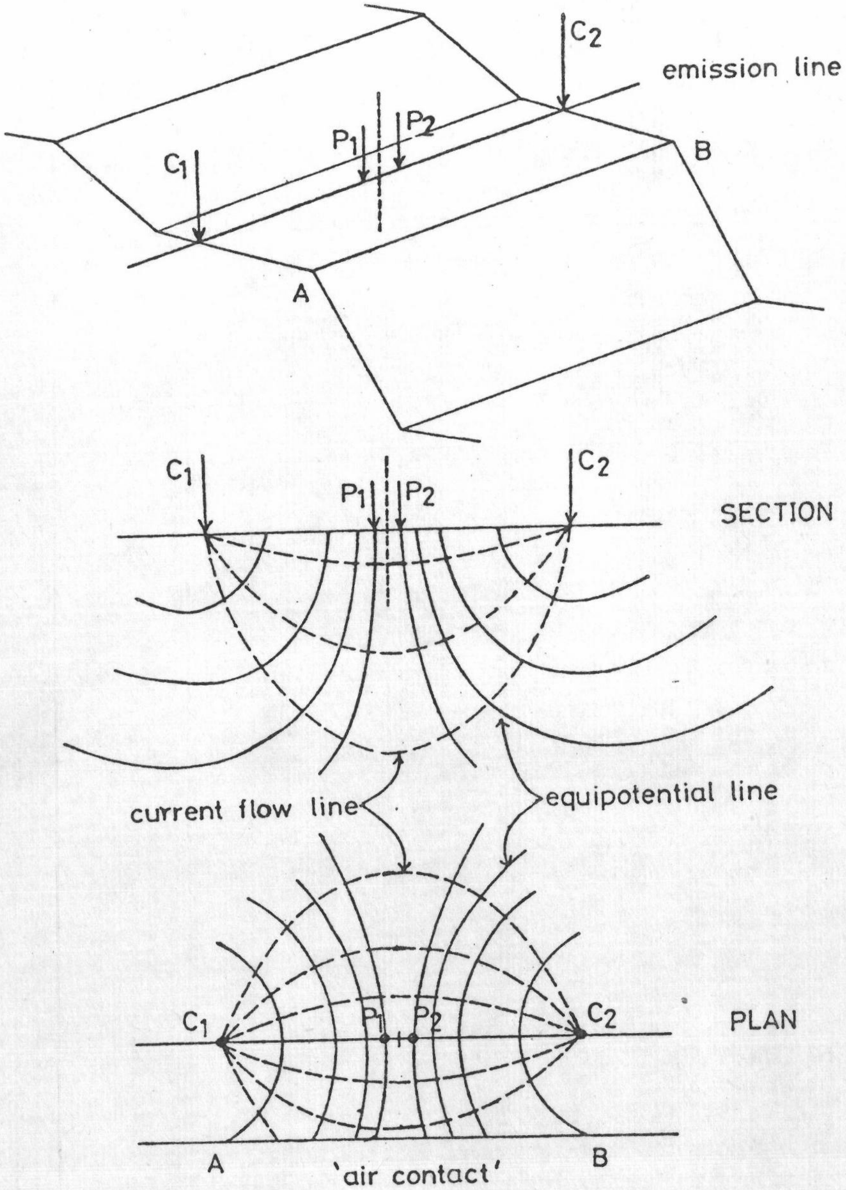

Figure 24. The 'air contact' effect in resistivity survey.