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Geomorphological and Geo-Electrical Investigations for Ground Water Resources in Pulang River Basin, Andhra Pradesh

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Abstract- An endeavour is made in the present study to identify the groundwater potential zones in the Pulang River basin, Cuddapah district based on the Geological and Geo-electrical investigations. The Geomorphological features and lineament patterns are also studied in locating favourable sites for groundwater. The Geoelectrical soundings conducted at hundred locations in the basin area are interpreted by Schlumberger method. These studies helped to understand the subsurface Geology and in identifying the high groundwater potential zones and to locate in turn the favourable sites for good yielding bore wells.

Index Terms- Geomorphological features , Geoelectrical soundings, groundwater potential zones, Schlumberger method.

I. Introduction

The pulang river rises from the Seshachalam hill ranges in Rajampet taluk of Cuddapah district, flows in general northerly direction and joins Cheyyeru river at Atterala. The basin includes six sub-basins with a drainage area of about 757 aq. Km (Fig. 1). The climate of the river basin is hot and semi-arid. The basin receives an annual average rainfall of 795 mm, out of which 45 to 65 percent of the total annual rainfall is received during the north – east monsoon period.

II. GEOLOGICAL SETTING

The rock formations of the basin area represent a suite of sedimentary and metamorphic rocks formed during pre-cambrian times. Lithologically the Cuddapah formations are predominantly argillaceous sequence with subordinate calcareous sediments. Characteristically each group starts with quartzite and ends with dolomite or Shale/Phylite. The Nagari quartzite is exposed mainly in the southern part of the basin. This is dominantly an arenaceous consisting of conglomerate quartzite, quartzite with shale formations (Fig. 2).

The Pullampet formation rests over the Nagari quartzite conformably in the southern part of the basin with purple shale, carbonaceous shale and calcareous shale with prominent intercalations of dolomitic limestones. The basal part of the Pullampet is marked by the ferruginous chert and Jasper with lensoid dolomite patches. Large outcrops of quartzite are seen in the southern and western portion of the area as hills and ridges.

Dolomitic limestones occur at places as discontinuous interbands and lenses. The shale occurs mostly in low-lying lands and strike in a NNW direction with variable dips. The shale is interspersed by bands with quartzite, which sometimes occurs as low lying elongated hillocks. Alluvium of recent age is composed mostly of sand and subordinately of silty or clayey sand and is confines all along and on either side of the Pulang River.

The structural map of the basin area has been prepared using Landsat-5 (TM) and satellite imagery (LISS-II) with some field checks and presented in Fig.3. The map show lineament patterns mostly in NE-SW direction, parallel to the quartzite hill ranges. A large number of minor lineaments recognized are trending differently in different rock formations. The faults are running NS, NE-SW, NNE-SSW which are mostly parallel to the river course. The change of river course towards west at northern side is an important feature of the basin. This might be due to intersection of two major faults. Another major fault trending NS direction can be seen towards the northern most side of the area. Probably due to its influence, the river reaches Cheyyeru river where a natural spring also emerges.

III. GEOMORPHOLOGY

The Geomorphological features which influence the groundwater potential zones are identified. These are classified on the basis of their geomorphic expression, relief, slope factor and surface cover with soil or vegetation. The landforms identified in the basin area are broadly classified as denudational landforms covered by outcrops and depositional landforms covered by colluviums, alluvium and transported soils.

The denudational hills are the resultant landforms formed due to the natural dynamic process of denudation and weathering and mostly these are with negligible soil cover and vegetation. The residual hills present in the area are aligned E-W direction and a few are N-S direction. The denudational hills and the residual hills are mostly composed of quartzites and appear to be poor groundwater potential zones.

The gently sloping surfaces showing a greater degree of weathering adjacent to these hills are known as pediplain zones. The thin soil cover present over the pediment surface supports scanty vegetation of low shrubs and grass. As the erosion is active in the pediplain area, groundwater expected in this zone is low to moderate.

The Geomorphic features related to fluvial landforms present in the area of study are rock cut terraces and flood plain deposits. Flood plains are covered with alluvium transported and deposited by streams. Palaeochannel of substantial thickness of

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alluvium deposited by the action of abandoned rivers is noticed at Atterala where the river joins the Cheyyeru river. Certain alluvial fans loaded with resulting deposition of alluvium are formed at the foot of the hills.

The flood plains, Palaeochannels and alluvial fans which are present in the basin area comprise unconsolidated materials, coarse boulders and pebbles carried by the streams. Hence, a substantial groundwater potential zones are identified in these areas.

IV. GEOELECTRICAL STUDIES

In order to study the subsurface structure of the Pulang river basin, Electrical Resistivity method has been used. Soundings were carried out at about 100 locations in the area (fig. 4.). This technique had shown greater potential for ground water development, especially in hard rock terrain, where the weathered or fractured rock formations show as a conducting layer in an otherwise resistive bed rock. The results of these investigations, together with geomorphology should provide a good indication for identification of ground water potential zones in the river basin.

Schlumberger configuration has been used with a maximum electrode separation of AB/2=100 m. The sounding curves obtained in the area are mostly H, and A type with apparent resistivity values generally varying from about 10 Ohm-m to few hundred Ohm-m. A few examples of them are shown in Fig. 5.

The interpretation of the sounding curves has been carried out at National Geophysical Research Institute, Hyderabad using linearised inversion (Jupp and Vozoff, 1975) scheme. The inversion scheme required an initial model. The initial model for each curve has been obtained from curve matching technique. The inversion scheme progressively reduces the error between the observed and computed data by changing the parameters in the given initial model and finally gives a model that satisfies the observed data in a least mean square sense. The results of the investigation give a parametric layered model, assigning definite resistivity and thickness for each layer. The results thus obtained are presented in the form of contour maps also as 3-D perspective plots.

In fig.6 A and B contour map of apparent resistivity with 1.5m and 10m, are shown respectively. From these figures it can be clearly seen that high resistivity values of the order of 100 ohm-m and above are oriented in NW-SE direction, showing a cluster of high resistive contours. These high resistive zones correspond to the relatively high resistive formation of Quartzite. Towards NE direction there is a general decrease in apparent resistivity value indicating conductive formations, which corresponds to shale/dolomites.

In figs 7 and 8, interpreted results of sounding curves are presented. Figs, 7 A and B shown the surface layer resistivity plot and its 3D representation respectively and Fig. 8 A and B show the bottom layer depth contour map and its 3D perspective plot respectively. It can be seen from these figures that the surface layer is resistive towards NE-SW direction and conductive towards NE direction. The depth to the bottom layer in the study area varies from 4m (VES-33) to as great at 47.2 m (VES-82). In a hard rock terrain such as in Pulang river basin large basement depth areas are suitable for greater ground water potential. Based on the integrated surveys involving geological, geomorphological and geophysical investigations, the basin area is divided into three classes with varying probabilities of groundwater occurrence i.e. high, moderate and low potential areas (Fig.9).

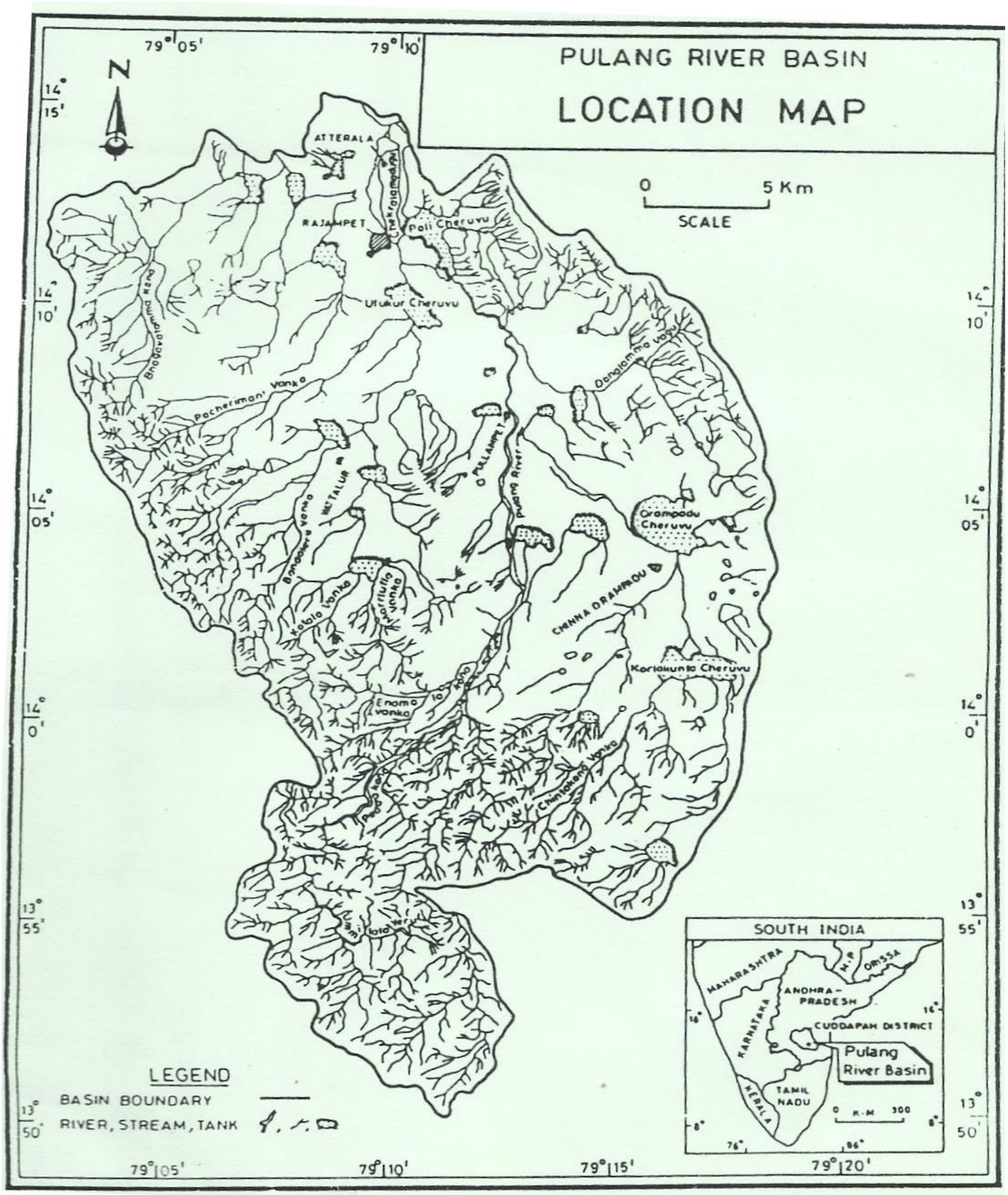

Fig.1 Location map of pulang river basin

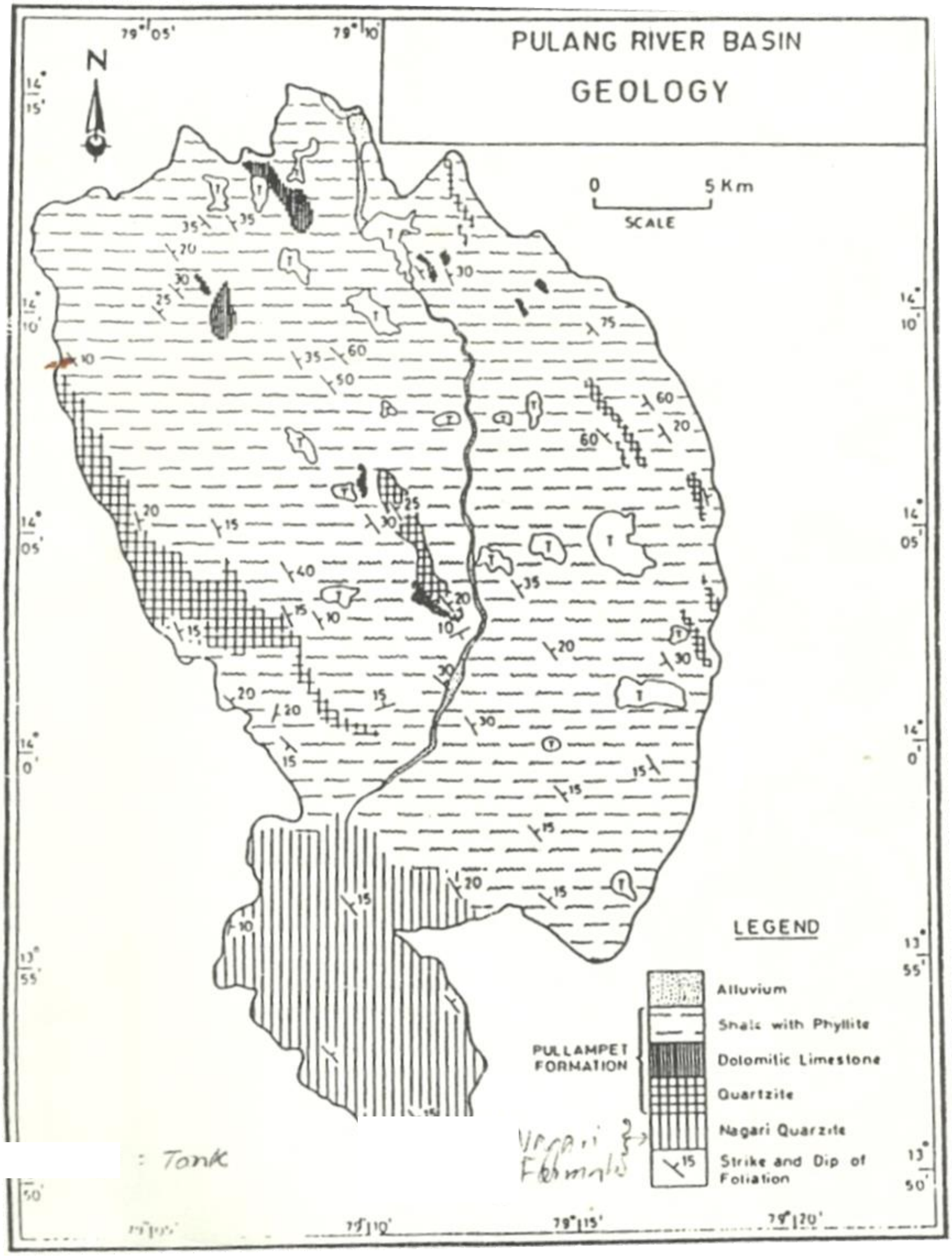

Fig.2 The map showing geo morphological features

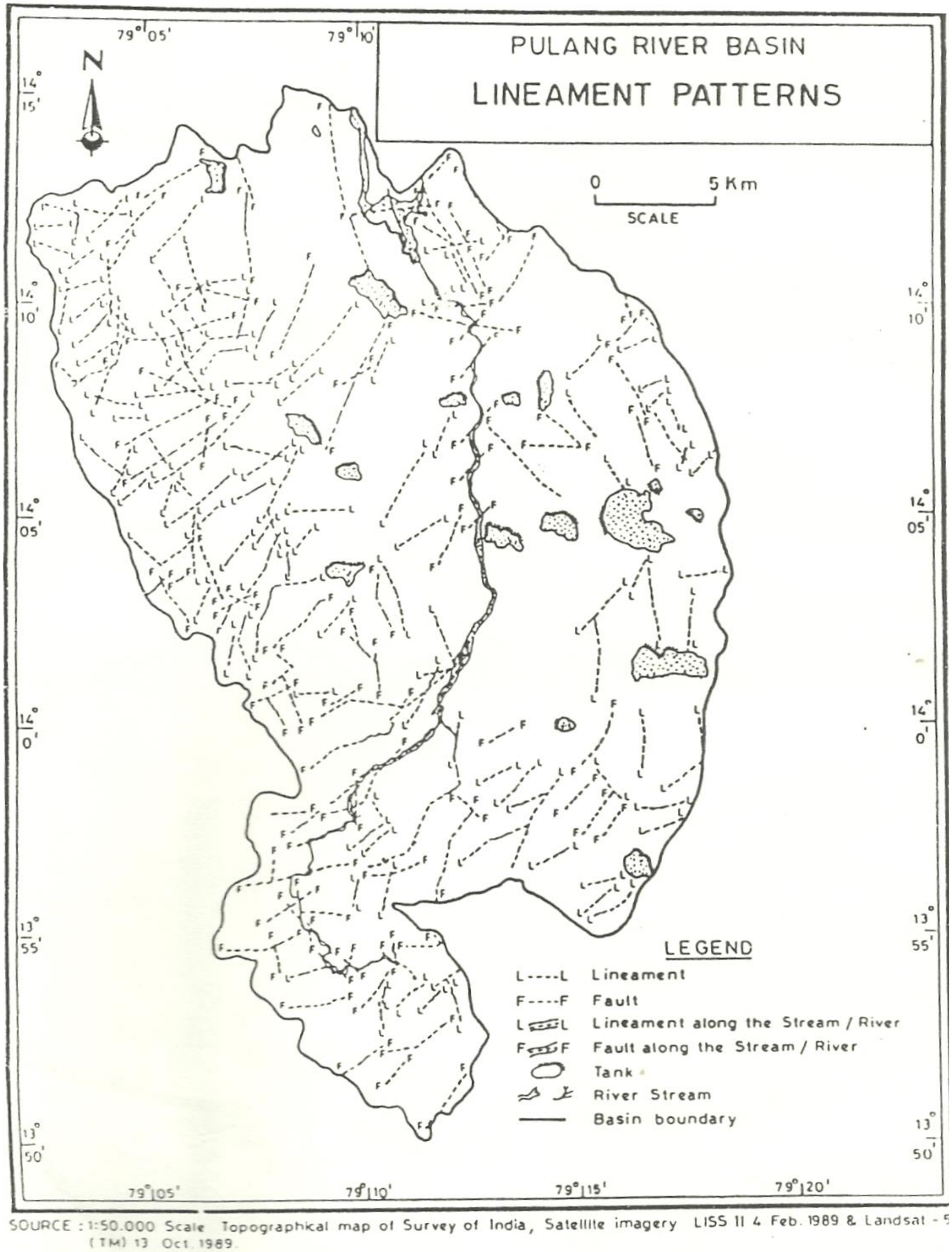

Fig.3 The lineament patterns identified from satellite imagery

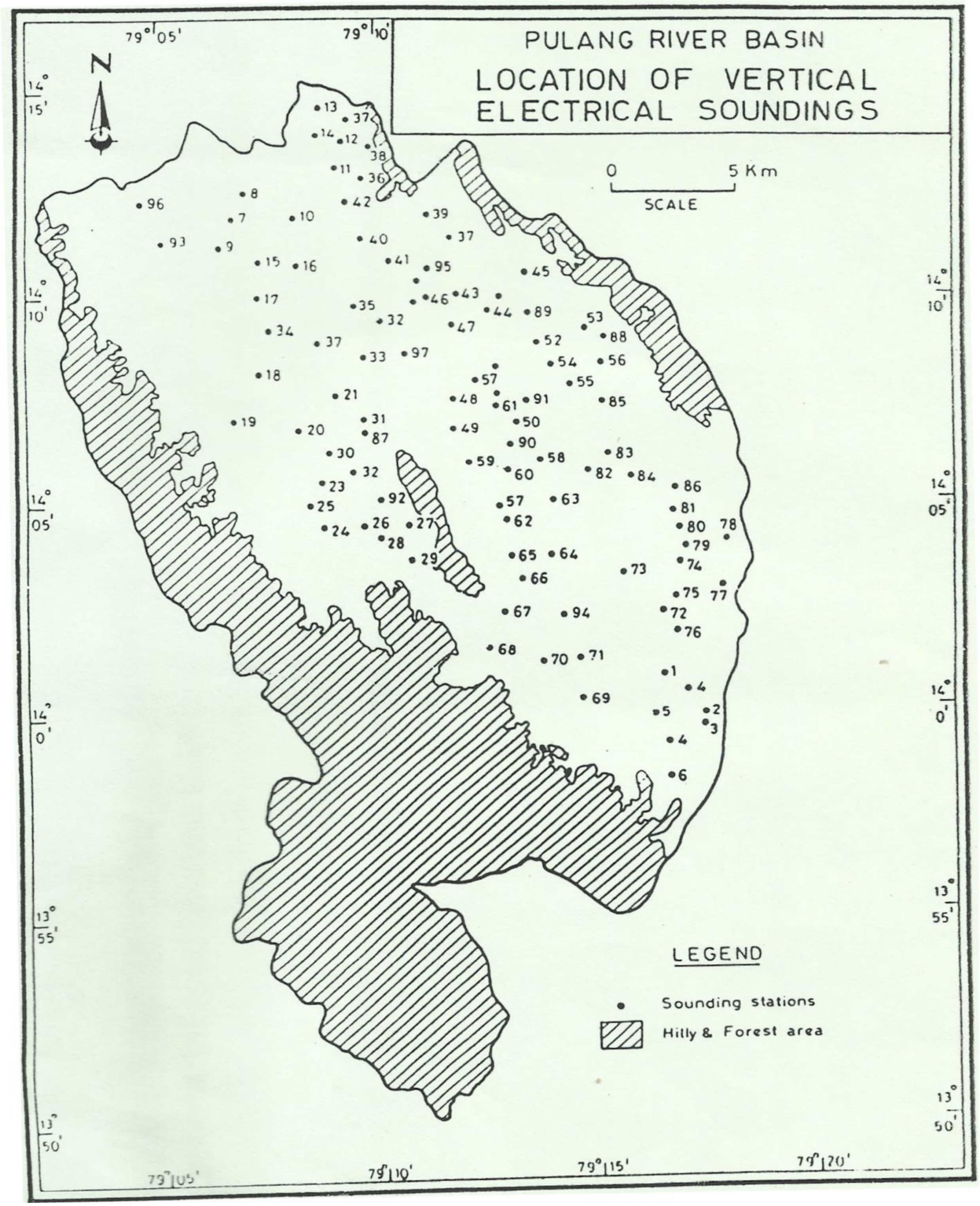

Fig.4 Location of vertical electrical resistivity soundings.

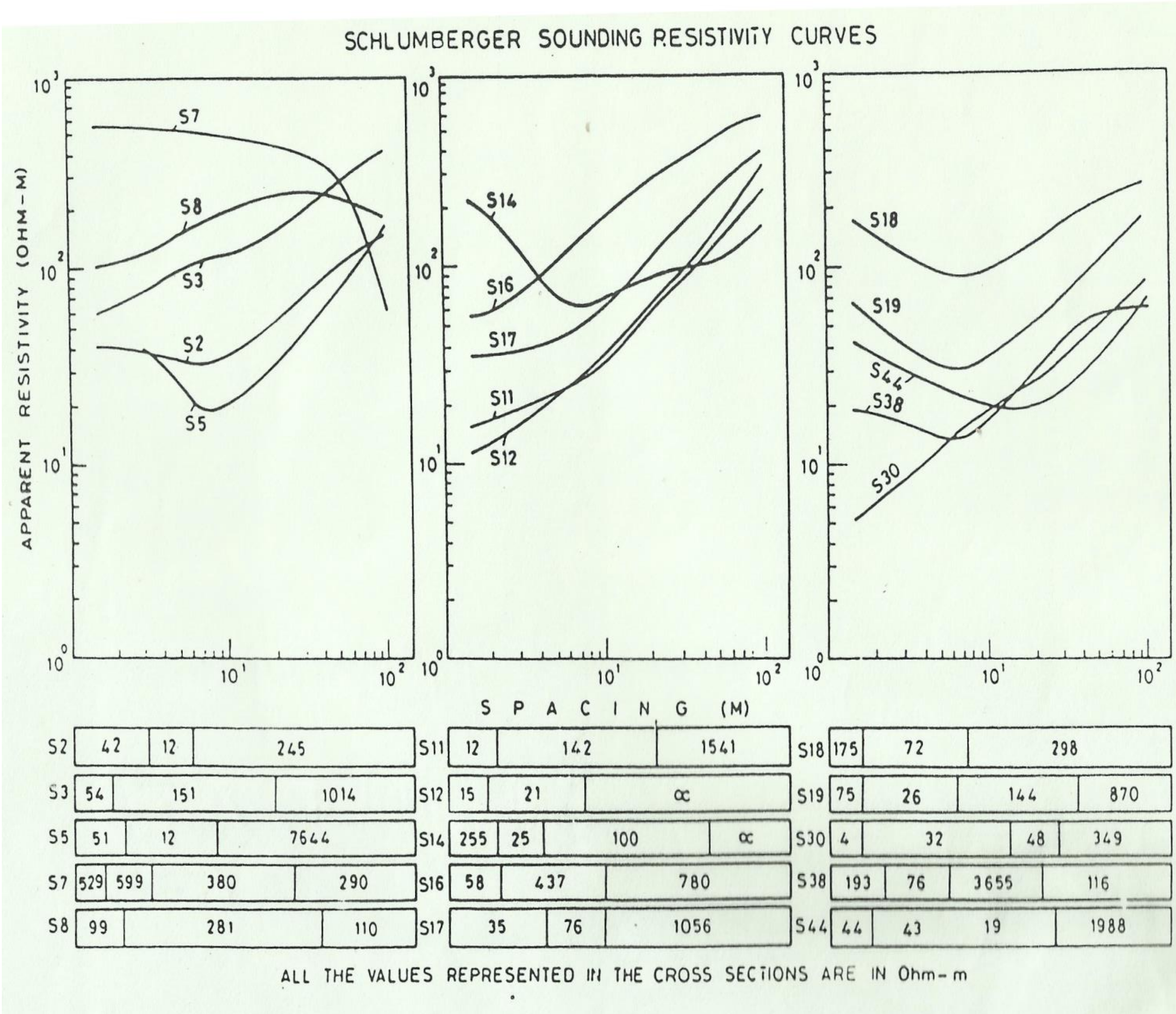

Fig.5 Schlumberger curves of electrical resistivity

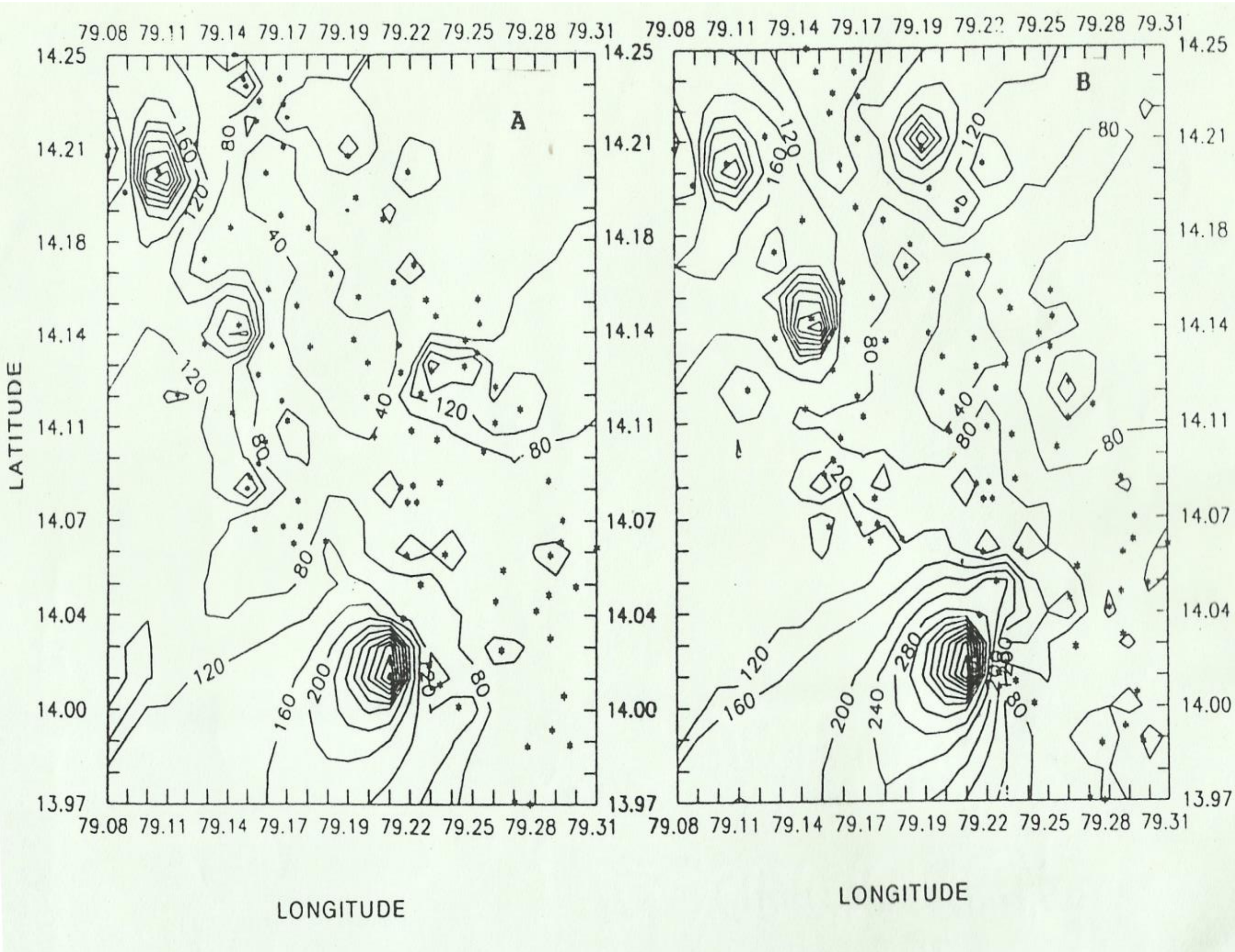

Fig.6 A & B contour maps of apparent resistivities with 1.5 & 10.0 mts electrode spacing's respectively.

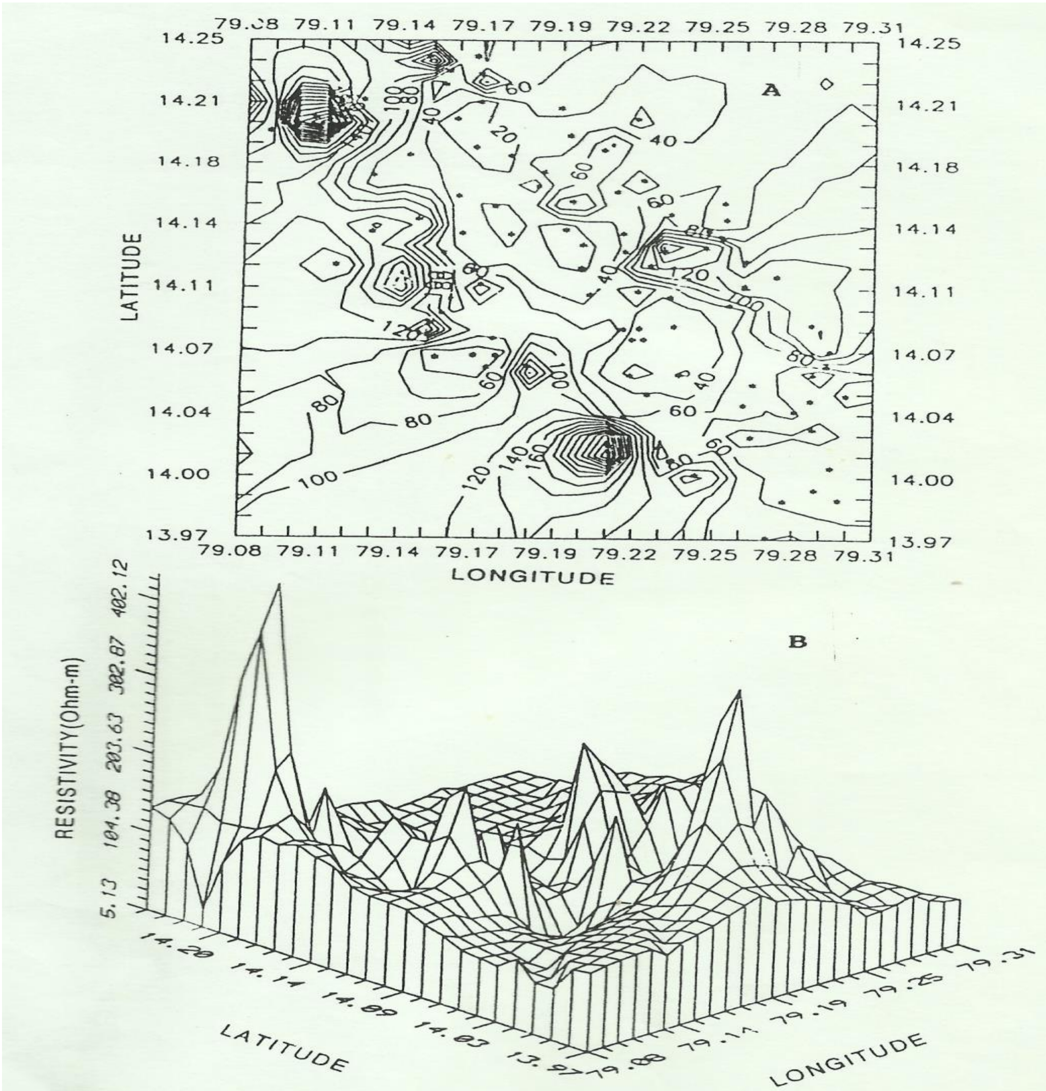

Fig.7 A & B The surface layer resistivity contours in Ohm-mts and 3D representation viewing from south-west corner respectively.

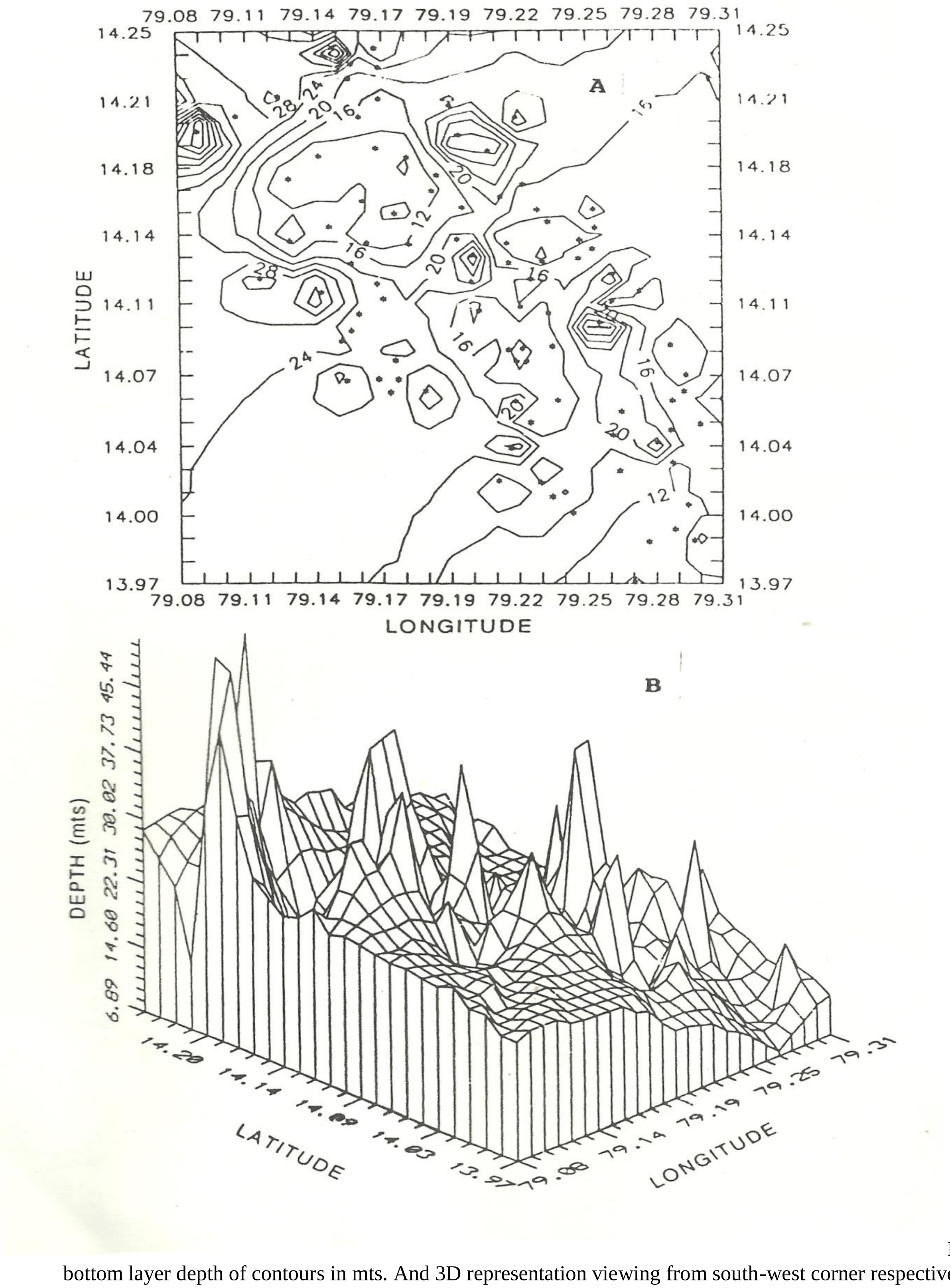

Fig. 8 A & B the bottom layer depth of contours in mts. And 3D representation viewing from south-west corner respectively.

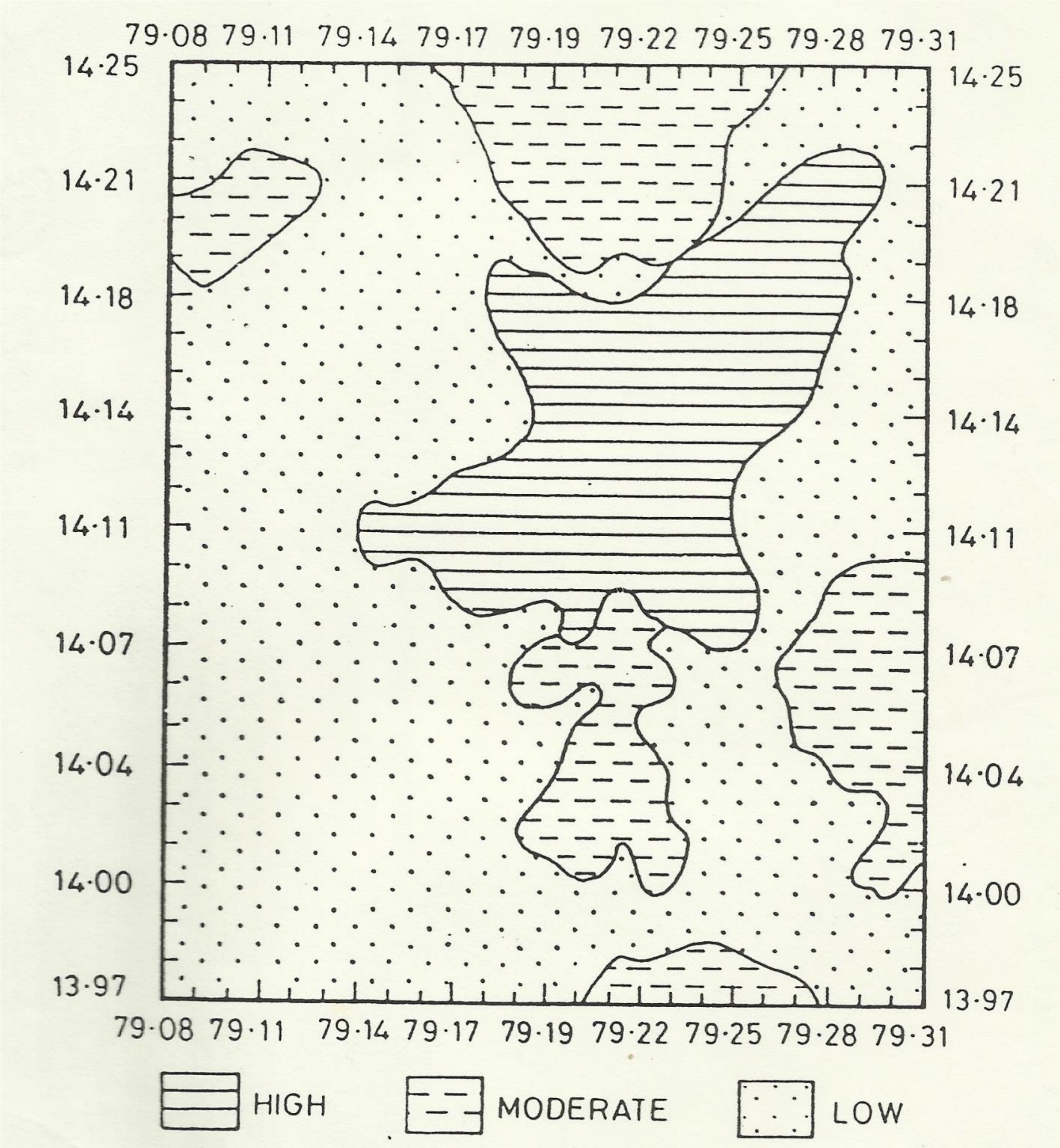

Fig.9 Delineation of ground water potential zones.

V. CONCLUSIONS

The study reveals that fractured shale with dolomitic intercalations situated in the central and NE parts of the study area are indicative of ground water potential zones. These potential zones are interestingly found to align the megalineaments which are inferred fault zones. Equally or more water potential zones are also identified in pockets of deep sandy alluvial regions all along the river course. Weathered peneplains rank next as moderate water potential zones while the hard rock areas such as quartzites that exits in the NW and southern parts of the study area is very poor in ground water potential.

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