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GEOPHYSICAL INVESTIGATION OF MARBLE OCCURRENCE IN TAKALAFIA AREA, AROUND ABUJA, CENTRAL NIGERIA

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ABSTRACT

Outcrops of marble occur in Takalafia environs south of Abuja, Central Nigeria. In an attempt to determine the lateral and depth extent of the marble deposit, a geophysical investigation involving electrical resistivity and magnetic methods was carried out. The horizontal profiling and vertical depth sounding techniques were employed.

The marble deposit is characterised by both local resistivity highs (in the range of 20-61 ohm-m within an immediate background of less than 10 ohm-m and low magnetic effect of less than 800 gammas. The outline of the marble deposit based on the above characteristic has an approximately NE-SW trend with a lateral and width extent of about 400m and 40m, respectively. The deposit has a southwesterly plunge. The outline of the deposit and its plunge direction were confirmed by drilling from which borehole logs show marble thicknesses of 1.3-2.7m at the edges and 16.0 and 19.6m within the marble outlined zone.

KeyWords: Marble, Abuja, geophysical investigation, Plunge.

INTRODUCTION.

Low lying outcrops of marble occur in Takalafia area (Fig. 1) about 23 km south of Abuja, in the Federal Capital Territory of Nigeria. The body occurs within a granite gneiss/calc gneiss host rock with a NE-SW foliation trend. A geophysical investigation of the prospect area was carried out with an intent to:

(i) delineate the lateral and width extent of the marble deposit

(ii) determine the overburden thicknesses within the prospect area

(iii)map the structural disposition of the marble and

(iv) estimate the depth extent of the deposit.

Geology/Geomorphology of the study area.

The area is underlain by rocks of the Precambrian Basement Complex of Nigeria (Fig. 1). The basement rocks belong to the migmatite-gneiss complex (Oyawoye, 1972). The lithological units include granite gneiss, calc gneiss and marble (see Figs. 2 & 3).

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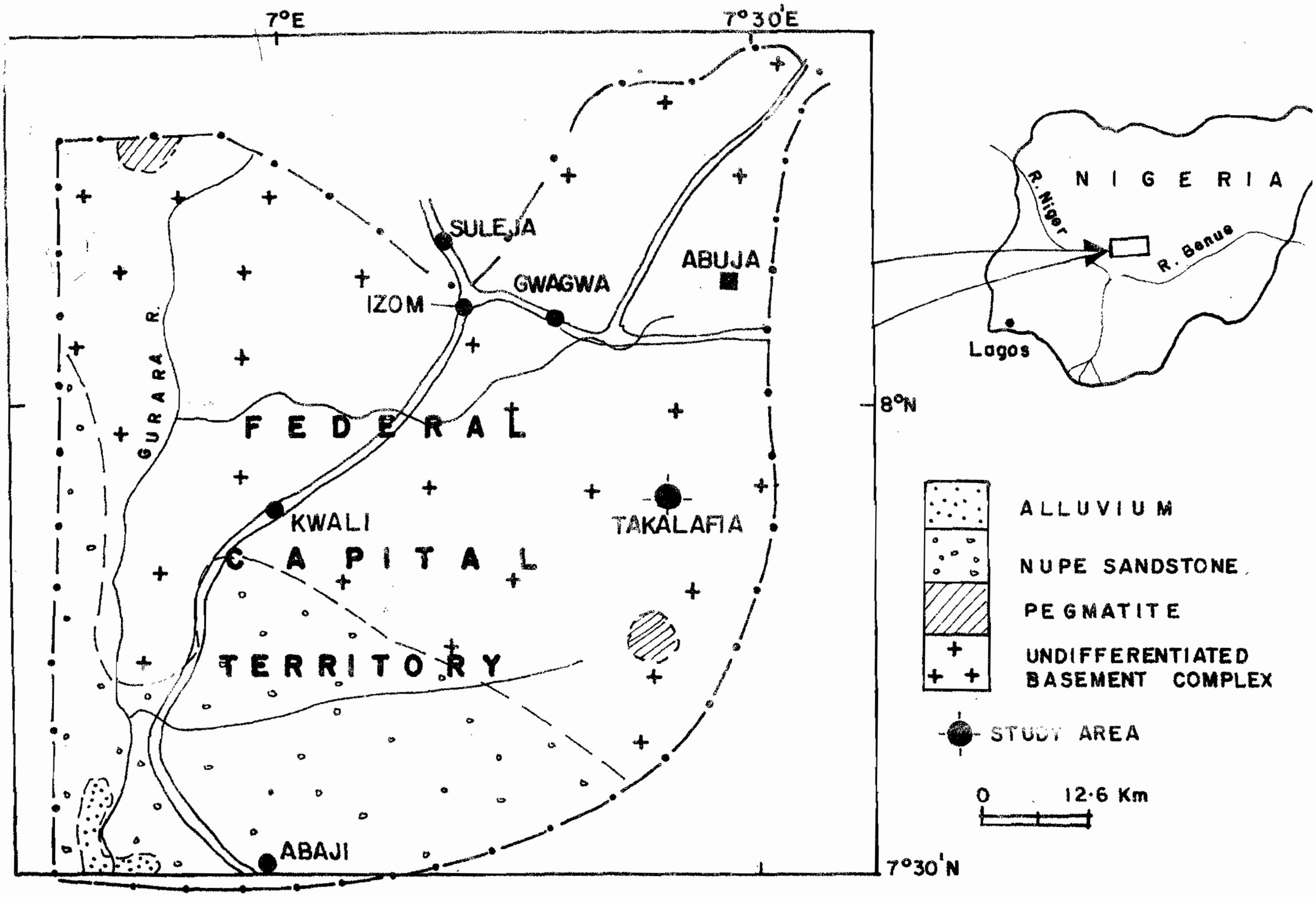

Figure 1: Generalised Geological Map of the Federal Capital Territory (Adapted from G.S.D., 1974) Showing the Takalafia Study Area.

The calc gneiss appears to be a transitional unit between the granite gneiss and the marble.

Except along the Tarkwa river channel where there are outcrops of granite gneiss/calc gneiss, there are very few outcrops of the basement rocks within the survey area. The marble outcrops towards the northeastern part are low lying and of limited (< 3m) lateral and width extent. The marble dips westerly at an angle of between 60° and ...

The area is drained by the Tarkwa river and its tributaries. The terrain is gently undulating but slopes towards the river channel. Topographic elevation varies from 170 to 210 m.

GEOPHYSICAL INVESTIGATION

The geophysical investigation involved the electrical resistivity and magnetic methods along

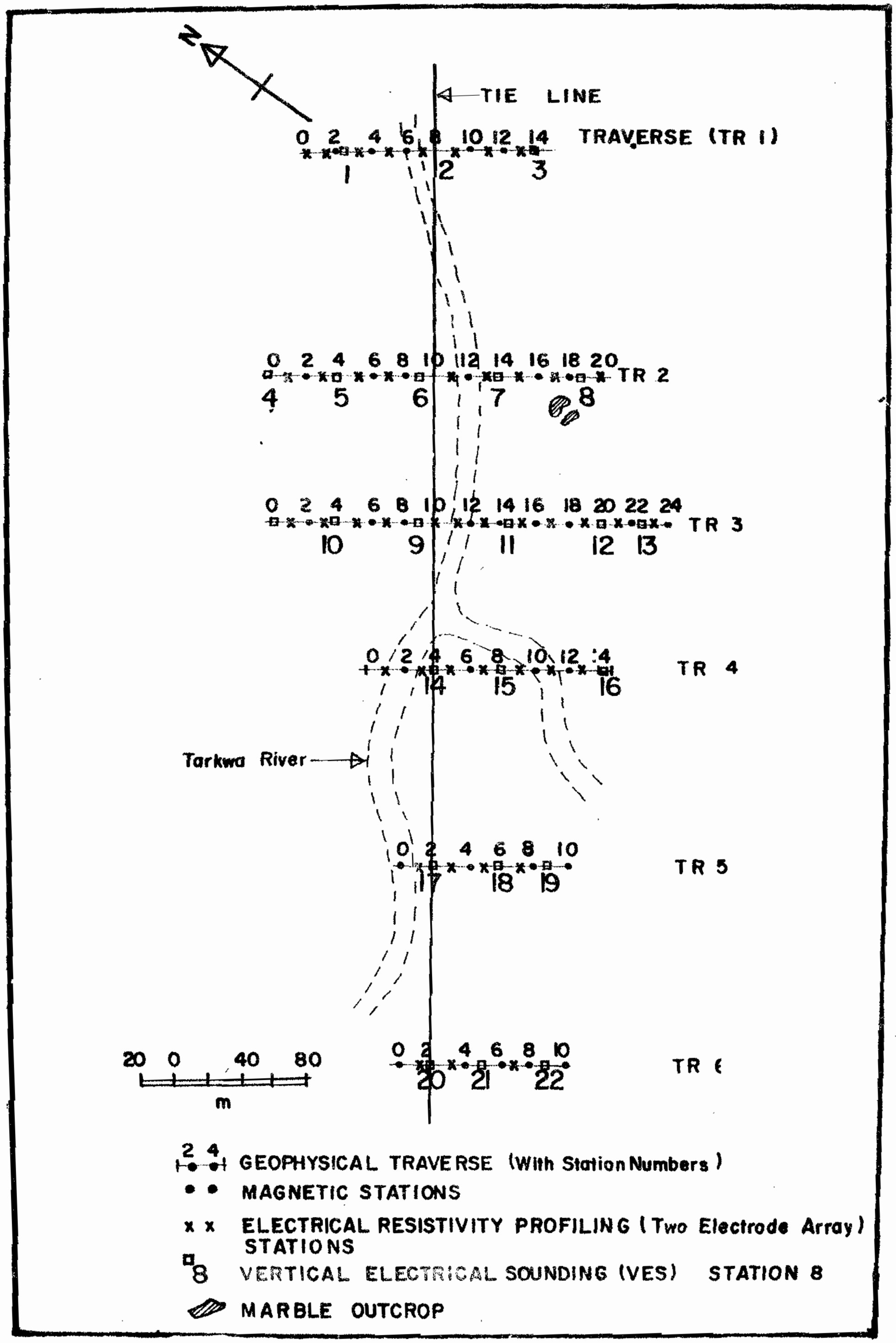

Figure 2: Geophysical Data Acquisition Map.

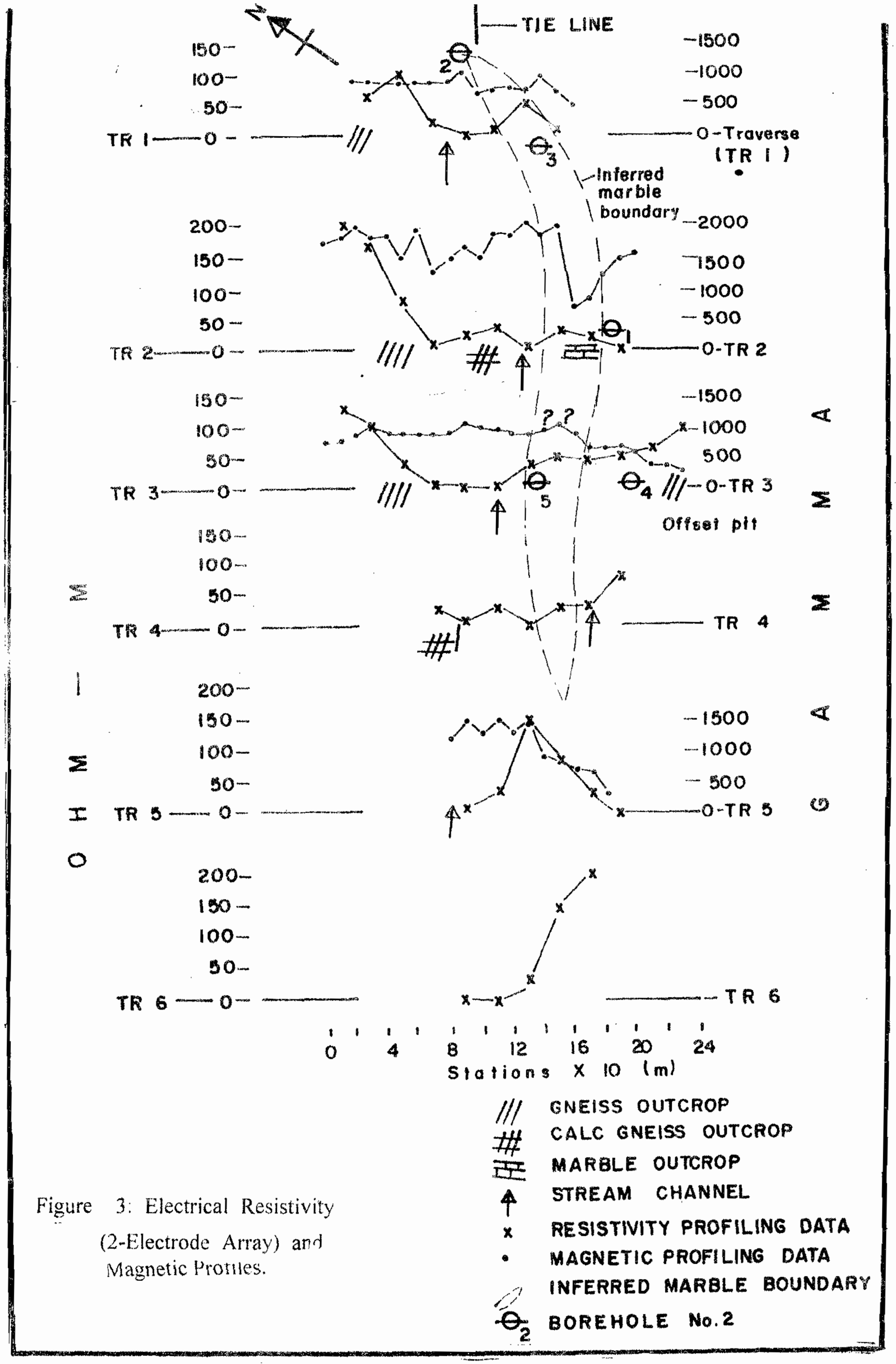

Figure 3: Electrical Resistivity (2-Electrode Array) and Magnetic Profiles.

six traverses with NW - SE trend and varying in lengths from 100 to 240 m. The resistance measurements were made with a PASI E2 Digital Resistivity Meter while the vertical components of the earth's magnetic field were recorded with a Fluxgate Magnetometer.

The horizontal profiling (HP) with a two electrode (Pole-Pole) array, vertical electrical sounding (VES) with the Wenner array and a single spacing in-line magnetic profiling techniques were adopted. The choice of the geophysical methods was informed by the distinctive high resistivity/low magnetic effect characteristic of marble deposits (Folami and Ojo, 1991; Ojo and Olorunfemi, 1992, Aina and Olorunfemi, 1996 and Odeyemi, et. al., 1997).

The resistivity profiling was carried out using a 20 m separation between the electrodes and between the stations. The VES electrode spacings varied from 1 to 64m with a maximum spread length of 192m. Twenty two VES stations were occupied as shown in Figure 2. In-line magnetic profiling was carried out along the six traverses using a station separation of 10 m.

RESULTS AND DISCUSSION

The resistivity and magnetic profiling data are presented as profiles(Fig.3). The magnetic data obtained along traverses TR4 and TR6 were not used due to high level of geologic noise arising from near-surface iron bearing laterite. The VES data are presented as depth sounding curves. Typical sounding curves representing the different geoelectric sequences are shown in Figures 4a and 4b.

The interpretation of the resistivity and magnetic profiles is qualitative involving recognition of signatures characteristic of the target. On the other hand, interpretation of the VES data for layer resistivities and thicknesses is quantitative, employing partial curve matching and computer iteration techniques. The computer programme is based on Ghosh (1971) linear filter theory.

Figure 3 shows the resistivity and magnetic profiles obtained along the six traverses. The apparent resistivity values vary from 2 to 205 ohm-m while the magnetic responses range from 300 to 2100 gammas.

The outcropping marble along traverse TR2 is characterised by a local resistivity high of 20 - 26 ohm-m within an immediate background of less than 10 ohm-m and a relatively low magnetic effect of less than 800 gammas. Similar geophysical patterns were observed over marble deposits in Igarra area of Southwestern Nigeria (Ojo and Olorunfemi ,1992 ; Aina and Olorunfemi, 1996).

Using the above geophysical characteristic as index for the marble, the inferred boundaries of the deposit along the geophysical traverses are as shown in Figure 3. The local magnetic high rather a low obtained over the proposed marble along traverse TR3 may be due to near surface magnetic noise caused by iron rich laterite.

Five test boreholes (Fig.3) were subsequently drilled within and outside the marble outline as a means of cross-checking the geophysical result. The lithological logs of the boreholes are correlated in Figure 5. The figure shows that marble with significant thicknesses (16.0 and 19.6m) was encountered at boreholes BH3 and BH5 located within the marble outline. At both locations the marble occurs close to the surface (at < 2.5 m).

Shorter columns of marble (2.7 and 1.3m thick) were encountered in boreholes BH1 and BH2 at depths ranging from 21 to 26m, close to the southern limit of the marble outline. Borehole BH4 located outside the marble outline shows no trace of marble.

The borehole lithological logs therefore confirms the geophysically inferred outline of the marble. The correlation of the marble rockheads at BH3 and BH5 with the marble outcrop near BH1 indicates a southwesterly plunge for the deposit.

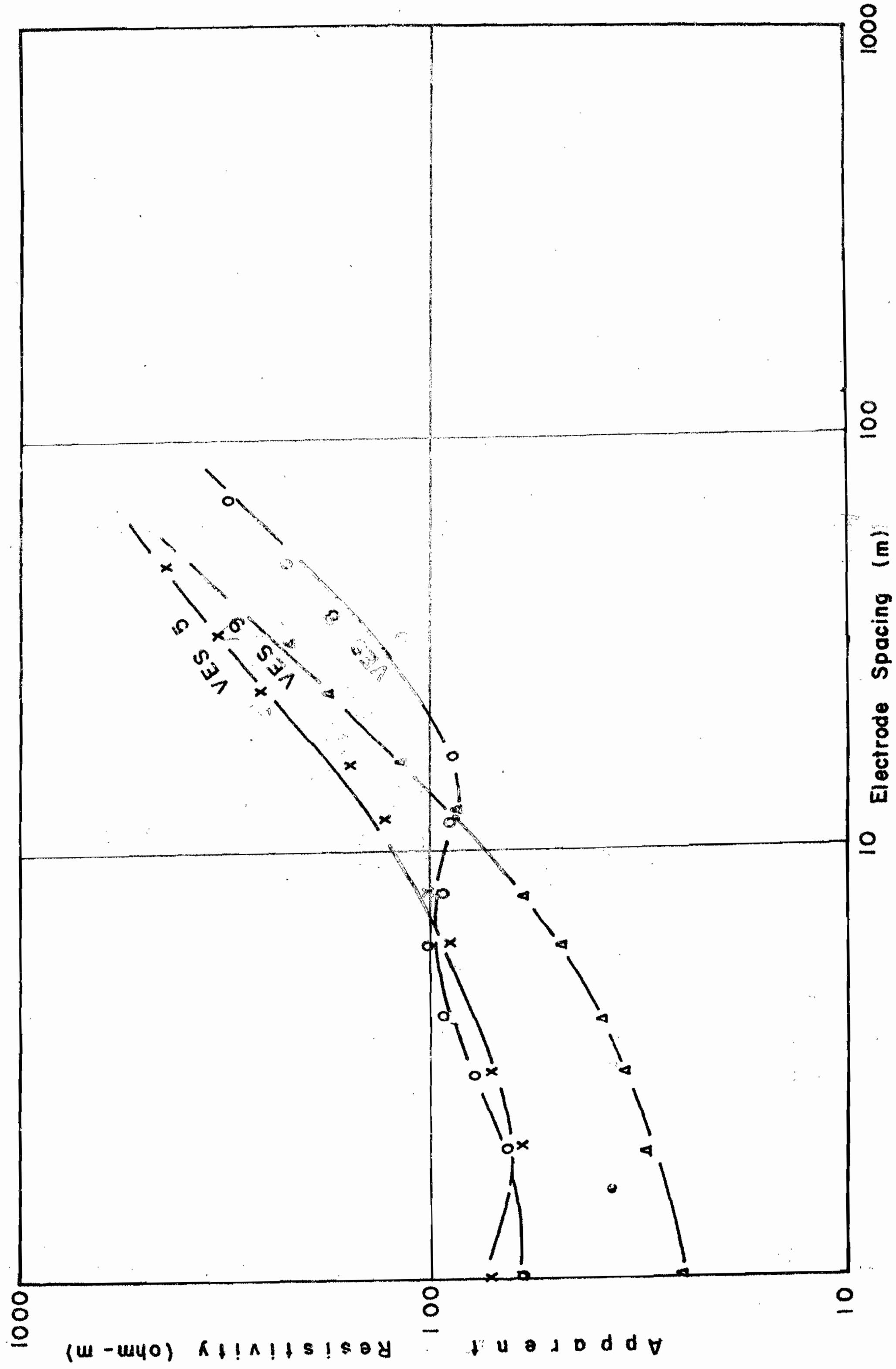

Figure 4a: Typical Depth Sounding Curves (A,HA and KH Type).

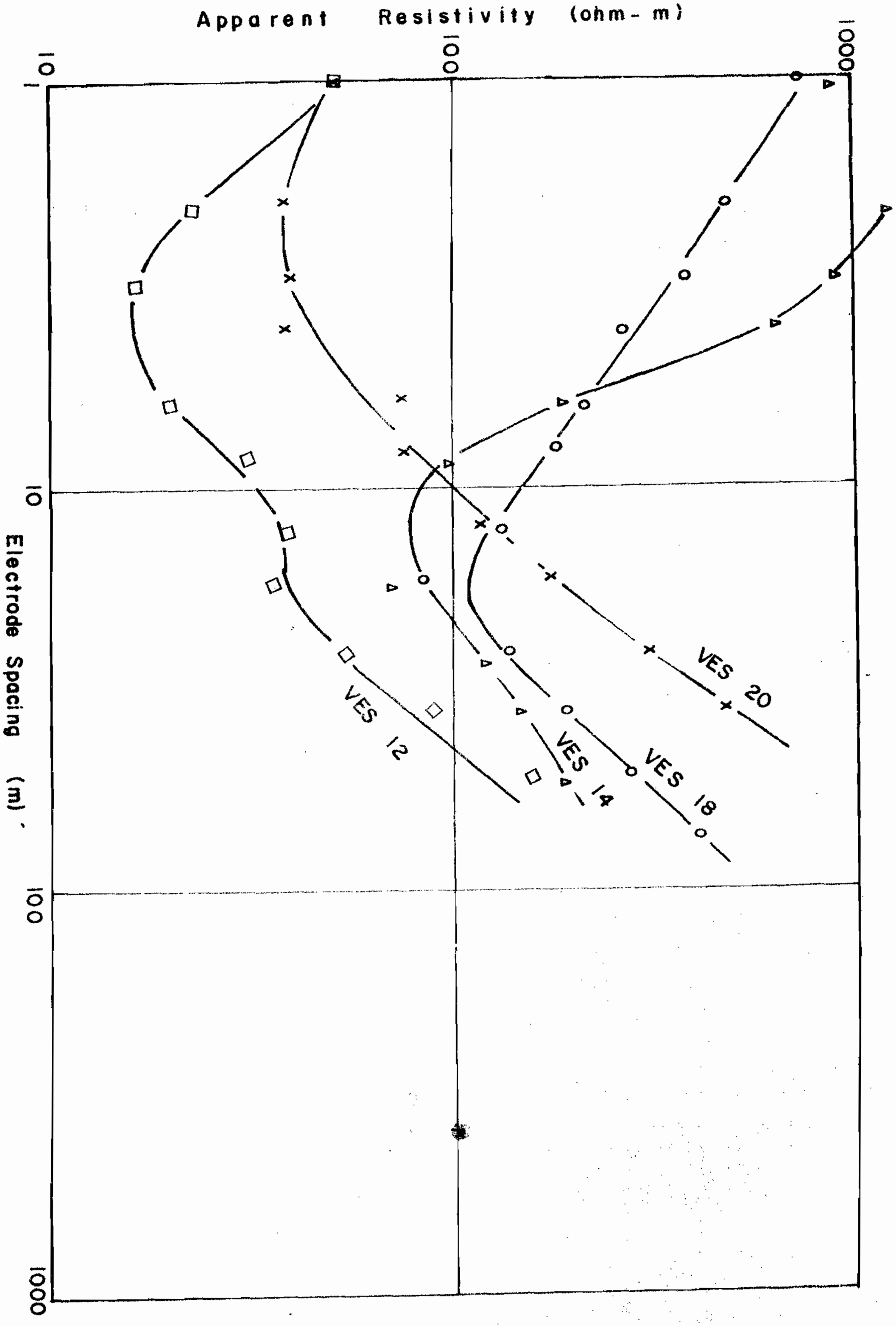

Figure 4b: Typical Depth Sounding Curves (H,QH,HKH and KQH Type).

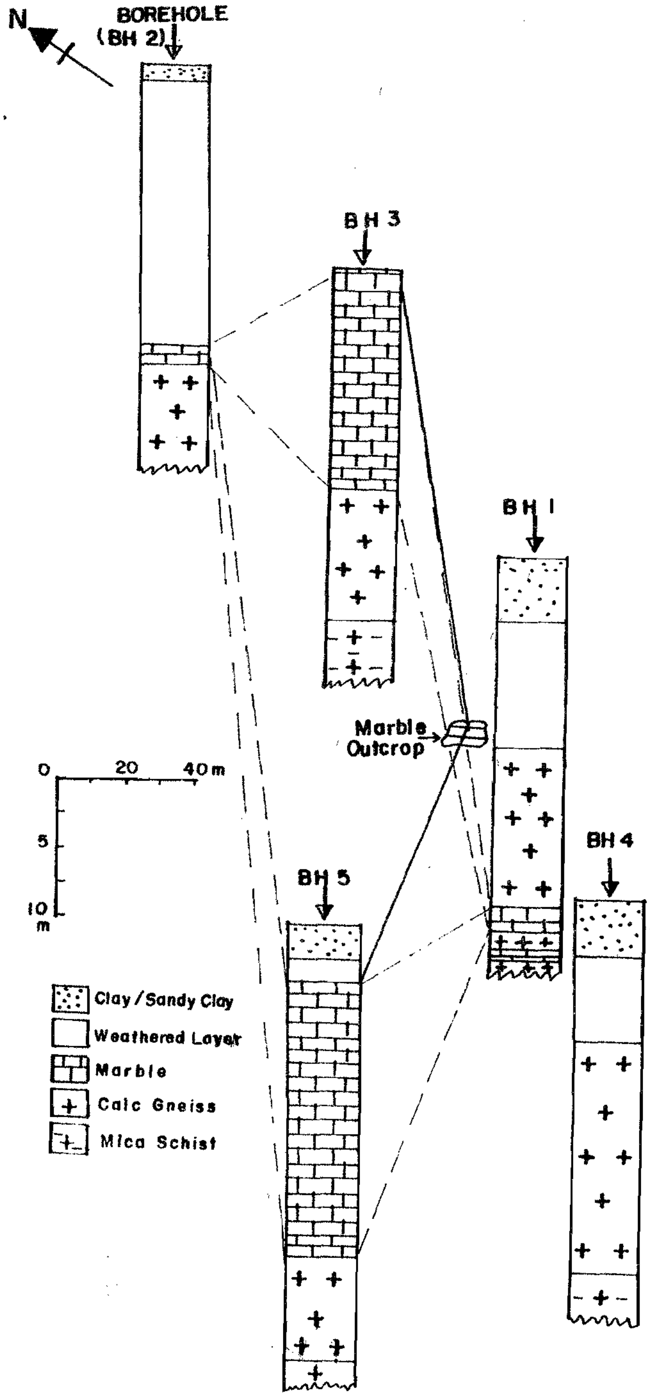

Figure 5: Correlation of Borehole Lithological Logs.

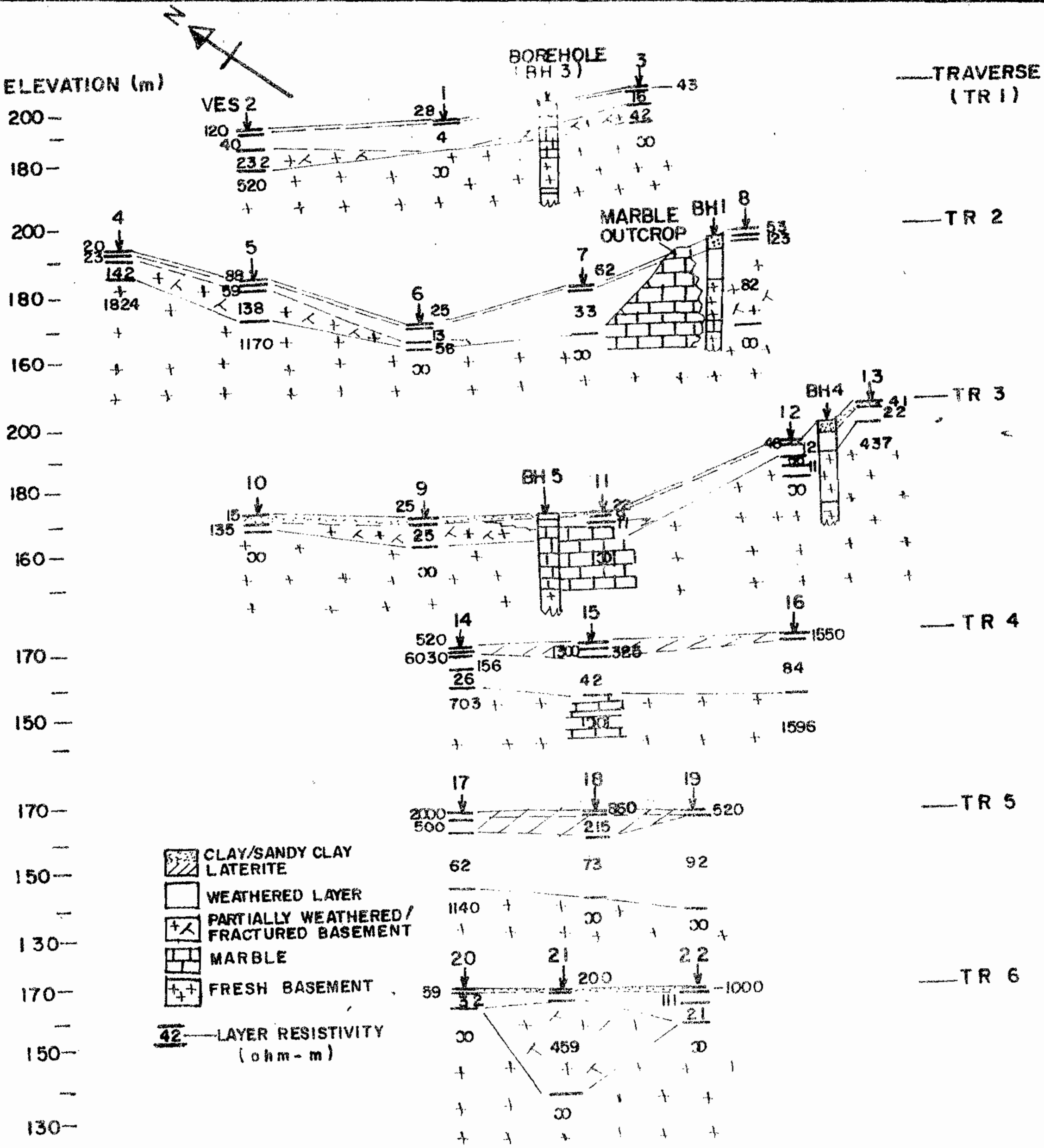

Figure 6: Geoelectric Sections with Correlated Borehole Logs along Traverses 1-6.

Figure 6 shows the geoelectric sections along all the traverses. Four geologic layers were delineated in the survey area.
These include a clay/sandy clay and lateritic clay topsoil, weathered layer composed of clay, partially weathered/fractured basement and the fresh basement of granite gneiss, calc gneiss and marble. The overburden thickness (i.e. depth to rockhead) generally varies between 0 and 30.4m while the depth to the outlined marble rockhead

ranges from 0 to 16m.

The bedrock relief map, as determined from the vertical electrical resistivity sounding interpretation results, is shown in Figure 7. The area is characterised by a major bedrock depression, approximately NE-SW and which may have influenced the course of the Tarkwa river. The inferred zone of marble deposit is located on the southern flank of this depression. The buried crystalline basement plunges in a southwesterly direction corroborating the inference made from the borehole data.

The marble deposit and the associated granite gneiss/calc gneiss (Fig. 5) are low porosity, high resistivity crystalline rocks whose resistivity values are generally within the same range. The no-resistivity or low-resistivity contrast situation between the rock units makes the determination of the marble thickness difficult from VES data.

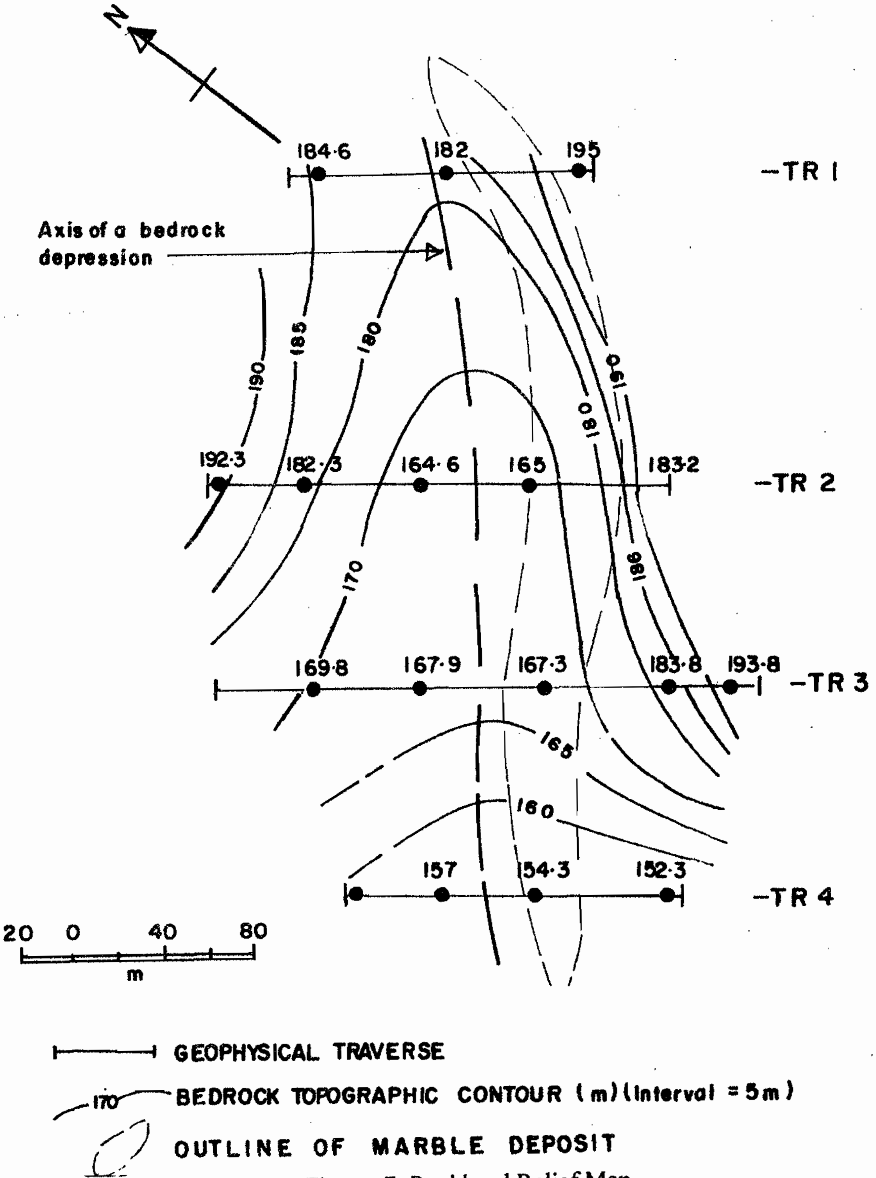

Figure 7: Rockhead Relief Map.

CONCLUSIONS

The Takalafia marble deposit was investigated using the electrical resistivity and magnetic methods. The deposit is characterised by combined local resistivity high of 20 - 61 ohm-m within an immediate background values of less than 10 ohm-m and low magnetic effect of less than 800 gammas. The outline of the deposit, based on this geophysical anomaly pattern, has an approximately NE-SW trend with lateral and width extent of approximately 400m and 40m respectively. The body has a southwesterly plunge.

Test borehole drilling confirmed the existence of the deposit within the geophysically inferred outline. The borehole logs showed that the marble deposit is concealed beneath a variably thick clay/sandy clay weathered layer with depth to the marble rockhead varying from 0 to 16m (see Fig. 5). The thickness of the deposit varies from 1.3 to 19.6m.

Although additional borehole data will be needed for an accurate resource quantification of the marble deposit, the delineated areal extent of the marble deposit (400 x 40) m^2 and thickness of up to 19.6 m makes it economically attractive.

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