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EVALUATION OF QUATERNARY AQUIFER BETWEEN QENA AND LUXUR. (NILE VALLEY, Egypt)

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تقييم خزان المياه الجوفية لزمن الرباعي بين قنا والأقصر (وادي النيل - مصر)

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تتناول الدراسة الحالية استخدام طريقة المقاومة النوعية الكهربية لتقييم خزان المياه الجوفية في جزء من منطقة وادي النيل بين قنا والأقصر – بمصر، وقد أوضحت تلك الدراسة النتائج التالية : تم تقسيم الطبقات التحت سطحية إلى ثلاثة مجموعات من الطبقات على النحو التالي:

١- **مجموعة الحقب الرباعي** : والتي تتكون من :

- **طبقة (أ)**: وهي الطبقة السطحية وتتكون من حصي ذات مقاومة نوعية كهربية عالية جداً تتراوح بين ٩٥٠ – ٤٩٣٠٠ أوم – متر ويتراوح سمكها ما بين ١,٥ – ٤٠,٥ متر.
- **طبقة (ب)**: وتتكون من حصي ورمل ذات مقاومة كهربية نوعية عالية نسبياً حيث تتراوح بين ٣٤,٨ و ٥٥٨ أوم – متر وعمق بين ٠,٤٨ و ٣٦,٩ متر.
- **طبقة (ج)**: تتكون من غرين النيل الذي يتميز بمقاومة كهربية نوعية صغيرة تتراوح بين ٢,٥ و ١٧,٧ أوم – متر وعمق يتراوح بين ١,٣ و ١٨ متر.
- **طبقة (د)**: وهي الخزان الرئيسي للمياه الجوفية لزمن الرباعي وهي ذات مقاومة كهربية نوعية بين ١٧,٢ و ٩٧ أوم – متر وعمق يتراوح بين ٦,٦ و ٢٩٧ متر.

٢- **تكوين طفلة الداخلة**: من العصر الماستيختيان–دانيان يتميز بمقاومة كهربية نوعية صغيرة تتراوح بين ١,٢١ و ٦,٥ أوم – متر وعمق يتراوح بين ١٧٨ و ٧٣٤ متر.

٣- **تكوين الحجر الرملي النوبي**: من العصر الكريتاسي ويتميز بمقاومة كهربية نوعية متوسطة تتراوح بين ٧,٤ و ٣٥,٦ أوم–متر وعمق يتراوح بين ١٧٨ و ٧٣٤ متر، وهذا التكوين لا يتواجد في كل القطاعات.

يتضح مما سبق أن هناك خزانان للمياه الجوفية الأول يتواجد بالطبقة (د) حيث تتميز المياه الجوفية بداخله بتفاوت في نوعيتها، والثاني يتواجد في تكوين الحجر الرملي النوبي حيث تتميز مياهه بأنها أقل جودة من الخزان الأول.

ABSTRACT

In order to evaluate the hydrogeological setting of the Quaternary aquifer and the related geological structures controlling its characteristics. A total of 50 vertical electrical soundings (VES,s) were conducted along 13 profiles covering the area between Qena and Luxur.

As revealed from the present study, the Quaternary section in the area is subdivided into four main geoelectrical zones distributed irregularly in the study area: Zone (A) with very high electrical resistivity values ranges between 950 and 49300 ohm-m. and thickness between 1.5 and 40.6 m. This zone is interpreted as gravely one. Zone (B) is characterized by electrical resistivity values ranges between 34.8 and 558 ohm-m. and depths between 0.48 and 36.9 m. and is formed of sand and gravels. Zone (C) has electrical resistivity values ranges between 2.5 and 17.7 ohm-m. and depths between 1.3 and 18 m., is formed from Nile silt. Zone (D) represents has electrical resistivity values range between 17.2 and 97 ohm-m. depths between 6.6 and 297 m. This zone represents the water-bearing layer of Qena - Dandara Formation.

A low resistivity zone with resistivity values ranging between 1.21 and 6.5 ohm-m. and usually extends to the maximum depth of penetration is detected (Dakhla Shale). Another water bearing aquifer layer with resistivity ranging between 7.4 to 35.6 ohm.m.(Nubia sandstone) underlying Dakhla Shale Formation.

INTRODUCTION

Decline in natural resources resulted from growing populations. The surface fresh water resources are relatively meagre to cater the need of various nations. As such, groundwater resources are the most suitable resources to cover between the water demand and already available sources. Geophysical techniques are among the suitable tools for searching for the groundwater.

The study area is located in a part of the Nile Valley which includes most of Qena Government, and lies between latitudes 25° 35\` and 26° 30\`E, and longitudes 32° 25\` and 32° 55\`N (Fig. 1).

The electrical resistivity method is considered as a quick and economic method for detecting the water bearing aquifer. Each geological formation is characterized by its specific electrical conductance, which typically depends on mineral, water content, porosity and salinity (Parasnis, 1997) [1].

Geologically, the Nile Valley is surrounded from both sides by escarpments that capped by rocks ranging in age from Pre-Cambrian to Eocene. The stratigraphic sequence in the study area ranging in age from Upper cretaceous to Quaternary and consists of seven formations. Table 1 shows these formations and their equivalent age, thickness and lithology. According to Said (1981) [2] the Quaternary Deposits are composed of four systems, each characterized by its specific lithologic content. These systems are:

* **Zone A:** made up of cobbles and gravel sediments (Protonile)
* **Zone B:** composed from gravels and sand.
* **Zone C:** the Nile Silt (Neonile).
* **Zone D:** composed of massive, cross-bedded sand (Qena-Dandara Formation) as the water bearing aquifer (Prenile).

METHODOLOGY AND INTERPRETATION

The electrical resistivity measurements executed within the present study were carried out applying the vertical electrical sounding (VES) technique, which measures the electrical resistivity variation with depth. The resistivity is more controlled by the water contents and its quality within the formation rather than its resistivity. Therefore, the geological unit may be subdivided into different geoelectrical units according to the different percentage of humidity within it.

Schlumberger arrays with 1m to 1000 m current electrode half spacing (AB/2) is used. This spacing is sufficient to reach adequate depths covering the Quaternary aquifer in the study area (Roy and Eilliot, 1981) [3]. A total number of 50 vertical electrical soundings were measured along 13 profiles (Fig. 1).

The geoelectrical resistivity measurements were performed applying two U.S.A. multimeter units of the type Fluke-27 allowing to filter the potential of the earth and measure the potential difference (?V) due to flowing current (I) into the subsurface. About 20% of the total measurements were recorded twice changing the supply voltage. According to these repetitions the mean relative error for the field measurements was calculated and found to be ±1.45%, which is regarded, as satisfactory.

The results of the geoelectrical survey were presented as geoelectrical sections. Quantitative interpretation of the earth resistivity measurements have been carried out by Koefoed (1965), Gosh (1971), Zohdy (1975 and 1989), and Hemeker (1984) [4, 5, 6, 7, 8 and 9]. The interpretation of the apparent electrical resistivity data were achieved using two methods, the first is based on curve matching technique using Generalized Cagniard Graph method constructed by Koefoed (1960) [10], in which the results obtained are subjected to a direct method using computer programs constructed by Hemeker (1984) [9].

DATA INTERPRETATION AND DISCUSSION

Profile A: (Fig. 3 and Table 2)

This profile is located to the east of Deshna, trending nearly NE - SW and extends for about 14.5 Km, it crosses nearly perpendicularly the Nile and the Nile Valley. Four soundings were measured along this profile namely, VES 2, 3, 4, and 5. This geoelectrical section is discussed as follows:

The Quaternary Deposits:

* A superficial unit with relatively high electrical resistivity value of about 5310 ohm-m. is detected at VES 2. It is formed from dry gravel (Zone A) and has maximum depth of about 28.6 m.
* A second layer extending to the surface and is characterized by relatively moderate electrical resistivity value of about 524 ohm-m, with depth of about 1.5 m. and is located at VES 5. It is formed from gravel with sand unit (Zone B).
* From the middle part to the southern part of VES 5, the ground surface is covered by Nile Silt (Zone C) which is characterized by low electrical resistivity values between 3.6 and 4.9 ohm-m. with maximum depth ranging from 5.7 to 8 m.

* Another layer with moderate electrical resistivity values ranging between 21.3 and 73 ohm-m. with depth ranging from 6.6 to 178 m. The Qena - Dandara Formation (Zone D). The main aquifer at the quaternary deposits belongs to this layer.

The Dakhla Shale Formation

Very low electrical resistivity values range between 2.9 and 4.04 ohm- m. characterize this formation and dominates allover this profile. The maximum detected depth to the Dakhla Shale Formation varies between 352 and 538 m. beneath VES 4 and VES 2 respectively and extends to the maximum depth of penetration beneath VES 3 and VES 5.

The Nubia Sandstone Formation:

At the maximum depth of penetration around VES,s 2 and 4, the Nubia Sandstone Formation can be detected with electrical resistivity values ranging from 11.4 to 16.3 ohm-m. This formation is being considered as the main aquifer of the Cretaceous age (Table 2).

Structure:

Profile A is affected by a geological- geoelectrical fault plane between VES 2 and VES 3 with down thrown side toward the southern direction. This fault is responsible for the characteristic depth variations along the study profile.

Profile B: (Fig. 4 and Table 2)

It begins nearly at the southern part of the Dandara, extending towards the NE direction going through Wadi Qena. It extends to a total length of about 36 Km. Five soundings namely VES 6, 9, 10, 16, and 15 were measured along this profile. This section which is represented by figure (4) is discussed as follows:

The Quaternary deposits

Three main geoelectrical units are detected along this profile:

* The superficial unit with relatively very high electrical resistivity values between 1010 and 4380 ohm-m. and depth ranging between 1.5 and 5.7 m. It is formed from **dry gravel** (Zone A) where located allover this profile, with an exception around of VES 9.
* The second unit is detected at various depth ranges between 5 and 13.3 m. It is characterized by moderate electrical resistivity values ranging between 171 and 558 ohm-m. It is formed from **gravel with sand** (Zone B).
* Relatively moderate electrical resistivity values ranging between 21.9 and 61.2 ohm-m. characterize the third unit of the Quaternary deposits. The maximum detected depth ranges from 27.5 to 110 m. It is formed from the **Qena-Dandara** unit (Zone D) which considered as the Quaternary water bearing layer.

The Dakhla shale Formation

This formation is represented as relatively low electrical resistivity layer ranging between 1.21 and 8.5 ohm-m. To the north of VES 9 this formation extends to the maximum depth of penetration. It extends from 225 to 503 m. south of VES 9.

The Nubia Sandstone Formation: (water bearing aquifer)

It can be detected at 225 and 503 m depth at VES 6 and VES 9 respectively, with relatively moderate electrical resistivity values ranging between 17.87 and 119 ohm-m.

Structure

This profile is affected by a geological - geoelectrical fault northeast of VES 6 with down thrown side towards the northeastern direction.

Profile C: (Fig. 5 and Table 2)

This profile begins from south of Qena with general trends to the northern direction, with a total length for about 38.2 Km. It is covered by seven VES,s namely VES 7, 9, 10, 11, 12, 13, and 14. This section (Fig. 5) is discussed as follows:

The Quaternary Deposits

It contains three geoelectrical units, which are explained as follows:

* The first unit is formed of **dry gravel** (Zone A), which is characterized by very high electrical resistivity values ranging between 1060 and 16600 ohm-m. and various depths ranging between 1.9 and 40.6 m. It is located at the area from VES 10 to the end of this profile in the northern direction.
* The second unit of the Quaternary Deposits is characterized by relatively high electrical resistivity values ranging between 171 and 269 ohm-m, and various depth ranging from 1.3 to 13.3 m. It is located at the southern part of VES 11 and is formed from the **gravel with sands** (Zone B).
* The Third unit (Zone D) is the **Qena - Dandara** Formation (water bearing layer) which characterized by relatively moderate electrical resistivity values ranging between 29.6 and 50 ohm-m. with various depth ranges from 14.6 to 129 m. allover this profile.

The Dakhla Shale Formation

Relatively low electrical resistivity values ranging between 1.21 and 3.68 ohm-m. represent this formation. The maximum depth to this formation ranges from 503 to

640 m. To the south of VES 9 it is extends to the maximum depth of penetration.

The Nubia Sandstone Formation:

This formation is located at the southern part of VES 9 with electrical resistivity range from 17.2 to 17.87 ohm-m.

Structure

This profile is affected by three fault planes (F1F1, F2F2 and F3F3) as shown by figure (4)

Profile D: (Fig. 6 and Table 2)

This profile is located south of Qena and extends normally SW-ENE for about 9.3 Km. Three vertical electrical sounding namely VES 7, 8, and 17 were measured along this profile. The study of the geoelectrical section indicates that:

The Quaternary Deposits:

Along this profile, three geoelectrical units are detected and explained as follows:

* The first unit is represented as a relatively high electrical resistivity value of about 1470 ohm-m. at the ground surface around of VES 17 and extends to 4m depth. It is formed from **dry gravel** (Zone A).
* The second unit characterized by moderate electrical resistivity values ranging between 39.8 and 199 ohm-m. with maximum depth ranges from 1.3 to 36.9 m. It is formed from **gravel with sand** (Zone B).
* The third unit characterized by relatively low electrical resistivity values ranging between 29.6 and 60.7 ohm-m. and maximum depth ranges from 34 to 137 m. This formation represents as the **Qena - Dandara** Formation (Zone D) as the main aquifer of the Quaternary age.

The Dakhla Shale Formation:

It is represented allover this profile with relatively low electrical resistivity values ranging between 2.4 and 3.68 ohm-m. with maximum depth from 475 to 640 m. southwest of VES 17.

The Nubia Sandstone Formation:

It characterized by low electrical resistivity values ranging between 16.2 and 17.2 ohm-m. This formation can be detected at the maximum depth of penetration northeast of VES 17.

Structure:

This profile is affected by a geoelectrical fault south west of VES 8 with down thrown side toward the northeastern direction.

Profile E: (Fig. 7 and Table 2)

This profile extends from the north of El Salheya cross the Nile bend in the southern direction and extends for about 12.2 Km till reaches the site of VES 19. Three vertical electrical soundings namely VES 17, 18, and 19 were measured along this profile. The geoelectrical units are discussed hereunder:

The Quaternary Deposits:

Four geoelectrical units are distinguished as follows:

* The first unit (4 m thickness) has relatively high electrical resistivity value of about 1470 ohm-m. This formation is formed from **dry gravel** (Zone A) covering the ground surface around of VES 17.
* The second unit characterized by relatively moderate electrical resistivity values ranging between 34.8 and 199 ohm-m. and thickness ranges from 0.6 to 36.9 m. It is formed of **gravel with sand** (Zone B) and is located allover this profile.
* The third unit is characterized by very low electrical resistivity values ranging between 2.5 and 6.1 ohm-m. It is formed from **Nile silt** (Zone C) underlying the gravel with sand which south west of VES 17 with maximum detected depth ranges from 3.8 to 4.7 m.
* The fourth unit characterized by electrical resistivity values ranging between 25.7 and 36.8 ohm-m. and is located at various depths along allover this profile ranging from 41.3 to 137 m. This unit is being considered as a water bearing aquifer at the Quaternary deposits.

The Dakhla Shale Formation:

This formation is formed from shale and marl as the impermeable layer. It characterized by relatively low electrical resistivity value ranges from 3 to 4.4 ohm-m and extends to the maximum depth of penetration allover this profile with exception around of VES 19 and VES 17 where depth for about 331 and 640 m., respectively.

The Nubia Sandstone Formation:

At the maximum depth of penetration around of VES 17 and VES 19, the Nubia Sandstone Formation can be detected as relatively moderate electrical resistivity values ranging between 17.2 and 18 ohm-m.

Structure:

Profile E is affected by a geoelectrical fault plane north of VES 19 with down thrown side towards the northern direction.

Profile F: (Fig. 8 and Table 2)

It begins from the northern direction of El Barahma and extends in a NE direction to cross the bend of the Nile and goes through Wadi El - Sura. It extends for about 12.4 Km. Four vertical electrical soundings, namely VES 19, 20, 21, and 22 (VES) were measured along this profile. The geoelectrical section are discussed as following:

The Quaternary Deposits:

Four geoelectrical units are distinguished along this profile as follows:

* A superficial unit located northwest of VES 20, and is characterized by relatively high electrical resistivity values ranging between 1050 and 3760 ohm-m. and is formed of **dry gravel** with maximum depth ranges from 2.1 to 5.6 m (Zone A).
* The second unit characterized by relatively moderate electrical resistivity value ranging between 34.8 and 195 ohm-m., and is located southwest of VES 22 with maximum depth ranges from 0.6 to 7.4 m. It is formed from **gravel with sand** (Zone B).
* The third unit characterized by low electrical resistivity value ranging between 4.7 and 6.1 ohm-m. and maximum depth ranging from 3.5 to 3.8 m. This layer is formed from the **Nile Silt** (Zone C) and is located southwest of VES 21.
* The main aquifer at the quaternary deposits is the **Qena - Dandara** Formation (Zone D) and is represented as the fourth unit. It characterized by relatively moderate electrical resistivity values ranging between 17.2 and 69.7 ohm-m. and maximum depth ranging from 40.6 to 85.9 m. It is detected allover this profile.

The Dakhla Shale Formation

It is characterized by very low electrical resistivity values ranging between 1.7 to 4.4 ohm-m. allover this profile. The maximum depth to the Dakhla Shale Formation varies form 279 to 331 m beneath VES 19 and 20, respectively and extends to the maximum depth of penetration at VES 21 and VES 22.

The Nubia Sandstone Formation:

At the maximum depth of penetration around VES,s 19 and 20, the Nubia Sandstone Formation is detected with relatively moderate electrical resistivity values ranging between 8 and 18 ohm-m. This formation is considered the main aquifer of the Cretaceous age.

Structure:

Profile F is affected by a geoelectrical fault plane between VES 20 and 21 with down thrown side toward the southwestern direction.

Profile G: (Fig. 9 and Table 2)

This profile begins southwest of El Barahma (Fig. 1). It runs nearly from the west to the east with a total length for about 15.3 Km. It is covered by four Vertical electrical soundings namely 26, 25, 24, and 23. This section is explained as follows:

The Quaternary Deposits:

* A superficial unit characterized by relatively moderate electrical resistivity values ranging between 60.1 and 401 ohm-m. with various depth ranges from 0.48 to 20.6 m. It is formed of the **gravel with sand** (Zone B).
* A second unit characterized by relatively low electrical resistivity values ranging between 3.5 and 10.6 ohm-m. with maximum detected depth range from 1.3 to 10 m. It is formed of the **Nile silt** (Zone C).
* The main water bearing aquifer (Zone D) belongs of the **Qena - Dandara** Formation which is located allover this profile. This layer characterized by relatively moderate electrical resistivity value ranging between 38.6 and 97 ohm-m. and various depths range from 34.9 to 76.5 m.

The Dakhla Shale Formation:

This formation is located at the maximum depth of penetration allover this profile. Low electrical resistivity values ranging between 2.19 and 6.5 ohm-m. The Nubia sandstone is not detected along this profile.

Structure:

This profile is affected by one geoelectrical fault near of VES 25 with down thrown side toward the western direction.

Profile H: (Fig. 10 and Table 2)

It begins nearly at the western part of the Quft, extending from the west to the east direction with total length for about 16.7 kilometers. Five soundings namely 26, 27, 28, 29, and 30 were measured along this profile. The geoelectrical section is discussed as follows:

The Quaternary deposits

It is represented along this profile by four units:

* The superficial unit characterized by high electrical resistivity value ranging between 950 and 2280 ohm-m. It is formed from **dry gravel** (Zone A) covering the ground surface at the area east of VES 28 with maximum detected depth ranges from 1.7 to 17.8 m.
* The second unit is characterized by moderate electrical resistivity value of about 507 ohm-m. and maximum detected depth for about 8.2 m. It is formed from the **gravel with sand** (Zone B) at VES 29.
* The third unit characterized by relatively low electrical resistivity value ranging between 3.5 and 9.8 ohm-m. and maximum depth ranges from 3.8 to 18.1 m. It

is formed from the **Nile Silt** (Zone C) at the west of VES 29.

* The fourth unit characterized by moderate electrical resistivity value ranging between 19.6 and 92 ohm-m. and maximum detected depth from 21.6 to 136 m. It is formed from the **Qena-Dandara** Formation (Zone D) which represents as the Quaternary water bearing aquifer.

The Dakhla shale Formation

This formation is represented allover this profile as a low electrical resistivity value ranging between 2.1 to 6.5 ohm. m.. At VES,s 26, 28, and 30 this formation extends to the maximum depth of penetration. While, at VES,s 27 and 29 it extends to 517 and 302 m., respectively.

The Nubia Sandstone Formation:

It is detected at 517 and 302 m depth at VES 27 and VES 29, with moderate electrical resistivity values ranging between 9.7 and 17.1 ohm-m.

Structure

This profile is affected by two geoelectrical faults east and west of VES 29 forming a horst structure.

Profile I: (Fig. 11 and Table 2)

This profile is located at the west of Denfak with a total length for about 17.6 Km. It is covered by five Vertical electrical soundings namely VES 35, 34, 33, 32, and 31 from west to the east, respectively. The geoelectrical section can be summarized as follows:

The Quaternary Deposits:

Four lithologic units are detected and discussed as follows:

* The first unit is characterized by relatively very high electrical resistivity value of about 2420 ohm-m. at the ground surface around of VES 31 extends to a depth of 4.5m depth. It is formed from **dry gravel** (Zone A).
* The second unit is characterized by relatively high electrical resistivity value of 332 ohm-m. with 23.4m. maximum depth around of VES 31. It is formed from **gravel with sand** (Zone B).
* The third unit characterized by relatively low electrical resistivity value ranging between 4.3 and 15 ohm-m. and various maximum depths range from 2.7 to 7.2 m. It is formed from **Nile Silt** (Zone C) allover this profile with an exception around of VES 31.
* The fourth unit characterized by relatively moderate electrical resistivity value ranging between 18.1 and 64.9 ohm-m. with detected depth ranging from 34.8 to 61.3 m west of VES 31. This unit is considered as a main the Quaternary aquifer named the **Qena - Dandara** Formation (Zone D).

The Dakhla Shale Formation:

It is represented allover this profile with very low electrical resistivity values ranging between 2.3 and 4.18 ohm-m. with maximum depth ranging from 337 to 734 m. at VES 31, 32, and 35, and extends to the maximum depth of penetration around VES 33 and VES 34.

The Nubia Sandstone Formation:

It characterized by moderate electrical resistivity value ranging between 9 and 14.3 ohm-m. This formation extends to the maximum depth of penetration at VES 31, 32, and 35.

Structure:

This profile is affected by a geoelectrical fault at the west of VES 31 with down thrown side toward the western direction.

Profile J: (Fig. 12 and Table 2)

It runs through the area northwest of Naga Asmant El-Keber and trends nearly from west to east with a total length for about 11.2 Km. It is covered by four vertical electrical soundings namely VES 36, 37, 38, and 39. The geoelectrical section is discussed as:

The Quaternary Deposits:

* The first unit is characterized by very high electrical resistivity value of 49300 ohm-m. It is formed from **dry gravel** (Zone A) covered the ground surface around of VES 39 and has a thickness of 2.3 m.
* The second unit of the Quaternary deposit characterized by relatively moderate electrical resistivity values ranging between 113 and 343 ohm-m. and various depth ranges from 0.6 to 10.3 m. It is formed from **gravel with sand** (Zone B) at the area between VES 38 and 39.
* The third unit characterized by relative low electrical resistivity value ranging between 3.7 and 4.3 ohm-m. west of VES 38. It is formed of the **Nile silt** (Zone C) and maximum detected depth ranges from 4.3 to 5.9 m.
* The fourth unit characterized by relatively moderate electrical resistivity values ranging between 20.9 and 89 ohm-m. It is considered as a water bearing aquifer at the Quaternary deposits from **Qena - Dandara** Formation (Zone D). This unit is detected at various depths allover this profile which range from 44.1 to 85.1 m.

The Dakhla Shale Formation:

This formation is formed of shale and marl as the impermeable layer. It is characterized by very low electrical resistivity values ranging between 2.6 and 4.9 ohm-m. and extends to maximum depths ranges from 178 to 668 m. allover this profile.

The Nubia Sandstone Formation:

At the maximum depth of penetration under V.S.E. 39, the Nubia Sandstone Formation is detected with moderate electrical resistivity value ranging between 11.5 and 35.6 ohm-m.

Structure:

Profile J is affected by two geoelectrical faults east of VES 36 and west of V.S,E.39 with down thrown side towards the east and west direction respectively.

Profile K: (Fig. 13 and Table 2)

It begins from the west direction of El Karnak and extends east crossing the bend of the Nile and extends for about 18.5 Km. Five vertical electrical soundings (VES) were measured along this profile namely, VES 40, 41, 42, 43, and 44 (Fig. 1). The geoelectrical section is discussed as following:

The Quaternary Deposits:

* A superficial unit is characterized by high electrical resistivity value of 5540 ohm-m. It is formed from **dry gravel** with a maximum depth of about 2.1m. (Zone A) and located around VES 40.
* The second unit characterized by relatively low electrical resistivity value ranging between 3.2 and 7.6 ohm-m. and maximum depth ranging from 2.8 to 6.8 m. It is formed of the **Nile Silt** (Zone C) and is located southwest of VES 40.
* The third unit characterized by relatively moderate electrical resistivity value ranging between 17.2 and 69.7 ohm-m. and maximum depth ranging from 26.8 to 80 m. It is formed of the **Qena - Dandara** Formation (Zone D) detected allover this profile. It is forms the main aquifer in the quaternary deposits.

The Dakhla Shale Formation

It can detect by very low electrical resistivity value ranging between 1.3 and 3.4 ohm-m. along this profile. The maximum depth to the Dakhla Shale Formation varies from 172 to 379 m.

The Nubia Sandstone Formation:

The Nubia Sandstone Formation is detected with moderate electrical resistivity values ranging between 10.8 and 16.5 ohm-m. This formation is considered as the main aquifer from the Cretaceous age.

Structure:

Profile K is affected by two geoelectrical fault planes located to the east of VES 44 and near VES 41 with down thrown side toward the western and eastern direction, respectively.

Profile L: (Fig. 14 and Table 2)

This profile occupies the area northwest of El Dobia with general trend toward the southeast direction with total length of about 9.3 Km. It is covered by three vertical electrical soundings namely VES 45, 46, and 47 (Fig. 1). The geoelectrical section is discussed as follows:

The Quaternary Deposits:

* A superficial unit is characterized by relatively moderate electrical resistivity values ranging between 124 and 279 ohm-m. and maximum depth ranges from 0.9 to 3.1 m. northwest of VES 47. It is formed from **gravel with sand** (Zone B)
* The second unit is characterized by relatively low electrical resistivity values ranging between 5.2 and 16.8 ohm-m. It is formed from the **Nile silt** (Zone C) and is located southeast of VES 45 with various depth ranges from 1.5 to 2.6 m.
* The basal unit (third unit) is considered as the water bearing aquifer from the **Qena Dandara** Formation (Zone D). It characterized by relatively moderate electrical resistivity values ranging between 24.8 and 86 ohm-m. and various depths range from 111 to 297 m. This unit is detected allover this profile.

The Dakhla Shale Formation:

The Dakhla shale Formation is located at the maximum depths of penetration, with exception around VES 45. It has a very low electrical resistivity value ranging between 2.2 and 5.2 ohm-m.

The Nubia Sandstone Formation:

This formation is located at the depth of about 407m. at VES 45 with moderate electrical resistivity value of 26.2 ohm-m.

Structure:

This profile is affected by one geoelectrical fault northwest of VES 46 with down thrown side toward the southeast direction.

Profile M: (Fig. 15 and Table 2)

It occupies the area northwest of El Raiaina. The general trend of this profile is nearly northwest to southeast direction with a total length for about 10 Km. It is covered by three vertical electrical soundings namely VES 48, 49, and 50. The geoelectrical section is discussed hereunder:

The Quaternary Deposits:

* The first unit is characterized by relatively very low electrical resistivity values ranging between 4.7 and

8.4 ohm-m. It is formed from the **Nile silt** (Zone C) and is located at the ground surface with maximum extends ranges from 3.3 to 13 m.

* The second unit is characterized by electrical resistivity values range from 27 to 33 ohm-m. It represents the **Qena - Dandara** Formation (Zone D) and considered as the water bearing aquifer of the Quaternary deposits. This unit is located at various depths allover this profile ranging between 97.5 and 194 m.

The Dakhla Shale Formation:

This formation is formed of shale and marl as the impermeable layer. It characterized by very low electrical resistivity value ranges from 1.8 and 3.8 ohm-m. and extends to the maximum depth of penetration at VES 48 and from 452 to 497.5 m. at VES 49 and 50, respectively.

The Nubia Sandstone Formation:

The Nubia Sandstone Formation is detected at the maximum depth of penetration allover this profile, with exception around of VES 48. It characterized by moderate electrical resistivity value ranging between 7.4 and 8.05 ohm-m.

Structure:

Profile M is affected by two geoelectrical faults located SE and NW of VES 50 and 48, respectively. The central part of this profile beneath V.E.S. 49 and near the river bank forming graben structure.

CONCLUSIONS

The current study has revealed the following results:

The Quaternary deposits is formed of four units covering the ground surface of the area under investigation:

-Zone (A) represents the superficial one consists of gravel, which characterized by relatively high electrical resistivity value ranging between 950 and 49300 ohm-m. with maximum detected depth ranges from 1.5 to 40.6 m.

-The second zone (B) formed of gravel sand with variable electrical resistivity values ranging between 34.8 and 558 ohm-m. with maximum detected depth ranges from 0.48 to 36.9 m.

-The third zone (C) formed from Nile silt, which characterized by relatively low electrical resistivity values ranging between 2.5 and 17.7 ohm-m. with maximum detected depth ranges from 1.3 to 18 m.

-The main aquifer at the Quaternary deposits is the basal zone (zone D). It is characterized by moderate electrical resistivity value ranging between 17.2 and 97 ohm-m. with maximum detected depth ranges from 6.6 to 297 m.

*The Dakhla shale Formation characterized by relatively low electrical resistivity values ranging between 1.21 and 6.5 ohm-m. with maximum detected depth ranges from 178 to 734 m.

*The Nubia sandstone Formation (water bearing layer) of Cretaceous age detected with relatively moderate electrical resistivity value ranging between 7.4 and 35.6 ohm-m. and various depth ranging from 178 to 734 m. The presence of such units is not uniform allover the studied profiles, which indicate different mode of flooding and deposition. Therefor, the Nubia sandstone aquifer is being considered as good one.

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REFERENCES

(1) **Parasnis, D. (1997).** Principle of Applied Geophysics, London: Chapman & Hall.

(2) **Said, R. (1981).** The geological evaluation of the River Nile, Springer-verlag, New York, 174p.

(3) **Roy, K.K. and Elliot, H.M. (1981).** Some observation regarding depth of exploration in D.C. electrical methods, Geoexploration, Vol. 19, PP. 1-13.

(4) **Koefoed, O. (1965).** A direct methods of interpreting resistivity observations, Geophysical prospecting, Vol. 13, No. 4, PP. 568-591.

(5) **Koefoed, O. (1965).** A semi direct method of interpreting resistivity observations, Geophysical prospecting, Vol. 13, No. 2, PP. 259-282.

(6) **Gosh, D.A. (1971).** The application of geoelectrical resistivity measurements, Geophysical Prospecting, Vol. 19, PP. 192-217.

(7) **Zohdy, A.A.R. (1975).** Automatic interpretation of Schlumberger sounding curves using modified Dar Zarrouk functions, Bull. 13 B-E, U.S. Geological survey.

(8) **Zohdy, A.A.R. (1989).** A new method for the automatic interpretation of Schlumberger and Wenner sounding curve, Geophysics, Vol. 54, No. 2, PP. 245-253.

(9) **Hemeker, C.J. (1984).** Vertical electrical sounding model interpretation program, IWCO, The Netherlands.

(10)**Koefoed, O. (1960).** A generalized Cagniard graph for the interpretation of geoelectrical sounding data, Geophysical prospecting, Vol. 8, PP. 459-469.

Table (1)

General Stratigraphic Column at The Study Area.

Age	Formation	Thickness (m.)	Lithology
Quaternary	Fanglomerate	10	Fanglomerate
	Dibeira	20	Nile silt
	Qena-Dandara	80	Fluvial sands with thin clay lenses and gravel channels
Pliocene	Issawia-Armant	120	Clay and conglomerate
Lower Ecocene	Thebes	>300	Chalky limestone
Paleocene	Esna	90	Shale, with limestone and marl
Upper Cretaceous	Tarawan	20	Chalky limestone
	Dakhla	180	Shale
	Duwi	30	Shale, marly limestone, and phosphatic bands.
	Nubia	230	Sandstone with ferruginous band and glauconitic shale.

VES	Layer 1		Layer 2		Layer 3		Layer 4		Layer 5	
	ρ	D	ρ	D	ρ	D	ρ	D	ρ	D
1	301	2	60.1	27.7	11.4	178	5.1			
2	5310	28.6	25	17.8	4.04	538	11.4			
3	4.9	5.7	73	43.5	2.9					
4	17.7	1	3.6	8	21.3	27.9	3	352	16.3	
5	524	1.5	22.4	6.6	3.1					
6	4380	4	61.2	27.5	2.3	225	119			
7	186	1.3	29.6	34	3.68	640	17.2			
8	39.8	14.1	60.7	51.4	2.4	475	16.2			
9	171	10.3	39.2	67.5	1.21	503	17.87			
10	10601	1.9	269	13.3	36.24	32.8	3.02			
11	1080	40.6	50	129	2.63					
12	183	3.4	44.8	14.6	3.03					
13	16600	2.7	45	27.5	2.27					
14	1080	14.2	48	45.8	1.52					
15	1300	5.7	42	110	8.5					
16	1010	1.5	558	5	21.9	41.5	3.15			
17	1470	4	199	36.9	37.8	137	2.84			
18	77	0.6	2.5	4.7	25.7	64.5	3			
19	34.8	0.7	6.1	3.8	36.8	41.3	4.4	331	18	
20	36.	10.6	4.7	3.5	47.3	85.9	1.7	279	8	
21	1050	2.1	195	7.4	69.7	40.6	4.4			
22	3760	5.6	17.2	71	2.91					
23	40.1	20.6	38.6	64.4	2.19					
24	60.1	0.48	8.7	1.3	40.9	76.5	2.69			
25	10.6	10	97	34.9	4					
26	3.5	3.8	43	36.8	6.5					
27	6.6	10.4	36.8	36.3	3.9	517	9.7			
28	9.8	18.1	19.6	136	2.1					
29	2280	1.7	507	8.2	92	21.6	3	302	17.1	
30	950	17.8	35.6	90.2	5.8					
31	2420	4.5	332	23.4	3.3	337	14.3			
32	3.4	7.2	27.4	34.8	4.18	657	10.6			
33	11.5	7	46.3	61.3	3.4					
34	15	2.7	64.9	47.7	2.3					
36	3.7	5.9	24.7	85.1	3.2	406	35.6			
37	4.3	4.3	89	44.1	4.9	668	11.5			
38	113	0.6	69.4	67.6	3.1	633	11.7			
39	49300	2.3	343	10.3	20.9	61.1	2.6	178	13.8	
40	5540	2.1	80	14.3	2	220	13.8			
41	4.4	2.8	244	20.8	2.3	172	13.8			
42	3.2	3.6	26.8	21.3	199	3.4				
43	7.6	6.8	45.4	73	3	379	10.8			
44	4	4.4	32.3	21.8	1.3	336	14.3			
45	124	3.1	24.8	170	2.2	407	26.2			
46	279	0.9	5.2	2.6	40.5	111	3.5			
47	16.8	1.5	86	297	5.2					
48	6.2	3.3	33	194	3.8					
49	8.4	8	30.4	104	2.9	452	7.4			
50	4.7	13	27	97.5	1.8	497.5	8.05			

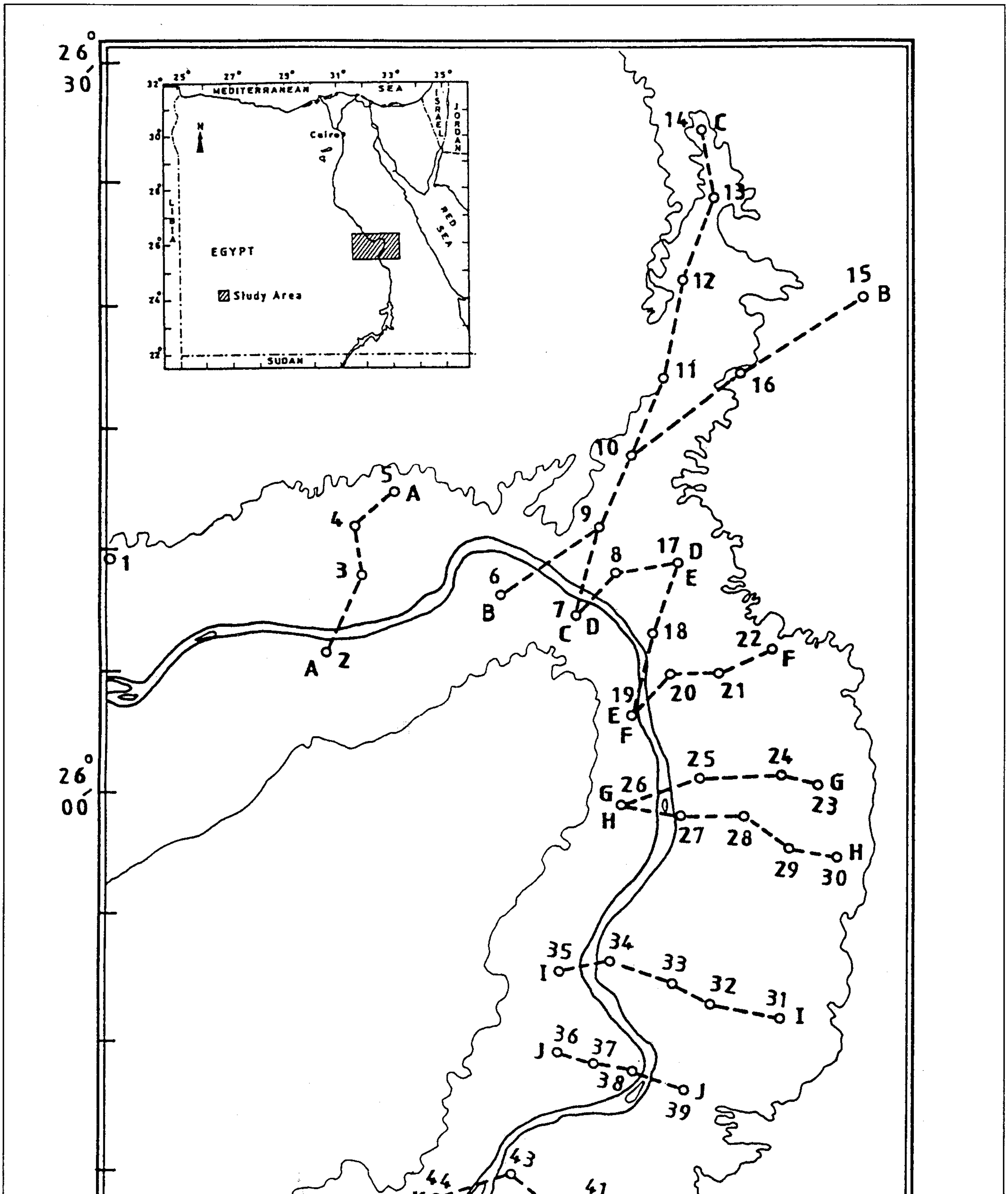

Fig. 1 : Area of Study

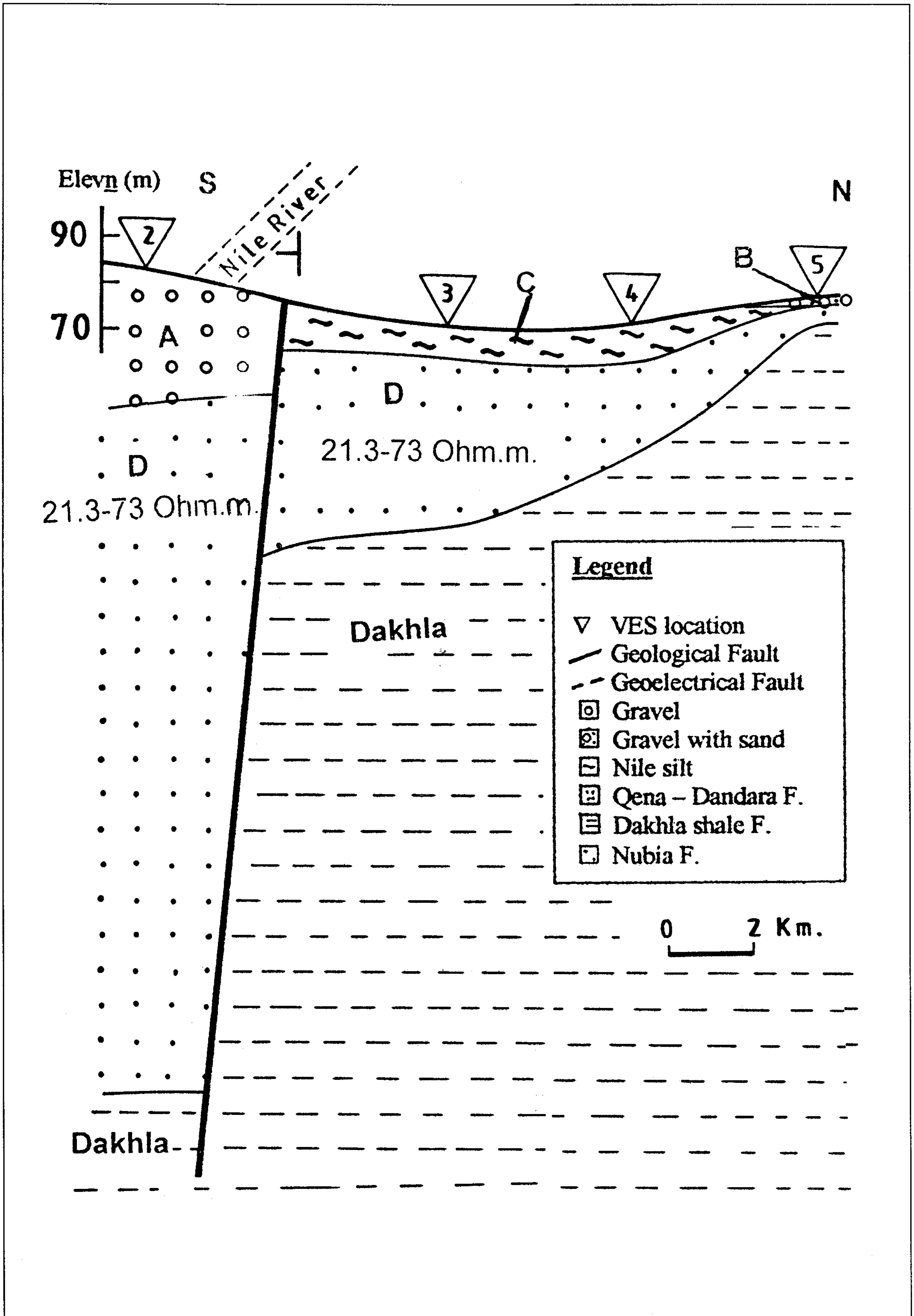

Fig. 2 : Geoelectrical Section of Profile A.

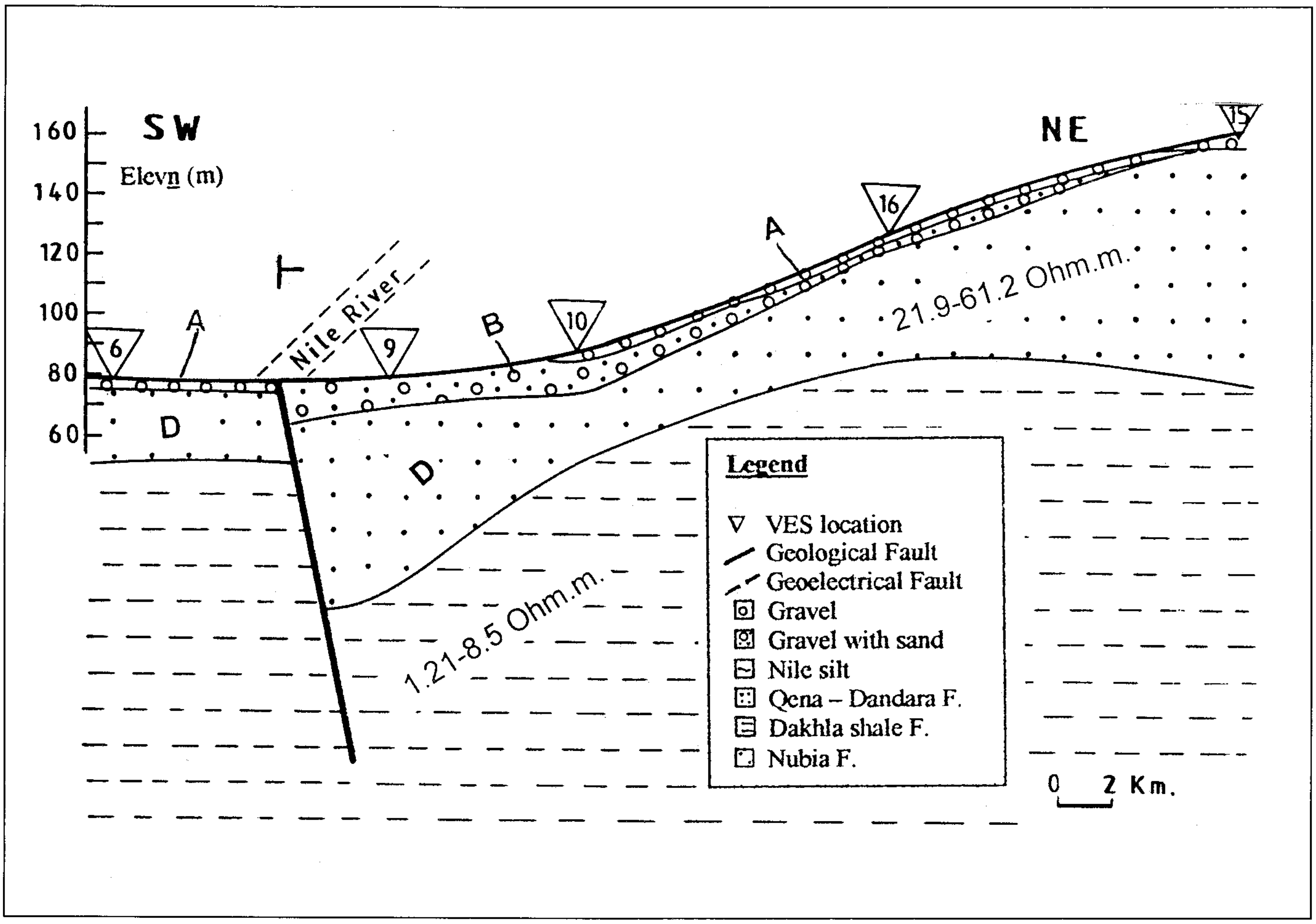

Fig. 3 : Geoelectrical Section of Profile B.

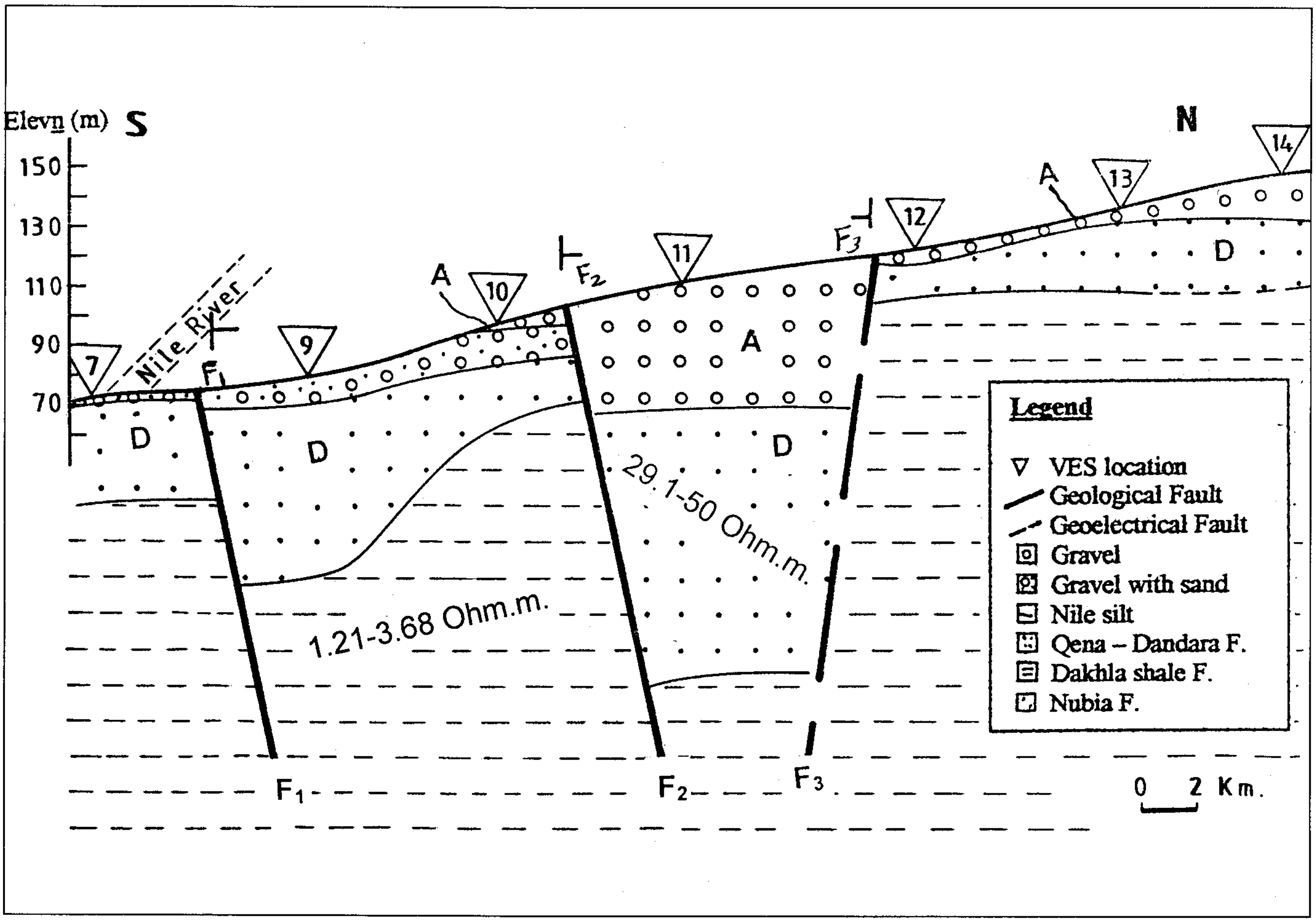

Fig. 4 : Geoelectrical Section of Profile C.

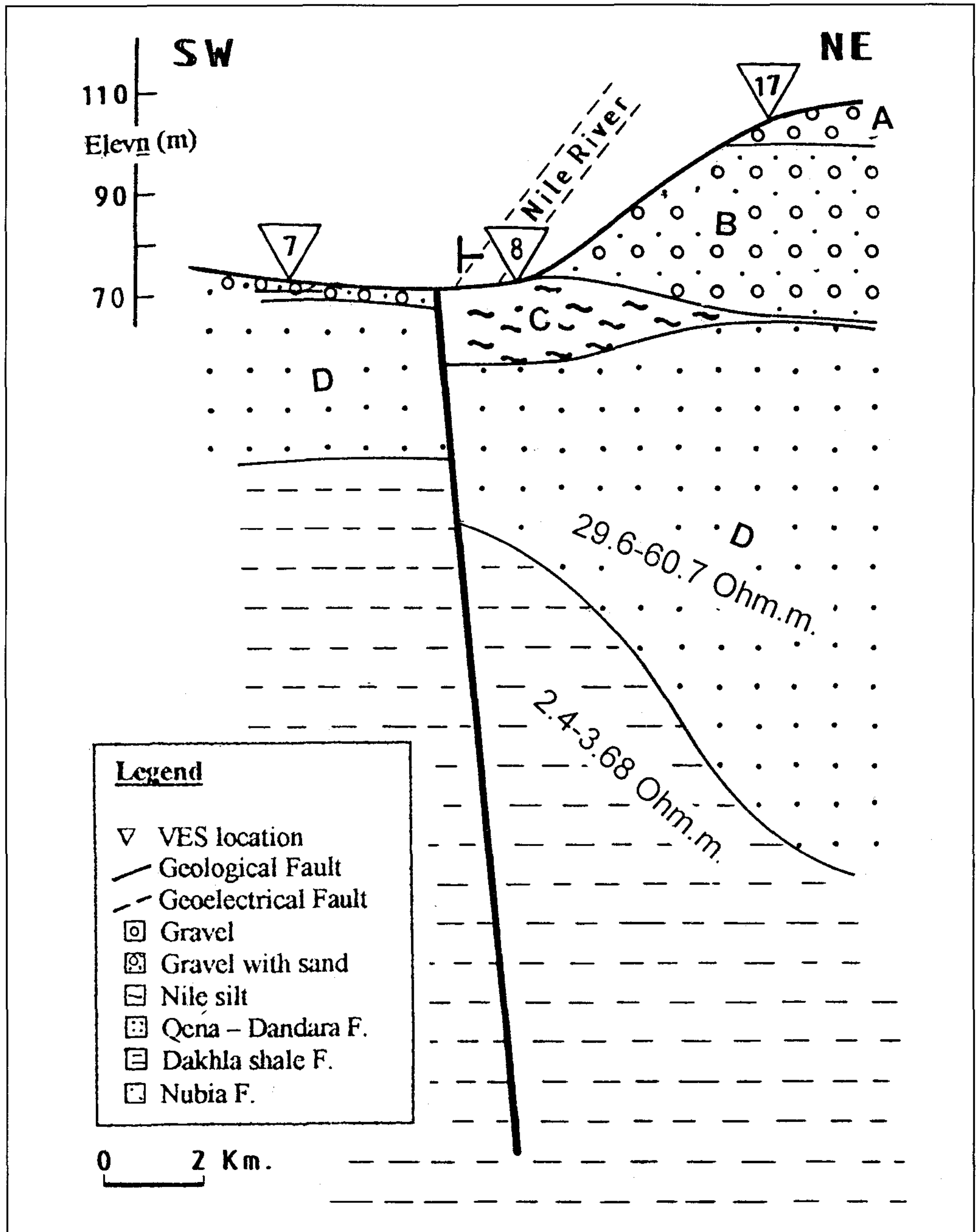

Fig. 5 : Geoelectrical Section of Profile D.

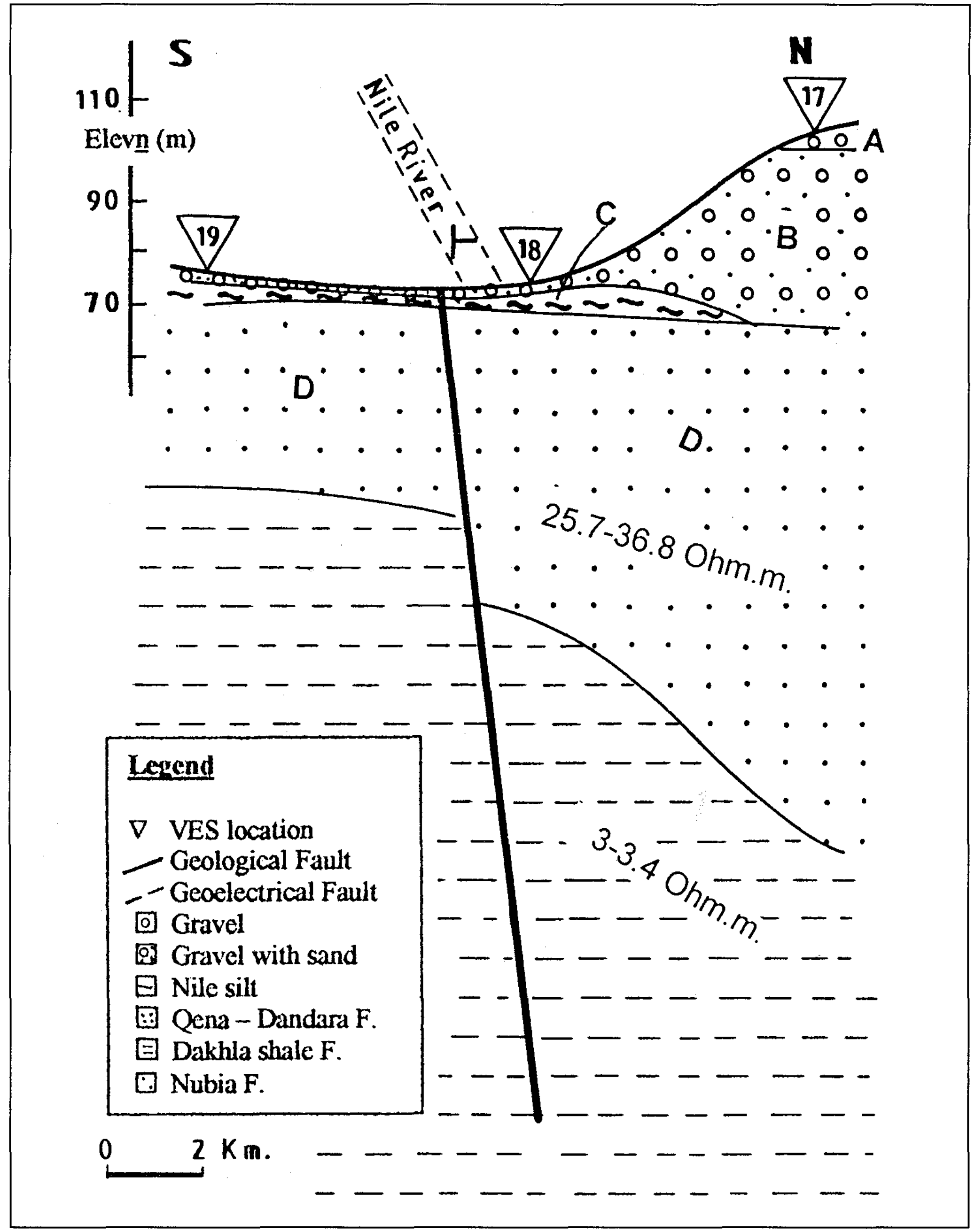

Fig. 6 : Geoelectrical Section of Profile E.

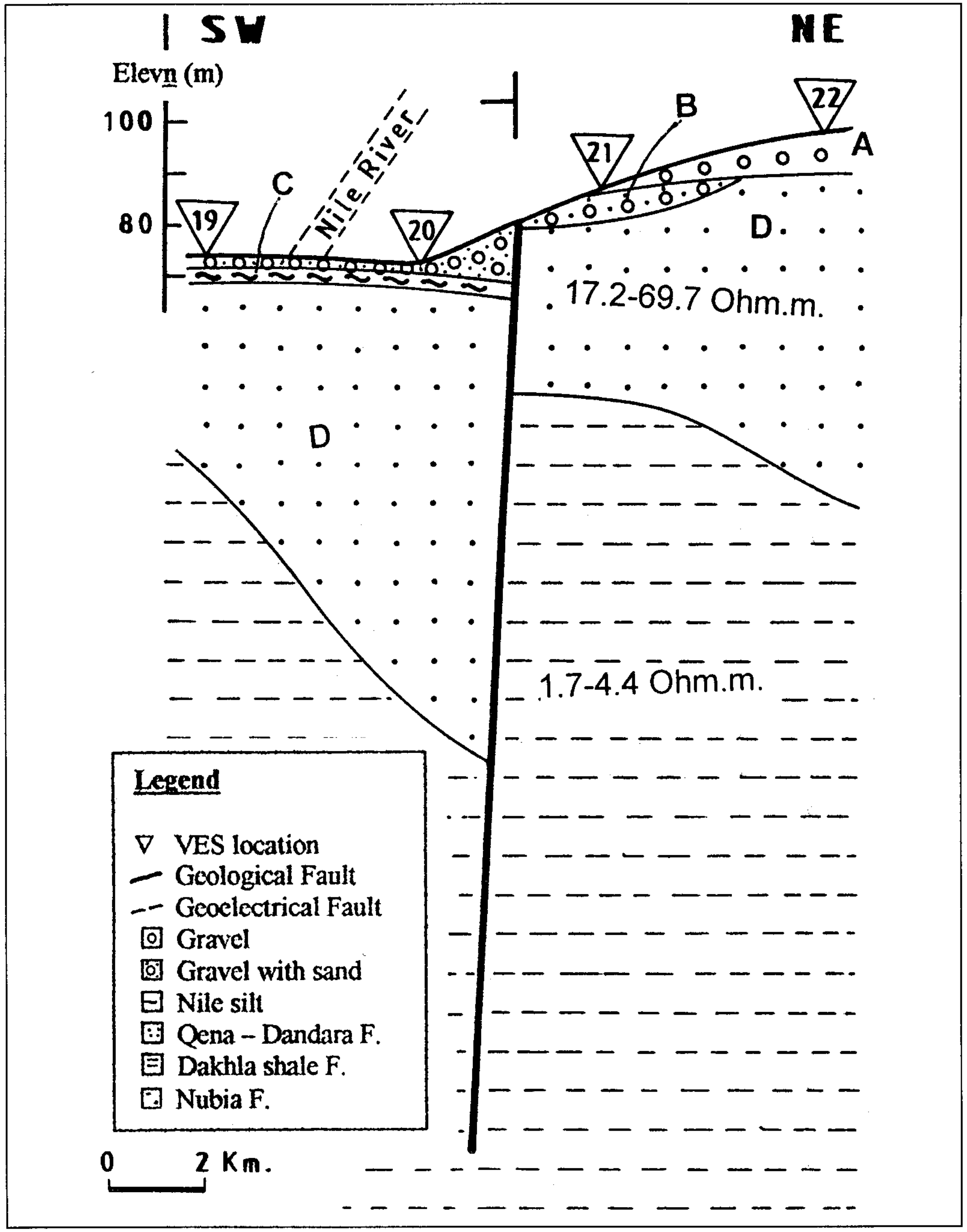

Fig. 7 : Geoelectrical Section of Profile F.

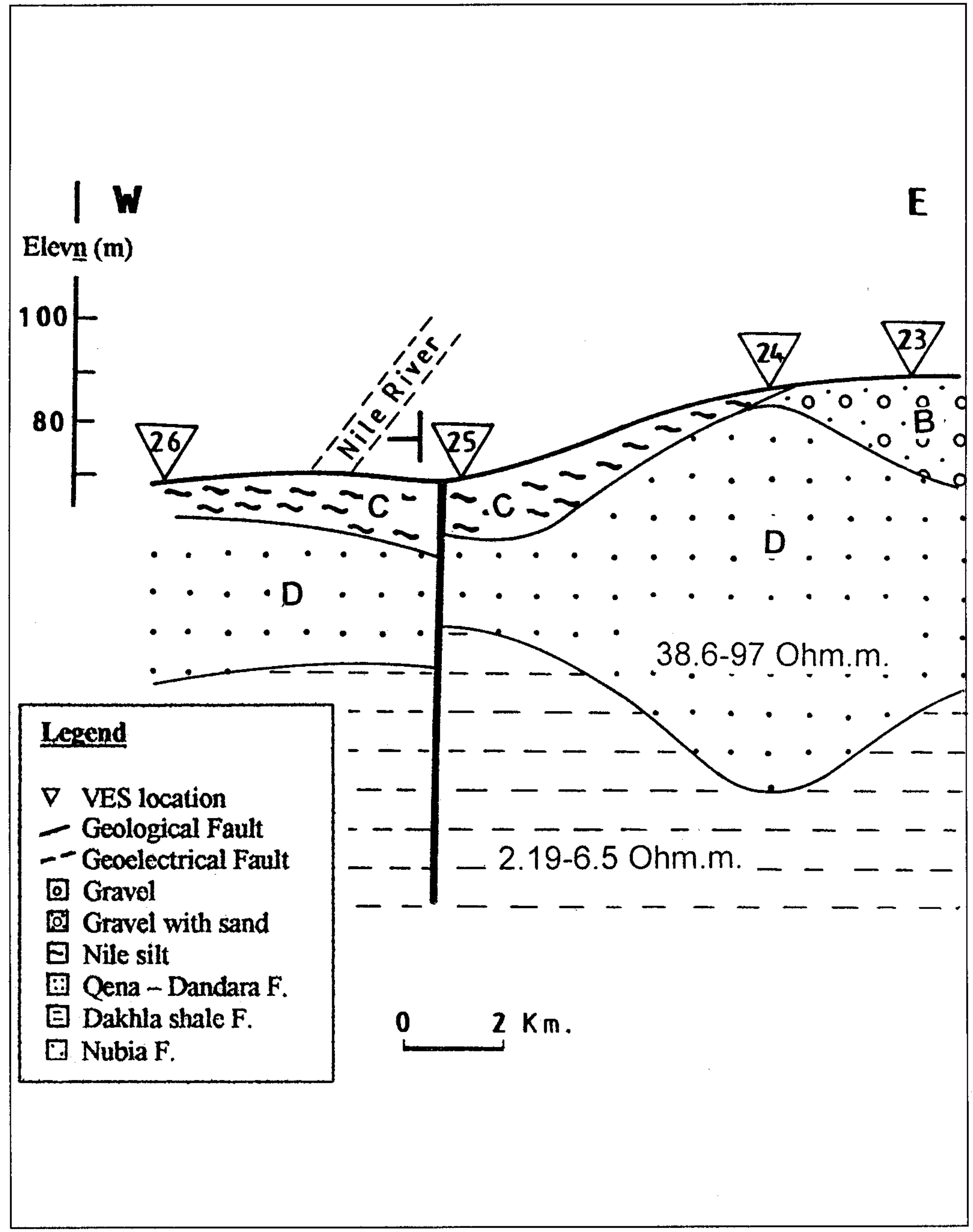

Fig. 8 : Geoelectrical Section of Profile G.

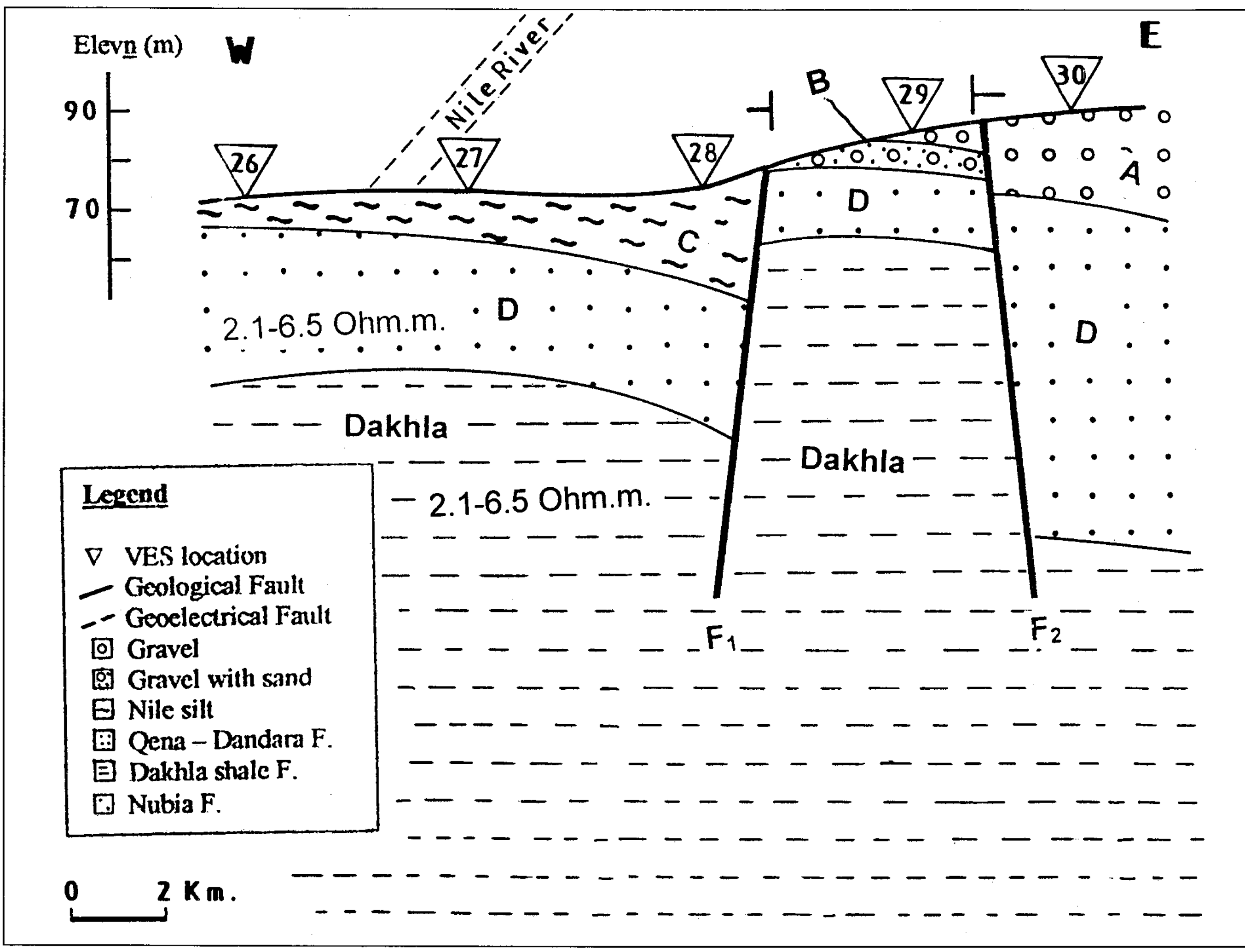

Fig. 9 : Geoelectrical Section of Profile H.

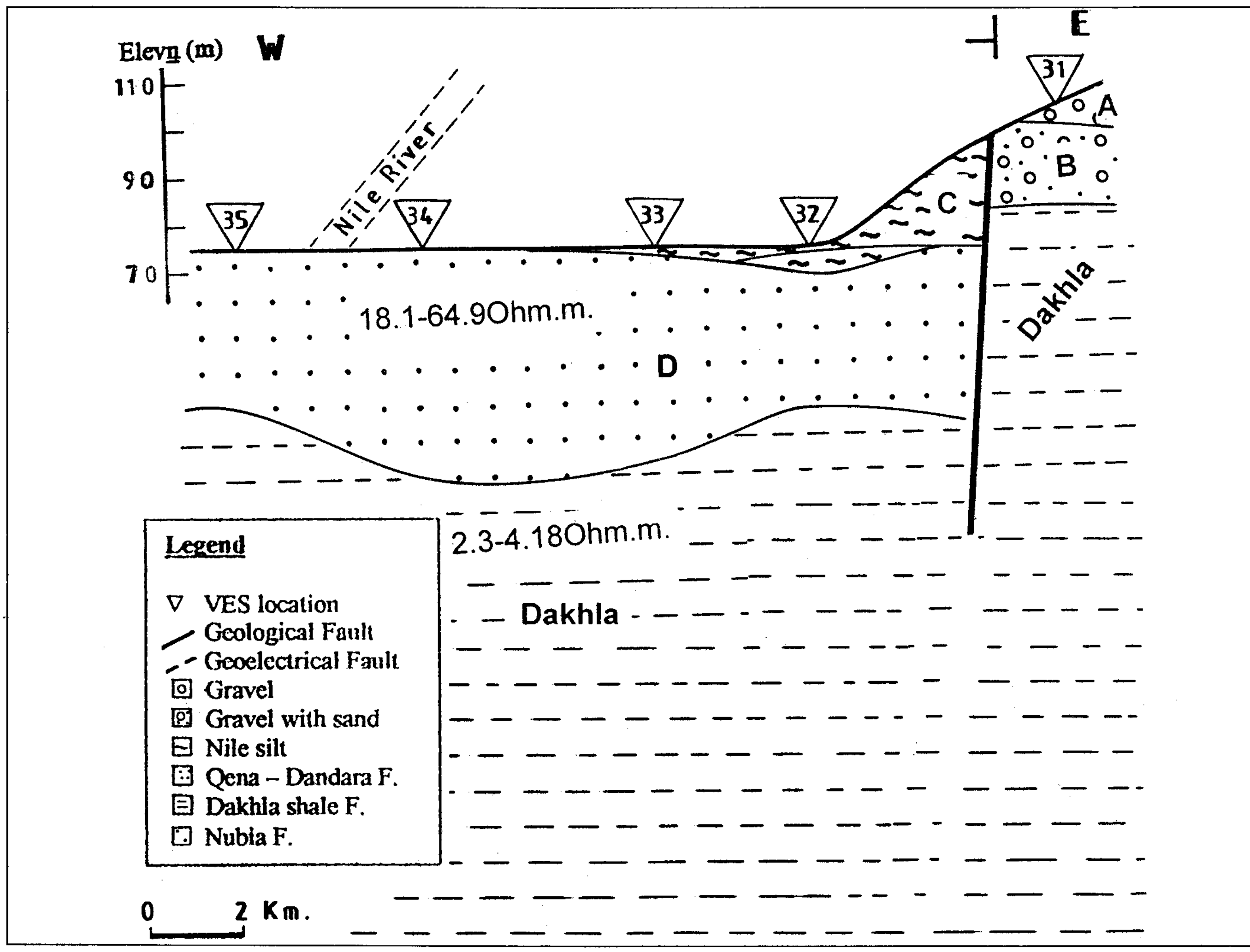

Fig. 10 : Geoelectrical Section of Profile I.

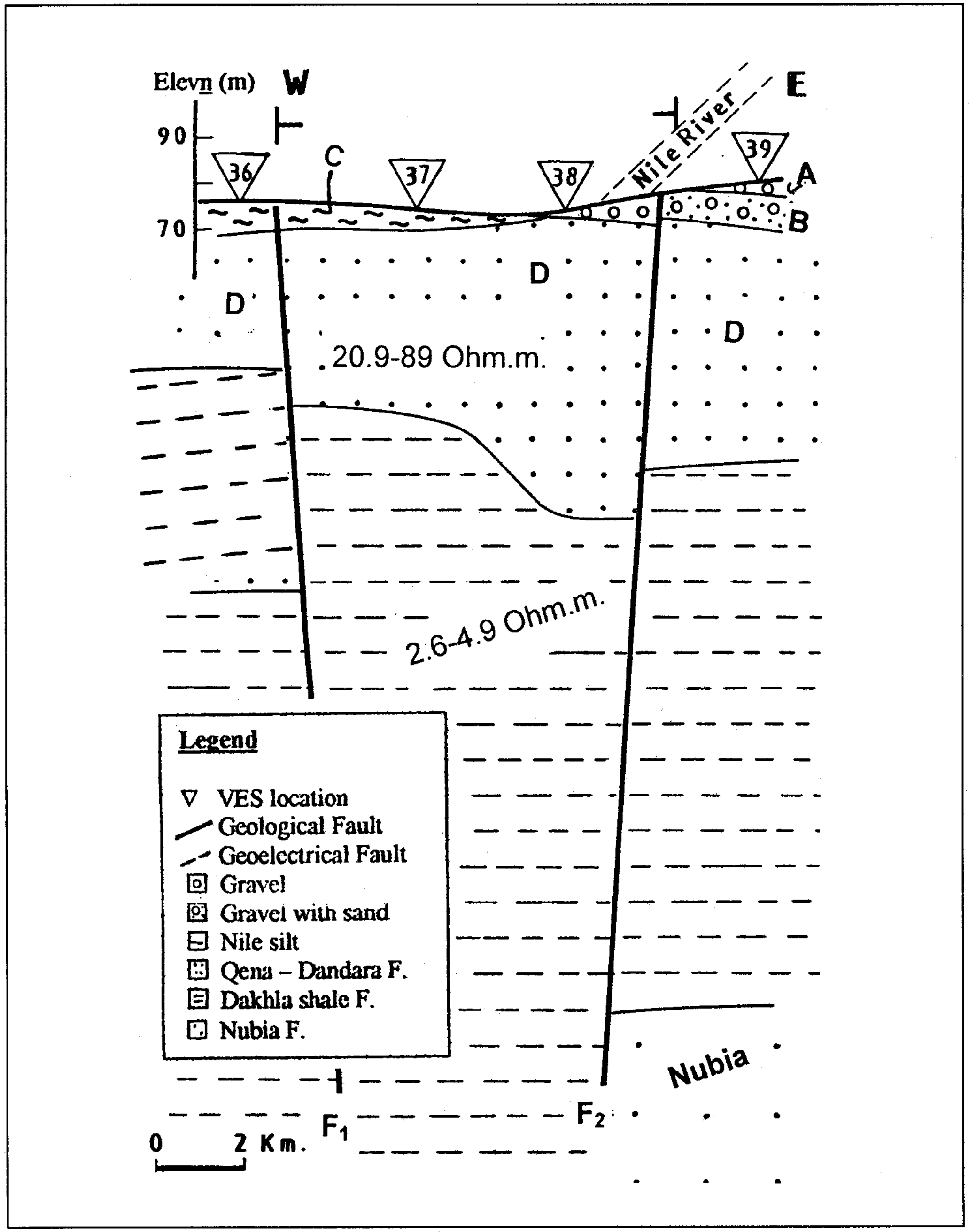

Fig. 11: Geoelectrical Section of Profile J.

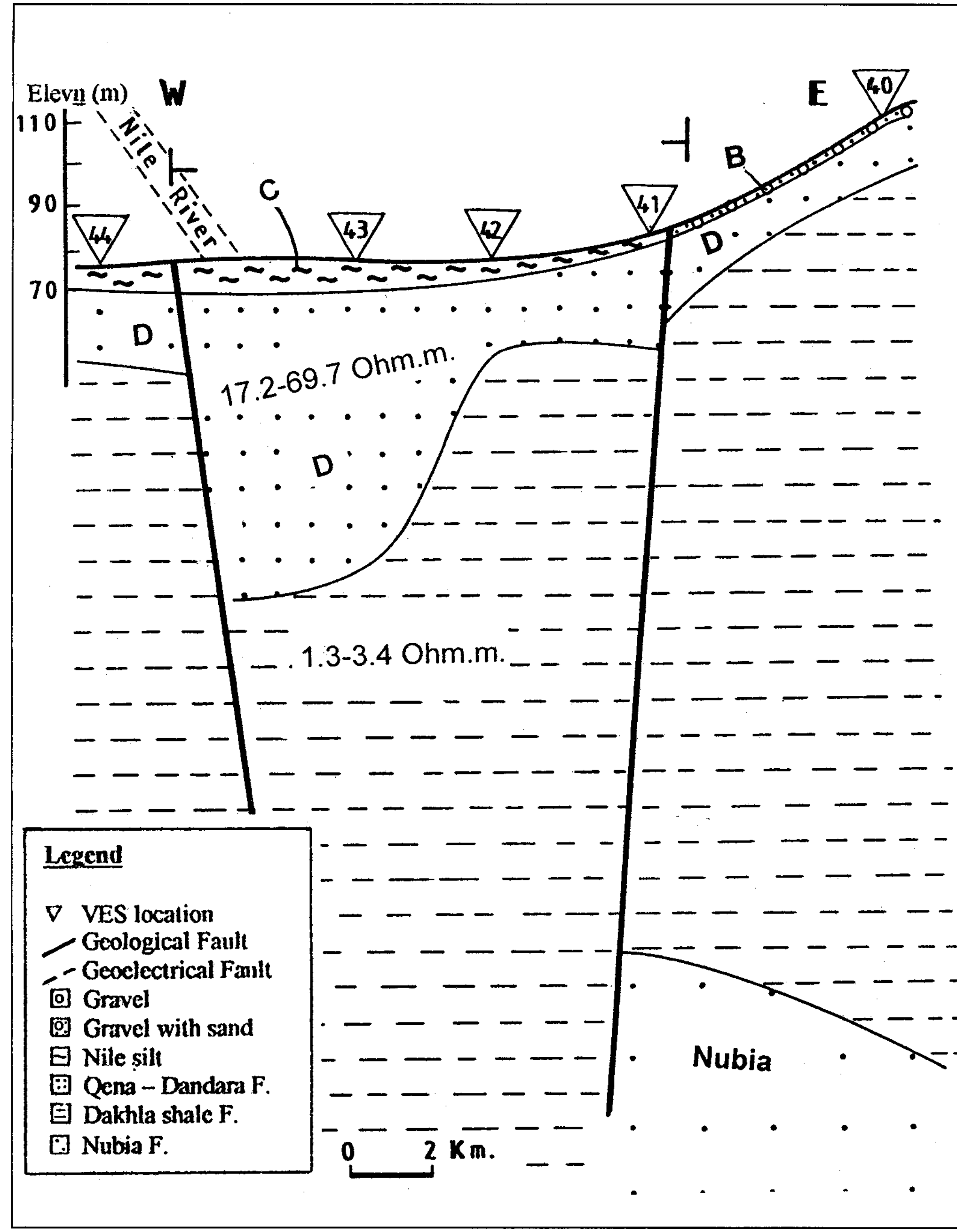

Fig. 12: Geoelectrical Section of Profile K.

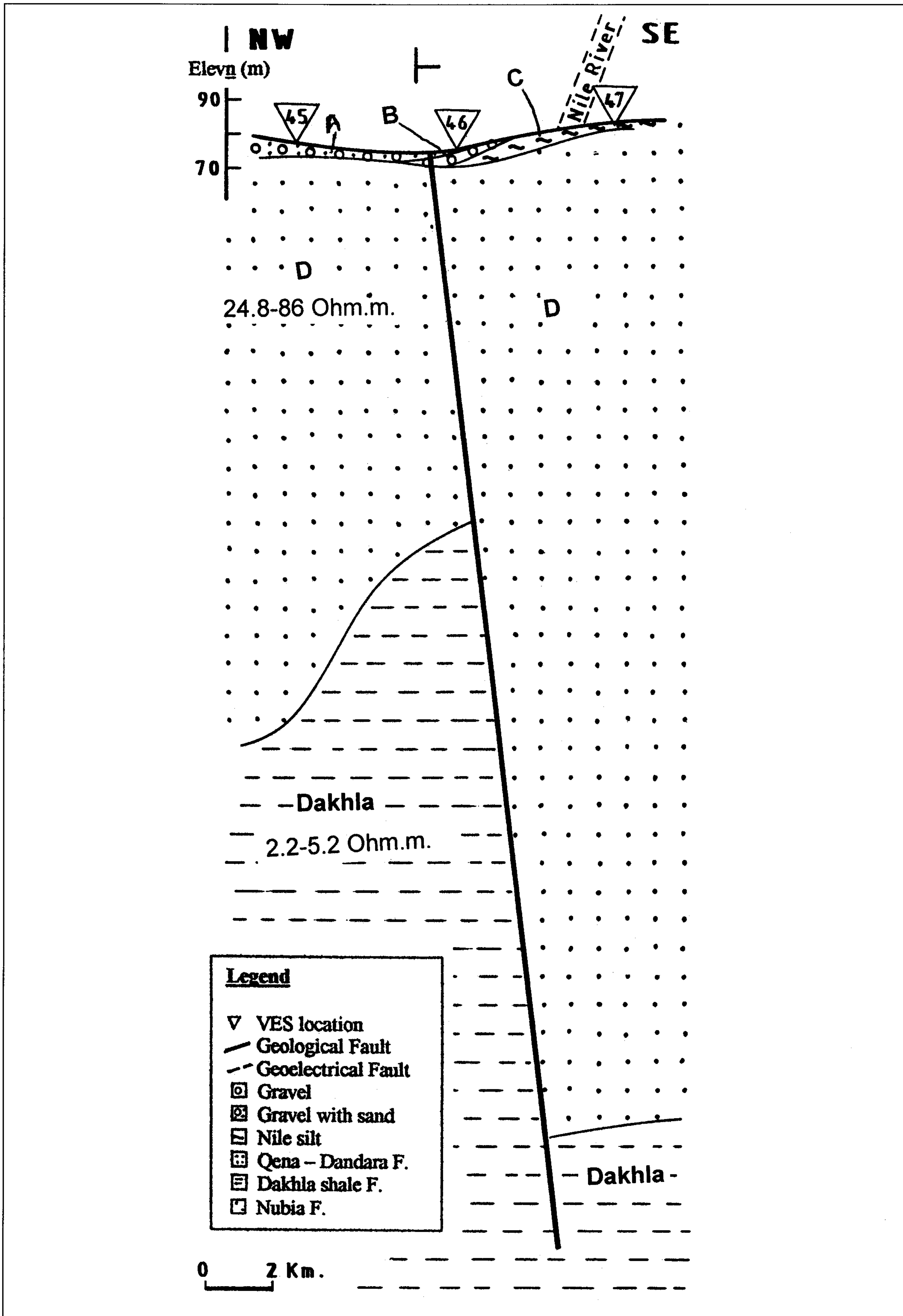

Fig. 13: Geoelectrical Section of Profile L.

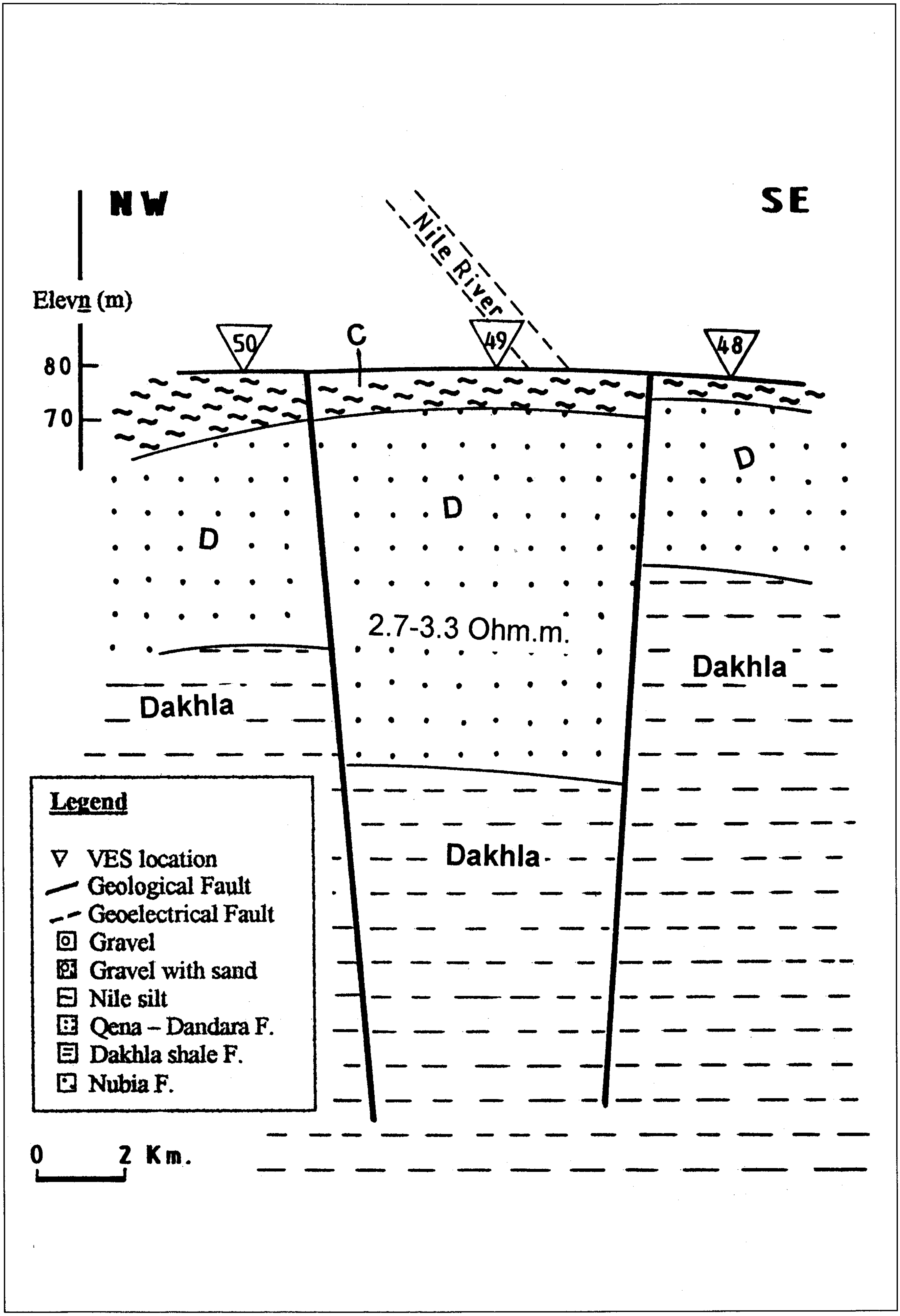

Fig. 14: Geoelectrical Section of Profile M.