

## **NATIONAL MUSEUMS OF SCOTLAND**

### **SAQQARA PROJECT 1996**

**Jon Dittmer and Ian Mathieson**

An interim report on the work carried out during the 1996 season covering the testing of electro-magnetic impulse equipment by repeating previous resistivity results with further scanning profiles over areas of particular interest and completing research into previous records at the Saqqara Necropolis of Memphis, Egypt

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## THE NATIONAL MUSEUMS OF SCOTLAND

### PRELIMINARY REPORT OF THE SAQQARA SURVEY PROJECT, 1996

By JON DITTMER and IAN MATHIESON

The aims of the National Museums of Scotland Project have been:

- a) To produce an up-to-date archaeological and subsurface geophysical map of an interesting and relatively little-studied area of Saqqara the great necropolis of Memphis, the major city of Egypt from c.3000 BC to Hellenistic times. The area concerned comprises the Gisir el-Mudir ('the Great Enclosure') in the south, an area of the Old Kingdom tombs round the mastabas of Ptahhotep, the area of the Serapeum and its dependencies, part of the Archaic necropolis, and the Sacred Animal Necropolis complex near to the village of Abusir in the north (see Fig. 1).
- b) To adapt and combine a series of well-known techniques to the special problems of plotting large monuments, cemeteries, catacombs and natural features in desert conditions where unexcavated and previously excavated monuments are buried either under drift-sand or the dumps of former excavations. These techniques incorporate resistivity survey, electro-magnetic impulse profiling, proton magnetometer survey, sonic profiling, field inspection, archival research and test-excavation (for descriptions see 1992/3 Report pp. 1-4).

The National Museums of Scotland acknowledge with gratitude the help and co-operation of the Supreme Council for Antiquities with whose permission the Museum's work is carried out; the Chairman Dr Ali Hassan, the Secretariat and Mme Samia, Dr. Zahi Hawass at Giza, Mr Mohammad Hagra, Director of Saqqara, the Chief Inspector Mr Magdi el-Ghandoor and Mr Hazim Said, the inspector attached to the mission. The October - December 1995 season has been undertaken with the generous financial support of grants from the British Academy, the National Museums of Scotland, the loan of the electro-magnetic impulse equipment by ERA Technology of Leatherhead, Surrey, technical assistance in map reproduction by Survey and Development Services, Bo'ness, West Lothian and administrative assistance by the Foreign & Commonwealth Office, London which the National Museums of Scotland acknowledge with gratitude.

The National Museums of Scotland team comprised Ian J. Mathieson, field director, Dr Jon Dittmer, geophysicist, Professor Harry Smith, co-director and advisor. The 1996 season opened on the 1<sup>st</sup> October and continued until the 8<sup>th</sup> November.

#### *Previous Fieldwork*

During the 1990 season resistivity work was completed along the length of the concession area and four of the proposed cross-sections covering the large enclosure known as the Gisir el-Mudir were surveyed (Fig. 1). In 1991 the complete concession area was field-walked and all visible surface indications of structures and old excavations were located for inclusion on the base maps. Work was completed in 1992 on the observation of the resistivity data covering the southern two-thirds of the original concession area, from the northern access road to the Serapeum to the southern limit of the concession which lies some 100m south of the southern boundary of the Gisir el-Mudir. In 1993 sondage trenches were opened on anomalies in the south-west corner of the Gisir-el-Mudir to check the resistivity data plotted at these points. A mud-brick platform was discovered inside the enclosure at the SW corner and the construction of the enclosure walls was investigated (Fig. 2, A7 & A8). In the 1994 season sondage trenches were opened to confirm the geophysical findings on profiles taken over the North Wall (Fig. 2-GMNWXS2). The construction of the wall was found to extend to the North with a buttress formation on the North face, several graves were found on the South side of the wall, one of which had a stela of the Persian period deposited in the sub-structure (Reports 1990 - 1994)<sup>1</sup>. During 1995 further sondage trenches were opened (Fig. 2, A9-14), to inspect anomalies over the south-west corner of the monument where the inside corner was located and surveyed. (Report 1995)

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<sup>1</sup> See I.J. Mathieson et al. *A Stela of the Persian period from Saqqara*. JEA 81 (1995), 23-41.

The Objectives of the 1996 season were:

- To test the use of a new instrument, the ERA Technology SPRscan Electromagnetic Impulse Equipment.
- To use the new instrument to verify results previously observed by resistivity.
- To carry out further observations on the position of the South Wall of the Gisir el-Mudir monument.
- To test the depth of penetration of the new instrument over the Serapeum and Sacred Animal galleries.

### **Fieldwork**

The electromagnetic impulse equipment consists of three main components; a computer controller, an electronics unit which provides the actual electronic impulses and the required timing circuits and an antenna, which fires the signal into the ground and detects the subsequent reflections. The equipment was operated in two ways as shown in Fig. 4.

Antennae with different operating frequencies can be used to penetrate deeper; low frequency 100 MHz units have greater penetration but less resolution, 500MHz higher frequency antennae provide more resolution of the sub-structure but do not penetrate as deep. The system continually emits impulses into the ground which produce a cross sectional image of the sub-surface materials. The image is colour coded depending on the strength of the returning signal. Digital signal processing through the computer can be applied to enhance and improve the image.

Initial testing was carried out using both antennae over known galleries of the Sacred Animal Necropolis and the Serapeum Apis bull galleries. On completion of the tests observations were carried out covering the previous resistivity profiles and extending areas of interest where anomalies existed. Fig. 7 shows a sample profile and the interpretation.

### **Gisir el-Mudir (The Great Enclosure)**

60 profiles were observed with particular attention being paid to 4 locations: the central area, the south-west outer corner, the assumed position of the south wall and the south-east inner corner.

Figure 2 shows the position of the profiles taken to examine the central area for signs of sub-surface disturbance which might indicate the presence of a trench or sloping ramp similar to the Sekhemkhet complex and other early dynastic tomb structures. The profiles confirmed the resistivity results from previous investigations in that no material disturbance other than surface burials was present. A profile was taken across the excavation credited to De Morgan (1897)<sup>2</sup> and this clearly shows the shaft which he had been investigating (Fig. 5) and by doing so gives added confidence in the results. Profiles taken over the prominent mound and the area between the mound and the south ridge again confirmed the resistivity and auger hole determinations (Report 1995, Fig. 5) that this area consisted of material removed from the desert surface and deposited on a natural ridge running east-west from the Sekhemkhet pyramid. Figure 2 also shows the grid of profiles surveyed over the south-west corner found in 1995 (Report 1995) and extending east along the assumed line of the south wall. From the profile results there appears to be a change from a constructed wall at the inner corner (Report 1995, Fig.3) to an excavated foundation trench which can be interpreted from an electro-magnetic

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<sup>2</sup> De Morgan, J 1897. *Carte de la Nécropole Memphite* Plans Nos. 7 & 9

profile (Fig. 6) and the results from resistivity dipole-dipole profiles taken in 1995 (Report 1995, fig.9). In 1993 the sondage at A7a encountered a cut edge at approximately the same line as the trench indicated on the profiles (Report 1993, Fig.4). The profile (Fig. 6) clearly shows the deposited material covering the south side of the natural ridge and the cut of the trench with the wind-blown sand deposits built up against the north face of the south side of the trench. Without making a trial *sondage* in this area it is impossible to determine if this face is simply cut *gebel* or faced with limestone blocks.

Investigations continued over the south-east corner and along the ridge leading to the Sekhemkhet complex. Fig. 2 shows the grid of profiles surveyed within the boundaries of the south ridge and the indications of the east walls of the Gisir el-Mudir. With the exception of previously identified shafts and surface exposures of the east wall no additional structures were found in this survey area. Continuing across the ridge towards Sekhemkhet the exploratory profiles show that the decomposed cut blocks exposed on the surface could belong to a structure in this area. On the top of the ridge where a possible cemetery was mentioned (Report 1990, p.4) the profiles indicated that most of the circular surface marks were indeed grave shafts.

### **L-Shaped enclosure**

The L-shaped enclosure lies to the south of the Serapeum ring-road and west of the Ptah-Hotep group of tombs, and contains many surface indications of tombs within the remaining two limbs of what might be yet another large enclosure. The north-west corner has provided resistivity anomalies in the surveys undertaken in 1993 (Report 1993, Map sheet 2, & p.3) and it was decided to survey a grid of profiles covering this area to augment the previous work. Fig. 3 Shows the grid of profiles which mainly confirmed the existence of mud-brick structures and isolated shafts extending towards the Serapeum ring -road. The grid was duplicated by proton-magnetometer survey and a very high reading was indicated at the position shown on Fig. 3.

### **Serapeum to Abusir valley**

One of the objectives of the Saqqara Project has been to establish the existence of a road or sledge route from the remnant Lake of Abusir to the pyramid complexes of Sekhemkhet and Zoser. Between 1990 and 1993 the project team has carried out extensive resistivity and proton-magnetometry surveys in the wadi situated between the Sacred Animal Necropolis and the line of ridges to the north and west. We decided to resurvey most of these profiles using the new impulse equipment and Fig. 1 shows the lines surveyed. As with the Gisir el-Mudir profiles the work confirmed the findings of the resistivity survey indicating shafts and probable mastaba positions but unfortunately no definite interpretation of a route through the wadi.

### **Conclusions**

The electromagnetic impulse equipment has shown that, when used in desert conditions, the higher frequency antenna can reach depths of typically 3 metres and even 4 metres, when in really dry wind blown sand. In the UK the antenna is doing very well to reach 2 - 2.5 metres. The equipment has been particularly useful in locating large holes and trenches filled with sand and gravel, for example on the South Wall of the Gisir el-Mudir. In addition it can easily locate shaft burials and the smaller pre-dynastic burials in the vicinity of the Serapeum. Surprisingly, the different layers within the sand filled pockets showed up quite spectacularly. (Figs. 5 & 6).

The equipment had difficulty in penetrating the local limestone in the attempt to locate the underground galleries of the Sacred Animal Necropolis and the Serapeum. This was due to a number of factors;



1. The lower frequency antennae are experimental and did not come up to expectations; with the tests carried out, new designs of antenna will almost certainly work better.
2. The local limestone seems to be more conductive than previously thought, which causes the electromagnetic impulses to attenuate rapidly.
3. The 500 MHz antennae were not expected to reach such depths.

Future work using such equipment should only be carried out using frequencies lower than 500 MHz, preferably 250 MHz and in some cases 100 MHz.

The National Museums of Scotland have now commissioned a further three years work and the project team hope that with the support of the British Academy and other bodies, the use of a Geonics EM31 ground conductivity meter, will further improve our results and enable the production of a digitised base CD-ROM providing archaeological, geophysical and historical information for interested parties.

Ian J Mathieson

Project Director

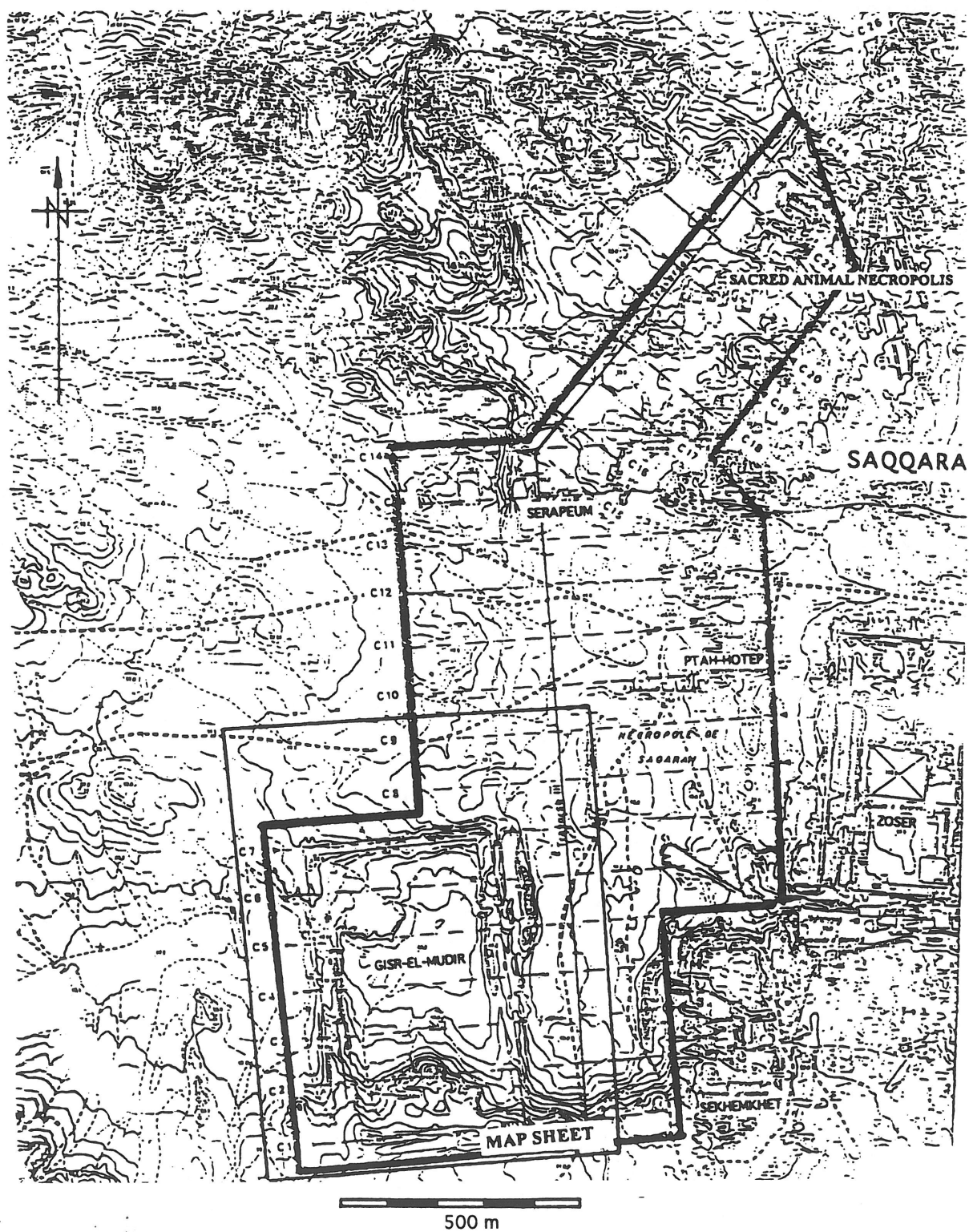


FIG. 1. National Museums of Scotland Concession Area



**ERA Technology electro-magnetic scanning equipment  
100 MHz Antenna**



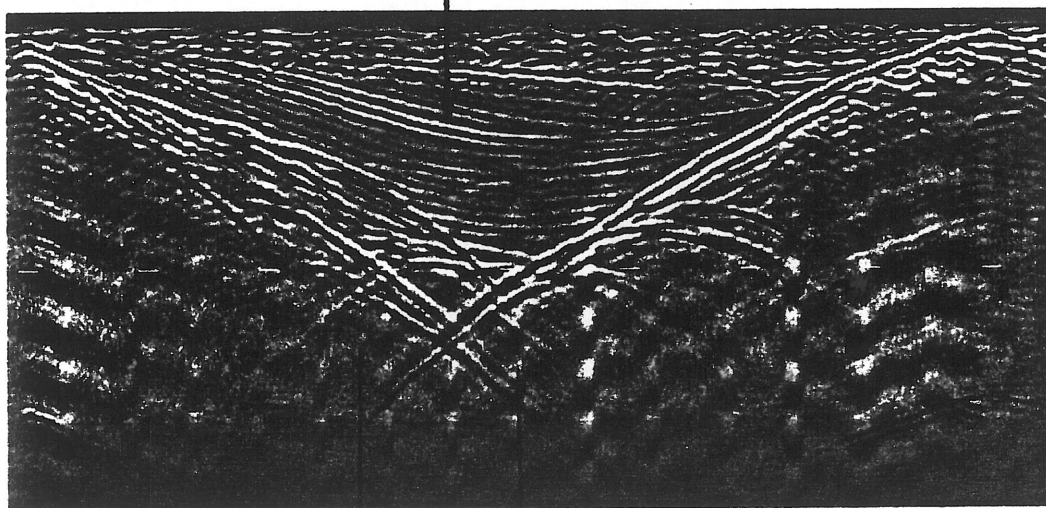
**ERA Technology electro-magnetic scanning equipment  
500 MHz Antenna**

# GISR EL-MUDIR

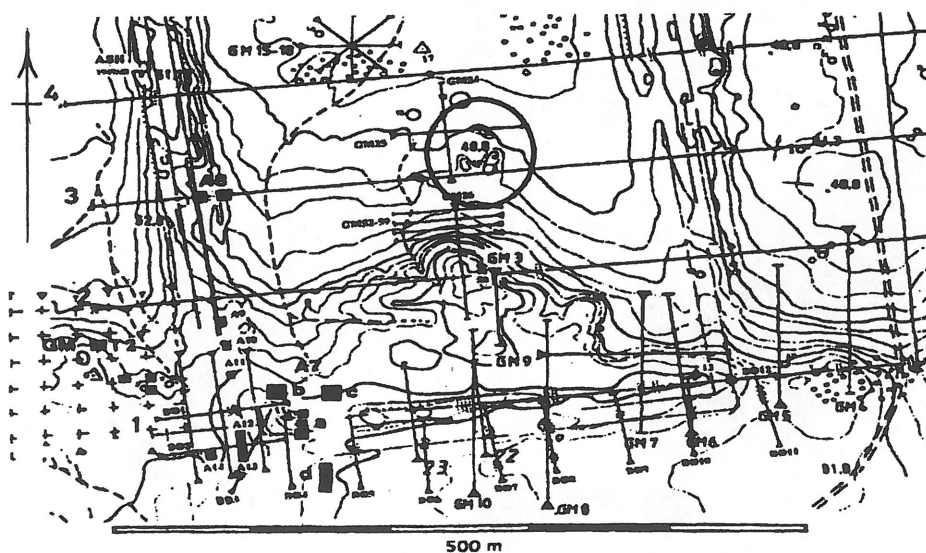
(DE MORGAN'S "GREEK TOMB" 1897, PLAN 9)

Profile from electro-magnetic scanning equipment

Wind-blown sand bedding clearly shown



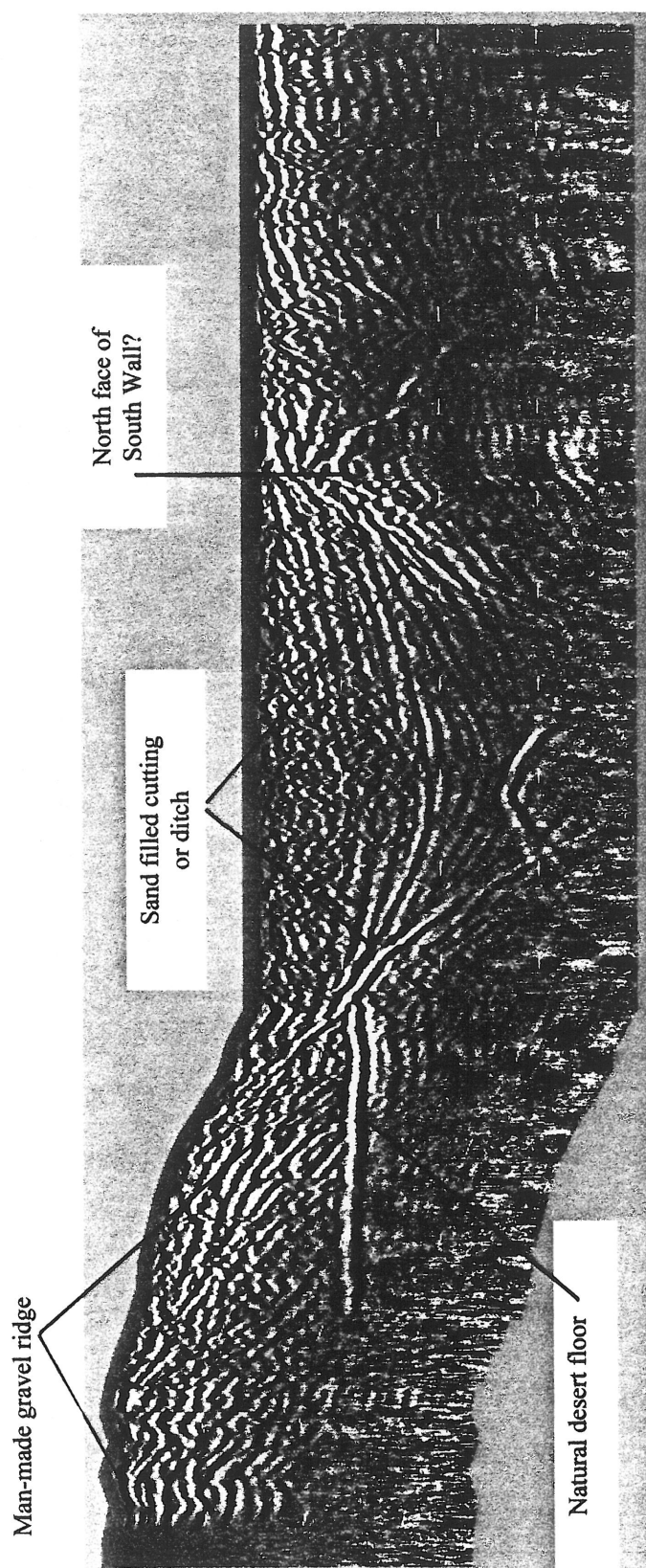
Probable shaft



Gisir el-Mudir  
Southern Area showing De Morgan's Tomb

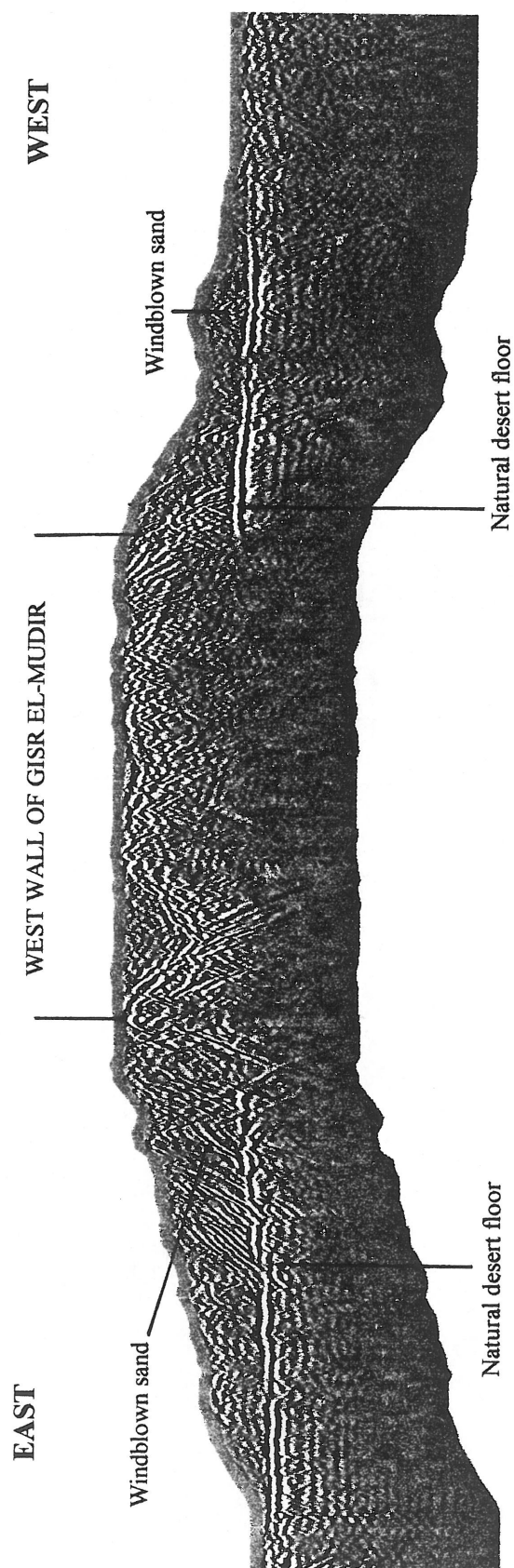


Scanning profile No. 62



**GISR EL-MUDIR**  
Profile from electro-magnetic scanning equipment  
across the assumed position of the South Wall





### GISR EL-MUDIR

PROFILE FROM ELECTRO-MAGNETIC  
SCANNING EQUIPMENT

Fig. 7

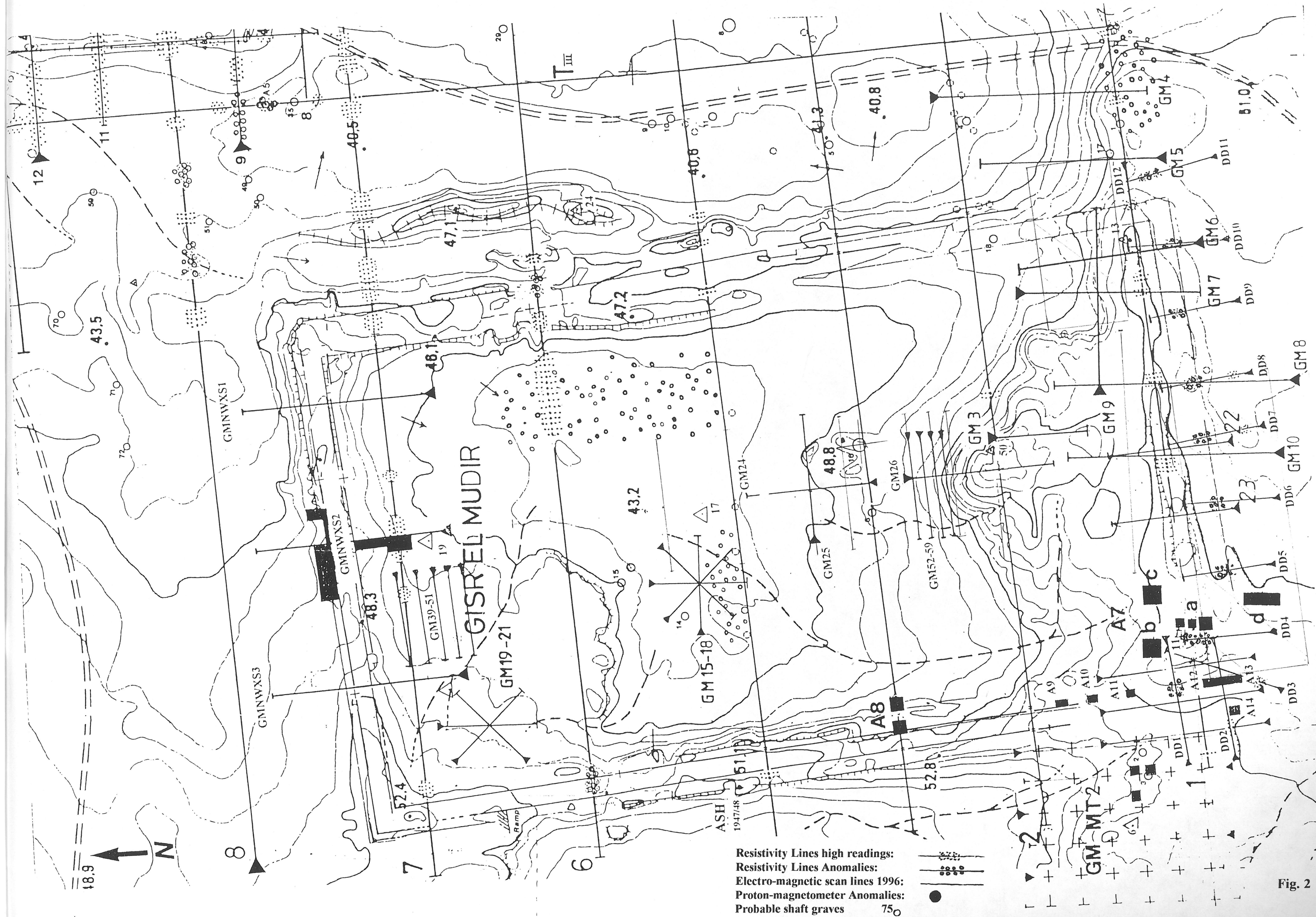


Fig. 2

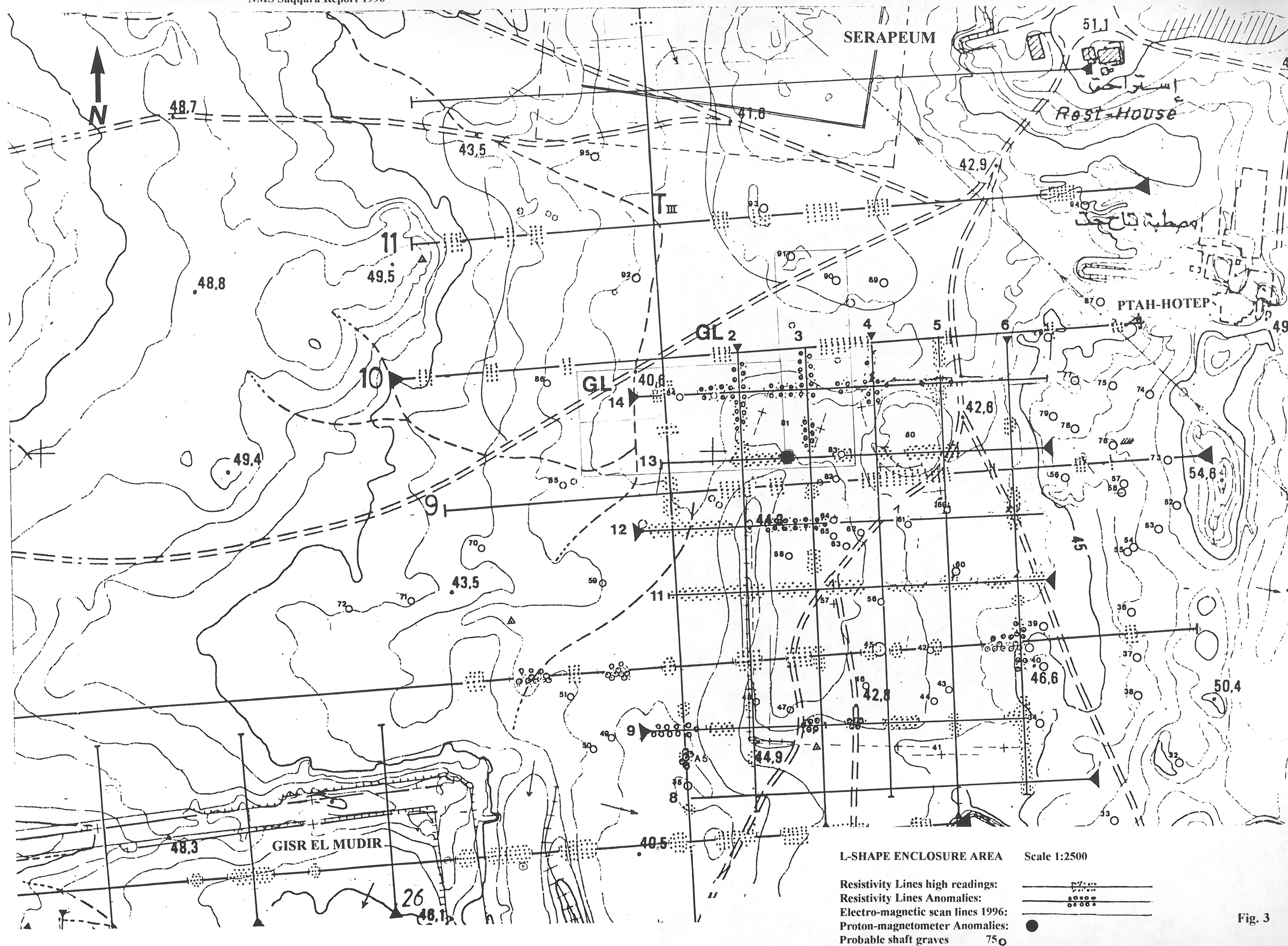


Fig. 3