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**THE GEOTECHNICAL PARAMETERS
FROM CSEM MAPPING
AND MONITORING DATA
AT THE OASIS KHARGA AND BARIS
OF SAHARA DESERT, EGYPT**

Abstract:

The site of investigation, oasis Kharga, is located at about 600 km south of Cairo, Egypt; Baris is about 90 km from Kharga also to south and towards more inside the desert. The work was aimed to investigate the rock mass stability at Baris and to estimate the water intake in the Oasis Kharga. A controlled source electromagnetic (CSEM) approach developed earlier by IGF UB RAS (Geophysical Federal Institute, Ural Branch of Russian Academy of Science) is applied to image the ranked deformation levels in the massive structure of the Baris. The wide profile system of observation has been used to monitor the three components of the alternating magnetic field along predefined measuring lines in the study area. Here we can show the first results that we shall continue during some cycles of monitoring. The second part of our work was linked with mapping the massif structure inside the oasis City, where only using our device we could construct the geoelectrical sections for 5 profiles and show the real structure of the water volume and its complicated structure up to 200 meters depth recording the values of real not apparent resistivity.

Key words: oasis, geotechnical research, stability, water aquifer

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**ГЕОТЕХНИЧЕСКИЕ ПАРАМЕТРЫ,
ОПРЕДЕЛЯЕМЫЕ С ИСПОЛЬЗОВАНИЕМ
АКТИВНОГО ЭЛЕКТРОМАГНИТНОГО
ИНДУКЦИОННОГО МЕТОДА
КАРТИРОВАНИЯ И МОНИТОРИНГА
В ОАЗИСАХ ХАРГА И БАРИС,
ПУСТЫНЯ САХАРА, ЕГИПЕТ**

Аннотация:

Объект исследования оазис Харга расположен в 600 км к югу от Каира, Египет, оазис Барис – в 90 км также к югу от Харги глубже в сторону пустыни. Работа посвящена исследованию устойчивости грунта в Барисе и определению запасов воды в оазисе Харга. Использование метода электромагнитного индукционного площадного исследования с контролируемым источником, разработанного ранее в Институте геофизики УрО РАН, послужило для определения иерархических уровней деформации в структуре массива Бариса. Была применена система наблюдений в виде широкого профиля для мониторингирования трех компонент переменного магнитного поля вдоль запланированных профилей наблюдения на участке исследования. В этой работе показаны первые результаты, которые будут продолжены в рамках нескольких циклов мониторинга. Вторая часть нашей работы посвящена картированию структуры массива в пределах городской части оазиса Харга, где только использование аппаратуры МЧЗ-12 (ИГФ УрО РАН, автор А.И. Человечков) позволило построить геоэлектрические разрезы для 5 профилей и показать реальную структуру аквафора в сложной вмещающей среде до глубины 200 метров, представляя разрезы в виде удельных, а не кажущихся сопротивлений.

Ключевые слова: оазис, геотехнические исследования, стабильность, вода, структура аквафора, источник подземных вод

Some geological information about oasis Kharga and oasis Baris

The Western Desert covers approximately 700,000 km², which are more than two-thirds of the total area of Egypt. The significant oases in the Western Desert are Siwa, Bahariya, Farafra, Dakhla and Kharga. Kharga Oasis is the southern one in this cluster of depressions and represents an important feature in the Western Desert (fig.1). It is bounded by the Eocene limestone plateau from the east and north, where steep cliffs form a sharp boundary to the depression floor [1]. This limestone plateau stretches along Middle and Upper Egypt with an elevation of up to 550 m above the sea level and about 400 m above the depression floor at the study area. However, towards the south and west, the depression floor merges gradually into the Nubian Sandstone open desert. Geomorphologically, the landscape is considered as either high plateau in the northern and eastern boundaries, or low-lying depression floor, meanwhile the pediment areas in-between, are considered as badlands.

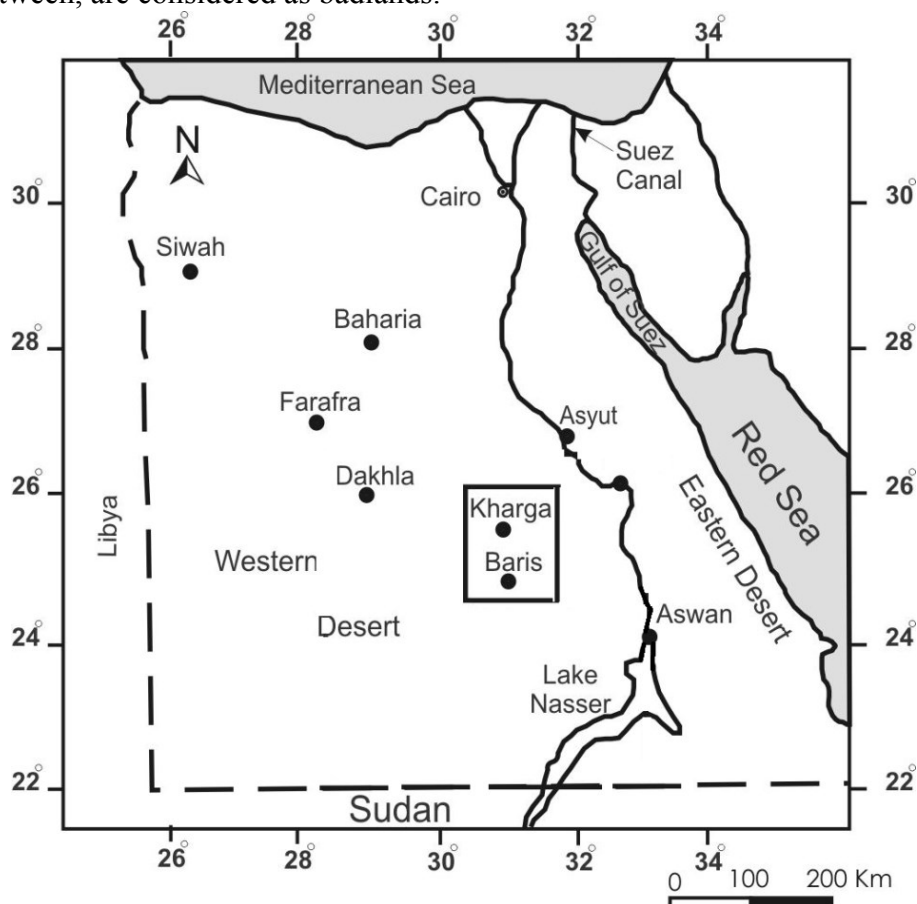


Fig.1. Location map of the study area.

Kharga Oasis is characterized by tropical arid climate. The maximum day time temperature fluctuates within a wide range, reaching up to 45–50 °C in summer months [1], meanwhile in winter, the minimum temperature may drop to as low as zero at night. Kharga Oasis is known as the driest area in the Eastern Sahara and probably the driest region on Earth [2]. Wind speed tends to be low in August; it increases progressively in November to January and reaches a peak from March to May causing dust storms famously known as ‘‘El-Khamasin’’. The annual mean value of relative humidity is about 39%. Generally, the atmospheric precipitation as rainfall is extremely scarce and insignificant (1 mm/year). Although rain is very scarce, occasional heavy rainstorms severely attack the area from time to time, where rainwater might flow for short distances as sheet flashfloods causing damage to villages and roads. The last rainy event took place in the year 1993, where Kharga-Assiut and Kharga-Dakhla roads suffered significant damage [1]. The potential environmental impacts of rainstorms are obvious due to absence of drainage outlets in the depression area. The oasis domestic and agricultural water is obtained

from springs and wells dug into the underlying porous Nubian Sandstone. Thermal springs at Bulaq and Nasser villages to the south of the city of Kharga are famous with water temperature of up to $+43^{\circ}\text{C}$ [2]. The geology of the Western Desert, including Kharga Oasis, is very well documented in Knetsch and Yallouze, 1955; Said, 1962, 1990; Issawi and El-Hinnawi, 1982; Salman, 1984; Salman et al., 1984. [4] (fig.2). From the geologic point of view, the Upper Cretaceous-Lower Tertiary sedimentary sequence overlies no conformably the Precambrian basement rocks. This sedimentary sequence comprises the Nubian Sandstone overlain by the Variegated Shale rock units, which are well exposed forming most bedrocks of the depression floor. These widely exposed rock units are followed upward by the Duwi, Dakhla, Tarawan, Esna and Thebes formations exposed on the eastern and the northern scarps bounding the depression. This sedimentary sequence includes different varieties of sandstone, shale and limestone with heterogeneous physical and mechanical properties. Furthermore, the Quaternary times in the study area were characterized by alternating periods of wet and dry climates, which resulted in several fluvial, lacustrine and aeolian deposits strewn on the depression floor [1,4]. The Upper Cretaceous Nubian Sandstone at Kharga Oasis is a highly dissected, laminated and cross-bedded unit.

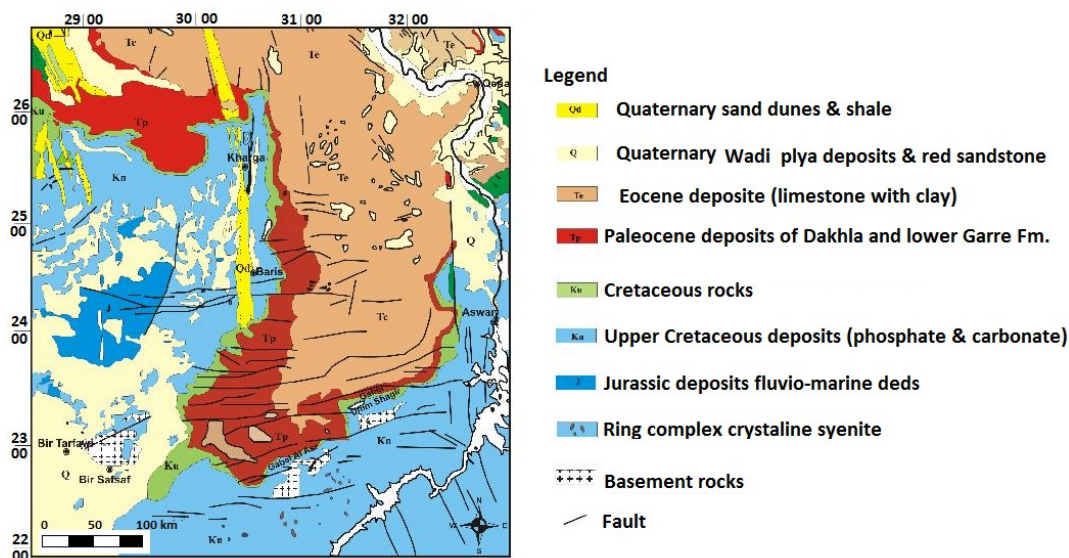


Fig.2. Geological map of the Kharga and Baris oases. [3]

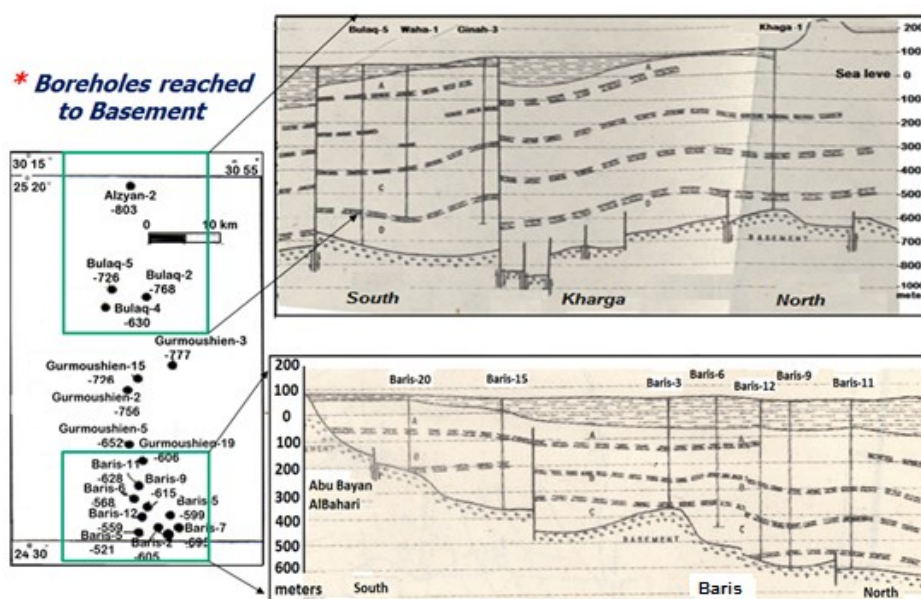


Fig.3. Boreholes information [5]

The thickness of sedimentary sequences are decreasing toward south direction. The maximum thickness is 600 m in the wells (Baris-9, Baris-11 and Baris-12) and the minimum thickness is 200 m in the well Baris-20) (Fig.3.).

Results of geotechnical research, using electromagnetic CSEM method.

The site of investigation, oasis Kharga, is located at about 600 km south of Cairo, Egypt; Baris is about 90 km from Kharga also to south and towards more inside the desert. The work was aimed to investigate the rock mass stability at Baris and to estimate the water intake in the Oasis Kharga (Fig.4). A controlled source electromagnetic (CSEM) approach developed earlier by IGF UB RAS (Geophysical Federal Institute, Ural Branch of Russian Academy of Science)[7,8] is applied to image the ranked deformation levels in the massive structure of the Baris. The wide profile system of observation has been used to monitor the three components of the alternating magnetic field along predefined measuring lines in the study area. Here we can show the first results that we shall continue during some cycles of monitoring. The second part of our work was linked with mapping the massif structure inside the oasis City, where only using our device we could construct the geoelectrical sections for 5 profiles and show the real structure of the water volume and its complicated structure up to 200 meters recording the values of real not apparent resistivity. Here is a plan of our work inside the Kharga city.

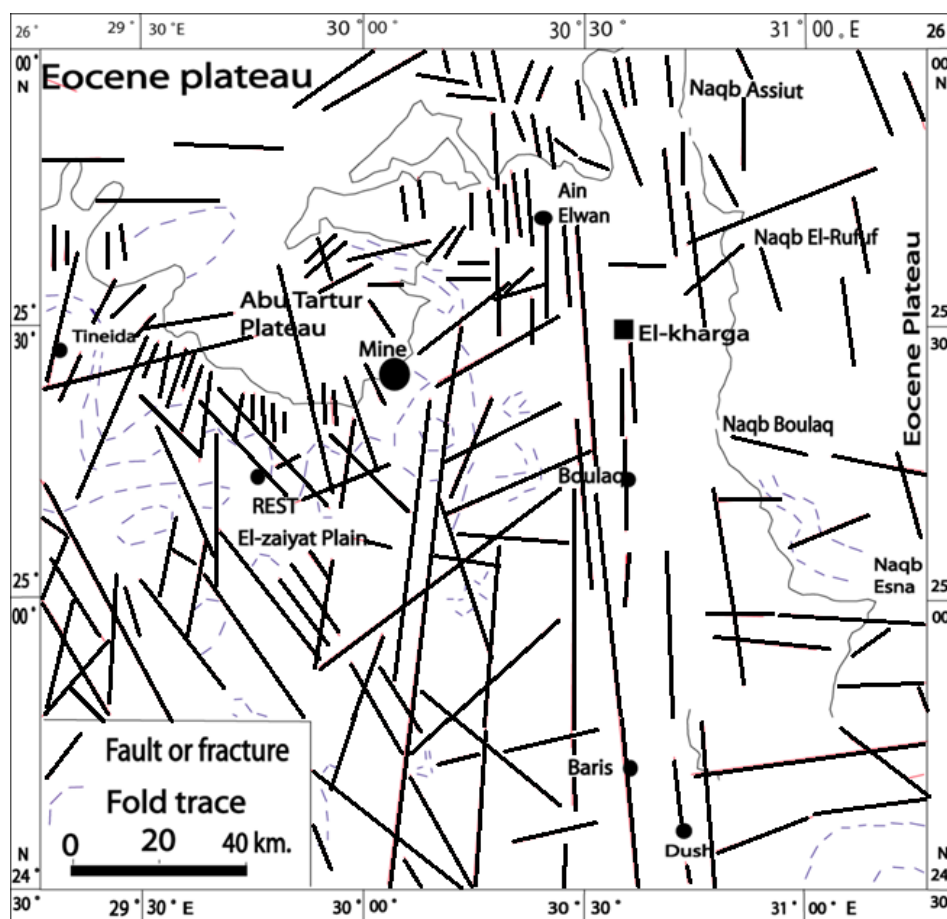


Fig.4. Structural lineaments map of the Kharga Oasis [6].

We showed the location of disintegration zones inside the upper part of the sections (fig.6). We see that on the left side of the section is a very high resistivity block that is spreaded until 192 m. It coincides to the resolution of our device for the frequency 1.27 Khz. At the middle of the section we see a horizontal layered and vertical layered conductive block, which can be linked with aquifer. The disintegration zones are spreaded to the depth about 40m also in the conductive block.

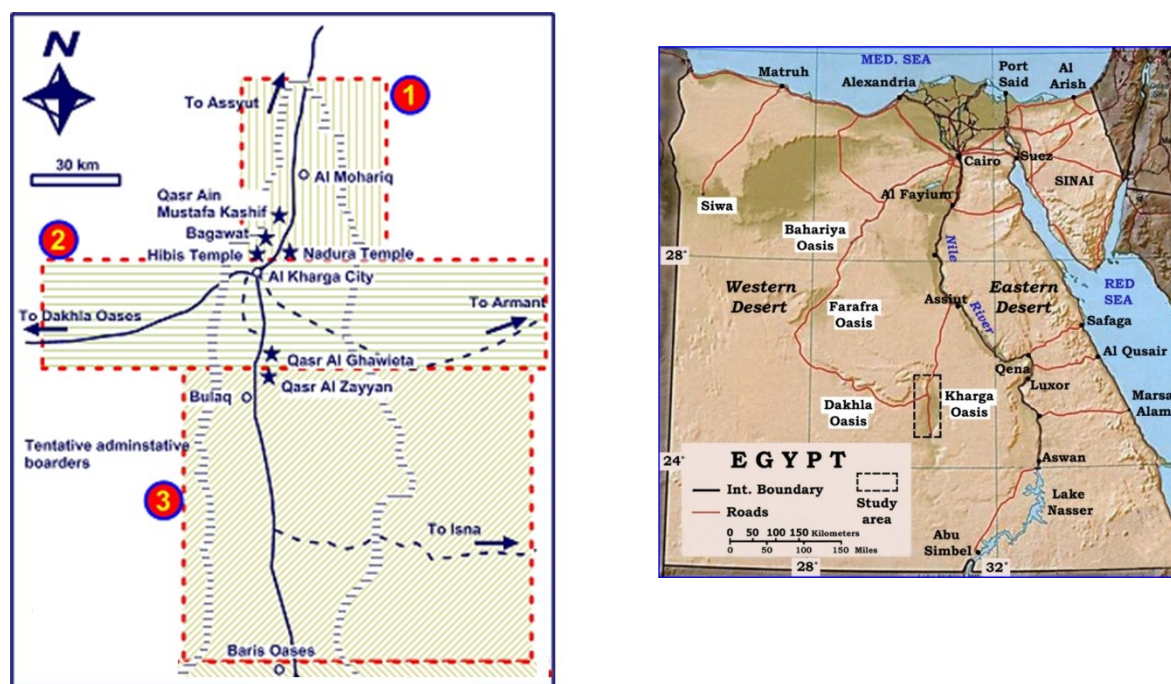


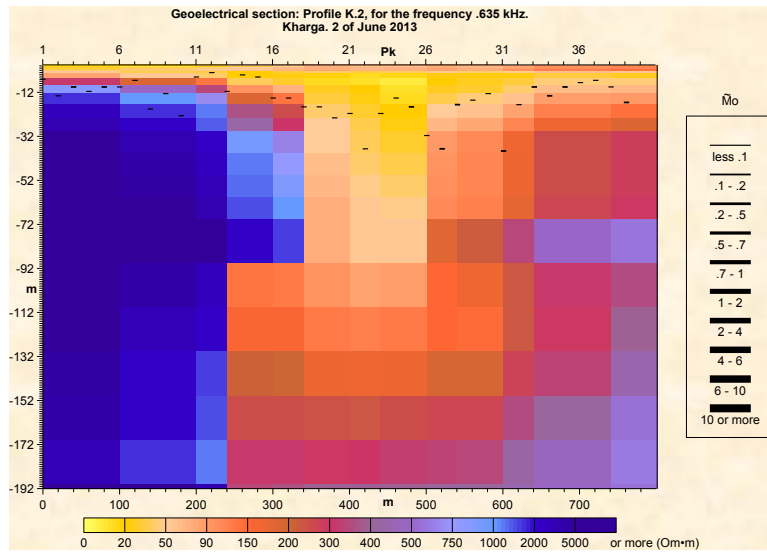
Fig.5 Detailed scheme of geophysical work, map of Egypt



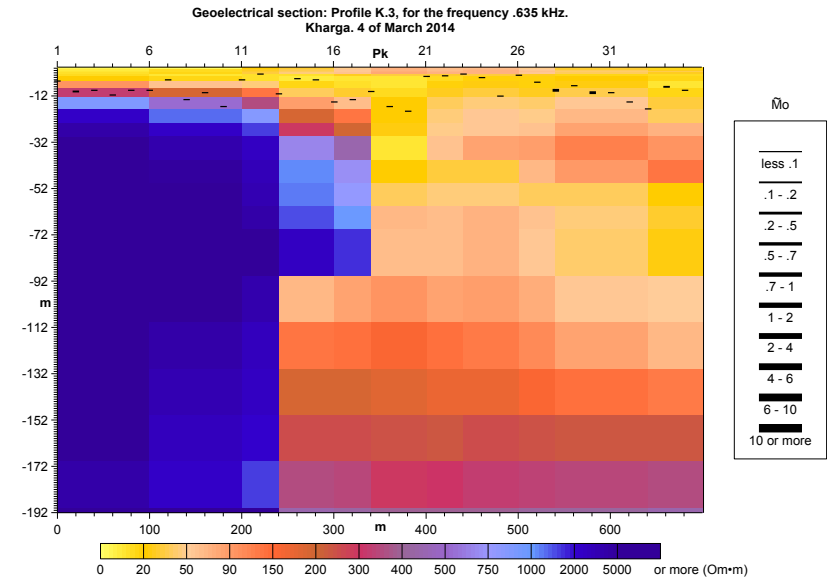
Fig.6. Plan of electromagnetic profiles in a frame of frequency-geometrical method [7]

From the received results (fig.7, a-d) we can see that the structure of the aquifer is not homogeneous. As we go to the southern profiles (3-5) the disintegration zones are shallower. It is needed to continue detailed electromagnetic frequency-geometrical measurements for lower frequencies on additional latitude and longitudinal profiles for constructing the 3-D electromagnetic model of the aquifer. It is needed to calculate the amount of deep horizons water.

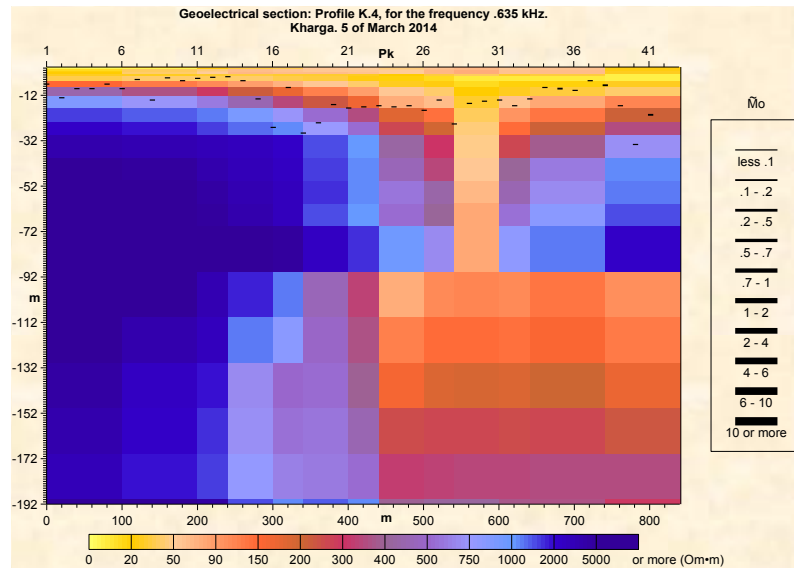
In Baris we had solved a geotechnical problem which was analogous to the problem of the 15-th May City. We had made measurements in a frame of wide profile [1] with the same device MFS-12 of the Institute of geophysics UB RAS, made in Russia Ekaterinburg. The detailed studies demand higher frequencies and the step of the receiver - 5m. The profiles 1 and 3 are parallel to each other and the 2 profile was perpendicular to them.



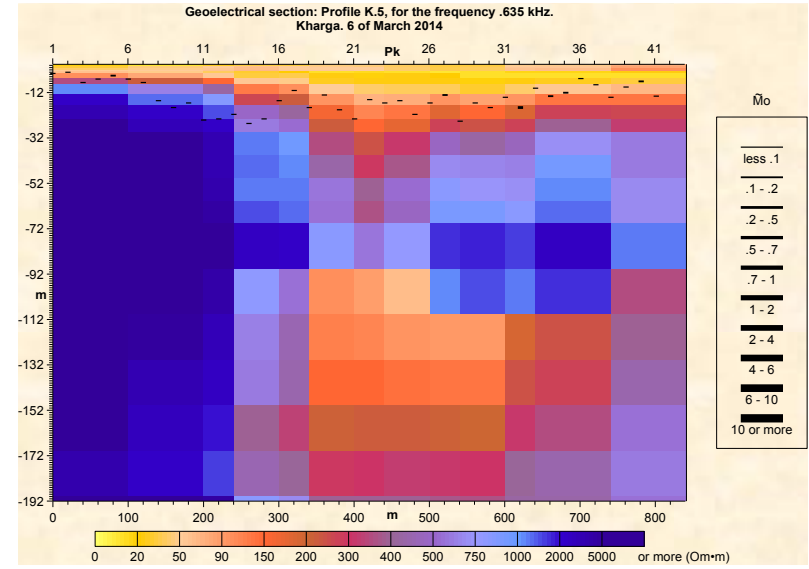
a)



b)

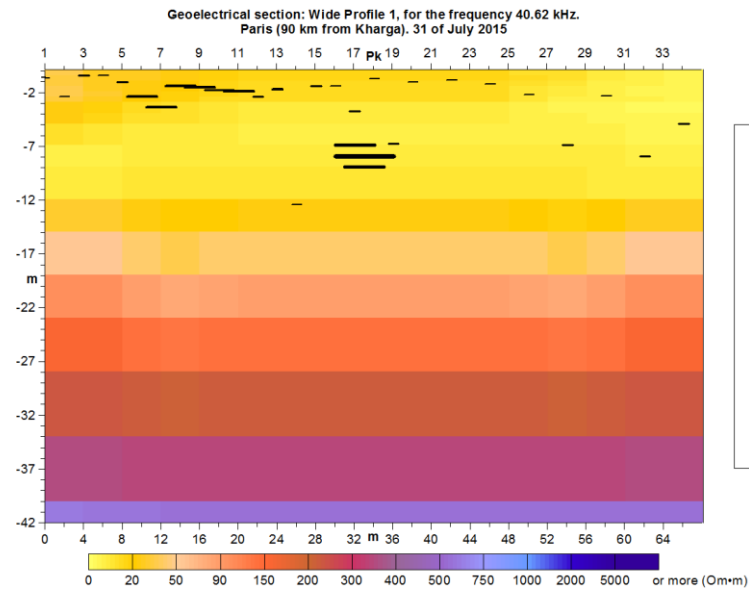


c)

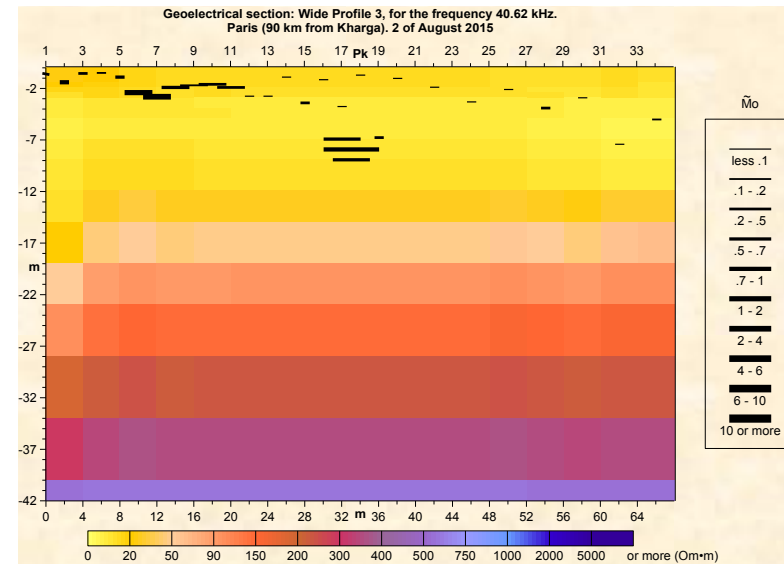


d)

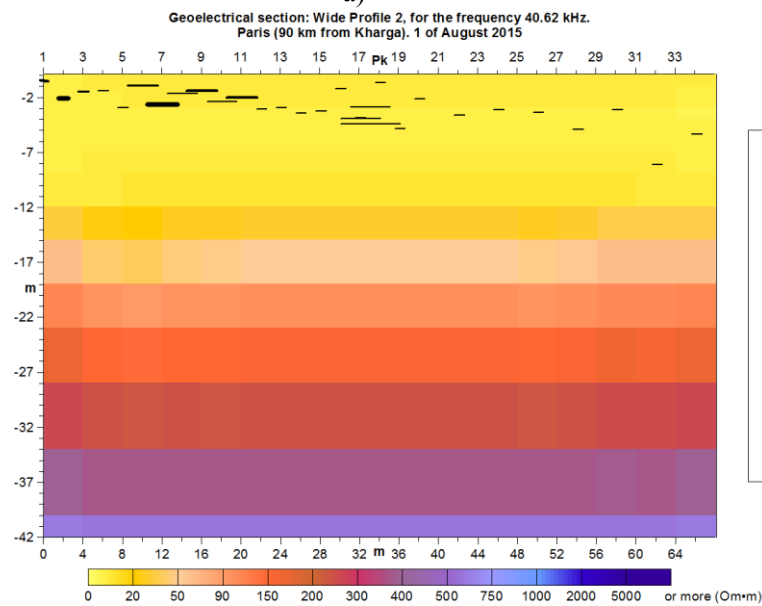
Fig.7. Geoelectrical sections of profiles: a)-profile2, b)-profile3, c)-profile4, d)-profile5 (fig.6)



a)



b)



c)

Fig.8. Geoelectrical sections: a)-profile 1, b)-profile-3, c)-profile-2

Between the pickets 17-19 (fig.8, a-c) we see on all profiles an object with different intensity of an unknown nature. It needs additional monitoring research to estimate the degree of changing of their parameters for answering of the question how it is linked with the cracks on the house located near the profiles.

Conclusions

The analytical treatments provided good information about the structure of the rock massive and its rank of degradation, the lateral distribution of the geotechnical heterogeneity, and finally a conclusive outcome about foundation stability. We can conclude that the general dynamic state close to the destruction level within the investigation areas is getting worse over the time; this is reflected in the crack's densities and positions, also on the changes in the lateral distribution of geoelectrical heterogeneity as an indicator of the saturation of the surface rock in the study area with water.

References

1. El-Sankary, M.M.2002.Geological,sedimentological and radioactive units of the Quaternary sediments, El Kharga Depression ,Western Desert, Egypt. Unpublished Ph.D.The-sis. Ain Shams Univ., Egypt, 241p.
2. Kehl,H and Bornkamm,R.1993. Landscape ecology and vegetation units of the Western Desert of Egypt. Catena Supplement 26.
3. Klitzsch E. and Hermina M. 1989. The Mesozoic. In Stratigraphic lexicon and explanatory notes to the geological map of Egypt 1: 500 000 (EGPC & Conoco Inc., Cairo), pp. 77-140.
4. The geology of Egypt. 1989.
5. Dept. of water resources in Kharga, 2014, Boreholes information of Kharga and Baris Oases, Egypt (Personal communication).
6. El-Shazly E., Abdel Hady M., El Ghawaby M., Salman A., El Kassas I., Khawasik S., El Amin H., El Rakaiby m., El Aassy I., Abdel Megid A., Mansour S. 1980. Structural lineaments map of the Kharga Oasis, Remote sensing Center, Cairo, Egypt.
7. Magdy A. Atya, Olga A. Hachay, Mamdouh M. Soliman, Oleg Y. Khachay, Ahmed B. Khalill, Mahmoud Gaballah, Fathy F.Shaaban and Ibrahim A.El. Hemali 2010.CSEM imaging of the near surface dynamics and its impact for foundation stability at quarter 27,15-th of May City, Helwan, Egypt, Earth sciences research journal, Vol.14, N1, pp.76-87.
8. Аття М., Хачай О.А., Хачай О.Ю., Эль Сайед Эль Саид А.2014. Определение геотехнических параметров среды с помощью данных электромагнитного мониторинга с контролируемым источником, Уральский геофизический вестник, №2, с.4-12.