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GEOPHYSICAL INVESTIGATIONS FOR THE LOCATION OF THE HEPTASTADIUM IN ALEXANDRIA (EGYPT)

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As concerns the links between ancient Alexandria and its famous light house on the island of Pharos, Strabo describes the so-called Heptastadium as "an embankment (which) forms a bridge extending from the mainland to the western portion of the island and leaves open only two passages ... which are bridged over; ...this work formed... also an acqueduct...". Alluvium deposits on which now lies a large part of the present city of Alexandria, have completely masked the traces of the Heptastadium: its position in the large existing isthmus was, till now, entirely conjectural and, from the middle nineteenth century, its orientation was believed to be largely different from that one of the antique streets network.

New studies have been undertaken since 1995 in order to establish a valid position of this significant feature of the hellenistic city. This was done in cooperation between our team (*C.N.R.S., Garchy* and *Département de Géophysique Appliquée, Université de Paris 6 et 7*), the *Centre d'Etudes Alexandrines* (*I.F.A.O.*, Cairo) and a colleague from the National Research Institute of Astronomy and Geophysics (Cairo). Several investigations were conducted in different ways: ancient documents and maps, old streets network, levelling survey, local information, metrology, ... They all revealed a clear dissymetry of the isthmus, leading to pay more attention to its western part.

A differenciation which appears on the maps of the sewers system must be mentionned at first: the line of separation between the western and the eastern slopes of the sewers is very close to the western shore of the isthmus. We then conducted a very accurate levelling of the surface of the ground along transverse streets which shows that the highest points of the isthmus are close to its western shore as well (fig. 2). However the most relevant information was given by a carefull analysis of the streets network of the old turkish city on the isthmus. It clearly showed remains of portions of streets in a straight NNW-SSE line (in black), close to the western shore again and strictly orientated towards the southern point of the island of Pharos (fig. 1). Besides, the other old streets revealed that the isthmus developped from an initial nucleus which could have been an islet, or a small reef, between the coast and Pharos (black star on fig. 1). Each street here evidently represents a record of the position of the shore at subsequent times. It was then clear for us that this central black line marked the true position of the Heptastadium.

In addition to these studies and in order to consolidate our assumption, we conducted a series of geophysical investigations, selected in respect of their potential ability of being worked out in the urban environment and despite the unfavourable situation of the ground, which could be estimated very damp and salted. Four methods were operated on portions of the same transverse profiles as the topographic levelling (A to F: fig 2).

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The first method to be considered was refraction seismics ("ABEM Mark VI" recorder and 24 geophones) with a mechanical source of energy. Unfortunately the source revealed too weak and/or the streets far too noisy, even after closing the car traffic, in such a way that the interpretation turned to be problematic for technical reasons in this urban context.

The radar ("Pulse Ekko 1000") was operated with two sets of antennas at 50 and 100MHz. Surprisingly, relatively large depths could be reached (several meters) and this is in favour of the existence of a rather coherent rocky subsoil with limited salted water invasion in the explored area. Some good indications such as channel like responses (from the acqueduct?) or slope like reflectors, more or less in line, were obtained on the edges of the expected position of the Heptastadium.

But the best results were given by two resistivity methods which both provided similar information,with close average values, strongly consistent with the non geophysical data. The first one was an electromagnetic Slingram system ("EM31 Geonics"). Due to a number of metallic disturbances in the streets, it was necessary to collect a large amount of readings on a data logger in such a way that we could afterwards average and filter them along the profiles. The filtered data were then plotted on a map on which a clear low resistivity response could be recognized along one of the streets (D: Abd el Moneim el Deba). Elsewhere, high resistivity anomalies were concentrated close to the target area with low values outside, but no sharp and linear response was obtained above any hypothetic narrow causeway.

Our electrostatic resistivity prototype as well ("MPI-Eurocim") (fig. 4) gave excellent results as much reliable as they were in almost perfect accordance with the EM31 results. The profiles exhibits a very good correlation of anomalies between small and large quadripoles (Wenner, a = 3, 6 and 9m) (fig. 5); soundings (between streets B and D) could clearly differentiate an area of high resistivity along the target axis and of lower resistivities outside, *i.e.* on its ENE and WSW edges. All the data for a=6m (profiles and soundings) were gathered on a same map (fig. 3). The correspondence with the EM31 map, with the other data and with the supposed position of the Heptastadium, is excellent with very well centered responses, especially at the position of the hypothetic islet, and low values of resistivities along the same street D. This last observation is an additional argument for locating somewhere between this street and the southern point of Pharos (mosque Barta Kisch) one of the two passages described by Strabo.

Despite the fact that the Heptastadium definitely does not appear as a direct geophysical marker, several original data concerning the structure and the evolution of the now existing isthmus could be gathered during this survey, together with a new reliable hypothesis for the Heptastadium. Its position is consistent with the well-known antique street network of Alexandria (street R9), and fits an exact length of seven *stadia* (*i.e.* 1155m) between the Canopic street and the southern shore of Pharos (fig. 6). An entirely new geomorphological model of the isthmus can be proposed: it would consist in an evolution, in four or five chronological phases, of a resistant nucleus, with sharp edges, developped by sedimentation around a primitive islet located between the two passages which were successively closed.

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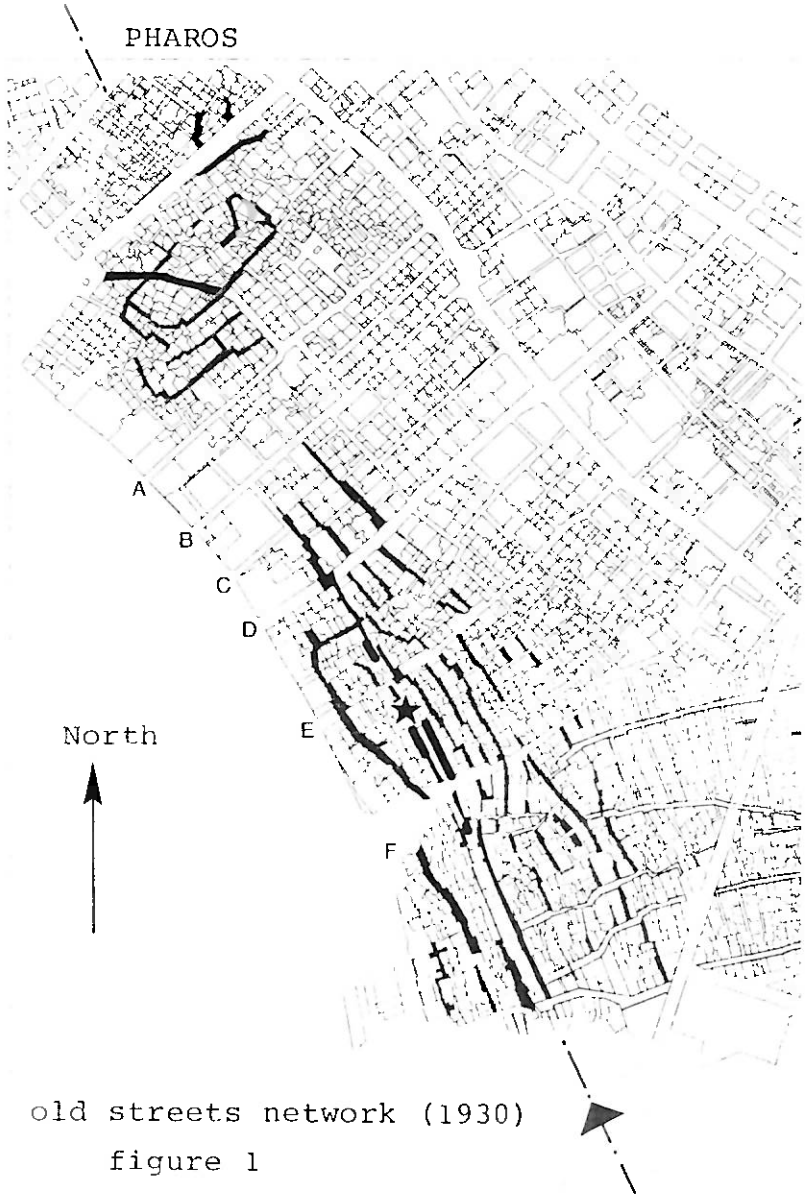

old streets network (1930)

figure 1

altitudes

figure 2

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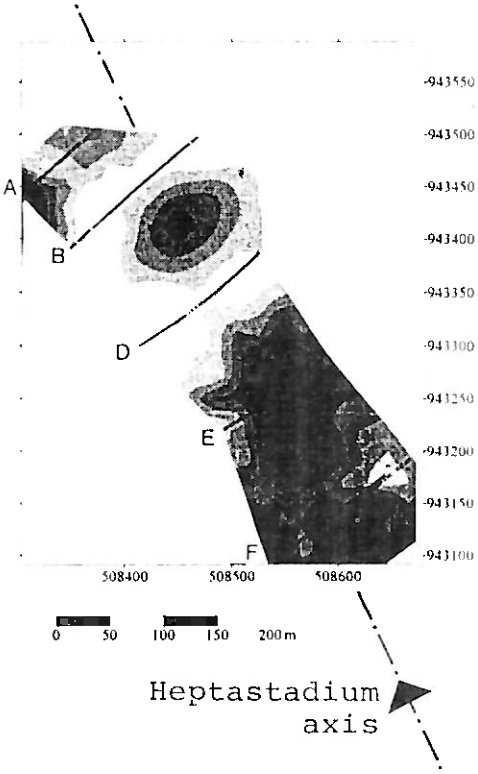
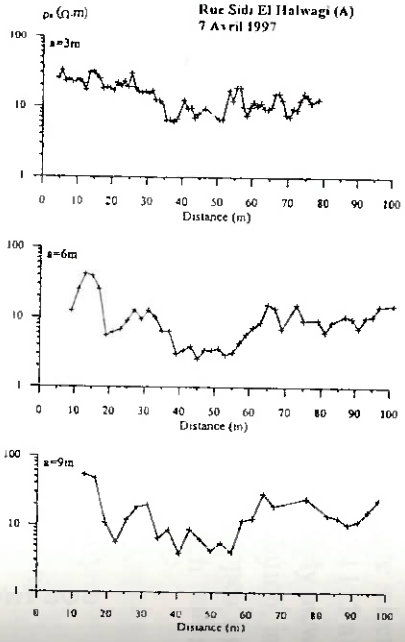


electrostatic
resistivities

figure 3

figure 4



electrostatic profiles
figure 5

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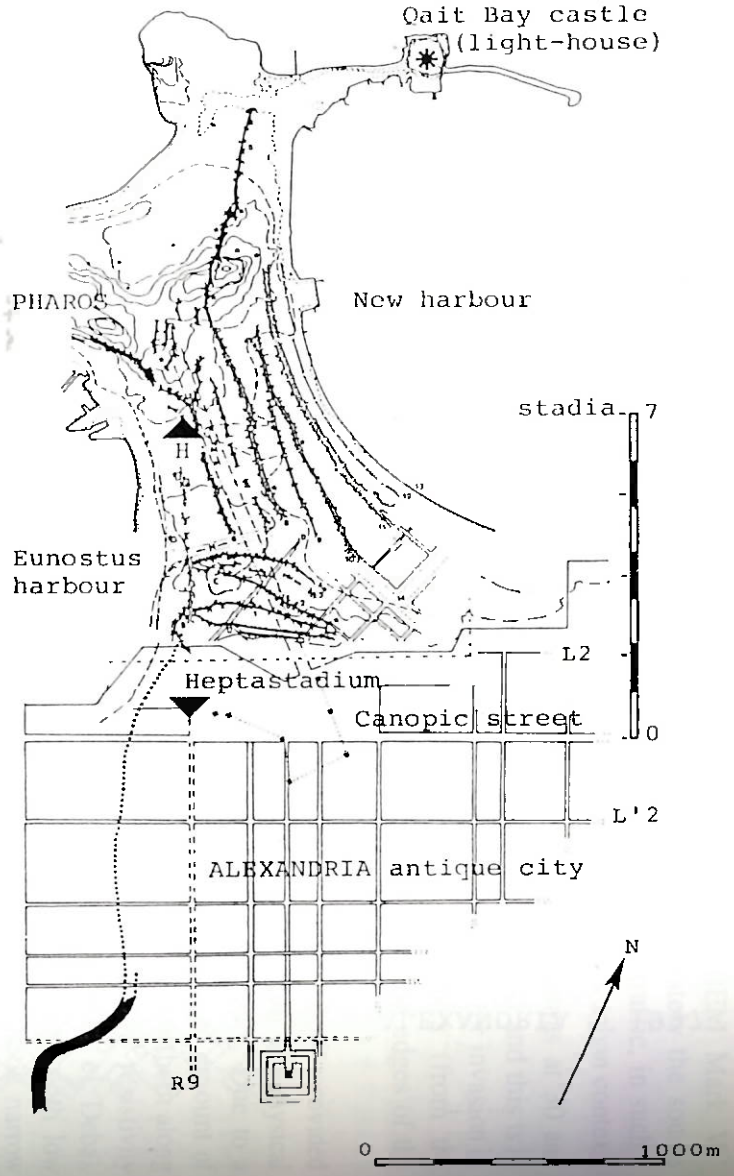

figure 6