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Early experiments with the use of new surveying methods in the archaeology of the Nile Valley

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Except for a short visit to England in 1961, my long stay in Sudan during the winter 1965–66 was my first opportunity to experiment with geophysical methods outside France. I am very much indebted to Jean Vercoutter and André Vila for inviting a young inexperienced researcher

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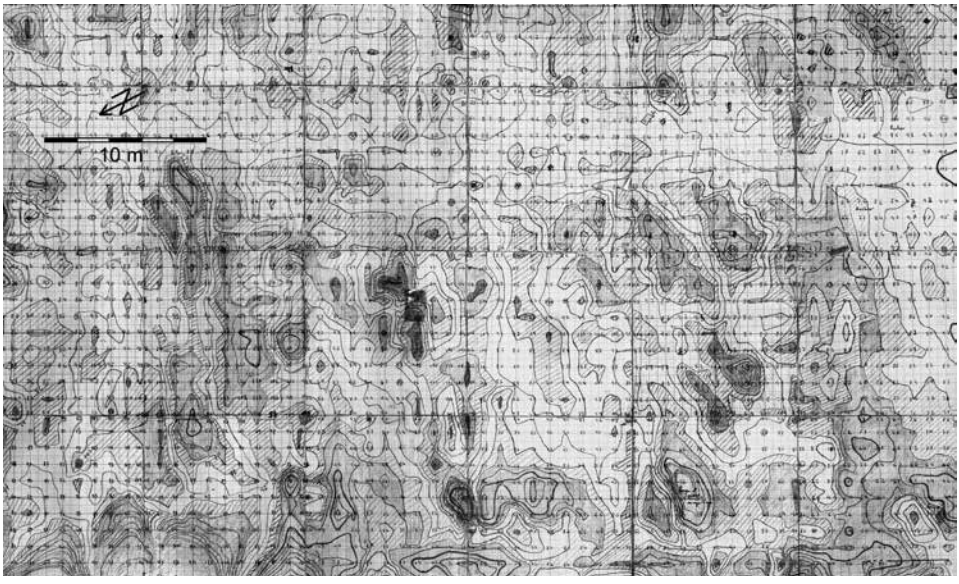

Fig. 1. Section of a "handmade" magnetic map of Mirgissa fortress dating from the Middle Kingdom (Sudan). Readings of the total magnetic field in gammas (nanoteslas) were written after correction of the diurnal variation and lines of equal value drawn by interpolation between the data and smoothing on the edges of each couple of the adjacent 10 m by 10 m squares (one measurement every meter on both x and y directions of the map)

like me to participate in such an archaeological context: the rescue of archaeological remains to be flooded by the waters of the Aswan dam.

The site of Mirgissa on the second cataract of the Nile was for me a kind of huge laboratory where I tried to use all the easily available geophysical methods of the time, that is, principally resistivity and magnetometry (Hesse 1970). I succeeded in performing a few electric soundings in the sand, but better results were obtained with a proton magnetometer. I was able to demonstrate that significant anomalies over mud-brick walls were caused by the high magnetic susceptibility of Nile silt used to make the bricks, compared to the aeolian sands in which they lay. Despite the low accuracy of my instrument (Elsec Littlemore Engineering) (see Fig. 7, page 131 in this volume) without differential readings and problems raised by the local environment (low latitude, hot climate and magnetic storms), I was able by using a kind of primitive handicraft filtering to give a sketch map of the internal organisation of a huge Middle Kingdom fortress (more than 1 ha) with its main streets and blocks of buildings. This needed about 10,000 readings to be plotted several times by hand (Fig. 1)!

While doing this, I noticed the incredible amount of pottery sherds scattered on the surface of this fortress and other sites. I was quickly convinced that considerable archaeological information could be deduced from such easily available and often neglected material. Then I decided to dedicate a part of my time to collecting, sorting and mapping a selection of these remains. At that time, my methodology was not very sophisticated, but several interesting

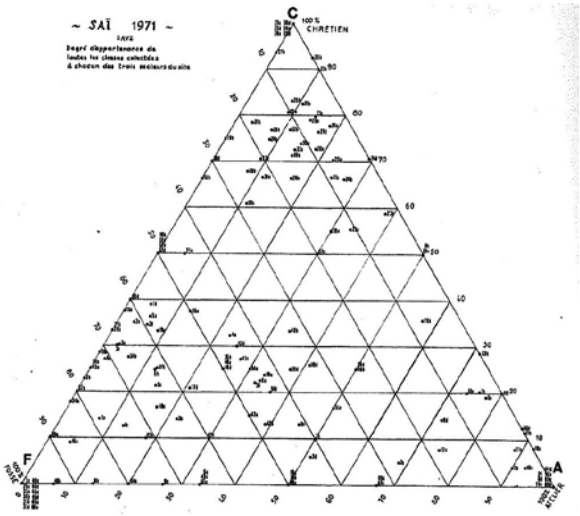

Fig. 2. Representation on three scales of a triangular graph of all the classes of objects collected on the surface of the camp site SAV2 on Saï island (Sudan). Each coordinate corresponds to the percentage of presence of each class in three different and significant sectors of the site: F inside the camp site limited by remains of a New Kingdom ditch; A in the area of a pottery workshop; C in the area of Christian occupation. Good clustering of points confirms land division and contemporaneity of close classes of objects

archaeological results were obtained, mainly concerning different types of Nubian non-thrown pottery compared with Egyptian ones: their different distribution on the surface was significant of differences of period and/or of culture (Hesse 1971).

My following research with the *Mission archéologique française au Soudan* took place a little later, in 1977, on the island of Saï, when almost everything of Mirgissa had disappeared. This area again was fascinating with almost all ancient periods represented from prehistory until the Turkish occupation. Some limited investigations with an electromagnetic device (EM 15 Geonics) was paralleled mainly with a surface collection survey. At the campsite called SAV2, I was still missing an appropriate process for analysing the data. However, I improved my methodology by introducing a sorting technique of the different classes of collected objects: the triangular graph that was in current usage among geologists dealing with the granulometry of sediments (Fig. 2). It turned out to be powerful enough to distinguish and localise accurately different occupations of the site: the original one dating from the Middle Kingdom, a later pottery workshop and then a partial Christian reoccupation. At the time other scholars were developing new processes and algorithms and, as a mater of fact, I discovered that I had been using unconsciously a kind of very primitive "factorial analysis" (Hesse 1985). The method was so powerful that I used it again on another very large space (SKP1) on the same island of Saï: this new survey revealed a very clear distribution of the remains in a kind of horizontal stratigraphy, ranging from the Khartoum Variant Neolithic (observed there for the first time) on the high ancient terraces through to the Christian occupation just behind the present bank of the Nile (Hesse 1996).

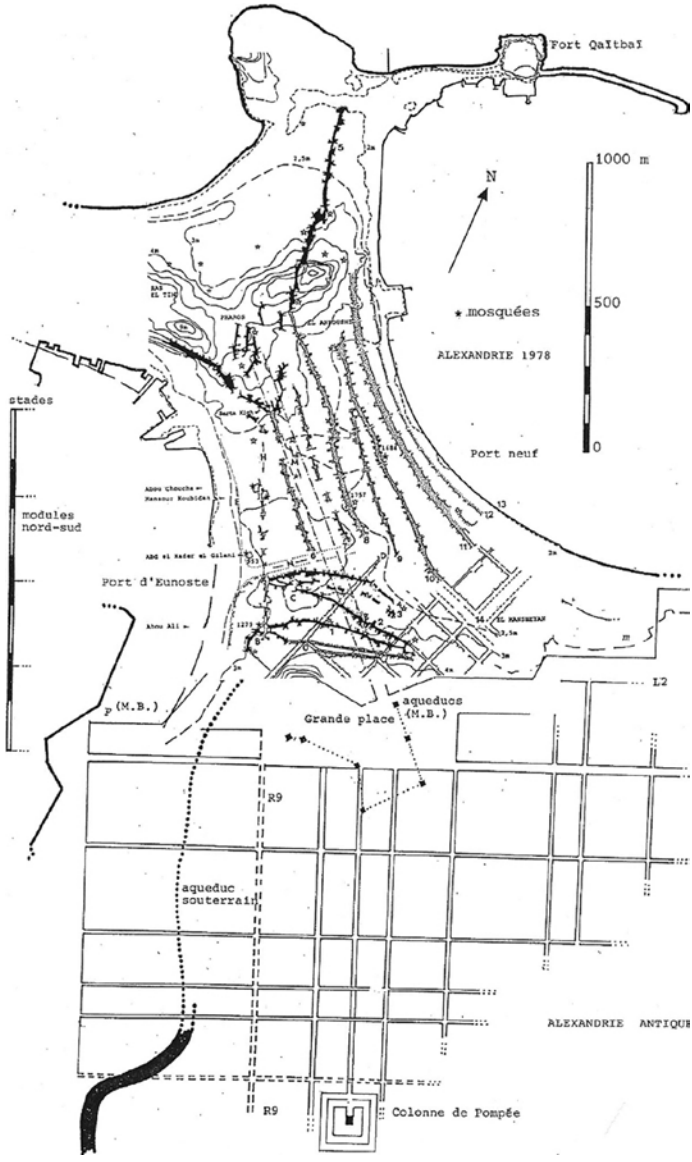

Fig. 3. Final map of the survey searching for the course of the Heptastadium in Alexandria (Egypt). Strabo described this way as joining the antique city (bottom of the sketch) to the island of Pharos (top of the figure). Among several possible courses of this major axis, only one was found to fit perfectly the results of a series of investigations (including geophysical surveys) on the isthmus between the island and the city. It can be identified in the figure on the same axis as one of the antique streets, starting from a clear crossroads and finishing at the south corner of Pharos, with an exact length of seven stadia (scale on the left side of the figure)

Later on I had the opportunity of more surveys of this kind on several sites in different countries (France, Italy) and along the Nile Valley again, in Egypt, on the Predynastic site of Adaïma in 1989 (Midant-Reynes *et al.* 1990). The archaeological efficiency of the method was always confirmed by checking in the field.

In 1993, I came back to Egypt to train some colleagues who wanted to search for possible remains of a river port just below the Ramesseum (west bank of the Nile at Luxor) with a resistivity survey (Guillaume *et al.* 1995).

Collection of surface remains was not my last contribution to Saï archaeology: the most ancient occupation on SKP1 had left an incredibly large number of pits dug into the Neolithic levels. In 1994, the Saï mission restarted under Francis Geus, who was like myself interested in the intact features of this type still visible on the ground. Topographic mapping over such a large area was inconceivable. At that time, the use of remotely piloted aircraft systems for photographing the earth surface was not as commonplace as it is nowadays. Bernard-Noël Chagny was already making a name for himself in kite photography and thanks to such light equipment, I could carry out with him a very original survey of this prehistoric settlement located in such a remote area. At the same time we made a few flights over the Kerma necropolis (3rd millenium BC) and obtained the first legible and magnificent views of this unique site with its large tumuli (40 m in diameter) strengthened by several concentric circles of black and white stones (Hesse 1996).

Tomasz Herbich was responsible for other geophysical experiments in the Nile Valley. It was during the relatively early times of radar investigation in archaeology, when I was conducting research in Alexandria in 1997 to reconstruct the course of the Heptastadium (see below). Since we had ground-penetrating radar at our disposal, Michel Dabas and myself tried to answer his question concerning a possible structure under the chapel of Hathor at Deir el-Bahari. The results were not very successful, but the trip was an opportunity to check the instrument in the long corridor of Seti the First's tomb in the Valley of the Kings in Luxor in search of a possible empty space somewhere under the floor. We were luckier there with a very interesting response that, as far as I know, is still to be checked (Dabas and Hesse 1998).

Last but not least, Jean-Yves Empereur asked me to reconsider Mahmud Bey's surprising but duly accepted conclusions of 1870 concerning the Heptastadium, this major axis leading from the antique city of Alexandria to the island of Pharos, as described by Strabo. The examination of many different factors (history, ancient city maps, old building analysis, field surveys in the streets including topography and geophysical data, such as EM and electrostatic resistivity, GPR and seismic, obtained with the help of an efficient team of colleagues) allowed me to suggest a new course of this famous way (Fig. 3). It is much more (I must say "absolutely"!) in accordance in length (seven *stadii*), orientation and position with the grid (Hippodamian) plan of the Alexandrian city and is currently accepted by archaeologists (Hesse *et al.* 2002).

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