

## **Geophysical surveying in Egypt: periodical report for 2013-2015**

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The article reviews briefly prospections carried out by the author in Egypt from 2013 through the middle of 2015, adding to the cyclical presentations of research during AP conferences in the past starting from 1999 (complete list of references in Herbich 2013). The surveys in Berenike,

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Heliopolis, Buto and Kom el-Gir are ongoing projects, whereas the investigations in Dahshur, Tanis, Abu Billo and Plinthine are new initiatives (Fig. 1).

The magnetic and electrical resistivity methods were employed. Fluxgate gradiometers (Geoscan Research FM256) were used and sporadically a caesium instrument (Geometrics). Sampling density for the FM instrument was 0.5 m by 0.25m, the survey was carried out in parallel mode within a grid of 20 m x 20 m. The electrical resistivity method, both profiling and sounding, was based on a Polish-made ADA 05 (Elmes) apparatus.

OLD KINGDOM (2575 – 2134 BC)

DAHSHUR (German Archaeological Institute, project director Nicole Alexanian)

The survey was carried out around the valley temple of the Bent Pyramid and on the southern side of the Red Pyramid. An area of 11.3 ha was prospected. Measurements to the north of the temple mapped in considerable detail a settlement that could be dated to the Old Kingdom based on a surface pottery collection. The network of anomalies clearly reflects fragmentary housing as well as the street grid, whereas the nature of these anomalies indicates the presence of mud-brick architecture (Fig. 2). Linear anomalies adjoining the temple on the north (extending its long sides) have been interpreted by Felix Arnold as the remains in all probability of an early dynastic funerary enclosure of the same kind as the ones discovered at Saqqara and Abydos. Prospection in the area of the hypothetical harbour, connected to the temple by a causeway, mapped mud-brick walls embracing the bay on the north and south (the southern wall had already been traced by H. Becker using a caesium instrument).

Surveying on the south side of the Red Pyramid was aimed at verifying two architectural complexes marked on Lepsius' plan from the middle of the 19th century and still faintly outlined in Google Earth images. The magnetic map of the better preserved eastern complex revealed a dozen or so long and narrow units. Their layout and size are analogous to the workmen's (pyramid builders) barracks at Giza. The surface pottery collection dated the complex to the Fourth Dynasty, which is the time of construction of the Red Pyramid. The indistinct image of the structures on the map is due to the fact that they were built of stone, a determination suggested by earlier limited excavations by the western complex and an analysis of surface evidence.

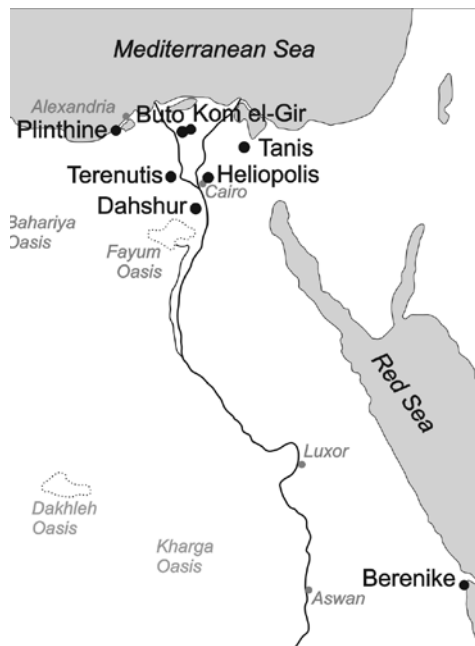


Fig. 1. Location of sites investigated in 2013-2015

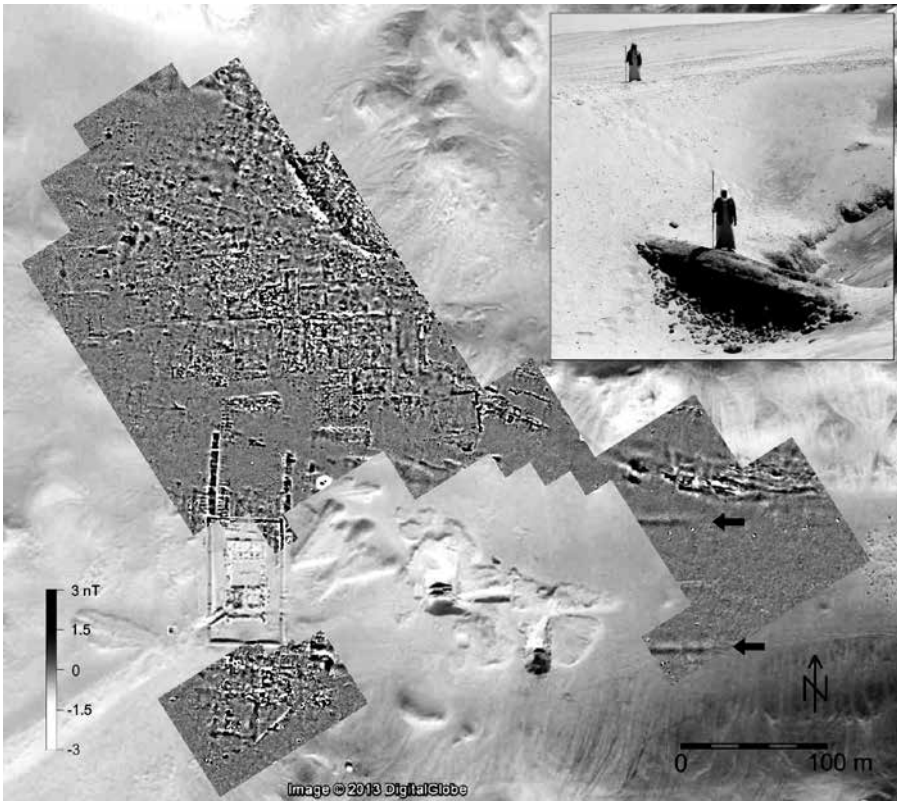


Fig. 2. Dahshur. Magnetic map of structures in the area of the valley temple of the Bent Pyramid. Arrows indicate the position of walls embracing the harbour. The wall depth (average of 4 m below ground level) was tested archaeologically on the south side (see photo in the box) and by core drilling on the north side. Satellite image by Google Earth

NEW KINGDOM (1550 – 1070 BC)

HELIOPOLIS/EL-MATARIYA (Leipzig University, project director Dietrich Raue)

The investigations concentrated on the remains of a temple of Re-Horakhty and Atum in Heliopolis, covered by at least two meters of alluvial mud. The earliest remains of architecture reach down 8 m in places. The accruing rubbish dump (6 m thick in places; for earlier work, see Herbich 2013: 241–2) threatens the ancient remains, hence the need for this salvage project. Electrical resistivity profiling (with an asymmetrical Schlumberger arrangements, the probe settings being AM=5 (or 7) m and MN=1 m) was carried out with considerable difficulty due to hard field conditions: a dry and hard ground that did not allow for any measurements until an iron rod was used to break open holes and fill them with water to decrease contact resistance. The asymmetrical arrangement was employed owing to the small dimensions of areas available for surveying (part of the area was cleared of rubbish with a bulldozer).



Fig. 3. Tanis. Magnetic map of architecture from the Late Period in the southern part of the tell

Measurements uncovered a higher-resistance anomaly of elongated shape; coring established that it was caused by a limestone structure and that its foundations reached 4 m below ground level (and 3 m below the ground water table) (de Morgan and Herbich 2015). The structure will be excavated the coming season once a program of pumping has reduced the water table.

#### THIRD INTERMEDIATE AND LATE PERIODS (1070 – 332 BC)

BUTO/TELL EL-FARA'IN (University of Poitiers, French Institute of Oriental Archaeology in Cairo and German Archaeological Institute, project director Pascale Ballet)

The magnetic prospection covered a total of 3.1 ha to the north, west and south of the temple enclosure, mapping remains of mud-brick architecture and industrial installations, presumably pottery kilns. Since 1999, the prospection has covered altogether over 25.5 ha (Hartung *et al.* 2009)

**TANIS/SAN EL-HAGAR** (École pratique des hautes études, project director François Leclère)

The new director of the French excavation mission at Tanis, the capital and principal Mediterranean port of Egypt in the Third Intermediate Period, initiated a program of non-invasive research aimed at reconstructing the urban layout on the tell (which is 1.5 km in diameter) and the paleolandscape around it. The magnetic method was employed to map the city, starting with an area of 30 ha in the northern and central/southern parts of the tell. The results were so good that not only was it possible to reconstruct the street grid, but detailed plans of individual houses could also be drawn (Fig. 3). The architecture that was mapped was dated to the Late and Graeco-Roman periods based on an architectural analysis of the plans and the surface pottery collection. Landscape research concentrated on establishing the course of the defunct Tanitic branch of the Nile. A series of vertical electrical soundings (VES) was carried out (within the frame of an agreement on co-operation between EPHE and IAE), providing data for drawing sections in which areas of stable geological sequences were isolated from those characterized by a disturbed layer arrangement. Data interpretation will follow a program of auger drilling to verify the findings.

**GRAECO-ROMAN PERIOD (332 BC – 395 AD)****PLINTHINE/KOM EL-NUGUS** (French Mission to Taposiris Magna, project director Marie-Françoise Boussac)

The site, identified as ancient Plinthine, was considered the western gate to Egypt in the 7th and 6th centuries BC (analogously to Hebua on the east), until it lost its position to Taposiris Magna at the close of the Hellenistic period. A magnetic survey covered 2 ha on the slope and in the middle of a horseshoe-shaped kom as well as to the south of the latter, in an area where architecture has been excavated ever since the project started in 2013. Testing on the kom confirmed its anthropic origin as the accumulation of settlement deposits with architectural remains preserved in the subsurface layer. Structures in front of the kom were also mapped. The walls were constructed of non-magnetic limestone; their distinct image on the magnetic map is due to the higher magnetic susceptibility of the soil in which they are buried (of values up to  $0.3 \times 10^{-3}$  SI).

**KOM EL-GIR** (German Archaeological Institute, project director Robert Schiestl)

The prospection continued a project started in 2011 (Herbich 2013), achieving a coverage of almost 80% of the structures on the main mound (12.8 ha). A rectangular structure measuring 170 m by at least 160 m was discovered as a result of the prospection; running around it was a wall 6 m thick, periodically reinforced with towers. It is most likely a Roman fort, the first to be discovered in the Nile Delta (Schiestl and Herbich 2013) (Fig. 4).

**BERENIKE** (University of Delaware and Polish Center of Mediterranean Archaeology of the University of Warsaw, project directors Steven E. Sidebotham and Iwona Zych)

A full magnetic map of the ancient city and harbour was completed, permitting a reconstruction of the street network, the urban layout of individual houses and a precise tracing of the town limits. A structure of monumental size, possibly a funerary mausoleum, was mapped in part where an analysis of old Corona satellite images located it, unexpectedly, on flat ground already outside the



Fig. 4. Kom el-Gir. Magnetic map of Roman-period architecture. Arrows point to anomalies that reflect the position of the northern and western corners of a hypothetical fort. Satellite image by Google Earth

city limits to the west of the town (for more on the prospection, see Zych and Herbich 2015: 95-118) TERENUTHIS/ABU BILLO (French Institute of Oriental Archaeology in Cairo and University Lille 3, project director Sylvain Dhenin)

Excavations conducted at the site from the 19th century have identified occupation from the Old Kingdom (burials), followed by settlement not earlier than the Hellenistic period. A new project undertaken at the site in 2012 has prioritized fieldwalking, as well as topographic and geophysical research. Magnetic prospecting covered the western part of the site (around a Ptolemaic-age temple) and areas in the southwestern part, covering a total of 8 ha. An improved temple plan was traced based on the prospection results (the original plan had availed itself of an analysis of ground relief and fragmentary excavation) and at least two major building phases were identified. Dozens of tombs constructed of mud brick were also located; they have been dated to the Roman period based on excavation work that is carried out concurrently.

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