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Small Harbours in the Nile Delta
The Case of Tell el-Dab^{c}a

There are two things that the authors of this article, who come from two separate scientific institutions, have in common. One is a deep respect and admiration for Professor Karol Myśliwiec and the other is a decade of working together on a geophysical research project at Tell el-Dabᶜa. The first of the authors enjoyed carrying out geophysical surveys in projects directed by prof. Myśliwiec in 80' in Tell Atrib[1] and Saqqara[2] thus initiating the author's adventure with Egyptian archaeology. The second author met Prof. Myśliwiec in 1987, when he supervised her first course in Egyptian archaeology as a visiting professor at the Institute for Egyptology of the University of Vienna. This evoked her deep interest in ancient Egyptians towns and initiated a lifetime of research on cities and landscape. The present article, based on data collected from a magnetic surveying project in the concession area of the Austrian Archaeological Institute in Cairo is a palpable attestation of the findings of this shared investigation.

The magnetic surveying project at Tell el-Dabᶜa has been ongoing since 1999[3] and has covered currently near to 150 hectares (**Fig. 1**).[4] Considered jointly with the results of magnetic surveying by the Roemer- und Pelizaeus-Museum Hildesheim expedition in Qantir[5] (the maps of the two projects connect in the area northeast of ᶜEzbet Machali, thus showing the opposite banks of the Pelusiac branch of the Nile which separated the two locations), these geophysical prospections, covering altogether more than 3.5 km^2, constitute the biggest area ever subjected to geophysical archaeological research in Egypt. The discussion herein has also included the results of a resistivity survey conducted using the vertical electrical sounding (VES) method.[6]

The issue presented in this article – the localization of river harbours and bays – is of utmost importance for understanding the function of settlements situated on the Nile or its branches and this line of research has greatly benefitted in recent years from the application of geophysical methods as a new and extremely effective tool.

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[1] K. Myśliwiec, T. Herbich, Polish archaeological activity at Tell Atrib in 1985, [*in*:] E. van den Brink (Ed.), Archaeology of the Nile Delta, Amsterdam 1988, pp. 177–189.

[2] K. Myśliwiec, T. Herbich, Polish Research at Saqqara in 1987, *EtudTrav* XVII, 1995, pp. 177–203.

[3] This project was initiated by Manfred Bietak on behalf of the Austrian Archaeological Institute, see M. Bietak, J. Dorner, P. Jánosi, Ausgrabungen in dem Palastbezirk von Avaris. Vorbericht Tell el-Dabᶜa/ᶜEzbet Helmi 1993–2000, *ÄgLev* 11, 2001, pp. 74–78; T. Herbich, Archaeological geophysics in Egypt: the Polish contribution, *Archaeologia Polona* 41, 2003, pp. 28–30.

[4] For a complete map, see: I. Forstner-Müller, T. Herbich, Ch. Schweitzer, M. Weissl, Preliminary report on the geophysical survey at Tell el- Dabᶜa/Qantir in spring 2009 and 2010, *ÖJH* 79, 2011, p. 70.

[5] E.B. Pusch, H. Becker, J. Fassbinder, Wohnen und Leben oder: Weitere Schritte zu einem Stadtplan der Ramses-Stadt, *ÄgLev* 9, 1999, pp. 155–170.

[6] The method was first tested in 2008 on selected parts of the site, at the interface of the settled area and the riverbed, see I. Forstner-Müllerr, T. Herbich, Ch. Schweitzer, M. Weissl, Preliminary report on the geophysical survey at Tell el-Dabᶜa/Qantir in spring 2008, *ÄgLev* 18, 2008, pp. 100–106. Since 2009 the research is carried out within the framework of a joint project of the Austrian Archaeological Institute and the Institute of Archaeology and Ethnology, Polish Academy of Sciences.

1. Tell el-Dab^c^a. Magnetic map superimposed on satellite picture. In boxes, areas of surveys in ^c^Ezbet Rushdi north (marked A), ^c^Ezbet Machali (B), ^c^Ezbet el-Ezzawin (C) and ^c^Ezbeti Mehesin (D). Magnetic prospection by T. Herbich and team (1999–2011) and C. Schweitzer (2000–2010). Magnetic data processed by T. Herbich and C. Schweitzer. Processing of the Google Earth picture and superimposing the maps on the plan by M. Weissl (© ÖAI).

RIVER HARBOURS IN EGYPT AND IN AVARIS

With travel and transport in Ancient Egypt taking advantage of the Nile for the most part, all kinds of harbours and mooring places should be expected on the waterways. Major harbours were located chiefly along the river and its branches, the pattern remaining valid for inland river shipment as well as for international seagoing transport whether to the south or, especially, to the Mediterranean and the Ancient Near East.[7]

Trading posts doubling as harbours have been found along the Red Sea coast and may have existed on the Mediterranean. Those on the Red Sea reached back to the Old Kingdom[8] and the Middle Kingdom,[9] when they were used to launch expeditions to inner Africa and Punt. Harbour-founding processes on this coast reached a peak under the Ptolemies, due to an interest, among others, in importing African elephants for the Ptolemaic army.[10] With regard to the Mediterranean coast, the issue of naval contacts between Egypt and the Mediterranean on one hand and the Levant on the other is more complex. There is no doubt that important cities of the Delta and those on the Nile (such as Memphis) also functioned as harbours. This phenomenon has been observed in other river deltas, where the main harbours are found not on the sea coast, but inland as a rule.[11] Nonetheless, harbours existed on the Mediterranean coast from at least the Late Period. The excavation of sites such as Thonis have expanded our knowledge of harbour locations, changing the generally accepted view of Alexandria as the first Mediterranean harbour to be founded in the era of the Ptolemies.[12]

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[7] For the maritime trade in the second millennium BC, see E. Marcus, Maritime Trade in the Southern Levant from Earliest Times to the Middle Bronze IIA Period, PhD dissertation, University of Oxford 1998.

[8] For Ayn Soukhna, see P. Tallet, Les Égyptiens et le littoral de la mer Rouge à l'époque pharaonique, *CRAIBL*, Séances de l'Année 2009 Avril-June, publication trimestrielle, fasc. II, Paris 2009, pp. 687–726; Id., Ayn Sukhna and Wadi el-Jarf: Two newly discovered pharaonic harbours on the Suez Gulf, *BMSAES* 18, 2012, pp. 147–168; http://www.britishmuseum.org/research/publications/online_journals/bmsaes/issue_18/tallet.aspx (accessed June 11, 2013); G. Marouard, P. Tallet, Wadi el-Jarf – An early pharaonic harbour on the Red Sea Coast, *EgArch* 40, 2012, pp. 40–43; P. Tallet, M. El-Sayed (Eds), The Red Sea in pharaonic times: recent discoveries along the Red Sea Coast, Proceedings of the colloquium held in Cairo/Ayn Sokhna 11th–12th January 2009, *BdE* 155, Le Caire 2012.

[9] For Wadi Gawasis, see K.A. Bard, R. Fattovich (Eds), Harbor of the Pharaohs to the Land of Punt. Archaeological Investigations at Mersa/Wadi Gawasis, Egypt, 2001–2005, Napoli 2007 and also updates in the internet: http://www.archaeogate.org/egittologia/article/1506/1/mersawadi-gawasis-2010-2011-report-by-kathryn-a-bard-bo.html (accessed June 11, 2013). Also recently R. Fattovich, Egypt's trade with Punt: New discoveries on the Red Sea Coast, *BMSAES* 18, 2012, pp. 1–59; http://www.britishmuseum.org/research/online_journals/bmsaes/issue_18/fattovich.aspx (accessed June 11, 2013).

[10] G. Hölbl, A History of the Ptolemaic Empire, London 2001, pp. 55–57. Material evidence of the import of live animals was discovered recently during the Polish-American excavations at Berenike on the Red Sea coast, see S.E. Sidebotham, M. Hense, H.M. Nouwens, The Red Land, Cairo-New York 2008, p. 162; I. Zych, S.E. Sidebotham, Temples, dogs and rubbish – the 2010 season in Berenike University of Delaware-PCMA expedition, *PCMA Newsletter online* 2010 (http://www.pcma.uw.edu.pl/index.php?id=555&L=2 (accessed June 11, 2013)), Fig. 14.

[11] M. Bietak, Minoan presence in the pharaonic naval base of Peru Nefer, [*in*:] O. Krzyskowska (Ed.), Cretan Offerings: Studies in Honour of Peter Warren, London 2010 [= Minoan presence], p. 20.

[12] See F. Goddio, Underwater Archaeology in the Canopic Region – The Topography and Excavation of Heracleion-Thonis and East Canopus (1996–2006), Oxford 2007.

It is well known that sites such as Memphis, Avaris and Piramesse were important harbour towns for international trade in the second millennium BC. One could argue, however, that the accepted view of harbours as sited solely inland may be due to our lack of knowledge. These inland sites were not the only places that could have served as starting points for international trade and military expeditions. Fortresses and military posts, such as Zawiyet Umm el-Rakham on the Mediterranean coast,[13] may have had a harbour function as well.

Although harbours are an essential feature of Ancient Egypt, little archaeological work has been carried out on them. Pivotal and pioneer work was carried out by B. Kemp and D. O'Connor on the ancient Nile harbour at the Birket Habu[14] on the west bank of the river Nile. Excavations undertaken in the 1970s uncovered the remains of an artificial harbour basin built during the reign of Amenophis III, connecting the large Malqata complex with the river Nile. Another artificial harbour was excavated in the Middle Kingdom fortress of Serra East.[15] An Old Kingdom mooring place was investigated in Elephantine.[16] Possible harbours or quay installations from the Old Kingdom are also known from the Giza area.[17] Recently, another artificial basin was excavated by the American AERA mission within the complex of Queen Khentkawes in Giza.[18] This large structure, which was 37.2m (71 ancient Egyptian cubits) wide and was most probably a harbour, was discovered to the east of the 'Khentkawes town'. Another important contribution for understanding Egyptian Nile harbours is that of A. Graham.[19] A new Egypt Exploration Society project was initiated recently in order *to take a look at the 'big picture' of past landscapes and waterways in the Theban region*.[20]

[13] L. Habachi, The Military Posts of Ramesses II on the Coastal Road and the Western Part of the Delta, *BIFAO* 80, 1980, pp. 13–30; S.R. Snape, P. Wilson, Zawiyet Umm el-Rakham I: The Temple and Chapels, Bolton 2007.

[14] B. Kemp, D. O'Connor, An Ancient Nile harbour. University Museum Excavations at the 'Birket Habu', *IJNA* 3/1, 1974, pp. 101–136.

[15] G. Hughes, Serra East: the University of Chicago excavations, 1961–62: a preliminary report on the first season's work, *Kush* 11, 1963, pp. 127–128; J. Knudstad, Serra East and Dorginarti, *Kush* 14, 1966, pp. 176–177.

[16] D. Raue, Die Stadt des früh- Alten Reiches, [*in*:] J.G. Dreyer *et al.*, Stadt und Tempel von Elephantine – 33./34./35. Grabungsbericht, *MDAIK* 64, 2008, pp. 70–72, Abb. 1.

[17] Z. Hawass, The Discovery of the Harbors of Khufu and Khafre at Gîza, [*in*:] C. Berger, B. Mathieu (Eds), Études sur l'Ancien Empire et la nécropole de Saqqara dédiée à Jean-Philippe Lauer, *OrMonsp* IX, Montpellier 1997, pp. 245–256; R.-D. D. Klemm, A. Murr, Zur Lage und Funktion von Hafenanlagen an den Pyramiden des Alten Reiches, *SAK* 26, 1998, pp. 173–189.

[18] M. Lehner *et al.*, The Buried Basin and the Town Beyond, *Aerogram* 12/1, spring 2011, pp. 10–12.

[19] A. Graham, Harbours and Quays in the Egyptian Nile Valley, PhD dissertation, University College London 2011 (not accessible to the authors when writing the article).

[20] A. Graham, Ancient Theban waterways, *EgArch* 38, 2011, p. 3; A. Graham, Investigating the Theban West Bank floodplain, *EgArch* 41, 2012, pp. 21–24. For former investigations, see also A. Graham, J. Bunbury, The ancient landscapes and waterscapes of Karnak, *EgArch* 27, 2005, pp. 17–19.

HARBOURS IN AVARIS[21]

Tell el-Dab^ca/ancient Avaris, situated on the Pelusiac branch of the Nile, was a gateway to the ancient Near East and an important harbour town in the second millennium BC.[22] In the Ramesside period the harbour of Piramesse, the capital of the Nineteenth and Twentieth Dynasties, was in Avaris, which was then the southern part of the town.[23] Recent work has shown that main harbour can be located in the middle of the ancient town where a large depression was visible in images of an earlier magnetic survey. This harbour was in use during the Ramesside Period, the Second Intermediate Period and possibly the later Middle Kingdom, however, there is no evidence for its use in the Eighteenth Dynasty.[24] Further work in this area, which is planned for future campaigns, will show whether this is an artificial or natural basin. A secondary harbour was identified by J. Dorner during his survey in the northern part of ᶜEzbet Rushdi.[25]

SMALL HARBOURS IN TELL EL-DABᶜA

The research on the harbours of Avaris has been geared so far to identifying the main town harbours. However, a magnetic survey on the scale accomplished at Tell el-Dabᶜa created the opportunity for recording even small harbours and easy mooring places, where it would have also been possible to trade from boat to waterfront. This information has proved crucial for understanding the function of particular urban districts or satellite villages.

Effective trade exchange can be assumed in places meeting certain requirements, such as open space on the waterfront to allow for storage of goods, appropriately reinforced waterfront surfaces which did not turn into mire during the rains (unless protected by

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[21] This project was initiated by the second author on behalf of the Austrian Archaeological Institute Cairo and was undertaken in cooperation with the university of Lyon 2, UMR 5133 Archéorient and CNRS to analyze the waterscapes and localize the harbour(s) of Avaris, see: H. TRONCHÈRE, Approche paléoenvironnementale de deux sites archéologiques dans le delta du Nil Avaris et la branch Pélusiaque Taposiris et le lac Mariout, PhD dissertation, Université Lyon 2010; H. TRONCHÈRE *et al.*, Geoarchaeology of Avaris: First Results, *ÄgLev* 18, 2008, pp. 327–340; H. TRONCHÈRE *et al.*, Geoarcheology of an ancient fluvial harbour: Avaris and the Pelusiac branch (Nile River, Egypt), *Geomorphologie: relief, processus, environment* 2, 2011, pp. 23–36. On a summary of the harbours of Avaris, see recently I. FORSTNER-MÜLLER, Settlement Patterns at Avaris, A Study on two Cases, [*in*:] M. Bietak, E. Czerny, I. Forstner-Müller (Eds), Cities and Urbanism in Ancient Egypt, Vienna, 22nd–26th November 2006, *UZK* 35, *Denkschriften der Gesamtakademie* 60, Vienna 2010 [= Settlement Patterns at Avaris], pp. 117–119. Note that later work has shown that the assumed harbour 2 was not a harbour.

[22] M. Bietak has attributed the site to the New Kingdom Peru Nefer, see M. BIETAK, The Tuthmoside stronghold of Perunefer, *EgArch* 26, 2005, pp. 13–17; ID., Minoan presence, pp. 11–24. The identification is highly doubtful, however; so far there has been no evidence for it in Tell el-Dabᶜa.

[23] On Piramesse and its harbours, see recently M. BIETAK, I. FORSTNER-MÜLLER, The Topography of New Kingdom Avaris and Per Ramesses, Ramesside Studies, [*in*:] M. Collier, S. Snape (Eds), Ramesside Studies in Honour of K.A. Kitchen, Bolton 2011, pp. 23–50.

[24] I. FORSTNER-MULLER *et al.*, Preliminary report on area RIV in Tell el-Dabca/Avaris, *ÄgLev* 23, *in preparation*. For the latest published map, see FORSTNER-MÜLLER, HERBICH, SCHWEITZER, WEISSL, *ÖJH* 79, 2011, Fig. 1.

[25] J. DORNER, Ergebnis der Geländeruntersuchungen zur Rekonstruktion der historischen Topographie von Auaris und Piramesse – ein Vorbericht, [*in*:] M. BIETAK, J. DORNER, I. HEIN, P. JANOSI, Neue Grabungsergebnisse aus Tell el-Dabᶜa und ᶜEzbet Helmi im östlichen Nildelta 1989–1991, *ÄgLev* 4, 1994, Fig. 1.

plant cover), and straight harbour boundaries permitting side mooring of boats to facilitate transport of goods onto and from them. A thorough analysis of the magnetic map has led to the identification of several locations satisfying the above conditions, the two best corresponding ones being a location recorded to the east of ᶜEzbet al-Ezzawin[26] and another location near ᶜEzbet Mehesin (**Fig. 1**).[27] These locations were additionally verified by a resistivity survey using the VES method.

Before embarking on a presentation of the deliberately constructed waterfronts, let us first present two of many places where the magnetic map has imaged a waterfront area in the immediate neighbourhood of inhabited land, apparently without human intervention, if the geophysical picture of these locations is anything to go by.

Natural untouched waterfronts – research in the areas of ᶜEzbet Rushdi and ᶜEzbet Machali: Magnetic mapping of the Tell el-Dabᶜa region revealed several areas where the arrangement of anomalies suggested either flowing water or places submerged during the annual river floods. Anomalies reflecting formations filling the river bed in places where the current had flowed once present a characteristic arrangement indicating sedimentation direction, which is in line with the flow of the river.[28] Seasonally flooded areas on the other hand are characterized by fairly uniform values of magnetic field intensity without any marked sedimentation directions and definitely without any kind of anomaly corresponding to settlement activity.

ᶜEzbet Rushdi. Excavations in the northern part of ᶜEzbet Rushdi indicated the presence of architecture from the Middle Kingdom.[29] Surveying with the magnetic method mapped a village on an orthogonal grid, touching on the river on the northern fringes (**Fig. 2**).[30] The river edge is not straight and in places loses its clearness; there are sections along the bank where a high-intensity magnetic field value attests to extensive accumulation of pure Nile mud.

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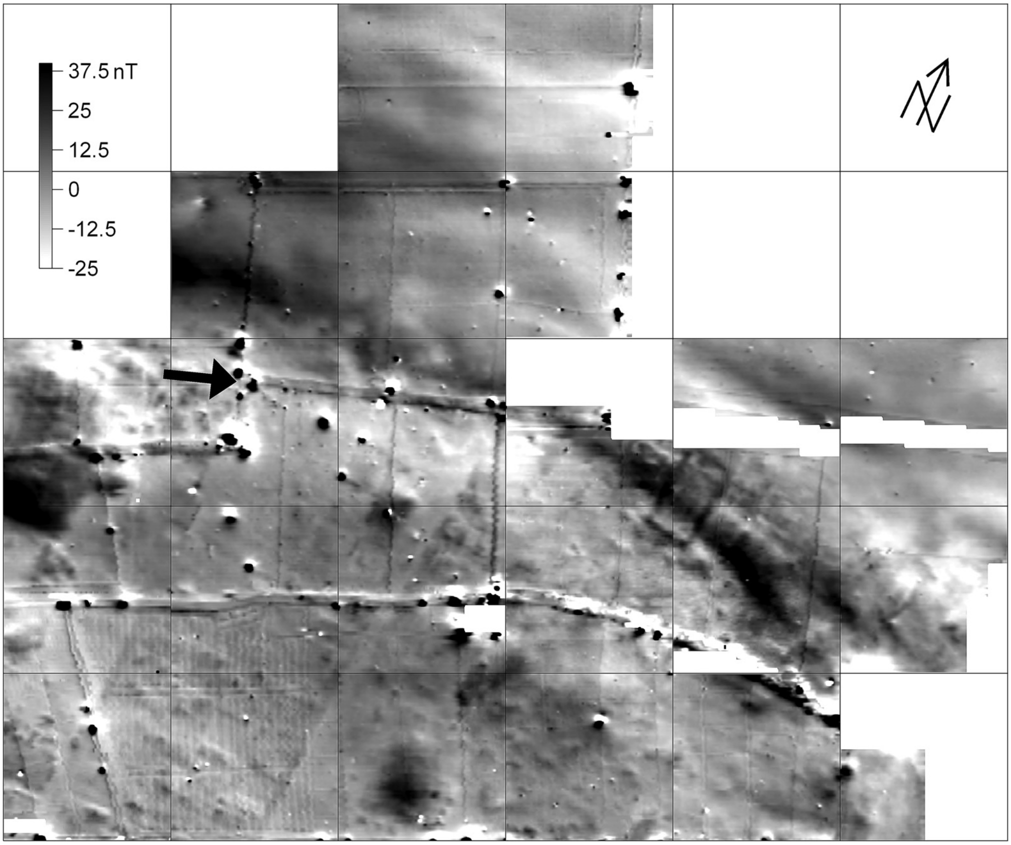
[26] Magnetic research in the ᶜEzbet el-Ezzawin area carried out by a team including T. Herbich, K. Kiersnowski, M. Kurzyk, R. Ryndziewicz and D. Święch, in 2010, using fluxgate Geoscan Research FM256 magnetometers, measuring the gradient of the vertical component of the magnetic field. The northern edge of the settlement was determined in effect of prospection by Ch. Schweitzer (who used a cesium magnetometer Scintrex Smartmag SM-4/4G measuring the total intensity of the magnetic field), see: Forstner-Müller *et al.*, *ÖJH* 79, 2011, pp. 73–74.

[27] Magnetic research in the ᶜEzbet Mehesin area, conducted by Christian Schweitzer in the 2006 and 2010 seasons, see: *ibid.*, pp. 76–78. His measurements were partly verified with a fluxgate instrument (in an area of 0.8ha) by T. Herbich in 2011.

[28] I. Forstner-Müller, W. Müller, C. Schweitzer, M. Weissl, Preliminary Report on the Geophysical Survey at ᶜEzbet Rushdi/Tell el-Dabᶜa in spring 2004, *ÄgLev* 14, 2005, pp. 104–105.

[29] S. Adam, Report on the excavations of the Department of Antiquities at Ezbet Rushdi, *ASAE* 56, 1959, pp. 207–226; M. Bietak, J. Dorner, E. Czerny, T. Bagh, Der Tempel und die Siedlung des Mittleren Reiches bei ᶜEzbet Ruschdi, Grabungsvorbericht 1996, *ÄgLev* 8, 1998, pp. 9–49; E. Czerny, Fragments of Information. Observations Concerning the Architectural Layout of the Middle Kingdom Settlement of ᶜEzbet Ruschdi, [*in*:] M. Bietak, E. Czerny, I. Forstner-Müller (Eds), Cities and Urbanism in Ancient Egypt, Vienna, 22nd–26th November 2006, *UZK* 35, *Denkschriften der Gesamtakademie* 60, Vienna 2010, pp. 69–80; Forstner-Müller, Settlement Patterns at Avaris, pp. 105–107.

[30] Forstner-Müller *et al.*, *ÄgLev* 14, 2005, pp. 101–109.



2. ᶜEzbet Rushdi north. Section of the magnetic map. Survey by cesium magnetometer. Magnetic prospection and data processing by C. Schweitzer. Grid lines every 40m. The anomaly marked with an arrow corresponds to a modern road (© ÖAI).

Thanks to the use of an instrument measuring the total value of the magnetic field (which well reflects shallow ground geological structure), the survey has also recorded an image of riverbed accumulations: the corresponding anomalies are characterized by blurred limits and are aligned with the direction of waterflow.

ᶜEzbet Machali. Magnetic research revealed an area with indistinct remains of architecture, bordered by a bend in the river on the west and south (**Fig. 3**).[31] Surface finds of pottery have indicated a date for the remains in the Second Intermediate Period. The magnetic map showed no regular formation of the riverbank, although it revealed long structures of undefined nature paralleling the waterfront, but at least 20m away from the bank (marked by arrows). Electrical resistivity results recorded two clearly different zones in this area: one of high resistivity in the surface layers (corresponding to the settled area, between VES

[31] IID., *ÄgLev* 18, 2008, pp. 97–110.

points 1 and 7, **Fig. 4**) and the other of low resistivity corresponding to alluvial formations filling the riverbed (between points 8 and 19).

Artificial waterfronts – research in the ᶜEzbet el-Ezzawin and ᶜEzbet Mehesin areas:

ᶜEzbet el-Ezzawin. Three distinctly different zones could be traced on a magnetic map of the area to the northeast of the modern village of ᶜEzbet el-Ezzawin (**Fig. 5**):

– zone formed by a set of anomalies with raised or lowered magnetic values (ranging from -6 to 6 nT), linear in shape, rectilinear in arrangement, corresponding to the remains of dense village architecture (zone A);

– zone formed of gently changing magnetic field intensity values (ranging from -3 to 3 nT), typical of a magnetic image of layers forming the fill of an old riverbed (zone B);

– zone of features with clearly uniform magnetic field intensity values, running in a band 30m wide at the broadest point, situated between the village and the riverbed (zone C).

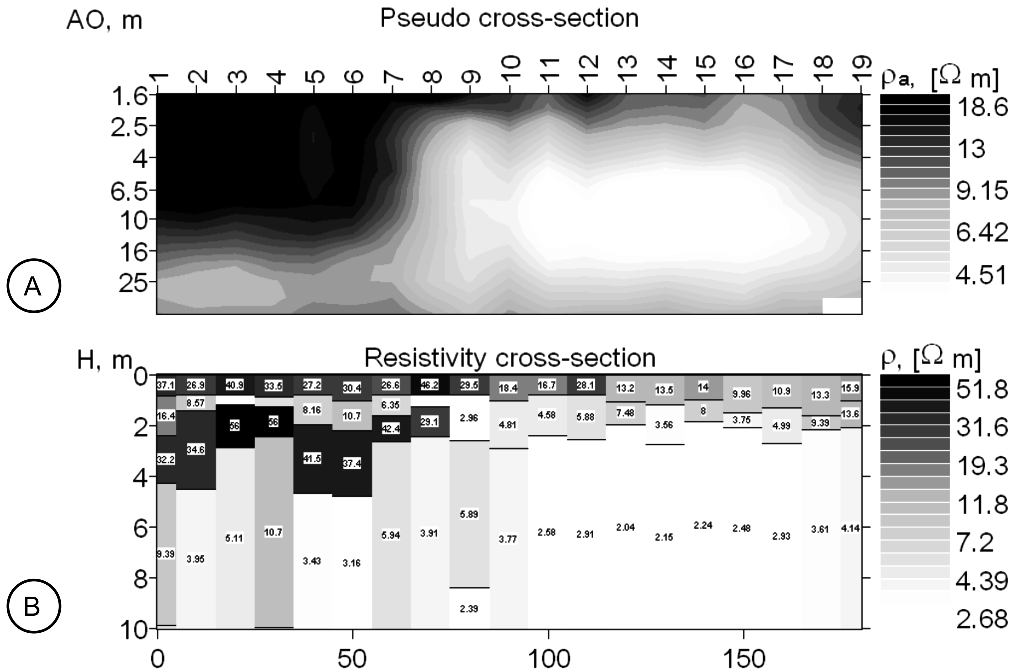
The shape of zone C suggested that its connection with the riverbed was formed artificially. Starting from the west, for a distance of 120m it ran in a nearly straight (slightly crooked) line and the uniform magnetic values in this section, clearly lowered, indicated that the zone was formed artificially of some sort of uniform material. Tracing the line further east between the waterfront and riverbed, one observes a narrowing of the presumed waterfront to about 12m over a section estimated to be 70m long. The line of the waterfront here was evidently straight. There is also an evident rectangular projection running into the riverbed (**Fig. 5** – structure marked by an arrow). The course of the waterfront line leaves no doubt as to its artificial formation, while the projection can be interpreted as a mooring feature, as it would have broken the force of the river current next to the waterfront. At the present stage of research it is impossible to interpret the anomalies with raised magnetic field intensity values, which parallel the southern edge of architecture and the line of the waterfront in its eastern and most narrow section.

The magnetic image of the river bed (zone B) produces more data for interpreting the described structure as a harbour bay. A zone of disturbances 30–40m wide, running alongside the structure (more distinctive in the western part of the map), which has been interpreted as an artificial waterfront, can be read as evidence of deepening of the riverbed immediately next to the quay, enabling boats to be moored even at low water level. Disturbances observed directly to the south of the narrowed section of the waterfront can also be read as imaging river-deepening activities.

The results of electrical resistivity prospection enhance the interpretation of the structure with uniform magnetic values (zone C) as a waterfront. The feature was sectioned by several series of vertical electrical sounding (VES; **Fig. 5** shows location of two VES lines)[32] and in each case the resultant image proved the same: in a qualitative presentation of the result in the form of apparent resistivity pseudo-sections (**Fig. 6A**), it corresponds to a structure

[32] *Ibid*., pp. 71, 83–84; T. Herbich, Geophysical methods and landscape archaeology, *EgArch* 41, 2012, p. 12. A detailed account of survey measurement methodology can be found in: Forstner-Müller *et al.*, *ÄgLev* 18, 2008, p. 103.

3. ʿEzbet Machali. Magnetic map and location of vertical electrical soundings. Magnetic survey by fluxgate (in settled areas) and cesium (river bed deposits) magnetometers. Arrows mark long structures of undefined nature, paralleling the waterfront (see text). Prospection and data processing by T. Herbich and C. Schweitzer (© ÖAI).



4. ʿEzbet Machali: A – apparent resitivity pseudo-section. Vertical (logarithmic) scale corresponds to particular levels of the sounding (from the shallowest at the top of the section to the deepest at the bottom), A0 – half distance between probes; B – resistivity cross-section. Processing by T. Herbich.

with definitely higher resistivity than the surroundings (between VES points 10 and 14), characterized by an extremely distinct border on the south side (between points 14 and 15) where it touches on the low-resistant formations filling the riverbed (points 15–20) and a more indistinct border at the northern edge where it adjoins higher-resistivity formations reflecting the remains of village architecture (between points 1–10). A quantitative interpretation indicates that layers forming the structure characterized by higher resistivity reach approximately 2–3m down (**Fig. 6B**) and its values in the surface layer (up to 0.7m deep) were definitely higher than in other parts of the section.[33] The reason for the higher resistivity in this area can be ascertained only through drilling or archaeological probing across the structure. The nature of the geophysical image, that is, uniformly low intensity of the magnetic field and high resistivity values, indicates that the material forming the waterfront contains sand or gravel.[34] Sand was extremely easy to obtain in this part of the Nile Delta thanks to the widespread presence of turtleback formations.[35]

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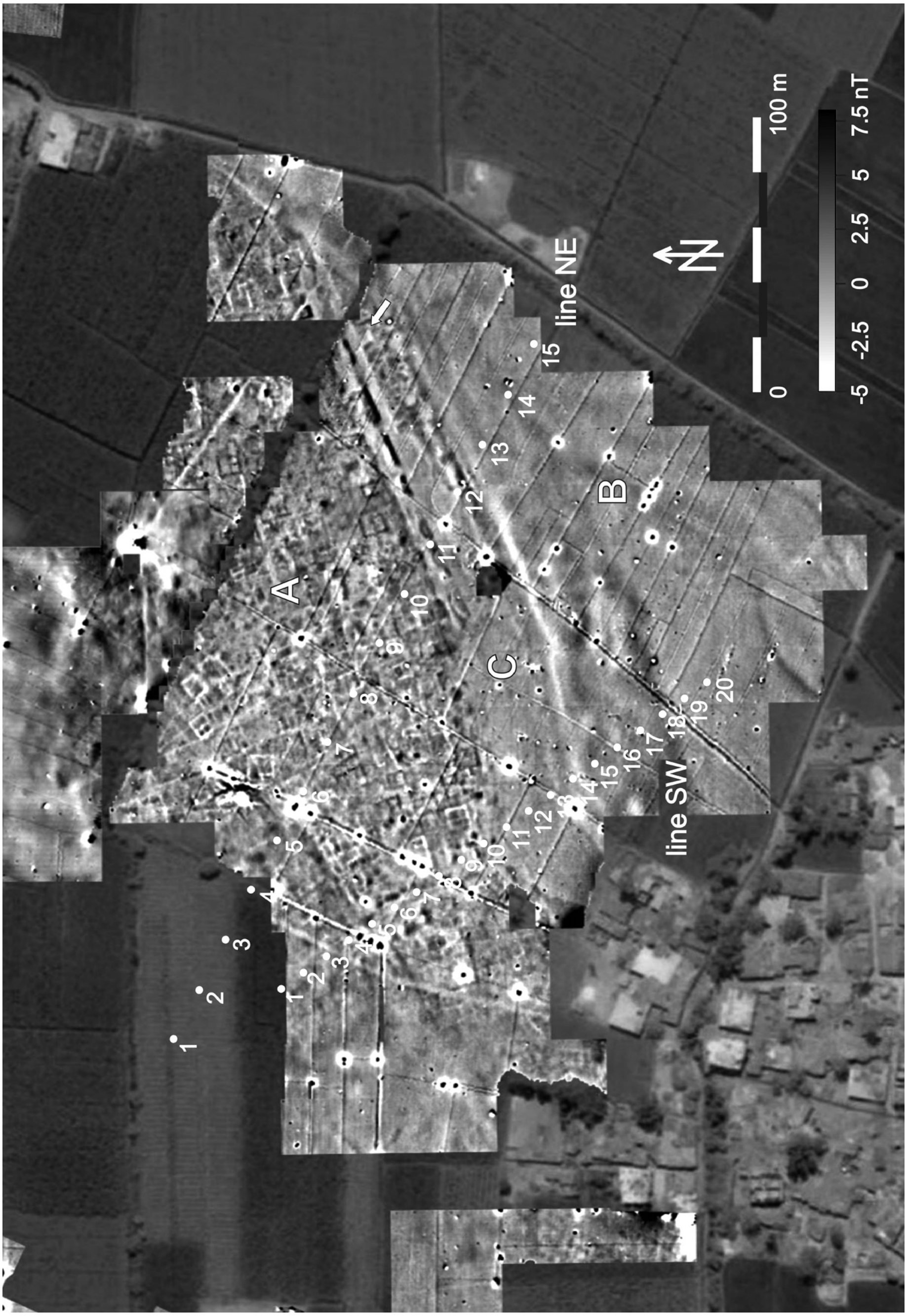
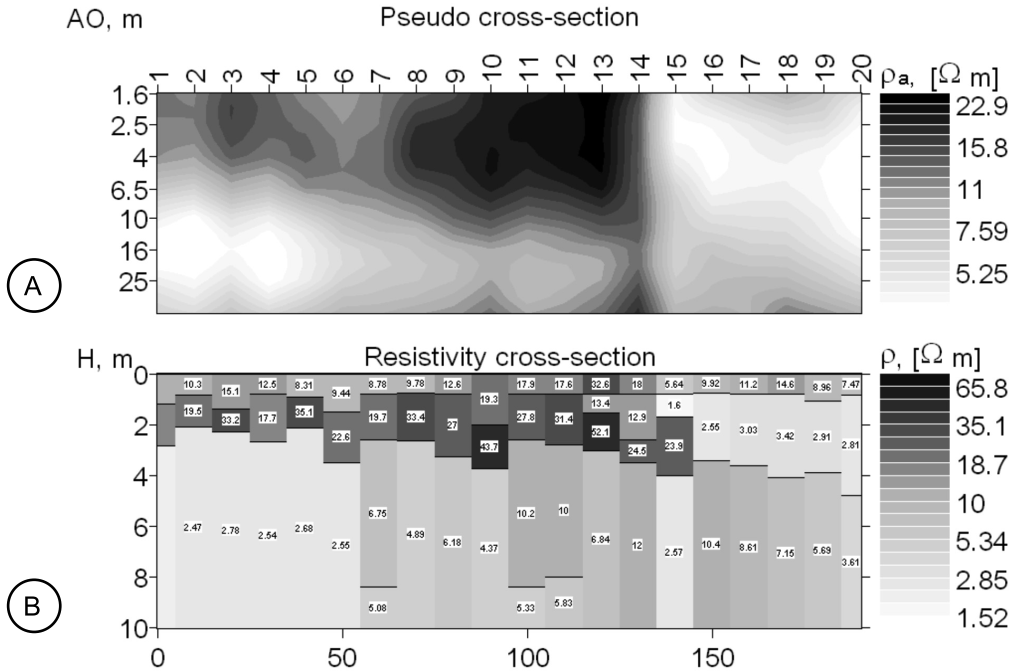
[33] VES result processing using IPI2WIN software.

[34] Drilling in place of the feature planned for 2012 was postponed till an upcoming season. Shallow survey drilling by M. Weissl in 2012 indicated the presence of mud brick with abundant sand temper.

[35] V. Coutellier, J.D. Stanley, Late Quaternary stratigraphy and paleography of the Eastern Nile Delta, Egypt, *Marine Geology* 77, 1987, pp. 257–275.



5. ʿEzbet el-Ezzawin. Magnetic map and location of vertical electrical soundings (SW and NE lines). Magnetic measurements by fluxgate and cesium magnetometers (section measured by cesium magnetometer covers northern edge of settlement). Magnetic prospection and data processing by T. Herbich and C. Schweitzer (© ÖAI).



6. ^{c}Ezbet el-Ezzawin. Results of vertical electrical sounding, SW line: A – apparent resistivity pseudo-section; B – resistivity cross-section. Processing by T. Herbich.

The surface pottery collection from the area sets the date for the site in the Second Intermediate Period; it would be an indication that the village and its harbour could be dated to this period.

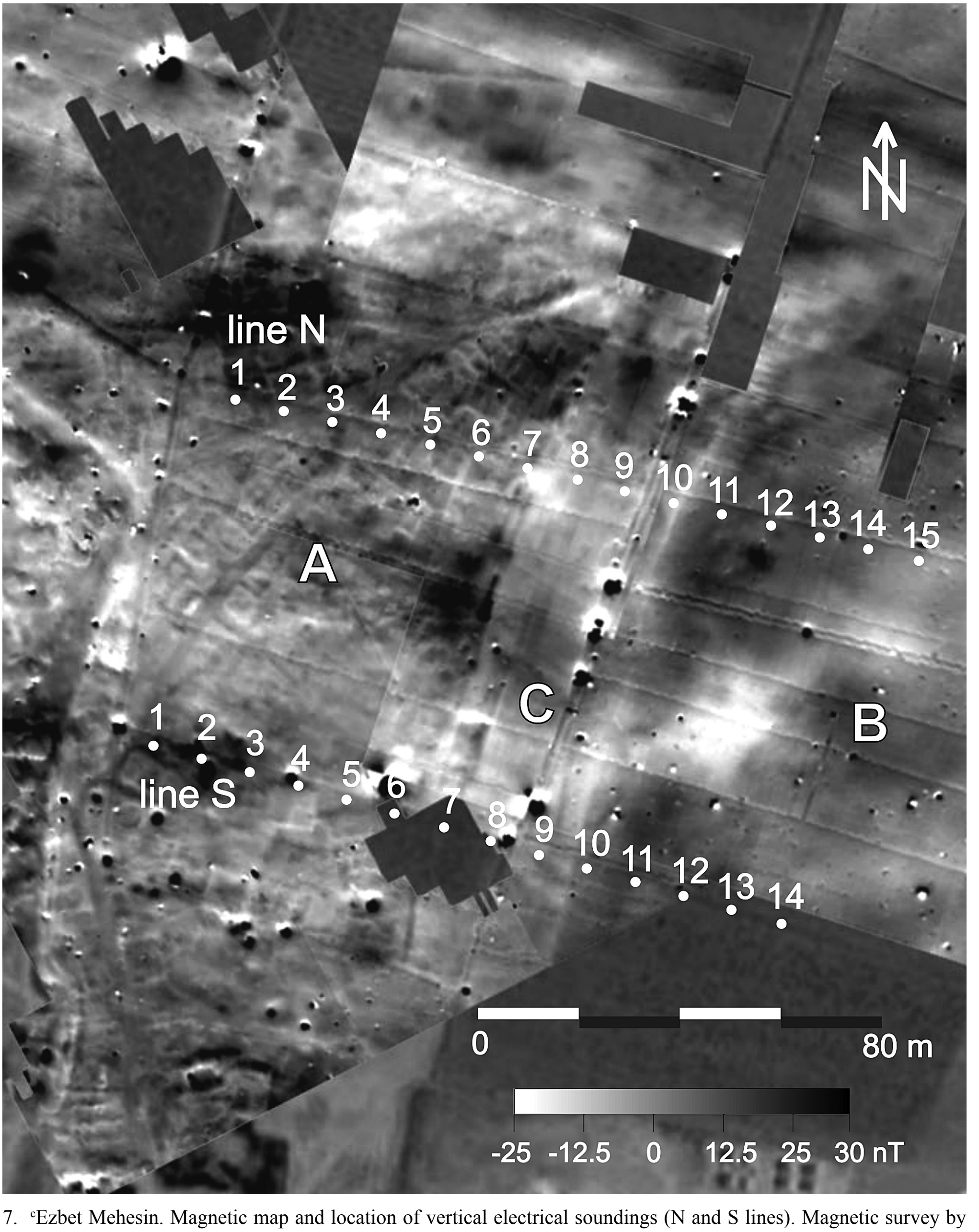
^{c}Ezbet Mehesin. Geophysical prospection of the area around ^{c}Ezbet Mehesin revealed three distinct zones on the magnetic map (**Fig. 7**), similarly as in the case of ^{c}Ezbet el-Ezzawin:

– zone of village architecture with evident negative anomalies corresponding to buildings and positive anomalies reflecting streets (zone A);

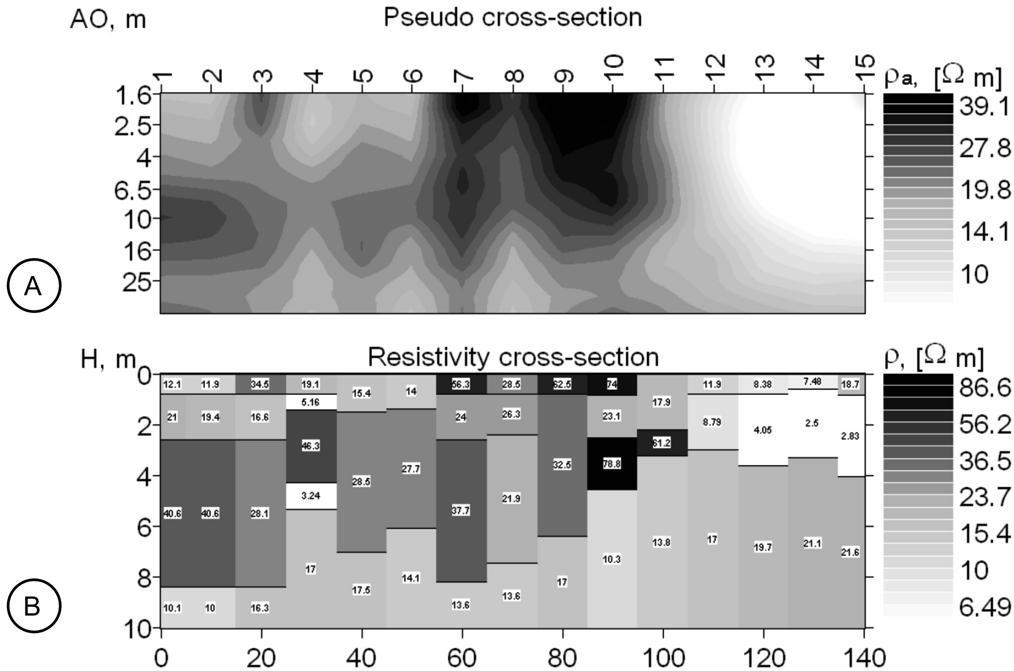
– zone corresponding to riverbed formations with gentle disturbances concentrated on the western side in a zone approximately 40m wide (zone B);

– zone of uniform magnetic field intensity values, about 30m wide, between the riverbed and the village (zone C).

Similarly as at ^{c}Ezbet el-Ezzawin, the zone with uniform magnetic values (zone C) can be interpreted as an artificially formed waterfront used as a harbour. The magnetic map shows a clear border between the waterfront and the village and between the waterfront and the riverbed. About 7–8m from the architecture there is a structure running parallel to the waterfront, estimated at 5m wide, featuring slightly raised magnetic values; it could correspond to remains of some kind of fortified wall protecting the village from the river.



7. ᶜEzbet Mehesin. Magnetic map and location of vertical electrical soundings (N and S lines). Magnetic survey by cesium magnetometer. Magnetic prospection and data processing by Ch. Schweitzer (© ÖAI).



8. ᶜEzbet Mehesin. Results of vertical electrical sounding, N line: A – apparent resistivity pseudo-section; B – resistivity cross-section along N line. Processing by T. Herbich.

Even assuming this interpretation for this feature, there is still room enough on the waterfront for effective commercial goods exchange.

The zone of disturbances about 40m wide, corresponding to riverbed formations, can be interpreted similarly as in the case of ᶜEzbet el-Ezzawin as evidence of a deepening of the riverbed next to the waterfront.

The interpretation of the structure as a reinforced waterfront is supported by the results of electrical resistivity research (**Fig. 8**). Two VES lines illustrate a feature corresponding to the hypothetical waterfront, characterized by clearly higher resistivity and evidently of the same width (points 7 to 10) as the feature mapped by the magnetic survey, reaching a depth of nearly 1m based on the quantitative analysis (**Fig. 8B**).

RECAPITULATION

The findings presented above, both the magnetic and the electric resistivity survey results, leave no doubt that the long features between the settlement and the river bed were made intentionally. They served as reinforcements of the riverbanks to protect the settled areas from destruction resulting from inundation. These ‘installations’ are well known to the present day from many modern settlements in the Delta. Their position, shape and size are also logically explained as images of harbour ports and the conclusion is strongly supported by the image of the eastern part of the feature recorded at ᶜEzbet el-Ezzawin, where sections of the waterfront run along a precisely traced straight line. The waterfront also apparently incorporated artificial bays, the most logical explanation for which is that they were intended for mooring boats in places protected from the current.

Structures of similar shape, that is, displaying uniform magnetic values, forming a zone of equal width separating the riverbed from the settled area, have been recorded also on magnetic maps of Qantir in the eastern part of the surveyed area.[36] Prospection in this area using the electrical resistivity method and with the same research assumptions as at ᶜEzbet el-Ezzawin and ᶜEzbet Mehesin could bring extremely interesting results. The magnetic image of these structures indicates that the sources of the anomalies were constructed in all probability from the same kind of building material as that used at Tell el-Dabᶜa.

Surface finds hint at a Second Intermediate Period date for the structures discovered at ᶜEzbet el-Ezzawin and ᶜEzbet Mehesin.[37] The feature in Qantir may be five hundred years later, most probably Ramesside in date. The similarities between the features point to a strong tradition of artificial riverbank architecture for the purpose of economic exploitation of the Nile.

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[36] Magnetic maps of the area were presented by E.B. PUSCH, Insights and outlooks: the Ramesside residence and its structure, Tenth International Congress of Egyptologists, Rhodes, 22–29 May 2008, and at a lecture given at the SCA/EES Delta Survey workshop, 31 March–1 April 2011 in Cairo.

[37] This dating has to be verified by archeological excavations.