PRELIMINARY REPORT ON THE GEOPHYSICAL SURVEY AT TELL EL-DABᶜA/QANTIR IN SPRING 2008

By Irene Forstner-Müller, Tomasz Herbich,** Christian Schweitzer,*** and Michael Weissl*

1. Magnetometry Survey[1]

The survey was undertaken from 10th May to 18th May 2008, a week earlier than in former years. Therefore not all fields had been already harvested and were ready for surveying.

As in the years before two different kinds of instruments were used: two Fluxgate Gradiometers (FM256, GEOSCAN, England) operated by Tomasz Herbich and his assistants Artur Buszek and Dawid Swiech and a Caesium-Magnetometer (SM-4/4G-'special', Scintrex, Canada) operated by Christian Schweitzer assisted by Mohammed Mutwalli. During the last campaigns a lot of experience could be gained to benefit from their respective advantages and select the instrument depending on the archaeological challenge.[2] The surveying and mapping was done by Anne-Catherine Escher, Astrid Hassler and Michael Weissl who also provided the digital maps.

The targets of the 2008 geophysical survey were (Figs. 1–3)

1. to explore the Western bank of the Pelusiac branch of the Nile river to see if the town of Avaris extends to the West or is limited by the Nile branch. A further issue was to look for possible Roman or Old Kingdom settlements.
2. to complete previous magnetometer surveys between ᶜEzbet Helmi and Khataᶜna and northeast of Khataᶜna.
3. to extend the surveyed area east of Khataᶜna in order to get better understanding of the palaeogeographic situation of the excavated 15th Dynasty palace complex in F/II.
4. to prospect the most eastern part of Avaris in the area west of modern ᶜEzbet Machali.
5. and to test the validity of an advanced resistivity tomographic profiling for delineating the flanks of the gezira.

Exploring the Western bank of the Pelusiac branch (Figs. 4, 5)

The exploration of the area to the west of the Pelusiac Nile branch was the main focus of season 2008.

The geological reconstruction of the ancient landscape of Tell el-Dabᶜa and Qantir by Josef Dorner revealed the exact situation and size of several turtle-backs or geziras to the south of deviation F2 of the Pelusiac branch which Avaris rested upon.[3] These geziras were excellent settlement areas as they were not flooded during the Nile inundation.[4]

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[1] For financing the project we are indebted to the Austrian Archaeological Institute and the Austrian Science Fund. The survey of season 2008 is part of the new project "Stadtentwicklung im Nildelta" funded by the Austrian Science Fund.

[2] For these surveys s. I. Forstner-Müller, W. Müller, C. Schweitzer, M. Weissl, Preliminary report on the geophysical survey at ᶜEzbet Rushdi/Tell el-Dabᶜa in spring 2004, *Ä&L* 14 (2004), 101–109; I. Forstner-Müller, T. Herbich, C. Schweitzer, Surveying ancient cities in the Nile Delta: the Tell el-Dabᶜa, in: Kuzma, J. Tirpak (eds.), *VII Conference on Archaeological Prospection, Nitra. Proceedings, I.,* Nitra 2007, 154–157; I. Forstner-Müller, W. Müller, Neueste Ergebnisse des Magnetometersurveys während der Frühjahrskampagne 2006 in Tell el-Dabᶜa/Qantir, *Ä&L* 16 (2006), 79–82; I. Forstner-Müller, T. Herbich, W. Müller, C. Schweitzer, M. Weissl, Geophysical Survey 2007 at Tell el-Dabᶜa, *Ä&L* 17 (2007), 97–106.

[3] J. Dorner, Die Rekonstruktion einer pharaonischen Flußlandschaft, *MAGW* Bd.123/124 (1993/94), 400–405; id., Ergebnis der Geländeuntersuchungen zur Rekonstruktion der historischen Topographie von Auaris und Piramesse – ein Vorbericht, in: M. Bietak, J. Dorner, I. Hein, P. Janósi, Neue Grabungsergebnisse aus Tell el-Dabᶜa und ᶜEzbet Helmi im östlichen Nildelta 1989–1991, *Ä&L* 4, (1994), 11–15; id., Vorläufiger Bericht über die topographischen Untersuchungen im Gebiet von Avaris und Piramesse, in: M. Bietak *et al., Tell el- Dabᶜa. Interdisziplinäre Studien*, Vienna, in preparation.

[4] M. Bietak, *Tell el- Dabᶜa II*, UZK 1, Wien 1975, 24.

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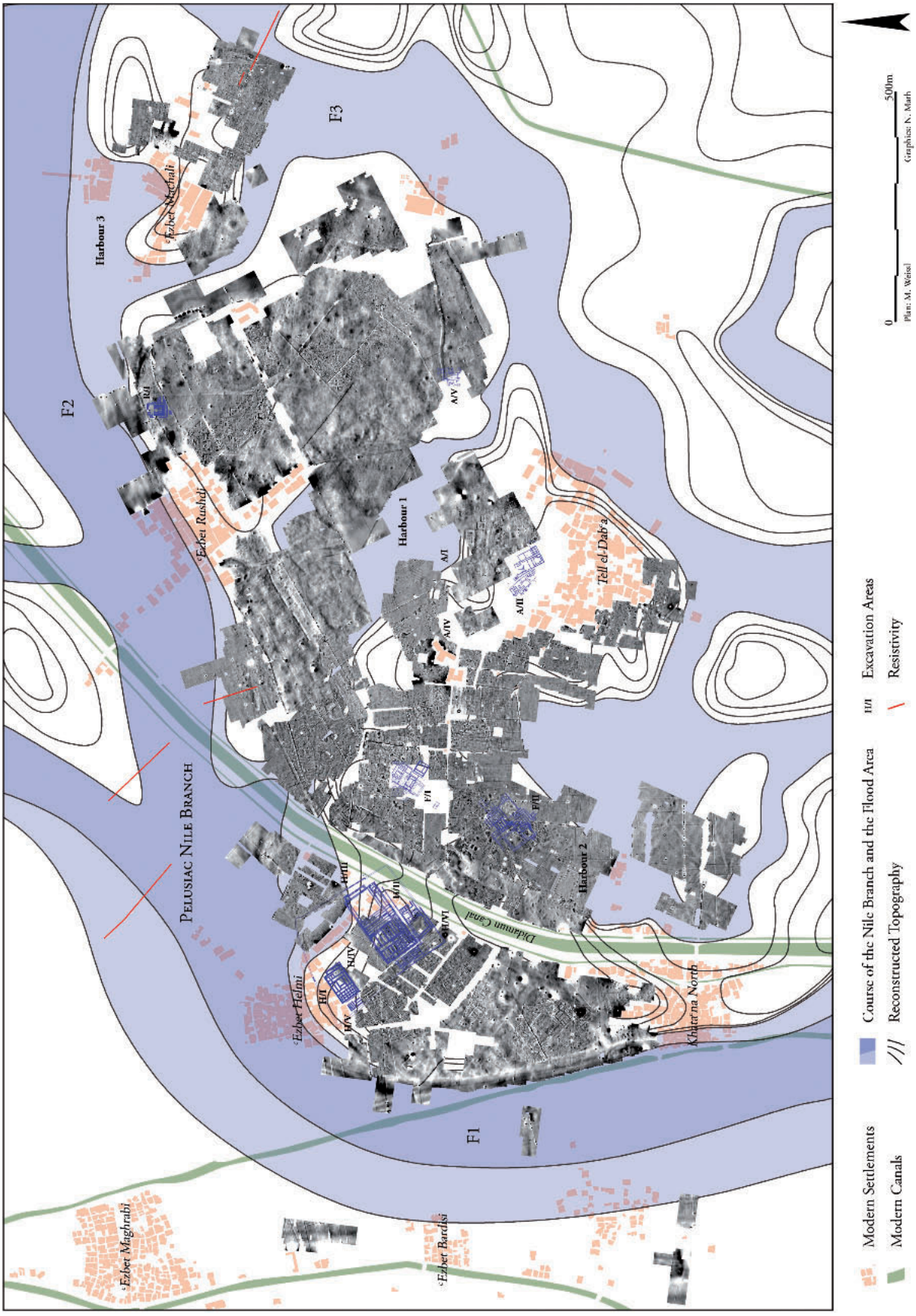

Fig. 1 Overall map of Tell el-Dab'a/Avaris

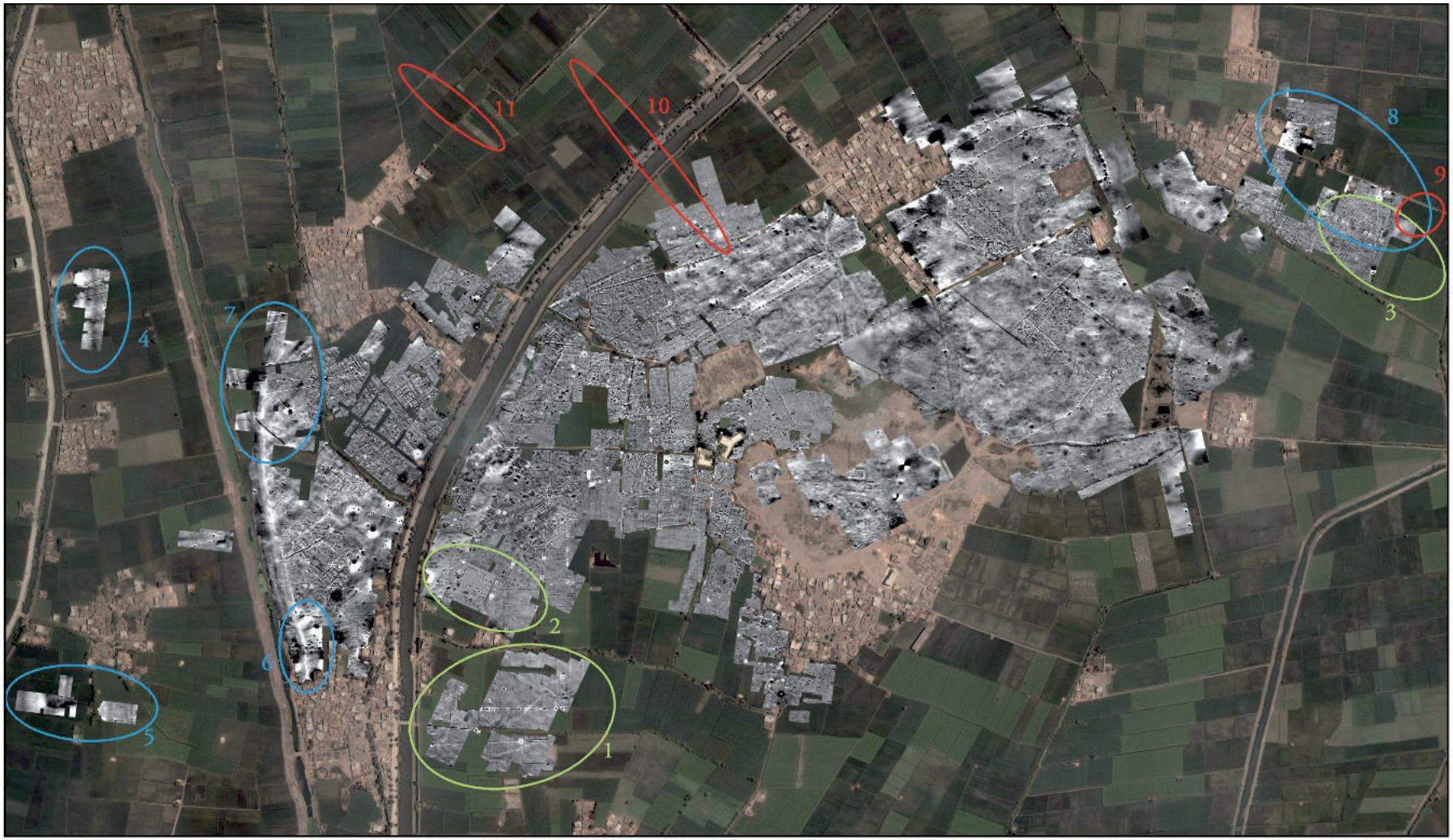

Fig. 2 Tell el-Dabᶜa – Geophysical Survey 2008 – Location Map

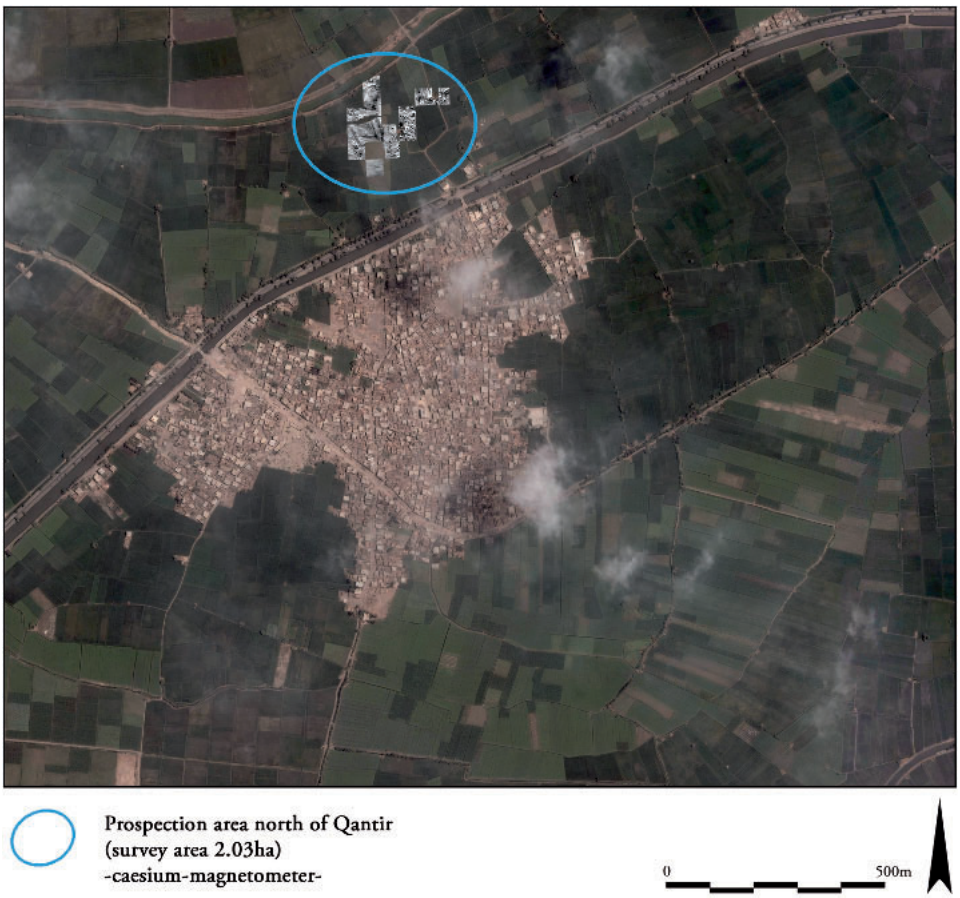

Fig. 3 Tell el-Dabᶜa – location map of magnetometer-prospection north of Qantir

The recent geophysical studies essentially confirmed Dorner's reconstruction of the ancient deltaic landscape of Avaris. Especially the caesium-magnetometer with a deeper penetration turned out to be extremely useful for paleo-geographic investigations and helped to map the river system with the F2 deviation northwest of Khataᶜna, west and northeast of ᶜEzbet Helmi and north of ᶜEzbet Rushdi, the F3 flood area between ᶜEzbet Machali and ᶜEzbet Mehesin and shallow delta lake between Tell el-Dabᶜa and ᶜEzbet Rushdi.

The southern or left bank of the river is best marked north of ᶜEzbet Rushdi and northeast and west of ᶜEzbet Helmi. The distinct river channels which are expressed as dark stripes on the magnetogram exist near the shoreline. Dorner's contour lines from boreholes predict equally a distinct steep transition zone from the gezira to the river bed (Fig. 1) which is in contrast to the expected long and relatively gentle slip-off slope inside of a stream meander.

So far little is known about the width of the Pelusiac branch and the location of the western bank in ancient times. During the 2007 campaign a first attempt was made to investigate an area on the western side of the modern Faqus canal north of Khataᶜna, some 200 m west of the left river bank. The magnetogram revealed only features of geological sedimentation including one sapropelic[5] filled riverbed which runs east-west and hence perpendicular to the general flow direction.[6]

[5] Sapropel is an organic rich sludge which putrefies at the bottom of river beds or shallow lakes in an anaerobic environment. In this aquatic environment magnetotactic bacteria were found which grow strings of microscopic magnetic particles called magnetosomes. Their production of magnetite (Fe_3O_4) and greigite (Fe_3S_4) leads to a higher magnetised material visible as positive anomalies.

[6] I. Forstner-Müller, T. Herbich, W. Müller, C. Schweitzer, M. Weissl, Geophysical Survey 2007 at Tell el-Dabᶜa, *Ä&L* 17 (2007), 98, fig. 1.

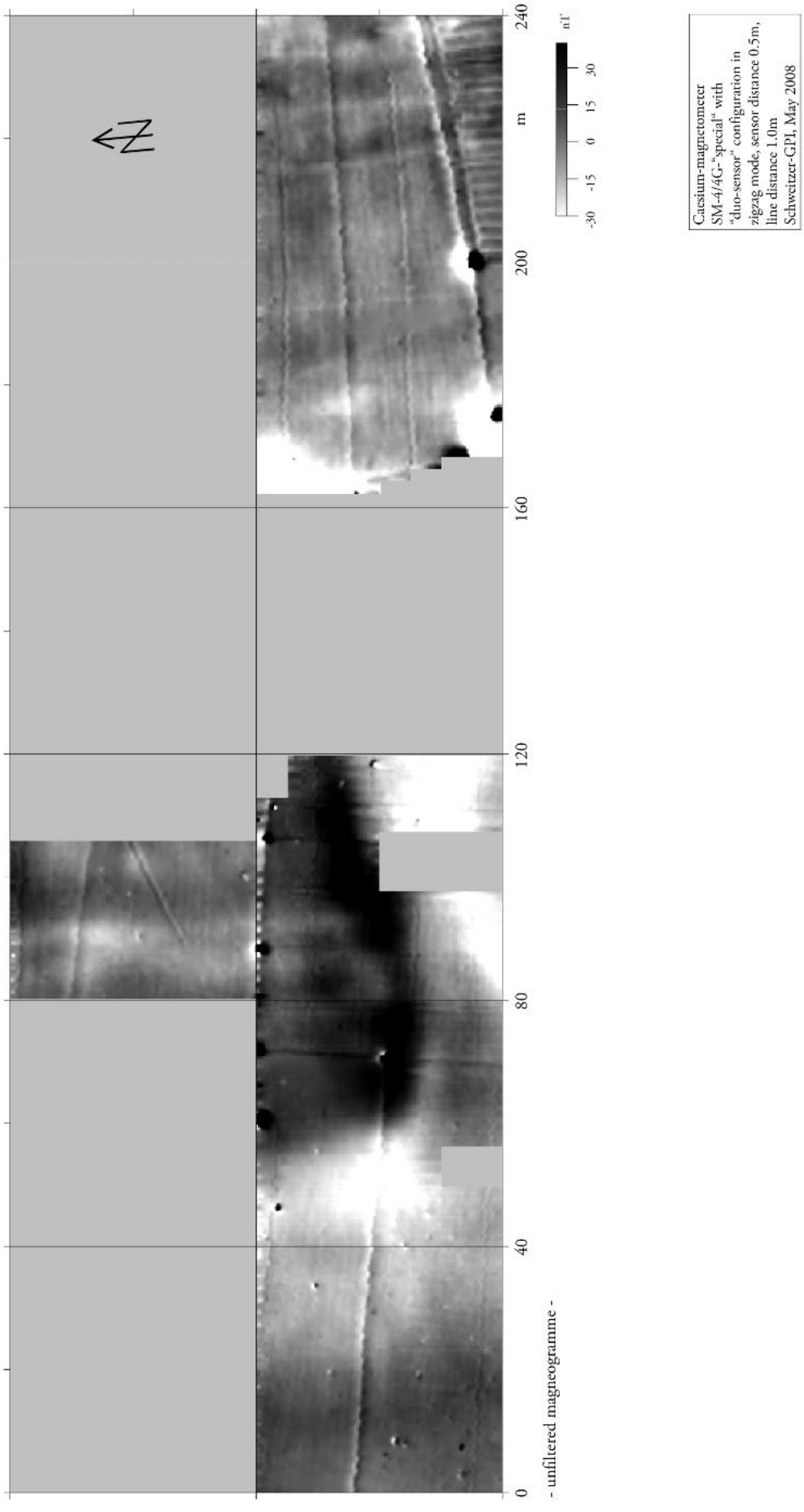

Fig. 4 Exploring the western side of the Pelusian branch – prospection area Bardisi (1.02 ha)

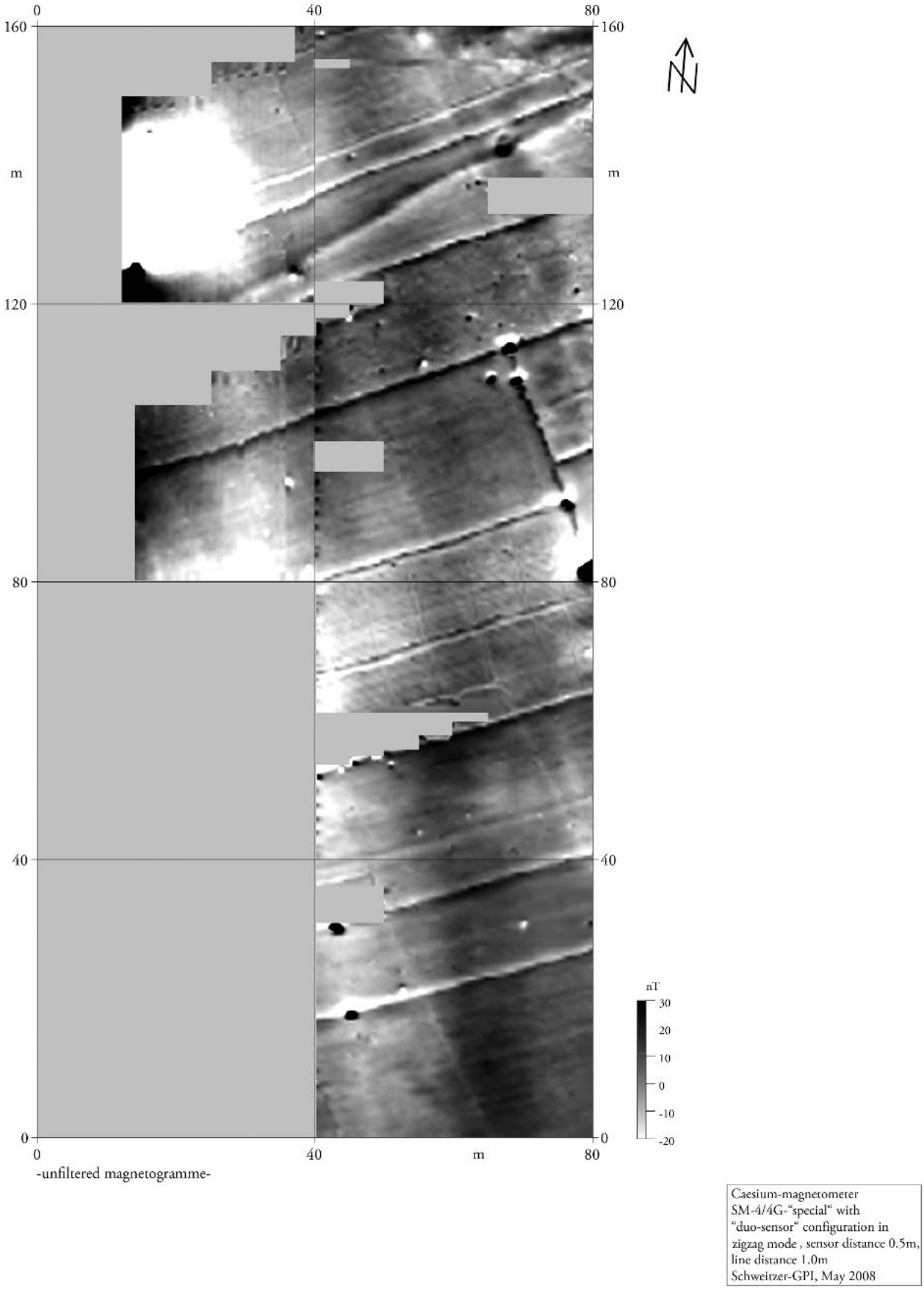

Fig. 5 Exploring the western side of the Pelusian branch – prospection area Maghrabi (1.56 ha)

Obviously the distance of the outstep was too short. Therefore two survey areas further away were selected near Bardisi and Maghrabi located 1250 to 500 m and 400 to 500 m resp. west from the left river bank. The choice of the areas was supported by some sherds found on the fields.

Magnetograms of both areas (Figs. 4, 5) reveal geological features which best fit to a river environment. The dark stripes are most probably caused by river beds filled with sapropelic material. Dark or light grey features extend over long distances. Therefore a shallow delta lake or lagoon environment is very unlikely because lake deposits, changing shoreline and sedimentation from small rivers lead to a small scale magnetic signature. The river environment is also reflected by the dark colour and fine-grained surface soil with a high shaly content.

Both areas do not show any signs of man made objects. During the measurement the ground was searched for sherds but only very few were found. Therefore the western bank of the Pelusiac branch is still open to further research to the west.

Khataᶜna-North – area between Khataᶜna and ᶜEzbet Helmi (Fig. 6)

Most of the area between Khataᶜna to ᶜEzbet Helmi could be covered by magnetometry during the geophysical campaign in 2007. With this survey a new part of the town, probably an administrative and industrial quarter of Avaris was discovered.[7] The aim of the survey in 2008 was to complete the magnetometer prospection in the most northern part east of ᶜEzbet Helmi and east of the Tuthmoside palace district and to the south in the direct vicinity of the modern village of Khataᶜna. The gap to the south could be closed whereas west of ᶜEzbet Helmi a remaining area was not accessable and still has to be measured in one of the next campaigns.

The northern survey disclosed the course of the Pelusiac branch and the eastern shoreline. The magnetometry confirms the contour lines by Dorner achieved by auger drilling.

The lineament of 8 m width could be a canal connecting the deep water of the Nile river with the area north of the palace complex. There are some small buildings along the northern side of the canal and one large building to the south with a row of rooms at its western side.

The survey exploring the south is disturbed by modern houses and metallic installations. The construction work of the Faqus Canal had most probably removed the near surface archaeology along the eastern bank in a marginal strip up to 30 to 40m wide. The remaining undisturbed area of the survey reveals that this quarter of Avaris extends further to the south and continues most probably below the modern Khataᶜna. Eventually remains of Avaris exist even west of Khataᶜna and west of the Faqus canal where the bridge crosses the canal. A lot of sherds covering the ground may be indicative of an ancient settlement.

Khataᶜna-East – area between Khataᶜna and Tell el-Dabᶜa (Figs. 7, 8)

The measurements covered an area south of sector F/II, where a monumental palace complex dated to the Hyksos period, was recorded by magnetometry in 2003–2005.[8] On the magnetic map of the area, the southern and eastern parts of the complex clearly lose in distinctness of the image. This could suggest that on these sides the complex had adjoined areas flooded by the Nile or a bend in the river. Geomorphological research in 2008 has brought evidence to indicate the presence of one of the town harbors on the southwestern side of the palace complex.[9]

The objective of the prospection in 2008 was to ascertain the extent of the flooded area further to the south of the palatial complex and to determine whether the remains of potential harbor structures could be recorded by a magnetic survey.

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[7] I. Forstner-Müller, T. Herbich, W. Müller, C. Schweitzer, M. Weissl, Geophysical Survey 2007 at Tell el-Dabᶜa, *Ä&L* 17 (2007), 98, fig. 1.

[8] M. Bietak, I. Forstner-Müller, T. Herbich, Discovery of a new palatial complex in Tell el-Dabᶜa in the Delta: geophysical survey and preliminary archaeological verification, in: Z.A. Hawass and J. Richards (eds.), The *Archaeology and Art of Ancient Egypt. Essays in Honor of David B. O'Connor*, CASAE 36, Cairo 2007, vol. 1, 119–125; M. Bietak, I. Forstner-Müller, Eine palatiale Anlage der frühen Hyksoszeit (Areal F/II), *Ä&L* 16 (2006), 63–78.

[9] H. Tronchere, F. Salomon, Y. Callot, J.P. Gorran, L. Schmitt, I. Forstner-Müller, M. Bietak, Géoarchéologie du site d'Avaris: premiers résultats, this volume.

Fig. 6 Prospection area between Khataᶜna and ᶜEzbet Helmi (3.56 ha)

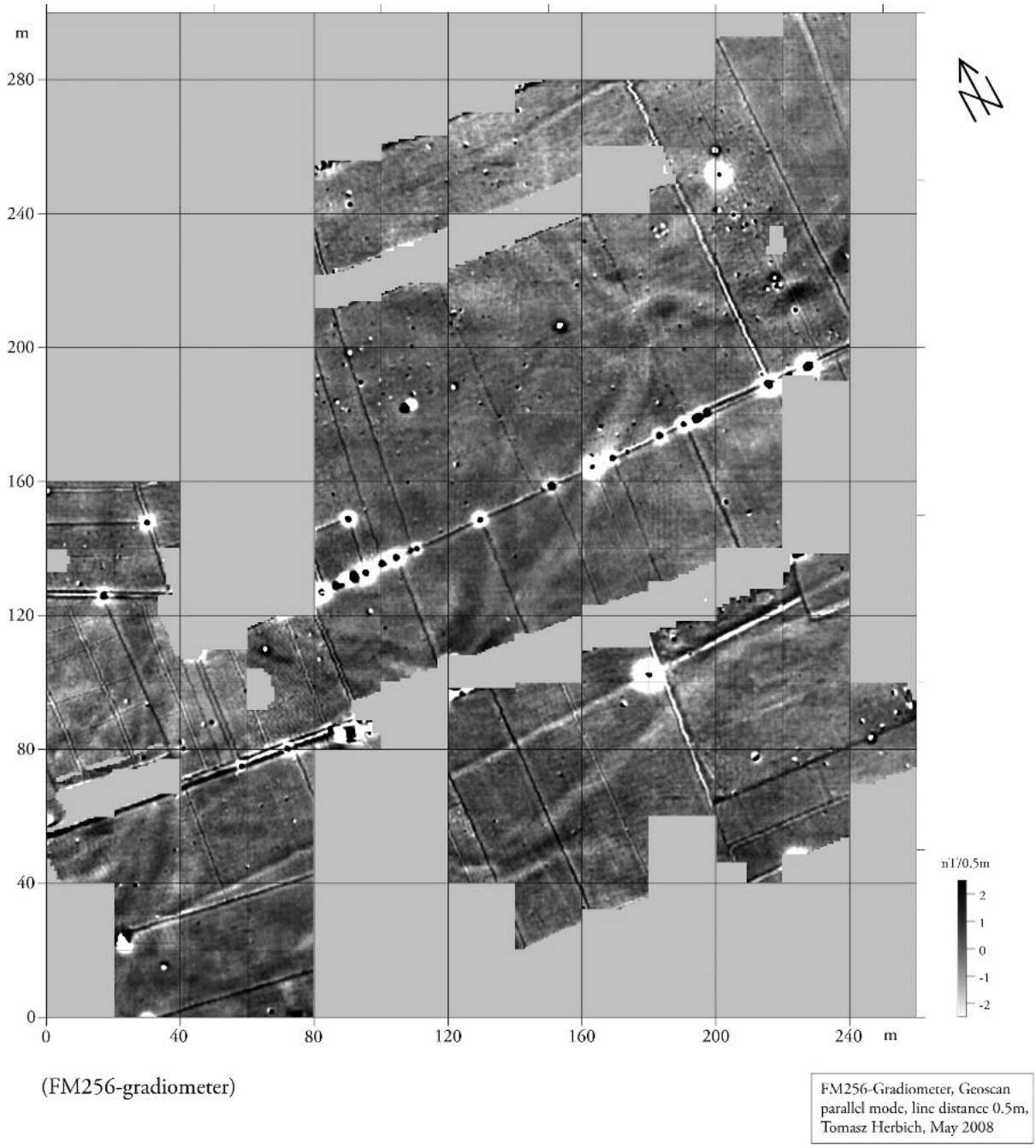


Fig. 7 Prospection area between Khataᶜna and Tell el-Dabᶜa: Khataᶜna-East

The surveyed area was divided into two sections separated by the channel: the northern one directly adjacent on the south to the area prospected in 2003–2005 (Fig. 8), and the southern one to the south of the channel (Fig. 7).

No structures which could be potentially identified as harbor installations were observed on the map of the area immediately south of the region prospected in 2003–2005. The southeastern part of this area is characterized by uniform values of magnetic-field intensity (indicating that at least seasonally the area would have been under water). Increased values of magnetic-field intensity at the southern edge of the map are caused by the modern village. A number of anomalies of oval or elongated shape can be observed in the eastern part of the map. Some of them can be inscribed into rectangles of a maximum length of c. 7–8 m. These anomalies feature increased values of magnetic-field intensity. They are a continuation of the anomalies observed to the southwest of the palatial com-

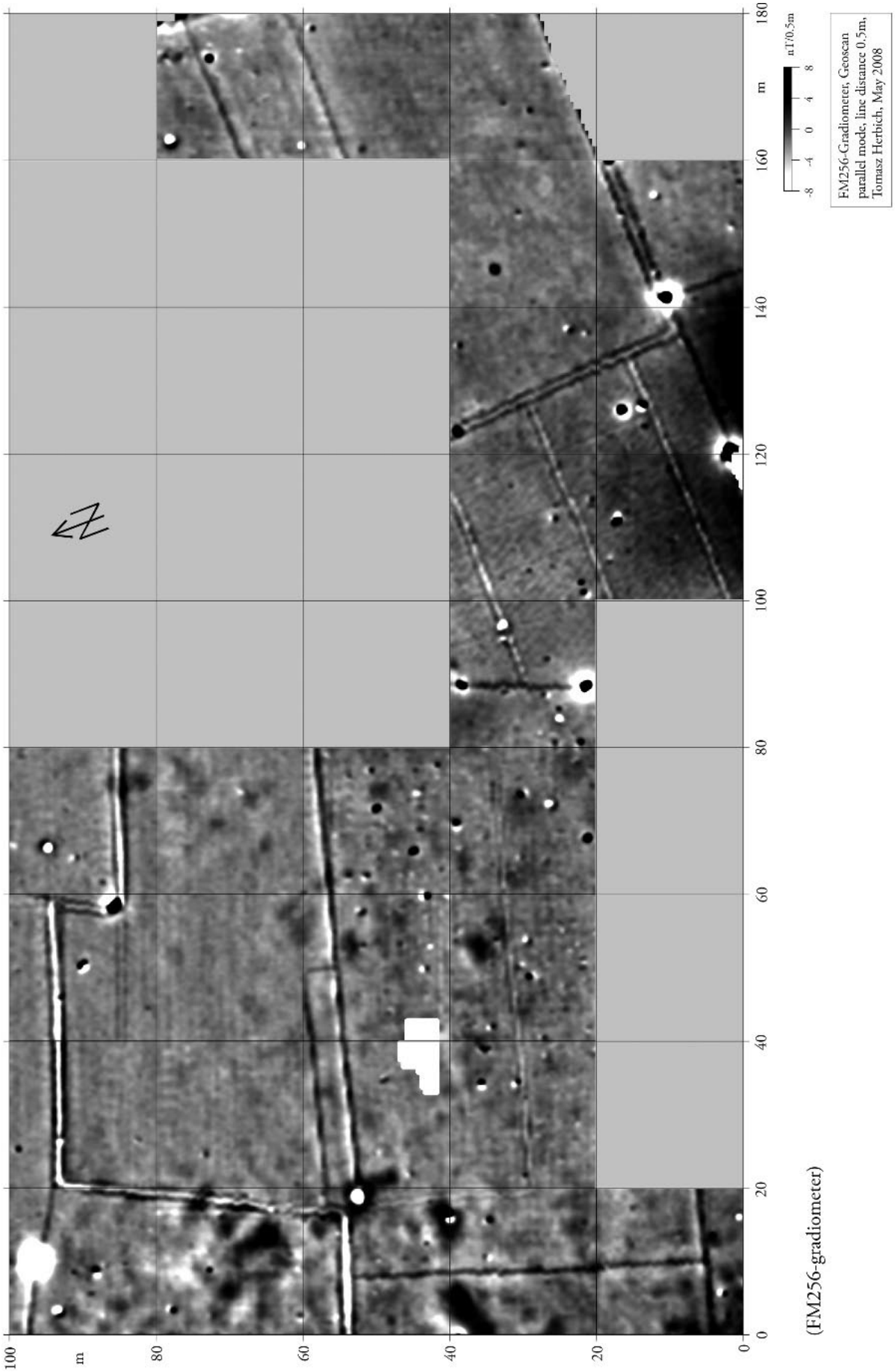


Fig. 8 Prospection area between Khataʿna and Tell el-Dabʿa: Khataʿna-Northeast

plex and continue themselves in a westerly direction, an observation confirmed by measurements made with a caesium magnetometer before. The nature of these anomalies can be explained only by archaeological testing.

The magnetic prospection results obtained in the area south of the channel indicate that there were no settled areas within this region covered by the survey. Characteristic anomalies of elongated shape and irregular course appear to correspond to features created by water action. It cannot be excluded that some of them correspond to watercourses occasionally used as channels.

ᶜEzbet Machali (Figs. 9–11)

The prospection area west of ᶜEzbet Machali is located on a gezira surrounded to the north by the F2 deviation of the Pelusiac branch and by the flood area F3 to all other directions. The dating of the settlement and docks is not certain. The magnetometer prospection (caesium-magnetometer) started in 2006 imaging the F3 flood area between ᶜEzbet Abd-es Salam el Sharqawi/ now ᶜEzbet Samir il Bilbeisi and ᶜEzbet Machali and the south-eastern part of the gezira. A large building of unknown function could be disclosed which is surrounded by small structures, probably houses in an east-west orientation. The material of the walls is mainly composed of sandy mud-bricks appearing as negative (white) structures. The banks to the F3 flood area were straightened and reinforced. One outstep survey to the east could validate the southern extend of the gezira as outlined by Dorner's reconstruction of the ancient landscape.[10]

In 2007 the prospection was continued west of ᶜEzbet Machali by a FM36-gradiometer survey. The survey disclosed a living quarter with small houses aligned WNW-ESE and foundations made of sandy brick-walls. The aim of the 2008 campaign was to cover this quarter of Avaris to its larger part. The magnetometry started with the caesium-magnetometer and again a quarter of smaller houses was discovered. The remains of the house foundations seemed to be only badly preserved. Due to the shallow target it was decided to continue the survey with an FM256-gradiometer with better imaging quality for near-surface objects (Fig. 11). The results of all surveys suggest that the ancient settlement covered probably the entire gezira and consisted of small houses aligned WNW–ESE. The prevailing foundation material consists of sandy mud-brick to the west and changes to mainly shaly mud-bricks to the east. There is a gentle transition zone from the gezira to the F3 flooded area. The eastern part is tentatively interpreted as a harbour area. The banks were partly straightened and at least three deep harbour basin (docks) were build (dark rectangular anomalies).

ᶜEzbet Machali seems to be another example like ᶜEzbet Rushdi, ᶜEzbet Helmi, Khataᶜna and especially Qantir that modern villages are located on an ancient settlement and impede the access for geophysical surveys.

After the 2008 campaign the outline of the gezira to the east and south is almost complete with only small areas in the south remaining to be measured in the next years. A larger survey is still required to cover the central part just west of ᶜEzbet Machali and the northern part of the gezira at the southern bank of the F2 deviation between Qantir and ᶜEzbet Machali.

Qantir (Fig. 12)

A small survey of 2 ha was carried out in the northern part of Qantir, in order to partly cover an unmeasured area[11] in one of the main temples of Qantir.[12] A detailed interpretation needs the knowledge of the context and the surrounding magnetogram. Unfortunately the data of the older survey by the German mission are not accessible for the moment, thus the interpretation given here may need to be revised at a later date.

The caesium-magnetometer survey disclosed a large building complex or a living quarter consisting of small houses (A). The complex extends at least 80m in S-N direction and 40 in

[10] See above.

[11] The previous magnetometer surveys were all performed by Helmut Becker, Jörg Faßbinder and Edgar Pusch, s. E. Pusch, H. Becker and J. Fassbinder, Wohnen und Leben oder: weitere Schritte zu einem Stadtplan der Ramsesstadt, *Ä&L* 9 (1999), 155–170; id., Palast – Tempel – Auswärtiges Amt?, *Ä&L* 9 (1999), 135–154.

[12] E. Pusch, paper given at the International conference at Rhodes in May 2008.

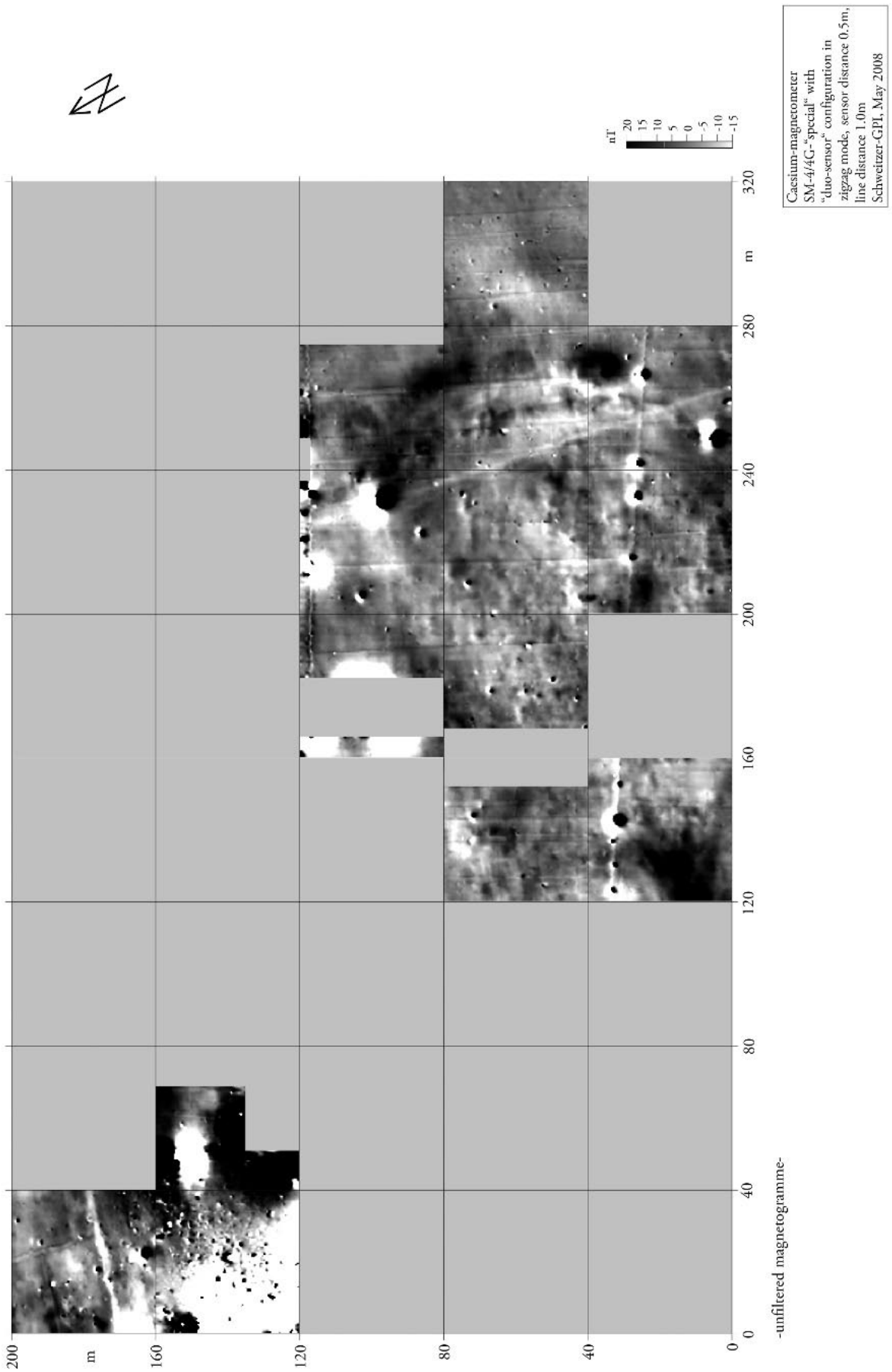


Fig. 9 Prospection area west of Machali – surveying with the caesium-magnetometer (2.02 ha)

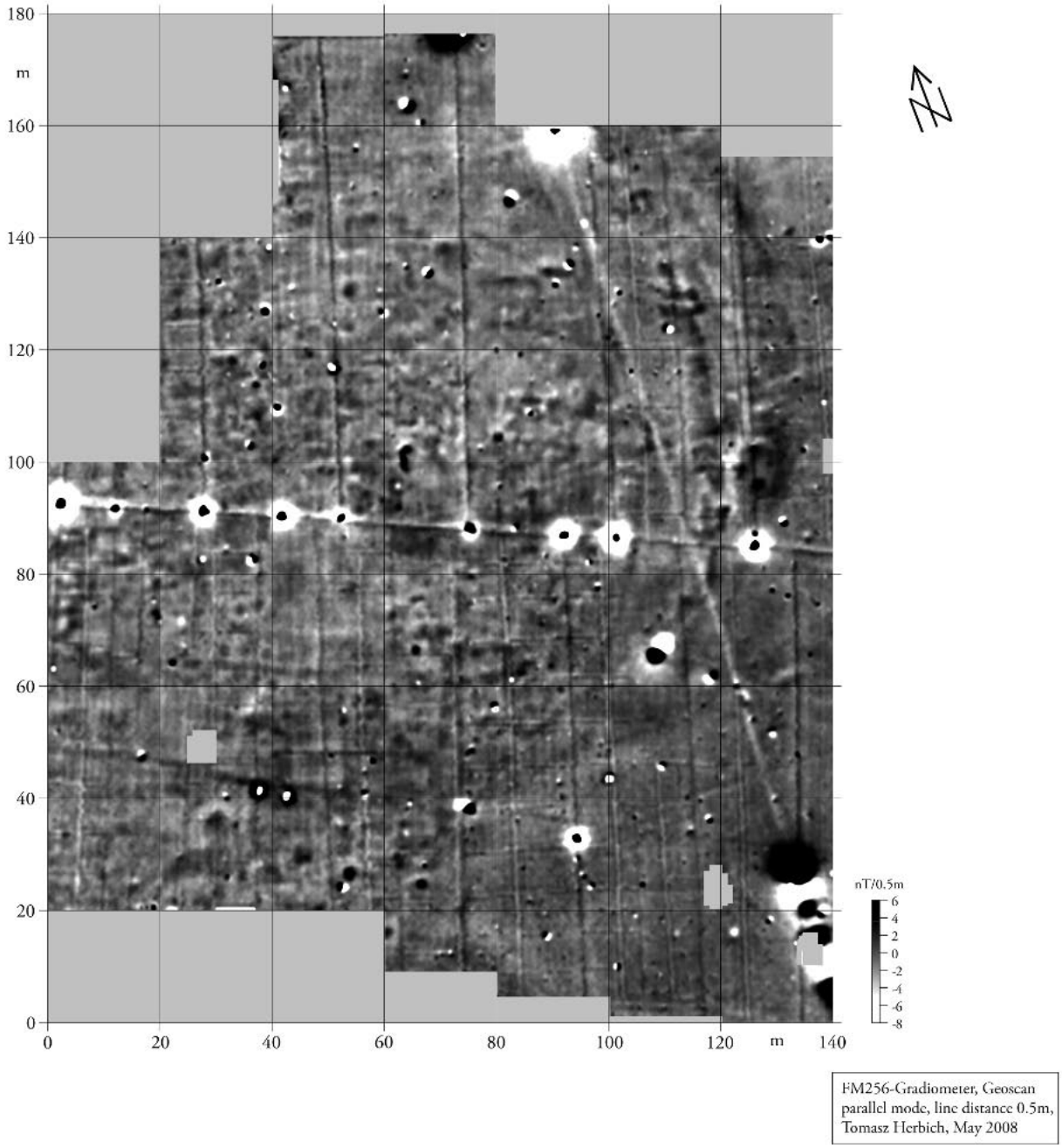


Fig. 10 Prospection area west of Machali –
surveying with the complementary use of caesium-magnetometer and FM256-gradiometer

East-West. The main direction is NE-SW and perpendicular. The outline of the structural complex is not distinct, but the edges are fading away. The area was probably flooded and foundations of the buildings were partly or totally eroded similar to the structure F/II in Tell el-Dabᶜa. The negative magnetization indicates the use of sandy mudbricks for the construction of walls. In the east the survey covered the western part of a large structural complex (B), most probably a huge temple, consisting of an enclosure wall and some buildings. The wall follows a trapezoidal shape with a short side of 30m to the north and a disclosed western side of 60m still inside the survey area. Inside this complex round circles are visible, this part may be interpreted as a courtyard with silos.

A modern water pipe crosses the complex and may misleadingly appear as the back wall of the row of houses.

The most northern quadrant shows no indication of any man made disturbance and therefore seems to be located in the ancient Pelusiac branch of the Nile river.

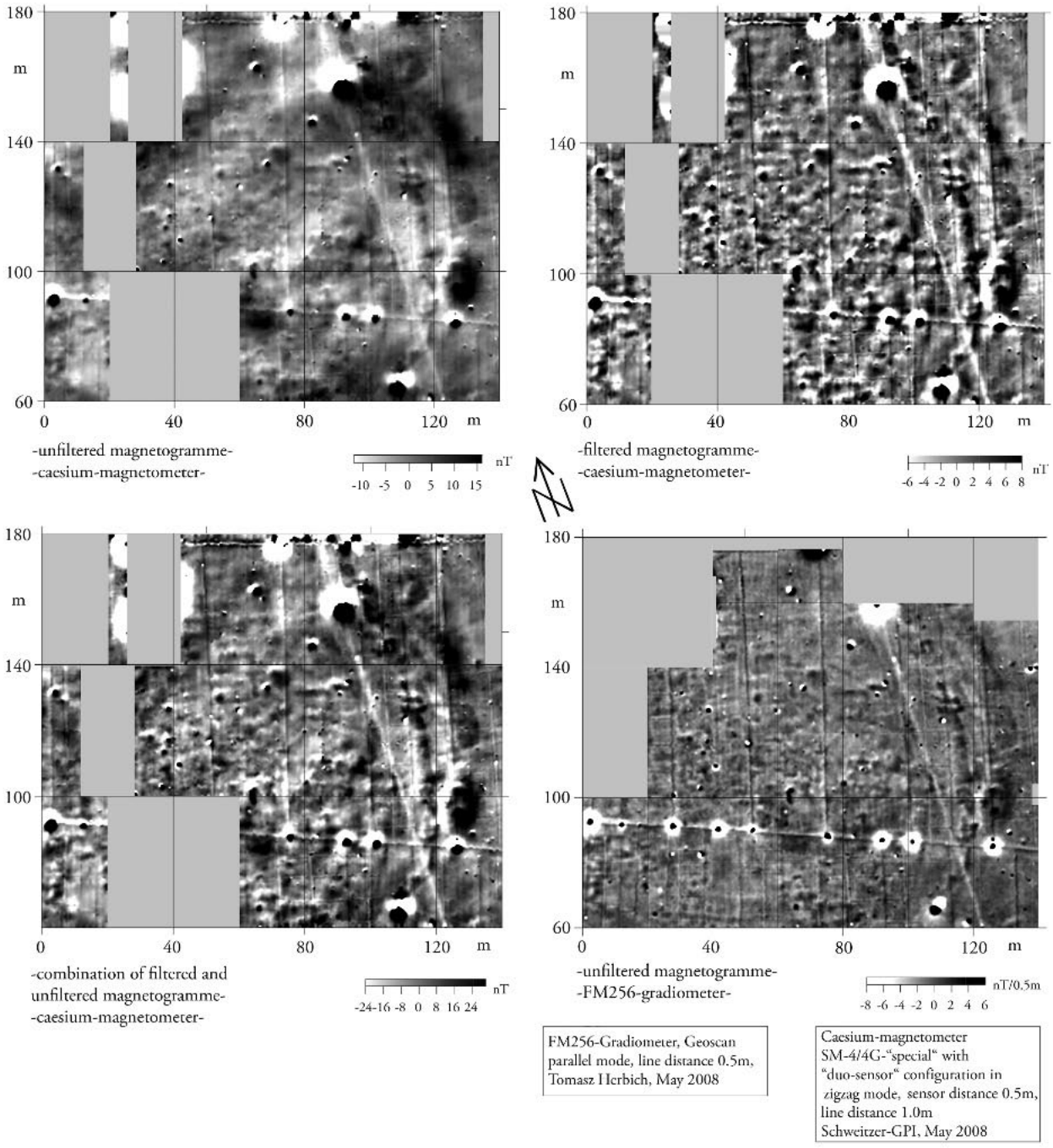


Fig. 11 Prospection area west of Machali – complementary use of caesium-magnetometer and FM256-gradiometer

2. Resistivity method in reconstructing the historical landscape of the Tell el-Dabᶜa area[13]

The aim of the project is to evaluate the effectiveness of the resistivity method for a reconstruction of the Pelusiac branch of the Nile in the Tell el-Dabᶜa region.

The course of this branch of the river has been mapped based on the results of drillings made by Josef Dorner[14] and – in some sections –

[13] This survey was funded jointly by the Austrian Archaeological Institute in Cairo, the Austrian Science Fund and the Institute of Archaeology and Ethnology, Polish Academy of Sciences, Warsaw.

[14] J. Dorner, Die Topographie von Piramesse – Vorbericht , *Ä&L* 9 (1999), 77–83.

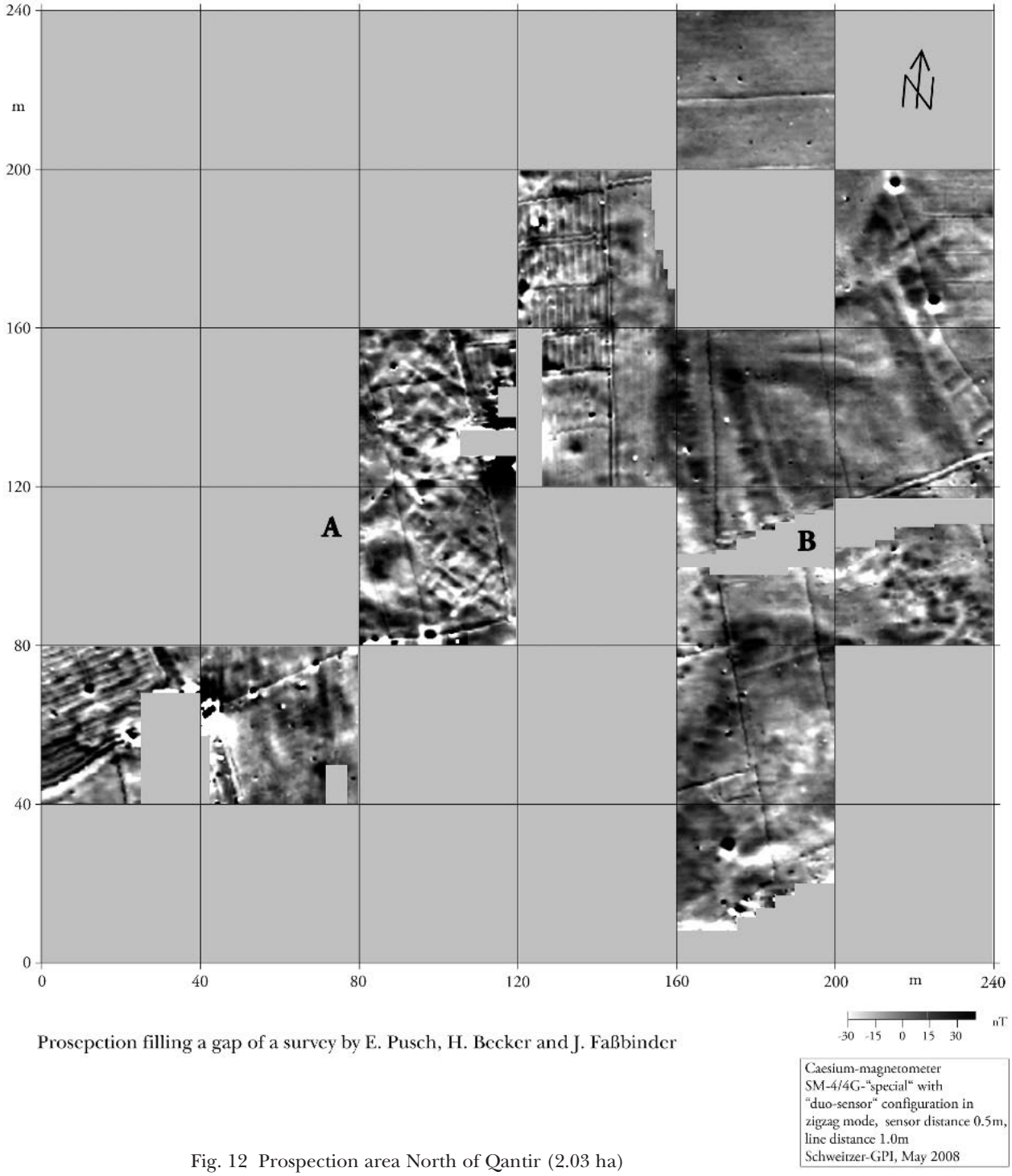


Fig. 12 Prospection area North of Qantir (2.03 ha)

clarified or corrected in effect of a magnetic prospection conducted by Christian Schweitzer with a caesium magnetometer.[15] The magnetic map clearly defines the riverbed in areas of settlement, but much less so in areas with no clear settlement traces, as indicated by the results of the 2007 and 2008 prospection with the use of caesium magnetometers in the area of the

[15] I. Forstner-Müller, W. Müller, C. Schweitzer, M. Weissl, Preliminary Report on the Geophysical Survey at ᶜEzbet Rushdi/Tell el-Dabᶜa in Spring 2004, *Ä&L* 14 (2004), 101–109; I. Forstner-Müller, T. Herbich, C. Schweitzer, Surveying ancient cities in the Nile Delta: the Tell el-Dabᶜa, in: I. Kuzma, J. Tirpak (eds.), *VII conference on Archaeological Prospection, Nitra. Proceedings*, Nitra 2007, 154–157.

Fig. 13 ᶜEzbet Machali area. Location of vertical electrical soundings

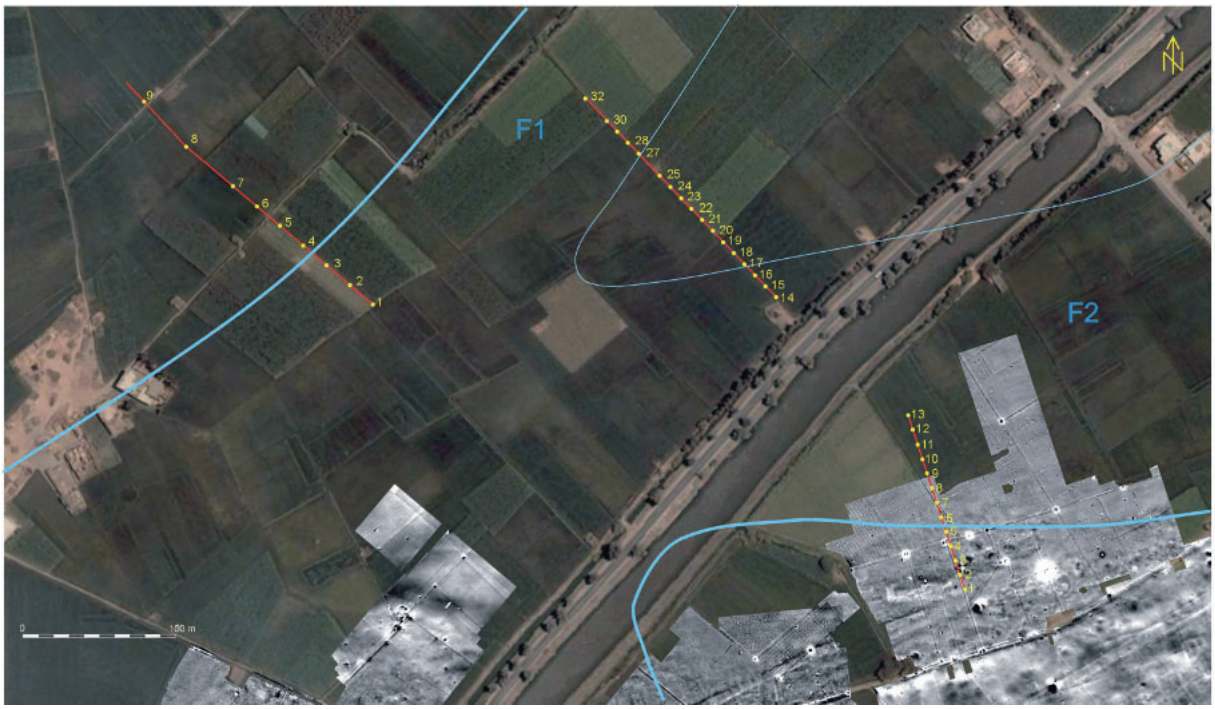


Fig. 14 ᶜEzbet Rushdi (on the right, soundings 1–32) and ᶜEzbet Helmi (on the left, soundings 1–9) areas. Location of vertical electrical soundings. The riverbed edge from Dorner's map is marked with a thick blue line, the edges of the island with a thin blue one

expected western bank of the Pelusiac branch of the Nile.[16] The opportunity was taken to test the usefulness of another geophysical method, vertical electrical soundings (VES), in marking out the course of a fossil riverbed.[17]

The VES method permits observation of bedding structure based on differences in the current-conducting ability of particular layers. Vertical electrical soundings taken in a line give a kind of cross-section imaging the structure of layers differentiated according to their geoelectrical properties. The geological setting of the Tell el-Dabᶜa area suggests that VES profiling should demonstrate differences between low-resistivity accumulations from the ancient riverbed and the turtlebacks *(gezirah)* made up of sands, which are always characterized by high resistivity values.

Research in 2008 tested the method in areas where the edge of the riverbed has been traced clearly by magnetic surveying (ᶜEzbet Rushdi and ᶜEzbet Machali areas) and where the course was determined by drillings (ᶜEzbet Helmi area). Altogether 57 soundings were made. Soundings were spaced 10 m apart in the ᶜEzbet Machali (Fig. 13) and the ᶜEzbet Rushdi areas (sporadically every 20 m in the northern part of the area, and 20 m apart in the ᶜEzbet Helmi area (sporadically every 40 m in the northern part of the area, (Fig. 14)).

The soundings were made with an ADA-05 apparatus by Elmes, made to allow rapid shallow sounding. A symmetrical Schlumberger array was employed. Half spacing between the current probes AB and potential probes MN for particular sounding levels was:

	AB/2	MN/2
1	1.60	0.5
2	2.00	0.5
3	2.50	0.5
4	3.20	0.5
5	4.0	0.5
6	5.0	0.5
7	6.3	0.5
8	8.0	0.5
9	10.0	0.5
9'	10.0	3.0
10	12.5	0.5
10'	12.5	3.0
11	16.0	3.0
12	20.0	3.0
13	25.0	3.0
14	32.0	3.0
15	40.0	3.0

The results were presented as sets of apparent resistivity curves made along sounding lines and showing resistivity changes at six selected sounding levels (Figs. 15, 17, 19) as well as apparent resistivity pseudosections (Figs. 16, 18, 20). Values on the Y axis of the curves and the depth at pseudosections (corresponding to AB/2 spacings) are in logarithmic scale, which emphasizes the resistivity changes in layers near the surface.

ᶜEzbet Machali area

The resistivity curves clearly indicate an area of much higher resistivity values at the western end of the line on all sounding levels (sounding 1–7;

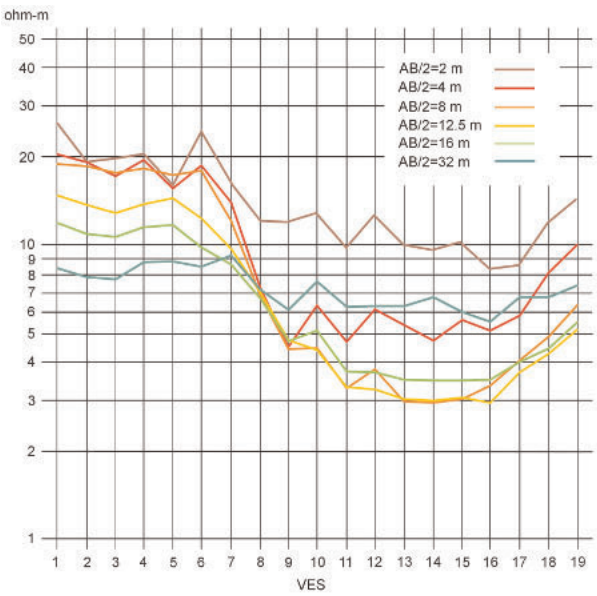


Fig. 15 ᶜEzbet Machali area. Apparent resistivity curves (selected levels of soundings). Vertical logarithmic scale

[16] S. above.

[17] On the VES method, see: C. Gaffney, J. Gater, *Revealing the Buried Past. Geophysics for Archaeologists*, Stroud 2003, 34–36.

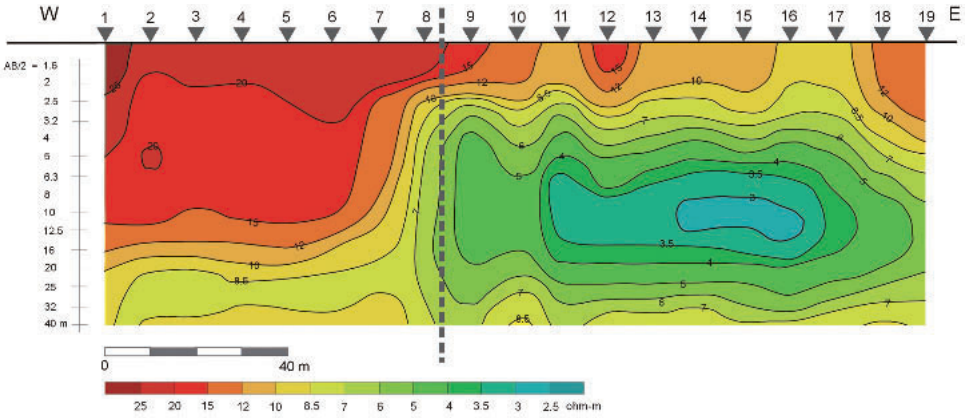


Fig. 16 ᶜEzbet Machali area. Apparent resistivity pseudosection. Vertical logarithmic scale. Dashed vertical line indicates position of the edge of the Nile riverbed

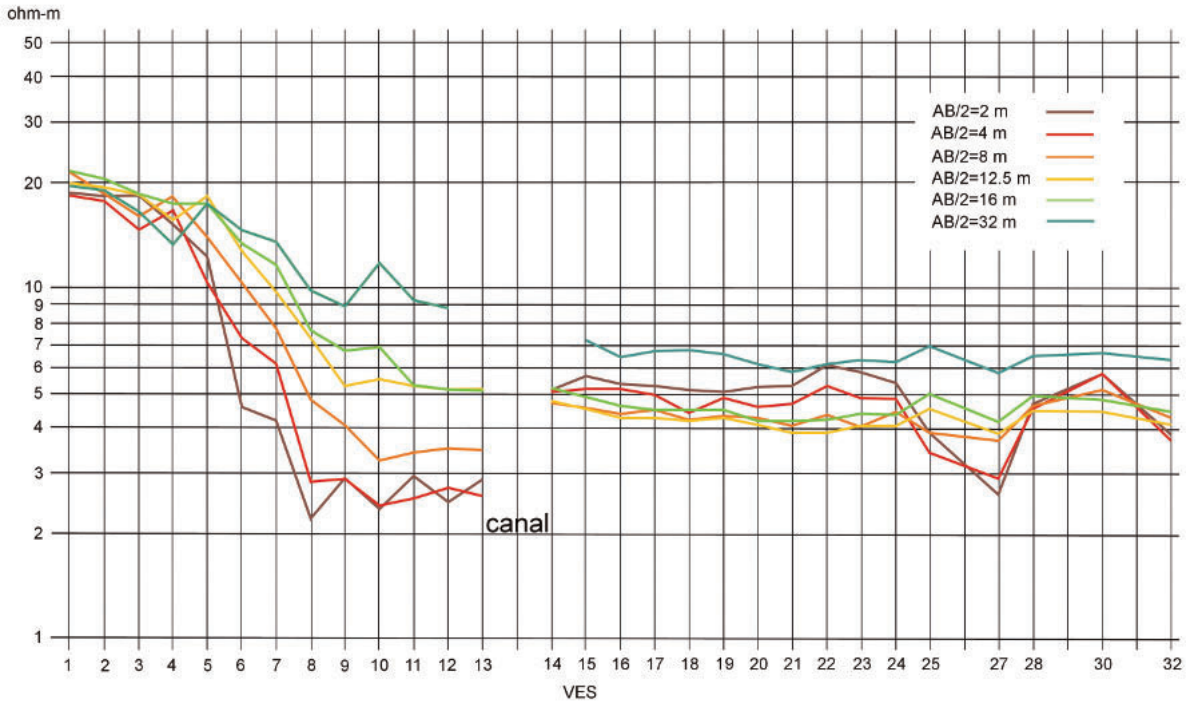


Fig. 17 ᶜEzbet Rushdi area. Apparent resistivity curves (selected levels of soundings). Vertical logarithmic scale

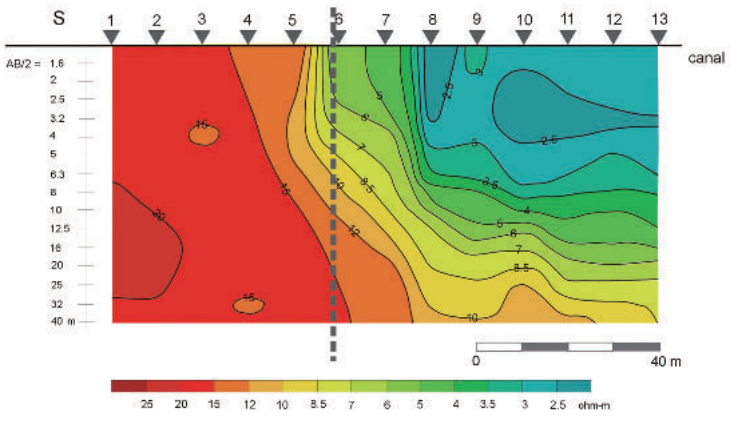


Fig. 18 ᶜEzbet Rushdi area. Apparent resistivity pseudosection.

values in the range from 8 to 27 ohm-m, depending on the sounding level (Fig. 15)), and one of much lower values in the eastern part of the line (sounding 9–19; values in the range 3 to 12.5 ohm-m, depending on the sounding level). A violent, stepped drop in resistivity values is evident between soundings 7 and 9.

The clear division between the zone of higher-resistivity values in the western part of the line and the zone of lowered values in the eastern part is reflected distinctly in the resistivity pseudosection (Fig. 16). The higher-resistivity topsoil with values higher than 20 ohm-m disappears between soundings 8 and 9, the layer with values over 15 ohm-m disappears in sounding 9 and can be seen down to a depth measured with an AB/2 spacing equal to 12.5 m. At the eastern part of the line of soundings, the bedding is characterized by lower-resistivity values; values under 8.5 ohm-m are already seen at a depth measured with a spacing of AB/2 = 2.5 m.

A comparison of the electrical soundings results with the effects of magnetic prospection (Fig. 14) reveal evident correspondence between the higher-resistivity zone and settled land and the lower-resistivity zone with accumulations forming the Nile riverbed. The riverbed edge runs between soundings 8 and 9.

ᶜEzbet Rushdi area

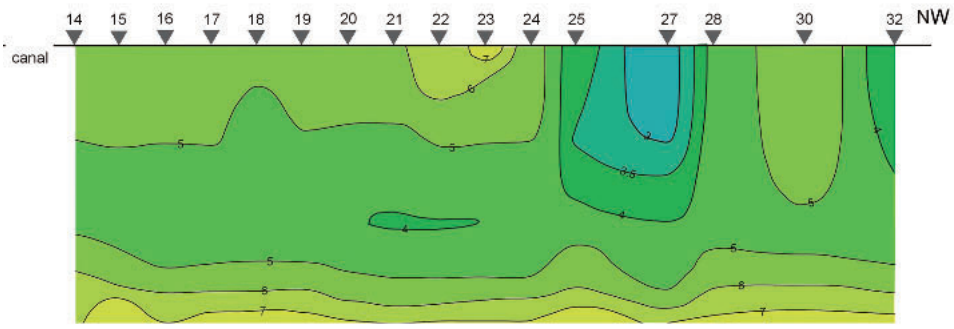
The presence of a channel and modern road in this area necessitated the breaking off of soundings for a distance of c. 130 m (Fig. 14). The orientation of fields to the north of the channel caused the line of soundings to be modified to run toward the northwest.

The curve charts and the pseudosection (Figs. 17, 18) reflect the two-zone nature of ground resistivity in this area, in similarity to the sounding results for the ᶜEzbet Machali region. In the southern part of the line of soundings (between soundings 1 and 5), the ground is characterized by higher-resistivity values (assuming standardized values in the range 14–20 ohm-m regardless of sounding level); to the north the resistivity drops suddenly, especially in the surface layers (starting with sounding no. 6 the resistivity does not exceed 6 ohm-m). The boundary between the higher and lower resistivity zones (seen at the no. 6 sounding point) would correspond to the border between the riverbed and settled area.

This observation has been verified by the magnetic mapping. North of sounding points 6–7 there are no disturbances of the magnetic field and this area would thus correspond to the homogeneous deposits forming the riverbed. The zone of disturbances to the south of the sounding points 6–7 corresponds to cultural accumulations. Dorner's drillings corroborate this as well. On his map of the Pelusiac branch of the Nile, the boundary of the riverbed runs between soundings 5 and 6 (Fig. 14). However, the VES results do not bear out Dorner's proposition of locating an island between the F1 and F2 branches of the Nile. According to his proposition, the southwestern edge of the island should appear between soundings 17 and 27. This section on the resistivity pseudosection is no different from that where the river flowed. To believe the VES results, the edge of the island should be moved eastwards beyond the line of the soundings.

ᶜEzbet Helmi area

A comparison of the charted resistivity curves indicates the dual character of the bedding, evi-



Vertical logarithmic scale. Dashed vertical line indicates position of the edge of the Nile riverbed

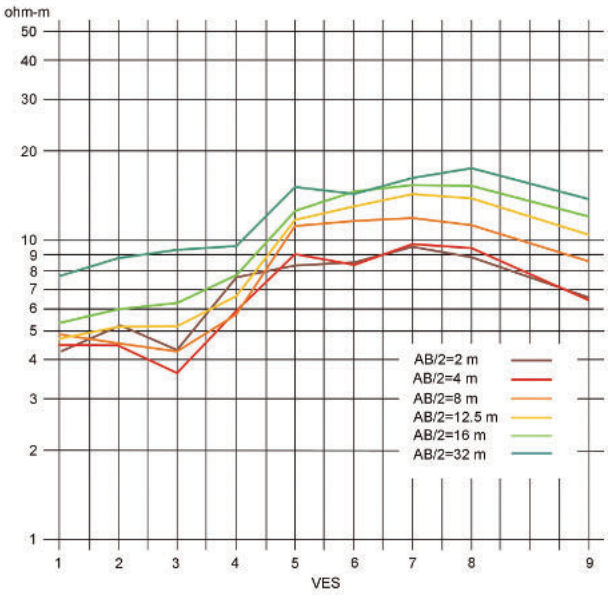


Fig. 19 ᶜEzbet Helmi area. Apparent resistivity curves (selected levels of soundings). Vertical logarithmic scale

dently divided into two zones: a lower-resistivity part in the southeast (soundings 1–3, Fig. 19) and a higher-resistivity part in the northwest (beyond sounding 5). Nonetheless, the resistivity pseudosection differs from that for the Rushdi and Machali areas: in the higher-resistivity zone the resistivity values grow with the depth of the prospection and there is no higher-resistivity surface layer. Based on an analysis of the sounding results, the northeastern edge of the riverbed runs between soundings 4 and 5.

Dorner's map shows practically the same course of the riverbed edge, that is, southeast of sounding 4. The absence of a higher-resistivity surface layer, which is observed outside the purported riverbed, might suggest that there was no distinct cultural accumulation on the northwestern side of the river. This could be taken as indicating a regularly inundated floodplain.

As the magnetic prospection has not yet reached this area, it is impossible to say to what extent magnetic mapping would have supported these findings concerning the course of the riverbed. Caesium magetometer prospection in 2007 and 2008 carried out to the north and west of the Khataᶜna region, in an area far west of the river edge as reconstructed by Dorner, did not give a conclusive image of the riverbed edge. But in view of the observations carried out in other areas, the VES method can be deemed as useful in determining the extent and course of the riverbed, as well as the surrounding floodplains where repeated flooding would have obliterated all traces of settlement activities, assuming there were any in the area.

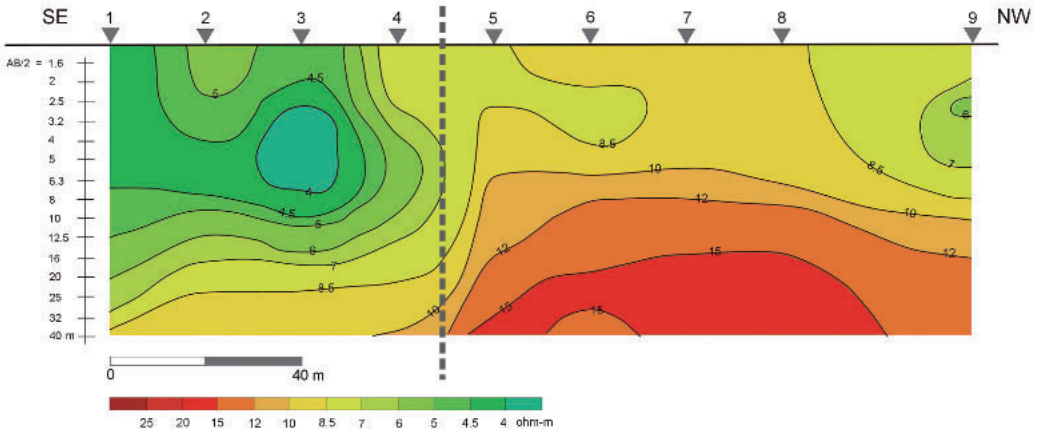


Fig. 20 ᶜEzbet Helmi area. Apparent resistivity pseudosection. Vertical logarithmic scale. Dashed vertical line indicates position of the edge of the Nile riverbed