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The Kirwan Memorial Lecture

Forts in Upper Nubia and a new perspective on the first centuries of Alwa and Makuria

Mariusz Drzewiecki

1-21

Reports

Sai Island: defensive architecture of a New Kingdom town in Nubia

Franck Monnier and Vincent Francigny

22-38

Sai Island: medieval architectural remains of a flourishing era

Hugo Dussart and Vincent Francigny

39-52

Newly identified macrobotanical remains from Old Dongola (14th-18th centuries AD), Northern Sudan: a breakthrough in archaeobotanical research

Mohammed Nasreldein

53-64

Keepers of tradition: preliminary remarks from the ethnographic investigation of customs associated with clothing and authority among Sudanese women

Joanna A. Ciesielska, Agnes Dudek and Fatima Edres Ali Mahmoud

65-72

Jebel Barkal 2018-2023: new research on the Napatan and Meroitic city

Geoff Emberling, Tim Skuldbøl, El-Hassan Ahmed Mohamed, Sami Elamin, Gregory Tucker, Pawel Wolf, Burkart Ullrich, Suzanne Davis, Saskia Büchner-Matthews, Dobiesława Bagińska, Rebecca Bradshaw, Tohamy Abulgasim, Jan Peeters, Timotheus Winkels, Richard Redding, Anna den Hollander, Dorian Q Fuller, Abigail Breidenstein, Taylor Bryanne Woodcock, and Jochen Hallof

73-98

Rescue excavations at Jebel Barkal by Dongola University's Department of Archeology (Seasons 14 and 15)

Mohamed Fath al-Rahman Ahmed Idris

99-109

Survey of the Meroitic site of el-Hassa. Understanding the links between the Amun temple of Amanakhareqerama and the settlement

Tomasz Herbich and Marie Millet

110-131

Archaeological discoveries in the hills and coastline of the Red Sea State, Eastern Sudan 2016-2021. Preliminary report

Fakhri Hassan Abdallah Hassan

132-151

The Sudan Military Railway between Wadi Halfa and Abidiya

Derek A. Welsby

152-193

Archaeological and paleoenvironmental survey in the White Nile state (first season, 2022)

Hamad Mohamed Hamdeen, Al Bagir Badwi, Siddig Mahadi, Manahil Mohammed Farah, Mukhtar Maaliieldin and Abdelhai Abdelsawi

194-210

Studies

Excavating 'Areika': Cuthbert Balleine and the 1907 Eckley B. Coxe Jr. Expedition to Nubia

T. O. Moller

211-222

Metal anklets at Faras and other Meroitic sites: form, function, chronology and a response to Vila's 'gens à anneaux'

Henry Cosmo Bishop-Wright

223-256

Darfur in the early 1980s: a photographic record of communities, craft, and change Zoe Cormack	257-266
Further insights into a forgotten aspect of Meroitic religion: the amulets of Apedemak Mahmoud A. Emam	267-278
The ancient Nubian skeletal collection at Universidad Complutense de Madrid, Spain Mar Casquero, Víctor M. Fernández, Salomé Zurinaga Fernández-Toribio, Mohamed Saad and Luis Ríos	279-289
Sudan in Swansea Kenneth Griffin	290-302

Obituaries

Professor Dr Ibrahim Musa Mohamed Hamdon – Director General of NCAM An homage to his work Ghalia Gar el-Nabi	303-305
Professor Khider Adam Eisa (1947–2023), Cairo Professor Intisar Soghayroun el-Zein	306-307
Professor Ibrahim Mousa Mohamed Hamdoun (1953-2024), Cairo Professor Intisar Soghayroun el-Zein	307-308
Professor Abdul Rahim Mohamed Khabeer (--2024), State of South Sudan Professor Intisar Soghayroun el-Zein	308-310
Professor Mahmoud El-Tayeb (1957–2024), Poland Professor Intisar Soghayroun el-Zein	310-311
Professor Herman Bell (10th March 1933-7th February 2023) Kirsty Rowan	311-314
Henry (Harry) Sidney Smith (June 14th, 1928–September 8th, 2024) Robert Morkot	314-318

Biographies

Miscellanies

Front cover. General view of Site WNP-J-22\1, Al-Jabalain, White Nile State. Photo by Hamad Mohammed Hamdeen.

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Survey of the Meroitic site of el-Hassa.

Understanding the links between the Amun temple of Amanakhareqerama and the settlement

Tomasz Herbich and Marie Millet

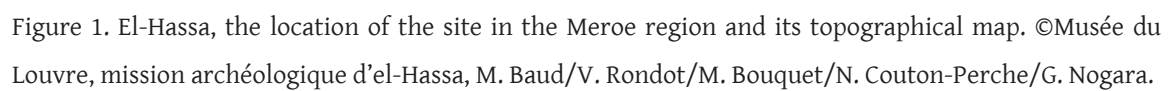
In the Meroe region, to the south of the capital of the Meroitic kingdom and its impressive pyramid necropolis, 'urban' settlements were built as 'relay points' for royal power, such as Hamadab, Muweis and el-Hassa (Wolf 2021, 120) (Figure 1). The layout of these sites appears to be consistent, with religious and administrative buildings arranged in a similar pattern. Located 25km south of Meroe, the capital of the Meroitic Kingdom, el-Hassa is one of the region's major settlements. The site has been known since the early 19th century, when it was first visited by European travellers. Excavations began in the early 2000s and have continued for two decades, providing invaluable insights into this significant urban settlement in the Meroe region. Research concentrated on the religious complex with the objective of gaining a deeper understanding of the evolution of the cult of Amun in the Meroe region. In order to contextualise the temple and its associated religious complex within their broader environment, a magnetic survey was conducted in 2008 and continued in 2022.

El-Hassa: its history and the results of the excavations (2000-2022)

The site of el-Hassa has been mentioned by European travellers since the early 19th century; in 1814, by Burckhardt, and then, with more detailed descriptions, in 1822 by Cailliaud and Linant de Bellefonds, who offered further insights by remarking on the remains of an ancient temple and a *sphinx bélier* (ram sphinx) in their notebooks (Rondot *et al.* 2022, 6-13). They described stone buildings, although the majority were of brick; all were gradually covered by windblown sand. Following these indications, and the unearthing of a ram statue in 1975, excavations started in 2000, which revealed a temple to Amun, dedicated by King Amanakhareqerama (AD80-90) (Kuckertz 2018; Rilly 2017; Rondot *et al.* 2019; 2022) (Figures 2 and 3). It is thanks to the inscriptions on the bases of the five rams discovered that not only is the name of the king known, but also the Meroitic name of the town in which the temple is located, *Tabakha*.

Archaeological excavations have revealed that the site of el-Hassa was occupied during the Neolithic period and then abandoned until the Meroitic period, when a new urban settlement was founded, including a religious complex. Following an initial construction phase comprising a pylon and three rows of halls, the temple was subsequently enlarged to the west. This new configuration, with its more balanced proportions, can be attributed to theological considerations rather than technical factors. The temple is similar to other Amun temples known in Sudan, notably Naga. The uncovered remains, from east to west, are those of an altar followed by a processional way of rams including a kiosk. This led onto the temple pylon, which itself opened onto a series of rooms leading to the sanctuary. During these two phases, a ceremonial palace to the south of the temple was undoubtedly used in conjunction with the temple for ritual purposes (Figure 2). The rituals were evidenced by the discovery of cult objects in the sanctuary, including bronze, stone and ceramic items such as statuettes, bowls and a libation table. The temple was subsequently abandoned for at least a century, after which it was rebuilt, but the quality of the workmanship was not as accomplished as in the previous two phases. During this final occupation, the ceremonial palace was used as a quarry for building materials.

The remains of the temple and the ceremonial palace adjoining it are no more than bases of walls and structures, built mainly of fired bricks, and are too fragile to be preserved in their current state. It was therefore decided to re-cover them up (Figure 4). The rams, on the other hand, are made of good quality



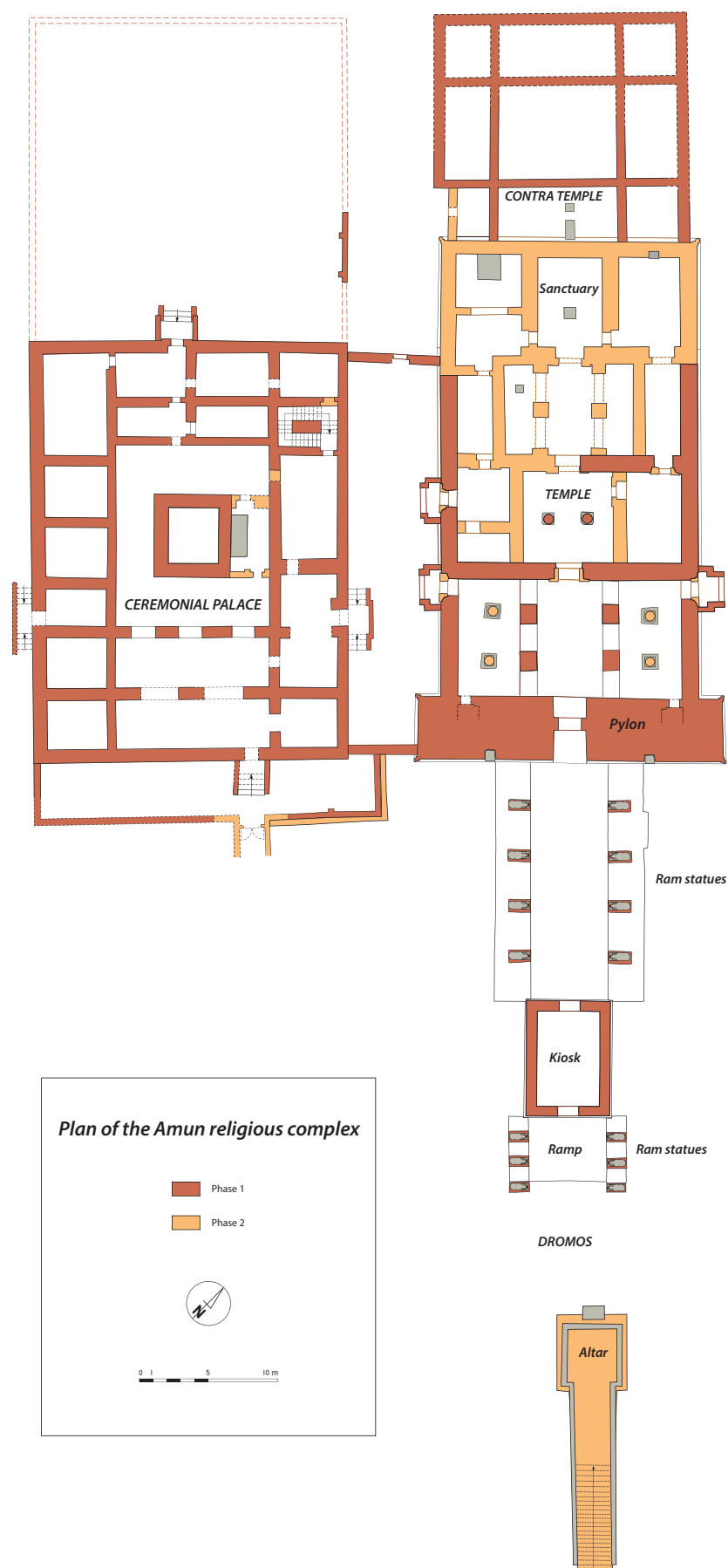


Figure 2. El-Hassa, plan of the Amun temple of Amanakhareqerema ©Musée du Louvre, mission archéologique d’el-Hassa, G. Nogara/R.-P. Dissaux.



Figure 3. El-Hassa. Aerial view of the Amun temple in 2010 © KapArchaeo - Bernard-Noël Chagny.

sandstone and can therefore withstand, after proper conservation, exposure to the open air. Originally, there were 14 ram statues in this alleyway, six in front of the kiosk and eight between the kiosk and the temple pylon. Of these 14 statues, six still exist, including five found at el-Hassa and one at Soba in the 19th century.¹ Bases higher than the originals were constructed from cement and plastered (Figure 4 bottom). On these bases, the six rams were placed back in their original position, and are therefore visible to visitors today to give them an idea of the location of the temple of el-Hassa. As the Soba ram is now in the collection of the Sudan National Museum, a plaster cast is now on display on the processional way on the site.

About 1km south-east of el-Hassa is the second site of the archaeological zone, Damboya (Figure 5) which, pending further investigation, has to be considered as linked to el-Hassa. Excavated by a large sondage between 2020 and 2022, the site reveals many buildings in red brick and mudbrick (Choimet 2022; Maillot and Poudroux 2022).

On both of these sites, the cult buildings mostly were made of red bricks with the walls then plastered. The mudbrick buildings and structures have also been levelled. All that remains of these buildings are their foundations, which limits our understanding of their elevation but nevertheless provides a detailed plan and an understanding of the construction phases. This is the result of having been dismantled in antiquity, to reuse materials for other constructions.

Non-invasive research – the choice of method

At el-Hassa the focus of the excavations was on the Amun temple and its immediate surroundings, but the site covers more than 20ha and more than 1ha has been excavated so far. In order to situate the

¹ Archaeological evidence (an existing base for this statue) and epigraphic evidence (identical text on the statue base) support the hypothesis that the Soba ram originated from el-Hassa (Rondot and Claustre 2018; Rondot *et al.* 2022, 4-49).



Figure 4. El-Hassa. The temple of Amun and the rams during the excavations in 2010 (top); the remains of the temple backfilled and the rams restored in 2022 (bottom). ©Musée du Louvre, Mission Archéologique d'el-Hassa, G. Nogara/M. Millet.



Figure 5. El-Hassa and Damboya, satellite image (©Google Earth). Dashed line indicates the protected area.

temple and the religious complex in its environment, the spectrum of research methods was expanded to include non-invasive ones, allowing for much faster registration of archaeological structures within the site than would have been the case with excavations. Previous experience gained during research in the Nile Valley, both in Sudan and in Egypt, has shown that magnetometry is the most effective method for locating buildings invisible on the surface (Herbich 2003; Abdallatif *et al.* 2019). It brings the best results when surveying dried mudbrick architecture, with the iron oxides in the mud guaranteeing higher values of magnetic susceptibility (Hesse 1967; Herbich 2019; 2023). Its effectiveness drops in the case of fired (red) brick because the thermoremanence effect makes baked clay strongly magnetic, paradoxically limiting the possibility of reconstruction of the layout of structures made from this material (Bevan 1994; Herbich 2020). Spaces between walls in densely built-up areas are usually filled with collapsed fired-brick rubble from the upper parts of the structures, making it difficult to distinguish anomalies indicating walls from those corresponding to fill deposits inside and between buildings. When dealing with buildings made of fired brick, the method is useful to establish the extent of built-up areas, limits of freestanding structures,

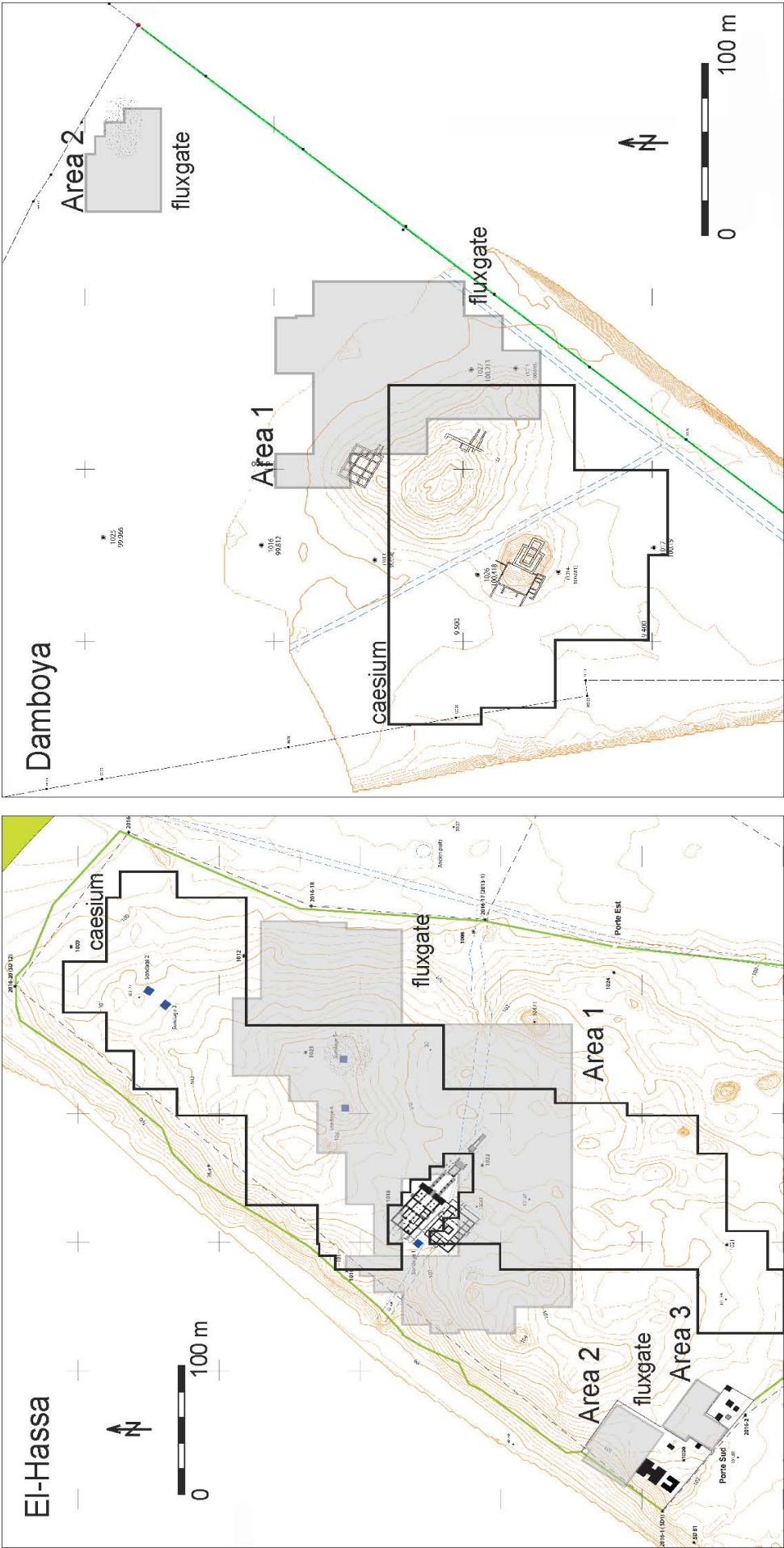


Figure 6. Topographical maps of el-Hassa (left) and Damboya (right). Solid line marks the area of the magnetic survey carried out in 2008 (with the use of caesium magnetometry); magnetic survey carried out in 2022 (with the use of fluxgate magnetometry) in transparent grey, © T. Herbich.

identification of industrial activities (e.g., pottery kilns and metallurgical furnaces) and reconstruction of the landscape around the site. Individual building layouts can only be reconstructed when the space between walls is not filled with brick rubble.

Magnetic survey – the first attempt

The initial magnetic investigation was undertaken in 2008. A caesium instrument with two probes was used to measure changes in the total intensity of the Earth's magnetic field (Aspinall *et al.* 2008). At el-Hassa, the measurements covered an area of 7.5ha; at Damboya 2.35ha (Bière 2008) (Figure 6). At el-Hassa, the survey and measurements were carried out on both sides of the Amun temple, north and south, situated in the central part of the archaeological zone. The measurements were taken along lines 1m apart, every 0.1 sec when mowing along a line (which makes approximately 7 to 10 measurements per 1m). As a result two buildings were identified southwest of the palace complex (Figure 7). Their orientation matched that of the monumental architecture consisting of the Amun temple and the ceremonial palace. Built-up areas were mapped as magnetic noise; that is, disturbed readings of magnetic field intensity, with a severely limited possibility of identifying individual walls in the magnetic image. Due to the limitations of instrument sensitivity and the measuring technique (the measurement of total magnetic field intensity), it was not possible to trace the features in question, which were of an industrial nature. However, their approximate position was indicated by strong dipole anomalies (showing high positive as well as negative values).

At Damboya, the results of the caesium survey were clearer, and showed outlines of two buildings. In the central part of the archaeological zone, a large building that measured at least 80x60m, with internal subdivisions with spaces whose sides measured between a minimum of 10m and a maximum of 20m. To the south, a small building measuring 18x20m is clearly visible (Figure 13). It also has internal divisions, but these are smaller modules (Bière 2008; Maillot 2020, 181). The excavations led by Marc Maillot between 2020 and 2022 used these results to open and clear the areas surveyed in 2008 (Maillot 2020; Choimet 2022; Maillot and Poudroux 2022).

Magnetic survey – the second attempt

Several years after the first magnetic survey and the uncovering of the cult-related monuments at el-Hassa, there was a need to place these buildings within the existing urban layout that developed following the construction of the cult structures. This new survey was motivated by the extension of the excavations to the north of the temple, to link the religious structures to the urban area. The northern part of the site, like the southern part, has a mound that may bear witness to an accumulation of archaeological levels. In addition, in both the north and south, metal slag preserved on the surface, indicating smelting activities, has always aroused interest in a greater understanding of the site. To facilitate the survey the meskit trees, which were very dense here, were removed over an area of 5ha in the course of three weeks.

The magnetic survey in the 2022 season was carried out with a fluxgate gradiometer (Aspinall *et al.* 2008) (Figure 8). The choice of a different measurement technique (the observation of the gradient of the vertical component of magnetic field intensity) provided more detailed data on industrial-type features: a more precise localisation and tracing of the outlines, as well as a better chance of distinguishing individual walls within the complex (Herbich 2023). An increased sampling density also improved the odds: measurements with the caesium magnetometer were performed along traverses spaced every 1m, while those with the fluxgate gradiometer along traverses spaced every 0.5m.

During the first season of the survey at el-Hassa, an area of 4.6ha in the central part of the site was studied (Figure 9). The area overlapped in part with the area surveyed with the caesium instrument, and extended beyond it to the east and west. Measurements also covered two areas (a combined area

118



Figure 8. El-Hassa. Konrad Jurkowski takes measurements with the use of Geoscan Research FM256 fluxgate gradiometer, © T. Herbich.

of 0.4ha) in the southern part of the site near the dig house. At Damboya, the survey was situated east of the mound covering the ancient remains and it minimally overlapped the area investigated earlier. In 2022, a total of 1.4ha was surveyed (Figure 12). A small fragment of the site (0.2ha) in the north-eastern quarter, where some fired bricks lay on the surface, was also mapped.

Data from the caesium magnetometer supplemented the results from the fluxgate gradiometer to make interpretative maps (Figure 13). At Damboya, combining the results from the two surveys proved particularly productive.

Results of the survey – description of the magnetic image

El-Hassa

In keeping with expectations, a detailed reconstruction of the town layout could not be generated from the measurements, but it was possible to determine its extent based on the accumulation of dipole anomalies reflecting concentrations of fired bricks.

A series of parallel linear anomalies running southwest–northeast, located southeast of the site, helped determine the extent of the architecture. The south-west section of these anomalies can be observed between Squares L7 and I10, the northern between H11 and the south-east corner of E13 (Figure 10). These anomalies cut off the area of magnetic noise, corresponding to the built-up area, from an area with minimal noise, presumably without any architecture. It is very likely that these linear anomalies correspond to large boundary structures. The characteristics of the anomalies suggests the type of building material that was used in the construction of these enclosure or perimeter walls. The southern anomalies feature low amplitude values, exclusively positive, which are indicative not of the walls themselves, but rather of the material with higher magnetic susceptibility lining the stone walls – which in itself does not have magnetic properties. Material of analogous magnetic values had not accumulated along the southeast face of this wall, making it difficult to estimate the width of the structure. A detailed analysis of the magnetic image (especially the length of two linear anomalies joining the wall at a right angle, observed in the southern part of Square K8 and the north-west corner of K9), suggest a wall thickness of approximately 8m. Anomalies recorded on the wall and in its vicinity, seen on the axis of the processional way leading to the temple to Amun (in J9), probably correspond to a gate. The northern section of the anomaly, assumed to be an image of an enclosure wall, is characterised by a greater amplitude of magnetic values, which are evidence for the presence of fired bricks. The doubling of this anomaly could indicate two walls in this place. The different orientation of this wall with respect to the alignment of the south wall and the different building material could have chronological significance. The course of the structures interpreted as the city perimeter walls finds no reflection in the topography of this part of the site (Figure 11).

The survey revealed a set of walls by the Nile alluvial plain on the north-east side of the site. Anomalies corresponding to the walls - of red brick by the nature of these anomalies - create a rectilinear arrangement lining three sides of an empty space with uniform values of magnetic field intensity (apart from a set of anomalies in Square F2, which can be attributed to a concentration of fired bricks on the surface). The walls stand in an area sloping towards the Nile (Figure 12). Magnetic evidence suggests walls reinforcing the sides of a harbour bay, which had the internal dimensions of about 55m by at least 25m. Inside this rectangle, no anomalies were found, suggesting an area devoid of buildings. The wall observed in Square G2, roughly 10m long, could have been a type of pier for mooring boats. It also seems that the parallel

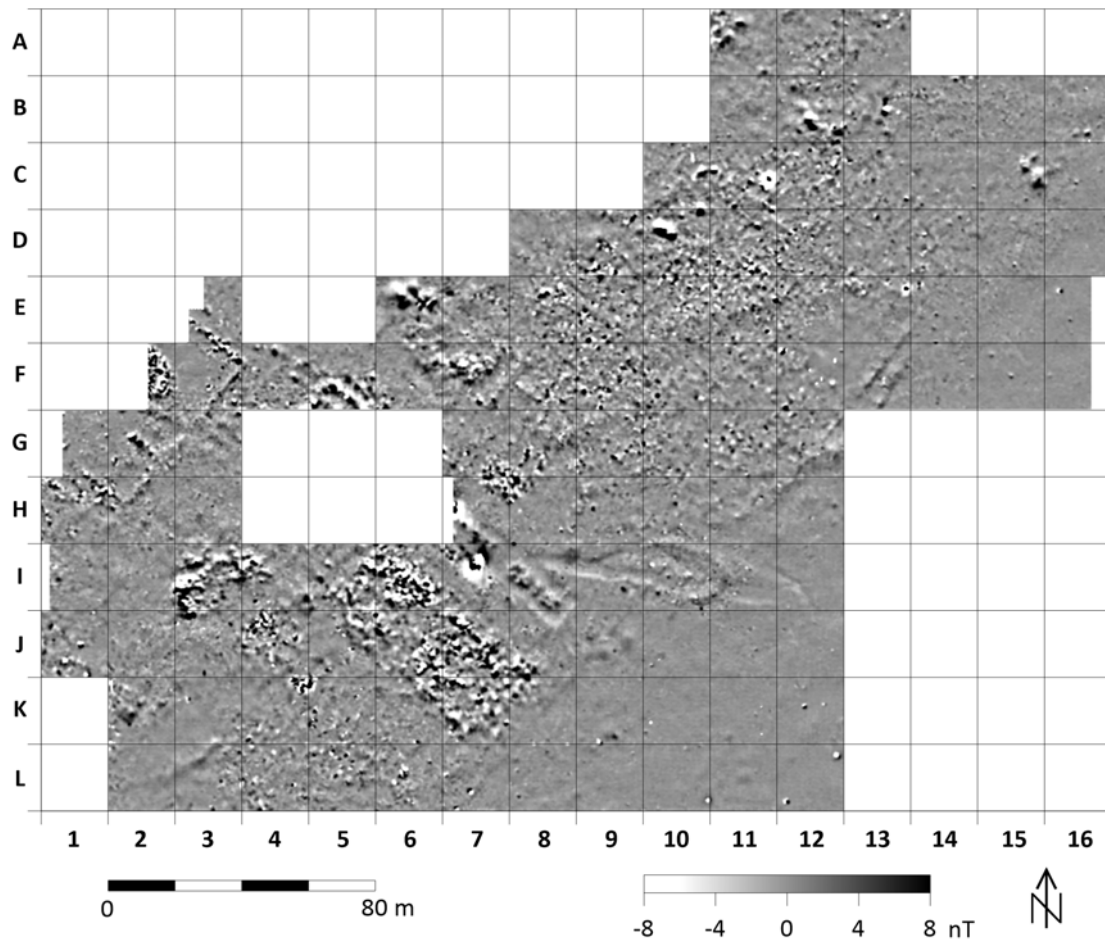


Figure 10. El-Hassa magnetic map (fluxgate magnetometry), © T. Herbich.



Figure 11. El-Hassa. The location where the enclosure wall was detected seen from the south-west, © T. Herbich.

linear anomalies observed in Square G3 are the remains of a monumental passage connecting the port with the religious complex.

A few compact anomaly sets corresponding to buildings could also be distinguished. Three of these complexes, or rather their extent, had been mapped by the caesium magnetometer survey: a building centred on the interface of Squares I5, I6, J5 and J6 (Figure 10); a building on the interface of Squares J7 and K7; and a building with the south-east side in Square F7. A more detailed description, going beyond just the general extent, is possible for the latter two of these structures. A few walls can be distinguished in the southernmost of the buildings, along with a small rectangular structure, not connected to the walls, in the west corner of the building, and a circular structure in the centre (at the interface of Squares J7 and K7), measuring about 6m in diameter. The latter could have been a well judging by the low magnetic field intensity values inside its outlines. A few walls can also be distinguished on the fringes of the building closest to the river (centred in the northern part of F7); added to this are anomalies on the south-west side, which could mark the sides of an adjoining courtyard.

Two structures were mapped symmetrically on either side of the processional way. The rectangular outline is estimated at 13x8m. The northeast structure lies at the interface of Squares G7, G8, H7, and H8 (Figure 10) whereas the southwest is in Square I6. Measurements have also revealed the extent of this religious complex (part of which was explored archaeologically) on the north-west side of the temple.

The survey also registered a square-shaped set of anomalies in Square K2, identified as a structure that is probably entirely made of stone (Figure 10). The anomaly shows higher magnetic field intensity values, which would correspond to the fill inside this unit and reflects the internal plan of the structure. The anomaly is outlined by walls, which are of a material that fails to register on the magnetic map.

Features of an industrial character can also be observed among the anomalies. They are located mainly in the northern part of the prospected area. Value amplitudes here are differentiated; the highest (reaching - 30/+30 nT) might reflect metallurgical activity. Lower amplitudes (with lower negative values)



Figure 12. El-Hassa. The location where the hypothetical harbour was detected: view from the south-west, © T. Herbich.

correspond to pottery production or bread baking, for example. In places with a greater concentration of anomalies, there is slag or strongly fired clay on the surface. It is very likely that the set of anomalies observed in I3 (Figure 10), southwest of the palatial structure, reflects a metallurgical installation. The high amplitudes indicate the presence of metal, while slag remains on the surface yield physical evidence in favour of such an interpretation.

Magnetic noise caused by fired brick rubble deposits makes it difficult to trace the layout of streets. There seems to be one street crossing the settlement between Squares D8 and the western side of F11 (Figure 10). The street – with no traces in surface relief – appears to join an open space of roughly rectangular shape, 20m long, featuring uniform values of magnetic field intensity (in F11/G11). It could have been a town square. A gap in the wall, along with magnetic noise southeast of this gap, appears in Square G12, aligned with the hypothetical street and open square. This arrangement of anomalies could be indicative of a gateway. Joining the anomaly interpreted as a street is a linear anomaly of lower magnetic field intensity values, mapped by the caesium magnetometer (Figure 7).

Modern activity on the site is also reflected on the magnetic map. A long anomaly with lowered values, observed between I8 and I11 (Figure 10), corresponds to a ditch, while ellipsoid anomalies adjacent to this ditch reflect spoil heaps of sand.

The small size of the surveyed area does not allow for much analysis regarding features mapped in Areas 2 and 3, near the dig house (Figures 6 and 9). The series of oval anomalies that are approximately 1m in diameter, mostly showing positive values (reaching 6 nT), visible over almost the entire surveyed area, could represent furnaces of some kind. Narrow linear anomalies of a rather low value amplitude could be interpreted as walls of mudbrick building. In area 2 located to the north, a street can be traced (represented by long narrow sections without magnetic noise). The building would thus be standing parallel to the edge of the street.

The structures described above, distinguished by their magnetic properties, were used to reconstruct the site plan. The results of both the earlier studies with the caesium instrument and the later ones with the fluxgate instrument were used for this interpretation (Figure 13).

Damboya

The results of the prospection confirmed the extent of the built-up area, which is restricted to the mound. Corresponding to this is a clustering of anomalies typical of concentrations of fired bricks. The only structure outside of this cluster is observed on the south-western slope. It was mapped by the caesium magnetometer survey and subsequently excavated (Figures 14 and 15).

The gradiometer prospection was able to establish the full size of one building only, which is located near the central section of the western edge of the survey (indicated by a yellow arrow in Figure 14). It had a length of 15m and a width of 10m, yet there was no indication in the surface relief. A combined analysis of survey results from 2008 and 2022 allowed a number of walls to be traced (Figure 14); however, the walls appear to follow two different orientations, one departing from the other by about 15 degrees (Figure 15). This could be proof of two construction phases. The buildings excavated to date and the structure in the highest part of the mound have the same orientation, while the architecture in the southern part of the mound has a different one. The latter, less distinctive in the magnetic image, could have been built earlier. These conclusions are entirely consistent with the outcome of the archaeological excavations, where two phases of construction were identified (Choimet 2022; Maillot and Poudroux 2022).

The magnetic map also reveals elements of the paleolandscape. Linear anomalies in the north-western part of the surveyed area (in areas surveyed by caesium and fluxgate instruments) presumably correspond to the sides of paleochannels (Figure 14).

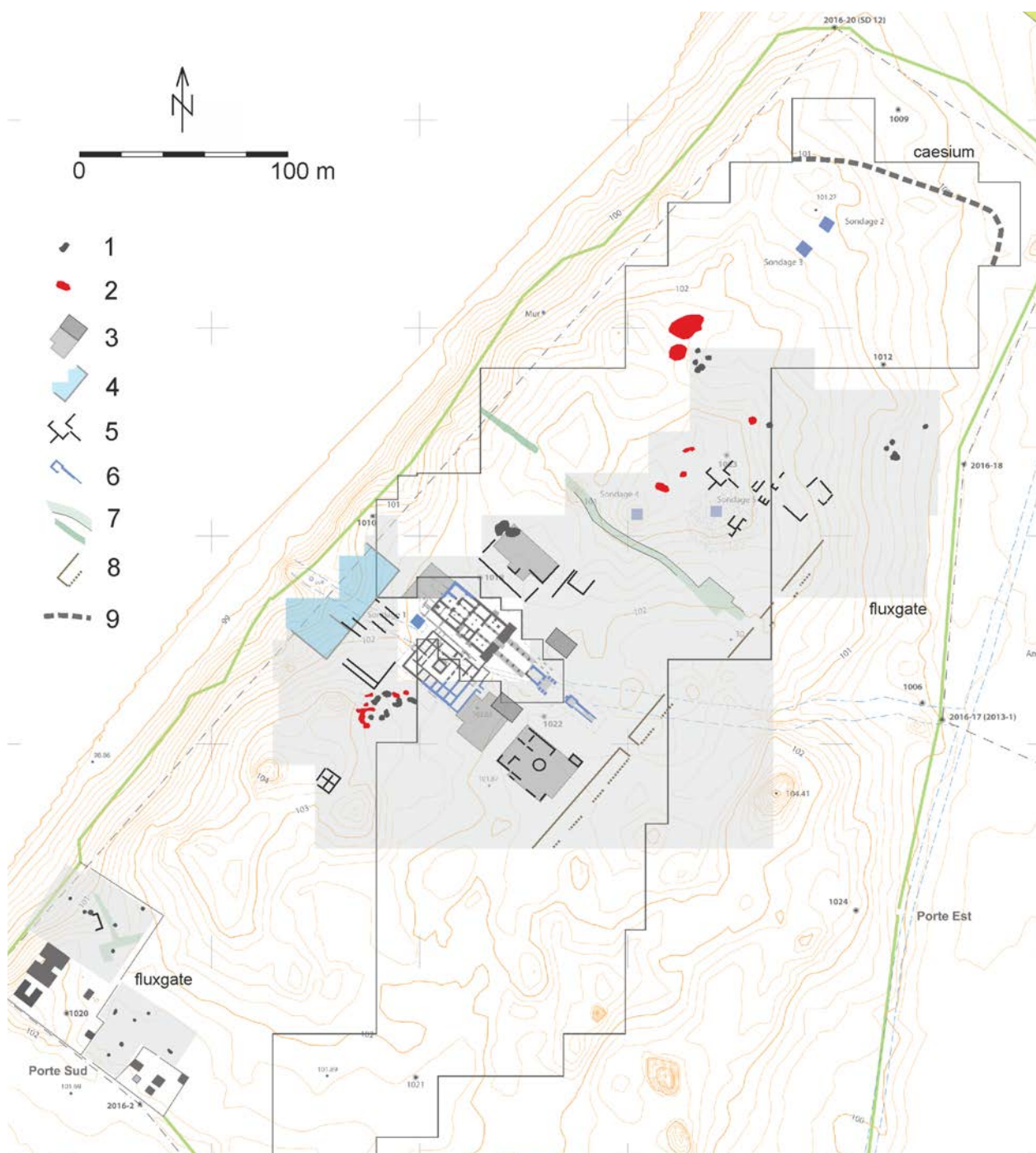


Figure 13. El-Hassa. Interpretation map based on result of fluxgate and caesium magnetometry. 1 – hearths, ovens; 2 – kilns with remains of iron processing; 3 – structures built of fired brick; 4 – harbour; 5 – walls; 6 – structures excavated prior to magnetic survey using fluxgate gradiometer; 7 – streets; 8 – enclosure wall (solid line – inner face; dashed line – hypothetical outer face); 9 – edge of the settled area.

The aim of a survey of a small area (2200m², Area 2) in the north-eastern part of the site was to explain the origins of a concentration of fired brick rubble lying on the surface. Nothing in the way of architectural structures was mapped. Instead, the magnetic map showed an anomaly located west of these remains, which could suggest an industrial character. The alignment of anomalies in part of this cluster is particularly interesting: southeast of a larger structure, with a maximum diameter of approximately 4m, there are four structures each about 1m in diameter, positioned radially around the larger structure, marked with a circle in Figure 14. This could suggest a functional interconnection of the structures in this complex.

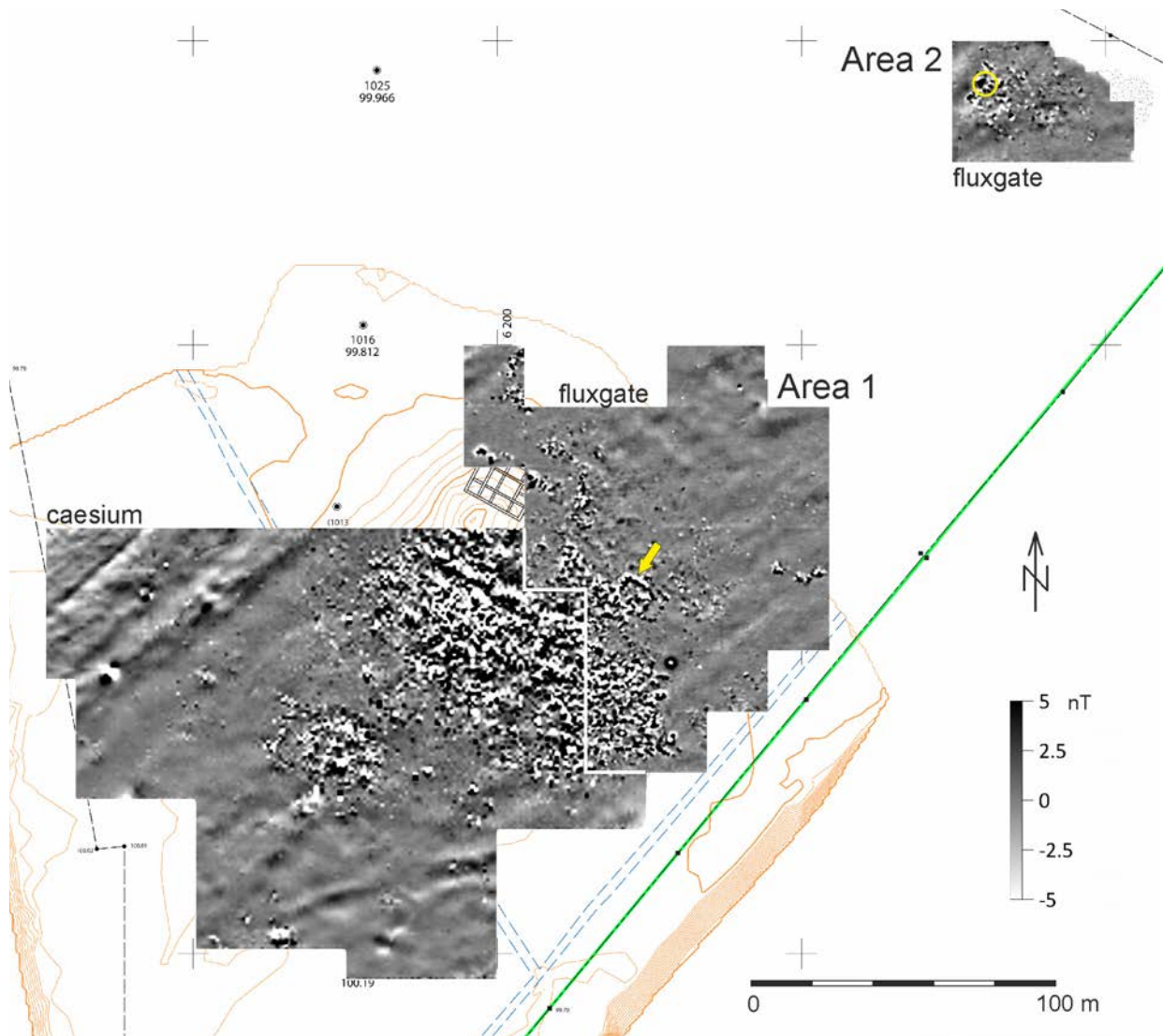


Figure 14. Damboya. Results of the magnetic surveys by caesium and fluxgate magnetometry, © T. Herbich.

As in the case of el-Hassa, the results of magnetic surveys were used to create a site plan, marking structures identified based on their magnetic properties (Figure 15).

Discussion

Links with the Nile and the boundaries of el-Hassa and Damboya

The limits of the settlements revealed by the survey certainly correspond to the ancient limits of the floodplain. At el-Hassa, the caesium survey shows the northern limit of the site, and through the interpretation of the results of 2022, this limit could be marked by an enclosure wall.² If excavations confirm the presence of an enclosure wall, then el-Hassa would be one of the few documented sites with this type of boundary. A wall (Wolf *et al.* 2019, fig. 9, Wolf and Nowotnick 2021, 526) encloses the town of Hamadab and at Dangeil the temple has an enclosure wall (Anderson *et al.* 2018). The sandstone enclosure wall of the city of Meroe enclosed the area with cult and official buildings, separating it from the production and domestic areas (Wolf *et al.* 2019, fig. 8; Wolf and Nowotnick 2021, 517). The survey of Damboya confirms the presence of buildings and structures partially excavated between 2020 and 2022,

² The 18th of March 1814, in his description Burckhardt mentioned the absence of an enclosure wall: 'I saw no remains of any town wall [...]' (Burckhardt 1819, 362).

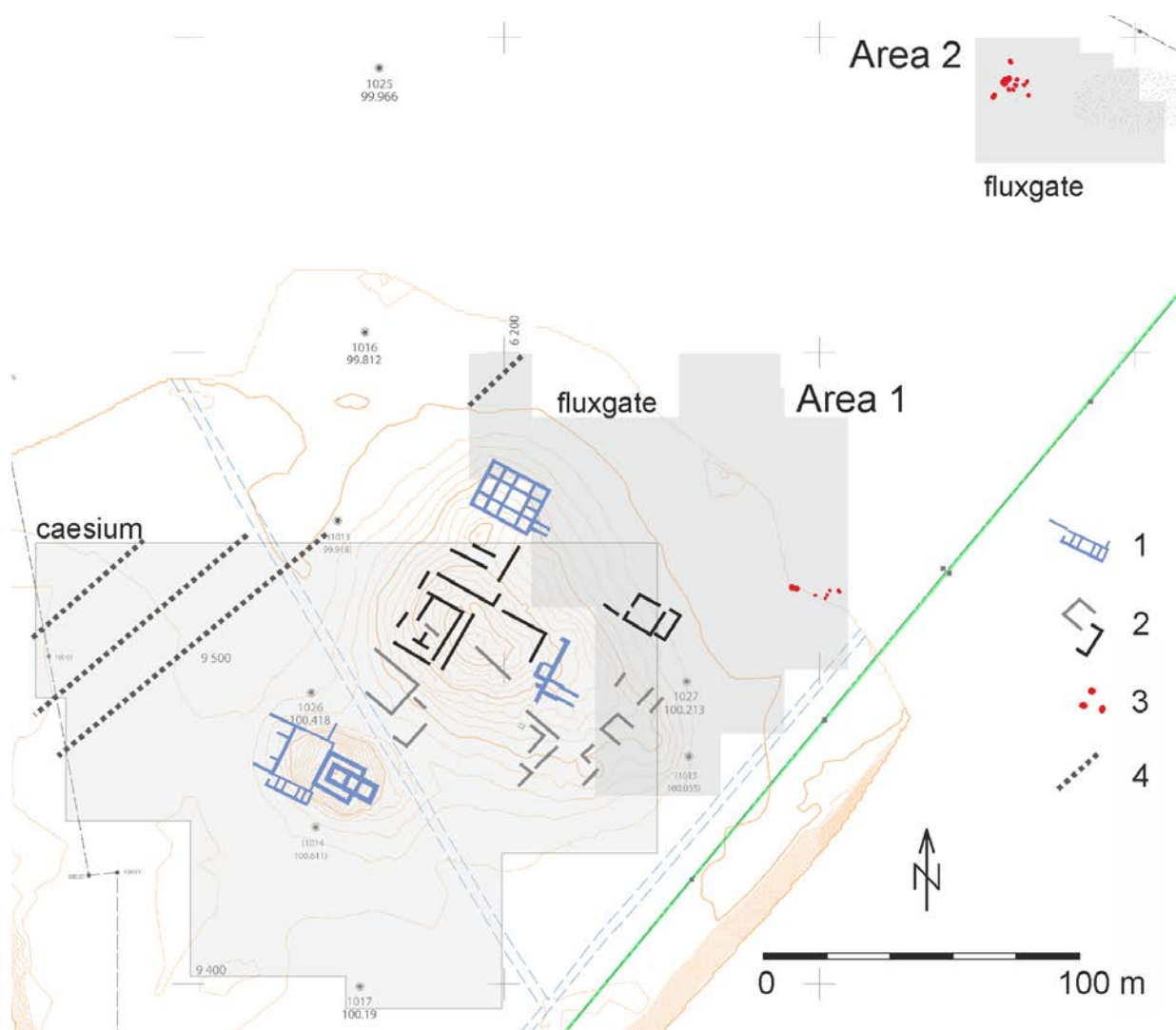


Figure 15. Damboya. Interpretation map based on result of fluxgate and caesium magnetometry. 1: Structures excavated prior to magnetic survey using fluxgate gradiometer; 2: walls (in two different greytones, appropriate for walls orientation); 3: hearths, ovens; 4: banks of paleochannels, © T. Herbich.

and supports an earlier observation that the settlement seemed to be limited to the mound but at this stage no enclosure wall has been found.

El-Hassa and Damboya are separated by a sterile plain of 1.4km with no buildings. The magnetic survey at Damboya helped understand the reason: the lack of architecture north of Damboya is caused by the presence of paleochannels, most probably active during flooding. Identical anomalies – interpreted the same way – were observed in Sonyat, Selib and Affad (Herbich and Ryndziewicz 2022). The same situation is seen at Hosh Ben Naga and Muweis, also separated by a sterile plain and a distance of around 1km (Lenoble and Sokari 2005).

The Nile River had a significant impact on the positioning of these sites on the east bank. However, no evidence of a harbour, quay or landing stage has been uncovered. The likely harbours that have been identified probably belong to Middle Kingdom fortresses, i.e., at Mirgissa and Semna, and possibly at Kerma and Jebel Barkal (Knoblauch 2019, 371; Spencer 2019, 444; Bestock 2021, 276, 279, 282; Bonnet 2021, 202-205, 224; Williams 2020, 420). For the Meroe region during the Meroitic period, the hypothesis of a port/harbour has been put forward for the site of Wad ben Naga, but no remains have been found (Onderka 2014, 86; Wolf *et al.* 2019, 741). At el-Hassa the structure, which measures at least 55m in length and 25m in width, can only be interpreted as a harbour. Using geophysical methods, a harbour basin of a similar shape and with reinforced

sides has been found – however, this was during research on an Old Kingdom funerary complex in Egypt (Herbich 2021). The lack of comparable data for contemporaneous sites in Sudan weakens our hypothesis.

Structures within the cult area around the temple of el-Hassa

The structures near the temple can be compared to the ones found at Meroe and other contemporary sites in the region: comprising a temple, chapels, palace and other official buildings (Wolf *et al.* 2019, 751). The magnetic survey at el-Hassa enables us to complete the plan of the cult buildings around the Amun temple, thanks to comparisons with the other sites of the Meroe region, with which we can assume that they are contemporary. The quadrangular structures are most probably chapels along the processional way. They were built during at least two different periods, which is consistent with the three different phases observed at the Amun temple. Nevertheless, the function of a circular structure³ inside the building is unknown, although the size of the building itself suggests an administrative building.

Workshops: pottery kilns and furnaces

The survey indicates the presence of workshops at both el-Hassa and Damboya. The survey mapped a set of industrial facilities, indicated by anomalies of a high amplitude.

We know of kilns and furnaces at Meroe, Muweis, and Hamadab, so it would not be unusual to have them at el-Hassa too, confirming its rank as a major town for craft activities during the Meroitic period. As well as surveying the site to find out what remains have been preserved and where they are located, the operation was also motivated by the desire to compare the results from el-Hassa and Muweis. Excavations at el-Hassa could be continued around the Amun temple in order to understand the economic and religious complex. This could also be achieved by comparison with the results of the survey at Muweis where the organisation of the urban complex and its cult buildings was studied.

Muweis lies at the heart of the plain of Meroe, and is part of this network of settlements established along the Nile east bank, presently located 1km from the Nile. The caesium survey carried out in 2008 revealed many structures and pottery kilns (Baud 2008a, 53-54, fig. 1; Baud 2008b, 267, fig. 49). Following the survey, kilns, religious buildings, and traces of various activities have been excavated. In the northeast of the site, pottery kilns and furnaces were found (Baud 2015; Dieudonné-Glad *et al.* 2020).

Kilns and furnaces were indicated by results of the survey; their presence was supported by metal slags found on the surface of the northern part of the site, like in Muweis. In this part of the settlement, a street has been identified that could help define the orientation and/or grid of the settlement, suggesting that these activities were planned or organised by a central authority (Wolf *et al.* 2019, 751). El-Hassa appears to have been a significant centre for craft activities, with workshops situated in close proximity to the religious complex. However, it is evident that these two activities were not necessarily contemporaneous and the craft activities were certainly situated outside of the boundaries of the religious complex. At Hamadab, pottery kilns are located to the southeast of the town and outside the enclosure walls (Wolf *et al.* 2014, 728-730). Furnaces in Meroe were located outside the enclosure walls (Humphris *et al.* 2018, fig.3; Shinnie and Bradley 1980, 75-79).

Conclusions

The season at el-Hassa and Damboya in November 2022 was the first of a new phase of research, with the aim of understanding the origins of this permanent settlement and highlighting the industrial aspects of the sites. Thanks to the magnetic survey, we now know more about el-Hassa and hope to be able to return

³ A possible parallel for the circular structure could be a similar feature found at Wad ben Naga, identified either as a silo or a cult shrine (WBN50) (Onderka 2014, 86-87; Wolf *et al.* 2019, 741). However, this structure is twice as large in diameter as the one detected at el-Hassa (see also Kom G at Dangeil (Anderson *et al.* 2022, 68-73) [ed.]).

there to continue our work on better understanding the site. It is noteworthy that despite the limitations of the magnetic method in surveying redbrick architecture, the survey has yielded new data on the site, allowing a more detailed interpretation of structures previously mapped with a caesium magnetometer. Using the survey results and comparing these with other sites of a similar nature, an image of the town of el-Hassa around the Amun temple is becoming more clear, providing the plan of the town both contemporary to the use of the temple as well as subsequent. A feature located at the back of the temple (to the west) has been interpreted as a harbour based on the magnetic image of an open area surrounded by walls and with no anomalies inside. Furthermore, the survey mapped previously missed structures related to the temple, most probably two chapels placed symmetrically on either side of the processional way leading to the temple. The measurements provided greater clarity regarding the structure erected in front of the ceremonial palace, especially its inner layout with a circular structure in its centre found near an enclosure wall. The discovery of enclosure walls gave a good idea of the boundaries of the religious complex. The enclosure wall could be dated to the same time as the temple because the entrance is on the axis of the temple and the processional way. Concerning the site extension during antiquity, it can be assumed that the northern limit of the current archaeological zone marks the extent of the Nile during the flood season. In this northern part, small size buildings with streets seem to follow an urban grid. Although the function of these structures cannot be determined, the presence of kilns and furnaces showed that there was craft production related to fire arts: metal and pottery, but there could also be faience production. A detailed mapping of these features was undertaken.

Although the site of el-Hassa-Damboya is protected by its classification as an archaeological zone and by a *zariba* and a fence, the pressure caused by the need for agricultural land is threatening the sites. Locating archaeological remains without excavation not only makes it possible to plan future research, but also proves the existence of the remains in order to safeguard them (Ryndziewicz *et al.* 2021, 114). Sometimes the magnetic maps are the only evidence of archaeological remains that have disappeared or been destroyed (Millet 2017, 6-7; Taj el Sir and Millet 2017; Millet 2019).

Using instruments of different sensitivity and applying various measuring strategies has resulted in interesting observations concerning the effectiveness of different variants of the magnetic method in surveying fired brick architecture. These observations are relevant for a whole group of Meroitic sites in Sudan, characterised by a similar geological setting and the same kind of building materials. A key observation is that on sites of this kind one needs to measure the gradient. Measurement of total magnetic field intensity is useful when determining changes of geological structure and in determining the extent of built-up areas: at el-Hassa, this established the northern limits of the site (Figure 13); at Damboya it recorded paleochannels (Figure 14). The ground-penetrating radar (GPR) method of non-invasive prospection appears to be a feasible option at sites like el-Hassa and Damboya. It was also very useful in the reconstruction of a plan of Hamadab (Ullrich and Wolf 2015) and in recording archaeological structures at Awalib/Abu Erteila (Fantusati *et al.* 2012). Its application at Old Dongola, for example, has yielded good results with regard to architecture built of different materials: stone, mud brick and red brick (Obłuski *et al.* 2022). Clearing surface vegetation at el-Hassa in preparation for the magnetic survey had the added advantage of enabling a GPR survey of most of the site. This complementary method has provided a more detailed understanding of the layout of el-Hassa and Damboya during the Meroitic period, allowing for new comparisons and understanding of these major 'urban' settlements.

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References

- Abdallatif, T. F., H. Odah, A. E. El Amam, and A. Mohsen. 2019. 'Geomagnetism explorations of the Egyptian archaeology: thirty-years of success and challenges', in G. El-Gad and M. Metwaly (eds), *Archeogeophysics. State of the Art and Case Studies*. 137-168.
- Anderson, J. R., Salah Mohamed Ahmed, Rihab Khidir el-Rasheed and Mahmoud Suliman Bashir. 2022. 'Amanitore and Natakamani at Dangeil: reconstructing the sacred landscape of the 1st century CE', in P. Onderka, V. Vrtal and J. Honzl (eds), *Studies in the Building Program of King Natakamani and Queen Amanitore*. Prague, 49-73.
- Anderson, J. R., M. Suliman Bashir and S. Mohamed Ahmed. 2018. 'Recent discoveries at Dangeil, Nile State: exploring the Amun temple complex', in M. Honegger (ed.), *Nubian Archaeology in the XXIst Century. Proceedings of the Thirteenth International Conference for Nubian Studies, Neuchâtel, 1st-6th September 2014*. Orientalia Lovanensa Analecta 273. Leuven, 407-413.
- Aspinall, A., C. Gaffney and A. Schmidt. 2008. *Magnetometry for Archaeologists*. Lanham.
- Baud, M. 2008a. 'The Meroitic royal city of Muweis: first steps into an urban settlement of riverine Upper Nubia', *Sudan & Nubia* 12, 52-63.
- Baud M. 2008b. 'Mouweis', in N. Grimal, E. Adly and A. Arnaudière (eds), 'Fouilles et travaux en Egypte et au Soudan, 2006-2008', *Orientalia* 77, 267-268.
- Baud, M. 2015. 'Trois saisons à Mouweis: premier bilan archéologique', in M. Zach (ed.), *The Kushite World. Proceedings of the 11th International Conference for Meroitic Studies, Vienna, 1 - 4 September 2008*. Beiträge zur Sudanforschung, Beiheft 9, Vienne. 97-109.
- Bestock, L. 2021. 'Egyptian fortresses and the colonization of Lower Nubia in the Middle Kingdom', in G. Emberling and B. Williams (eds), *The Oxford Handbook of Ancient Nubia*. New York, 271-288.
- Bevan, B. 1994. 'The magnetic anomaly of a brick foundation', *Archaeological Prospection* 1, 93-104.
- Bièrre, Y. 2008. *Rapport de prospection magnétique sur le site de El Hassa Soudan*. Unpublished report of the archaeological mission of el-Hassa.
- Bonnet, C. 2021. 'The cities of Kerma and Pnubs-Dokki Gel', in G. Emberling and B. Williams (eds), *The Oxford Handbook of Ancient Nubia*. New York, 201-212.
- Burckhardt, J. L. 1819. *Travels in Nubia*. London.
- Choimet, G. 2022. 'Building E at Damboya, the third and final season', *Sudan & Nubia* 26, 120-132.
- Dieudonné-Glad, N., C. Bouchaud, D. Gemehl, S. Guerin, M. Millet and A. Zazzo. 2020. 'Ironcraftmanship in Muweis, a town of the Meroe Empire: metal production and smithing', *Sudan & Nubia* 24, 212-230.
- Fantusati, E., E. Kormysheva and S. Malykh. 2012. 'GPR Survey and archaeological excavations at Abu Erteila (the Republic of Sudan)', in A. Sedov (ed.), *New Research in Archaeology and Epigraphy of South Arabia and its Neighbors. Proceedings of the "Rencontres sabeennes 15" held in Moscow, May 25th-27th, 2011*. Moscow, 165-208.
- Herbich, T. 2003. 'Archaeological geophysics in Egypt: the Polish contribution', *Archaeologia Polona* 41, 13-55.
- Herbich, T. 2019. 'Efficiency of the magnetic method in surveying desert sites in Egypt and Sudan: case studies', in R. Persico, N. Linford and S. Piro (eds), *Innovation in Near-Surface Geophysics: Instrumentation, Application, and Data Processing Methods*. Amsterdam, 195-251.
- Herbich, T. 2020. 'Geophysical research in Pelusium: on the benefits of using the resistivity profiling method' in R. E. Averbeck and K. L. Younger, Jr. (eds), *An Excellent Fortress for his Armies, a Refuge for the People: Egyptological, Archaeological and Biblical Studies in Honor of James K. Hoffmeier*. University Park, Pennsylvania, 130-144.

- Herbich, T. 2021. 'Magnetic and electrical resistivity methods in locating ancient waterways and riverine harbors in Egypt', *Archeosciences. Revue d'Archéométrie* 45(1), 235-238.
- Herbich, T. 2023. 'Fluxgate versus caesium: remarks on methodology of magnetic surveying', *Ricerche Storiche*.
- Herbich, T. and R. Ryndziejewicz. 2022. 'Polish geophysical research in Sudan/Polskie badania geofizyczne w Sudanie', in H. Paner, A. Obłuski and M. El-Tayeb (eds), *From Faras to Soba. 60 years of Sudanese-Polish cooperation in saving the heritage of Sudan/Od Faras do Soba. 60 lat współpracy polsko-sudańskiej w ratowaniu dziedzictwa Sudanu*. Warsaw, 333-350.
- Hesse, A. 1967. 'Mesures et interprétation en prospection géophysique des sites archéologiques du Nil', *Prospezioni Archeologiche* 1, 43-48.
- Humphris, J., M. F. Charlton, J. Keen, L. Sauder, and F. Alshishani. 2018. 'Iron Smelting in Sudan: experimental archaeology at the royal city of Meroe', *Journal of Field Archaeology* 43(5), 399-416. DOI: 10.1080/00934690.2018.1479085
- Knoblauch, C. 2019. 'Middle Kingdom fortresses', in D. Raue (ed.), *Handbook of Ancient Nubia*. Berlin, 377-402.
- Kuckertz, J. 2018. 'Amanakhareqerema - a Meroitic King of the 1st Century AD', *Der Antike Sudan. Mitteilungen der Sudanarchäologischen Gesellschaft zu Berlin e.v.* 29, 119-144.
- Lenoble, P. and A. Sokari. 2005. 'A forgotten Meroitic agglomeration in the region of Meroe: el-Muweis', *Sudan & Nubia* 9, 59-61.
- Maillot, M. 2020. 'The archaeological site of Damboya in the Shendi reach. First season', *Sudan & Nubia* 24, 181-189.
- Maillot, M. and S. Poudroux. 2022. 'The archaeological site of Damboya in the Shendi reach. Third season', *Sudan & Nubia* 26, 107-119.
- Millet, M. 2017. *Archaeological mission at Muweis*. Unpublished report. Shendi.
- Millet, M. 2019. *Archaeological mission at Muweis*. Unpublished report. Shendi.
- Obłuski, A., T. Herbich and R. Ryndziejewicz. 2022. 'Shedding light on the Sudanese Dark Ages. Geophysical research of Old Dongola Sudan, the capital of the Nubian kingdom of Makuria and a city-state in Funj period', *Archaeological Prospection* 29, 259-273.
- Onderka, P. 2014. 'Wad ben Naga: a history of the site', *Sudan & Nubia* 18, 83-92.
- Rilly, C. 2017. 'De l'ombre à la lumière: le roi Amanakharéqérem', in O. Cabon, V. Francigny, B. François, M. Maillot, Mohamed Musa Ibrahim, O. Nicoloso, C. Rilly and O. Rolin (eds), *Histoire et civilisations du Soudan de la Préhistoire à nos jours, Études d'égyptologie* 15, 286-291.
- Rondot, V. and D. Claustre. 2018. 'Nos premières sources sur le bélier de Soba REM 0001: le Bourguignon Pierre Trémaux, Johannes Dümichen et le Vénitien Giovanni Miani', in M. Honegger (ed.), *Nubian Archaeology in the XXIst Century. Proceedings of the Thirteenth International Conference for Nubian Studies, Neuchâtel, 1st-6th September 2014*. Orientalia Lovanensa Analecta 273. Leuven, 457-472.
- Rondot, V., G. Nogara and F. Drici. 2019. 'El-Hassa, 2000-2020', in M. Maillot (ed.), *50 ans d'archéologie française au Soudan*. Africae studies, Études d'égyptologie 22. Paris-Khartoum, 127-153.
- Rondot, V., G. Nogara, R.-P. Dissaux and F. Drici. 2022. *El-Hassa. Un Temple Sous les Sables*. Paris.
- Ryndziejewicz, R., M. Drzewiecki, Ł. Banaszek, T. Herbich and K. Kiersnowski. 2021. 'Survey of Soba (Sudan). Non-invasive approach to study the urban landscape of medieval capital of the Kingdom of Alwa', *ArcheoSciences* 45(1), 111-114 [DOI: <https://doi.org/10.4000/archeosciences.8880>].
- Shinnie, P. L. and R. J. Bradley. 1980. *The Capital of Kush 1. Meroe Excavations 1965-1972. Meroitica* 4. Berlin.
- Spencer, N. 2019. 'Settlements of the Second Intermediate Period and New Kingdom', in D. Raue (ed.), *Handbook of Ancient Nubia*. Berlin, 443-464.
- Taj el Sir, E. and M. Millet. 2017. *Muweis 2017: Survey after the Setting of Agricultural Lands on the Archaeological Site of Muweis*. Unpublished report. Shendi.
- Ullrich, B., and P. Wolf. 2015. 'Hamadab near Meroe (Sudan): results of multi-technique geophysical surveys',

Archaeologia Polona 53, 392-395.

Williams, B. B. 2020. 'The Napatan Neo-Kushite State 1: The Intermediate Period and Second Empire', in G. Emberling and B. B. Williams (eds), *The Oxford Handbook of Ancient Nubia*. New York, 411-432.

Wolf, P., U. Nowotnick and C. Hof. 2014. 'The Meroitic urban town of Hamadab in 2010', in J. R. Anderson and D. A. Welsby (eds), *The Fourth Cataract and Beyond. Proceedings of the 12th International Conference for Nubian Studies*. British Museum Publications on Egypt and Sudan 1. Leuven, 719-737.

Wolf, P., U. Nowotnick and D. N. Edwards. 2019. 'Settlement in the Meroitic kingdom', in D. Raue (ed.), *Handbook of Ancient Nubia*. Berlin, 713-782.

Wolf, P. and U. Nowotnick. 2021. 'The Meroitic heartland', in G. Emberling and B. B. Williams (eds), *The Oxford Handbook of Ancient Nubia*. New York, 518-530.

Wolf, P. 2021. 'The natural and cultural landscape of the Meroe region', in A. Obłuski, H. Paner, and M. Masojć (eds), *Bayuda and its Neighbours*. Nubia 1. Turnhout, 117-152.