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Magnetometer prospecting at Assur, 2023

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Fig. C1.2: Screenshot of the 3D model of the ziggurat of Assur created by Jens Rohde.

instead of excavation.⁴⁶ This has been the result of both the technical and scientific development of archaeological geophysics, as well as the wide acceptance of the method among archaeologists.⁴⁷ The resumption of fieldwork at Assur by a team headed by Karen Radner (LMU Munich) and F. Janoscha Kreppner (University of Münster) offered the chance to apply once again geophysical methods at Assur.

The ancient city of Assur plays a crucial role in the field of archaeological geophysics in Iraq as it offers the possibility of large-scale magnetometer prospecting. The very first archaeo-geophysical measurements in Iraq were carried out already in the 1960s. From 1969 to 1972, Guisepe Ratti and his colleagues Roberto Pra-

After taking these measurements, we mapped the New Town by drone photography. For that purpose, we placed temporary markers on the ground and measured them using the dGPS. Subsequently, we made three drone flights, flying at a height of about 40 m over the surface, at a velocity of about 5 m/s. The drone employed is a DJI Mavic 3 Pro drone owned by LMU Munich's History Department. The drone photos were then processed using the software package Agisoft Metashape to create orthophotos, Digital Elevation Models (DEM) and 3D models of the target area.

At a later stage, a 3D model of the ziggurat was created at the request of the Sherqat SBAH office (**Fig. C1.2**).

C2. Geophysical prospecting in Assur, 2023⁴⁴

C2.1 Magnetometer prospecting at Assur, 2023

Jörg Fassbinder, Jean-Jacques Herr, Marco Wolf & Lena Ruider

In recent years, magnetometer prospecting, which was for the first time applied in 1956 in England by Martin Aitken and John Belshé,⁴⁵ has developed into a very powerful tool to map large archaeological sites in detail before or even

to and Giorgio Mortinotti measured both magnetic and resistivity profiles on selected areas in Seleucia, situated in central Iraq not far from Baghdad, in order to detect ancient canals, kilns and fireplaces on the site. The team conducted four prospecting campaigns in Seleucia, with some additional work also undertaken in Hatra in northern Iraq, for a total duration of 7 months. For their magnetic measurements, they applied a proton magnetometer (Elsco type 592/N) with a sensitivity of 1 nanotesla and a measurement frequency of 6 seconds per point.⁴⁸ Although they claim to have performed geophysical mapping, the published works present solely magnetic profile measurements instead of contour maps.⁴⁹ Besides magnetic measurements, the same team also conducted electric resistivity measurements in Hatra, but due to the dry conditions during the summer, these were not successful.

It was Barthel Hrouda, then professor of Near Eastern Archaeology at LMU Munich, who undertook pioneering efforts to introduce and apply geophysical methods in the Middle East when he invited Helmut Becker to perform archaeomagnetic dating on samples from Isin in southern

⁴⁴ This chapter was language-edited by Karen Radner.

⁴⁵ Belshé 1957; Aitken 1958; 1961.

⁴⁶ Fassbinder 2023.

⁴⁷ Stone 2023.

⁴⁸ Ralph 1964.

⁴⁹ Ratti 1971; Lanza/Manzini/Ratti 1972. For the still severely restricted image processing and display of data of that time see Scollar/Krückeberg 1966.

Iraq in 1976.⁵⁰ Because of the Iran-Iraq War (1978-1988), it took another 13 years before Hrouda was able to organise a first magnetometer prospection. Meanwhile, the method for a “large scale” magnetometer survey had been developed and automated by Becker and myself at the Bayerisches Landesamt für Denkmalpflege (BLfD) in Munich. In 1989, this method was applied for the first time to an archaeological site in Iraq, namely Assur.

None of the archaeological work undertaken at Assur since 1989 involved or applied geophysical measurements. The resumption of fieldwork in 2023 offered Jörg Fassbinder the chance to return to Assur to continue the large-scale magnetometer survey on the site as well as introduce additional geophysical methods to the site.

C2.1.1 The data of the 1989 magnetometer survey at Assur

The first magnetometer survey in Assur was undertaken in April 1989 with a caesium magnetometer Scitrex/Varian CS-V101 in a so-called “variometer” configuration.⁵¹ One survey probe was carried ca. 30 cm above the ground while the second magnetometer probe served as a basis for the removal and corrections of diurnal variations and other secondary variable disturbances coming from technical installations located near the survey area. In a measuring grid of 20 × 20 m with a profile spacing of 50 cm, we obtained 1600 measured values (Fig. C2.1). The frequency of magnetic data collection with the new caesium-magnetometer Scintrex/Varian CS-V101 was 10 times



Fig. C2.1: Magnetometer prospecting in Assur in April 1989, with Jörg Fassbinder operating the handheld caesium magnetometer (Varian 101) in the so-called “variometer” configuration. Photo by Manfred Stephani.

⁵⁰ These samples remain untouched and are kept in the geophysics storage of LMU Munich’s Department of Earth and Environmental Sciences.

⁵¹ Becker 1991.

per second with a sensitivity of 0.1 Nanotesla. We used our newly developed semi-automatic data storage system on a handheld Epson HX-20 computer with a mini-tape recorder, then commonly used by dictation machines. In less than three weeks, we were able to survey an area of 2 hectares in the main part of the city of Assur, with a spatial resolution of 50 × 50 cm.

Once back in the Munich laboratory, we transmitted the data to an IBM DEC computer for further processing and visualisation of the data as a magnetogram image. Hardcopies from the magnetogram were produced by taking photographs of the computer screen.

The data was archived at the Bayerisches Landesamt für Denkmalpflege on an IBM DEC computer and magnetic tapes readable by the Epson HX-20 handheld computer. In 1996-97, in the course of routine maintenance for all data produced by the geophysical team led by Helmut Becker and Jörg Fassbinder, these old recordings were transferred to a PC running on Microsoft Windows NT and transformed into files readable by PCs with DOS and Windows operating systems. This also included the material for Assur. In 2015, the original data from 1989 was recovered by applying old programs, reprocessing and displaying them by using up-to-date visualisation programs (i.e., Geoscan, Geoplot 4 and Golden Software Surfer) in order to present these measurements as high-resolution magnetogram images.

In 2023, the 1989 data set was merged with the new data of 2023, without further processing. The magnetic anomalies can now be displayed and visualised using the same dynamics (Fig. C2.2).

C2.1.2 Resuming magnetometer prospecting at Assur in 2023

The city of Assur is situated on the western bank of the Tigris. The city lies on a slight elevation ca. 10 m above the average water level above the river. Fortification walls enclose the city, which are still preserved to a height of c. 10 m in many parts. Inside lies an area covering ca. 1.5 square kilometres, extending 2000 m in the north-south direction and between 500 and 700 m in the east-west direction.

Walter Andrae investigated this large area by digging a series of parallel excavation trenches across the entire city in east-west direction. On the one hand, these and other, more recent excavation trenches and the big heaps of excavated soil create an uneven and irregular surface. On the one hand, this situation impedes the creation of a complete magnetogram. On the other hand, conducting multi-channel magnetometry with a wheeled device

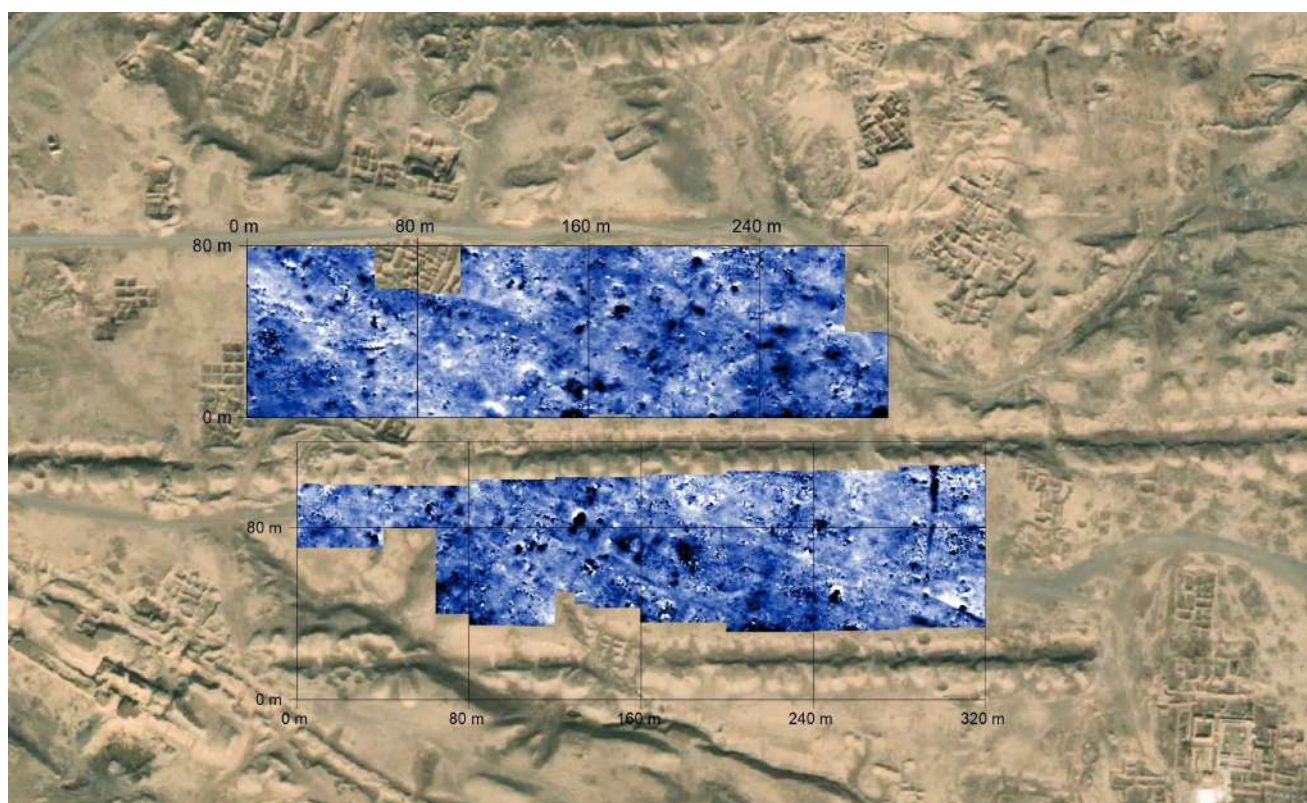


Fig. C2.2: Magnetometer measurements of the survey areas Ass23b and Ass89a taken in the “Mittlere Unterstadt” of Assur (Fassbinder/Becker/Wolf/Herr). In 1989, the caesium Scintrex/Varian CS-101 magnetometer was applied in a single sensor variometer configuration, with a sensitivity of ± 0.10 nanotesla, using a sampling density of 50×50 cm; dynamics ± 30 nanotesla in 256 grey scales. In 2023, the caesium total field magnetometer Geometrics G-858-special was applied in duo-sensor configuration, with a sensitivity ± 10 picotesla, using a sampling density of 25×50 cm; dynamics in 256 grey scales; 40 m grid; total Earth’s magnetic field at Assur (02/2023): 46.180 ± 30 nanotesla.

is utterly impossible, and the same applies to geophysical drone prospecting.⁵² The only option is therefore to use the handheld magnetometer and to produce a mosaic of magnetograms across the entire city wherever the terrain permits it.

The new geophysical survey in Assur aims to obtain an archaeological overview of the organisation and design of the city and to support the renewed excavations in the New Town. From a large variety of potential survey methods, we chose the magnetometer prospecting method. Magnetometry is a “passive” method that measures the latent existing Earth’s magnetic field. “Active” methods, namely radar and resistivity prospecting, are suitable for detecting stone buildings, but the application of these methods is time-consuming and requires suitable ground conditions, both topographically and geochemically. The delimiting boundary conditions at Assur are twofold. Firstly, we are dealing with sandy clay soils, which can dampen the penetration of the radar waves. Secondly,

the rough and uneven topography of the site renders a high-resolution radar survey impossible. Resistivity prospecting, on the other hand, is not only the most time-consuming prospecting method but its results might also be limited by the poor conductivity of the almost entirely dry, sandy topsoil layers at Assur. These theoretical assumptions, however, should be tested on selected areas in the future.

Therefore, at this stage of the project, magnetometer prospecting remains the most suitable method for a large-scale and high-resolution prospecting. The already-mentioned poor terrain conditions at Assur, however, pose a great challenge. Parts of the area are partly inaccessible due to the presence of deep trenches left by previous excavations, and other parts are covered by heaps of excavated soil and/or stones to a height of up to 3-4 m. These conditions require magnetometer equipment and a special configuration that tolerates tilting the instrument and does not require keeping precisely the same distance to the ground.

In order to reach the highest possible sensitivity combined with a maximum speed of prospecting and merge

⁵² Stele *et al.* 2023.



Fig. C2.3: Magnetometer prospecting in Assur in February 2023, with Jean-Jacques Herr operating the handheld duo-sensor caesium magnetometer. Photo by Jörg Fassbinder.

the new data with the 1989 measurements, we adapted and modified our caesium total field magnetometer (Geometrics G-858). We applied both sensors not as vertical gradiometers but in the so-called “duo-sensor” configuration. In this configuration, we mount the probes parallel to each other on a wooden frame and carry them in zigzag mode c. 30 +/- 10 cm above the ground (**Fig. C2.3**). The profiles of our 40 × 40 m grid were oriented east-west to minimise technical disturbance and interactions of the magnetometer probes with the electronic parts and the batteries of the device. The great advantages of this configuration have been described in greater detail in many previous publications.⁵³ In short, in comparison to fluxgate or other gradiometer measurements, the resulting data of the “duo-sensor” configuration provide us with higher magnetic intensity, hence more information on the buried features and more so on deeper parts of the archaeological layers and structures.⁵⁴ Compared to other methods, the interpretation of magnetic data is very complex and often does not provide clear results.

Therefore, in order to interpret the results obtained from Assur, we applied a combined interpretation using:

1. the intensity of the magnetic anomaly (based on magnetic properties);
2. the “magnetic shape” of the feature (based on archaeological science);
3. the direction and intensity of the remanent magnetisation of the feature;
4. the induced magnetisation of building materials (based on in situ measured volume magnetic susceptibility);
5. the morphological analyses of the topography of the site (based on ground observations and assessment of the orthophotos and the DEMs provided by the drone).

Points 1, 3, and 4 are based on the theoretical background of applied geophysics and rock magnetism. Supplementary susceptibility measurements allow us, for example, to assign positive and negative anomalies to the same archaeological structure (**Fig. C2.4**). In situ magnetic susceptibility measurements carried out on the site include measurements on rocks used for buildings, on topsoil and as well on baked bricks we found in the survey area (**Fig. C2.5**).

The intensity of the magnetic anomalies in Assur has a similar range to those of other archaeological sites in Iraq, including the Dinka Settlement Complex in the Kurdish Region of Iraq, Khorsabad (ancient Dur-Sharrukin) in northern Iraq, and Uruk, Fara, and Isin in southern Iraq. Interestingly, this seems to be independent of the very different geological conditions present in the different parts of the country. The alluvial sediment of the Tigris characterises the sites located in northern Iraq, while in the south, the Euphrates sediments dominate.⁵⁵

C2.1.3 First results of the 2023 magnetometer prospecting in the New Town of Assur

The total Earth’s magnetic field in Assur in February 2023 ranged around $46,177.5 \pm 17.1$ nanotesla. The magnetogram images generally are dominated by rather strong magnetic anomalies in the range of +/- 25-30 nanotesla.

The first impression of the magnetogram of the entire area, processed as total field measurement without filter, reveals large differences in the magnetic intensity of the topsoil. Dark areas of high magnetic background indicate high activity, which is due to the use of fire and the contamination with magnetic minerals in the topsoil. Areas with lighter colours were found in the southwestern part of the New Town, but partly also between some city quarters and in the northwestern part of our survey area.

It has emerged that Assur’s uneven topography plays a major role in the shape of the anomalies and that it is reflected disproportionately in our results. The old trenches excavated by Walter Andrae, which have left deep linear depressions across the site, show up as negative anomalies, while the small earth mounds left by subsequent archaeological excavations generate height magnetic anomalies and can easily lead to misinterpretation. Consequently, apart from a few exceptions, these anomalies cannot be assessed and interpreted without a precise consideration of the topography. Caution is also advised when interpreting fireplaces. Ideally, this type of feature can only be

⁵³ Fassbinder/Așandulesei 2016; Fassbinder 2023.

⁵⁴ Linford et al. 2007; Mathé/Lévêque/Druez 2019; Hahn et al. 2022.

⁵⁵ Hahn et al. 2022.

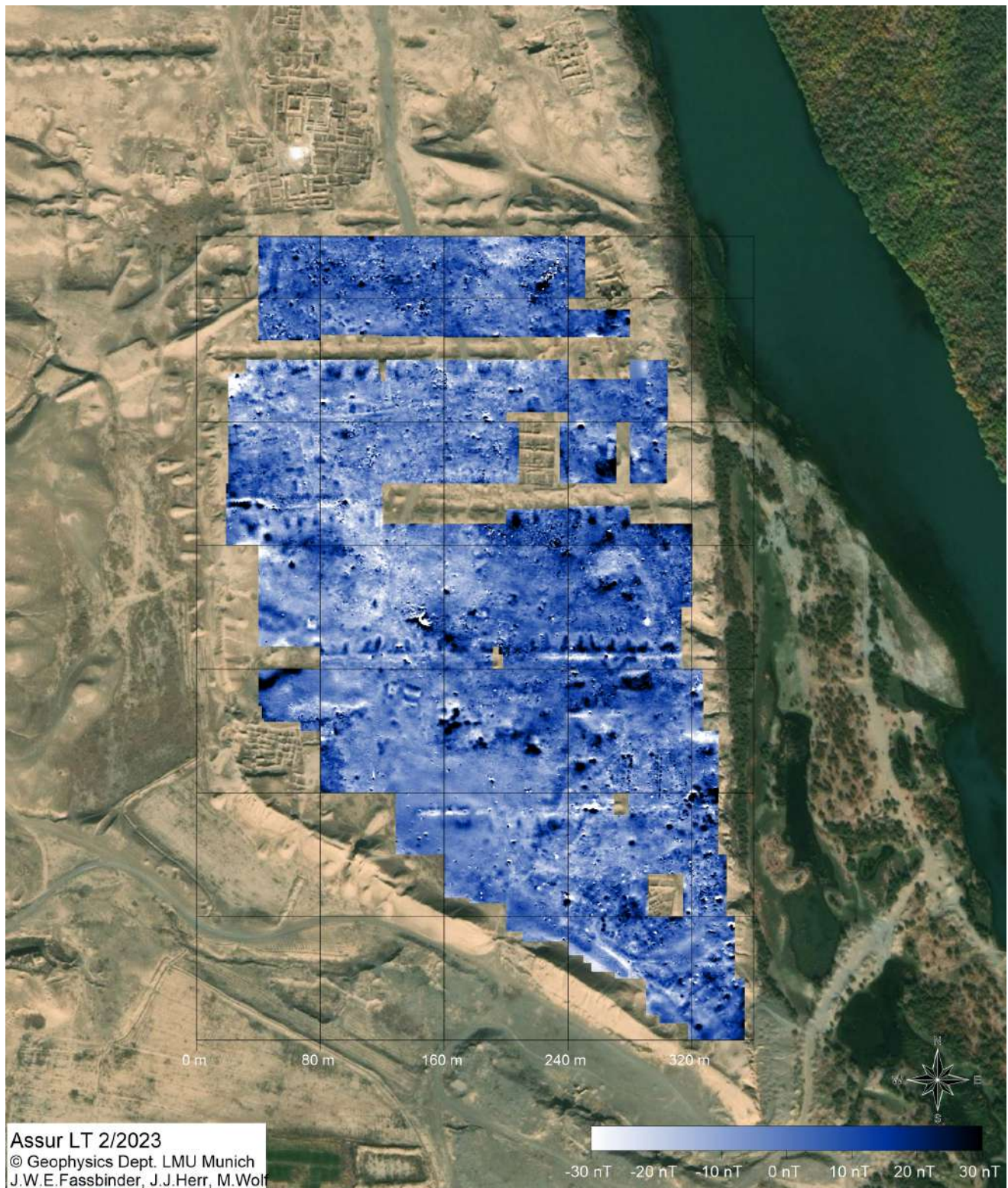


Fig. C2.4: Magnetometer measurement of the survey area Ass23a (520 × 320 m) in the New Town of Assur. Caesium total field magnetometer Geometrics G 858-special in duo-sensor configuration, with a sensitivity of ± 10 picotesla, using a sampling density of 25×50 cm, interpolated to 25×25 cm. Total Earth's magnetic field at Assur 02/2023: $46,177.5 \pm 17.1$ nanotesla, standard deviation.



Fig. C2.5: Magnetic volume susceptibility measurements taken *in situ* in Assur with a handheld Kappa-meter SM30 (Zh-Instruments). Clockwise from top left: Gypsum rocks (diamagnetic, with “negative” kappa value), limestone, topsoil and baked bricks.

distinguished by the metal scrap that occurs in modern barbecue fires but never inside ancient kilns. Furthermore, magnetic anomalies from sundried mudbrick walls can be both positive and negative and in the worst case, traces fade out without contrast into the adjacent soil.⁵⁶

While we had to exclude a wide band of 25 m because of disturbances due to the presence of rubble and litter, especially tin cans and other modern deposits, the interpretation of the new magnetogram of the New Town of Assur indicates the possible presence of c. 180 buildings and more than 101 pyrotechnological installations (kilns) and yielded clear evidence for the magnetic traces of a lightning strike in the centre of our survey area (**Fig. C2.4**). We identified c. 41,000 m² of built-up area within the 150,000 m² of measured area (**Fig. C2.6**).

However, we must stress that Walter Andrae’s excavations in the area of the Parthian Palace demonstrated that the “Parthian” occupation levels can reach a depth of 4 metres, and low-lying occupation levels assigned to that period were identified in the New Town in Andrae’s search trenches 11I to 14I.⁵⁷ As magnetometer prospecting reaches depths of 1–2 m below the surface most if not all structures identified in the magnetogram should belong to this later occupation of the New Town.

In the following, we present our preliminary interpretations. We have limited ourselves to marking the ground maps and orientation of building complexes, while kilns can be easily identified by their high magnetic intensity

and remanent magnetisation. At this time, we chose to refrain from going into further detail as we intend to interpret the data once all accessible areas have been surveyed and the various geophysical measurements completed.

C2.1.3.1 The urban layout of the New Town of Assur

As already observed by Walter Andrae and Heinrich Lenzen, some composite walls built up with gypsum fragments and baked brick fragments are visible directly at the surface of the site; this helped them to reconstruct the urban layout and the road network of the northern part of the New Town, to the south of the so-called Parthian Palace.⁵⁸ The new magnetometer results confirm the presence of certain linear structures that Andrae and Lenzen had identified as streets.⁵⁹ The magnetogram shows the street to the south of the Parthian Palace that they designated as “Ost-West Strasse 11X,” with a width of 3.1 m,⁶⁰ and also the “Ost-West Strasse 12V 13I,” with a width of 3.1 m;⁶¹ in the western part of the New Town, a 4–5 m large northern section of the “Nord-Süd Strasse I” is visible; and to the east, we identified remains of that same street.

Based on the local road networks, the New Town can be divided into two areas of similar size. The northern

⁵⁶ Fassbinder 2017.

⁵⁷ Miglus 1996, plans 155b–156c.

⁵⁸ Andrae/Lenzen 1933, 55.

⁵⁹ Andrae/Lenzen 1933, pl. 2.

⁶⁰ Andrae/Lenzen 1933, 56.

⁶¹ Andrae/Lenzen 1933, 56.

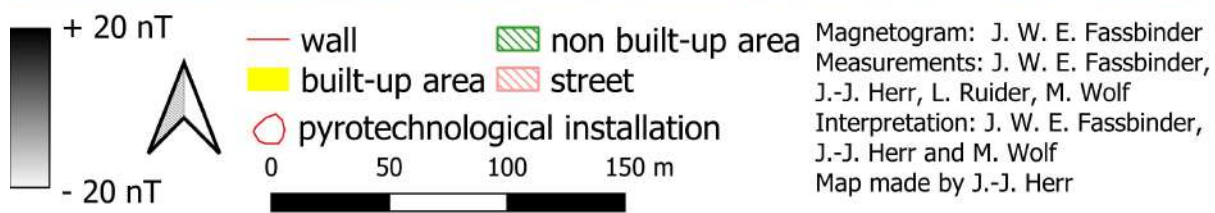
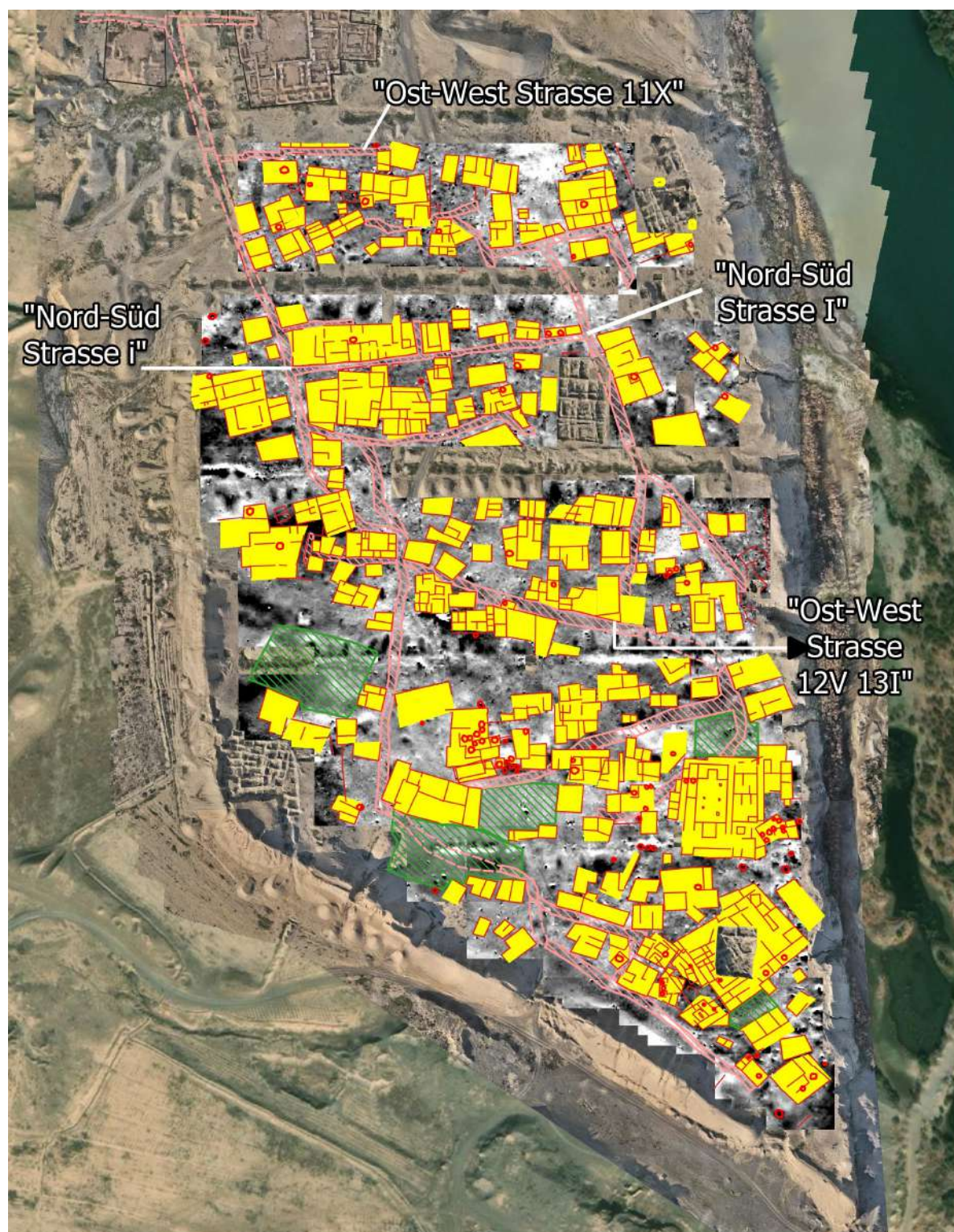


Fig. C2.6: Preliminary interpretation of the magnetic anomalies observed in the New Town of Assur.

half consists of an area of circa 7.2 ha that is structured by two parallel streets running north-south, with three perpendicular east-west-oriented streets. This northern part of the New Town can be divided into five districts (**Fig. C2.7**). Three districts are located at the centre and present as a densely built-up area, accessible from the east and the west by two north-south-oriented streets. A fourth district, occupied by relatively large buildings, is located along the western city wall. A fifth district is situated next to the Tigris, east of Andrae and Lenzen's "Nord-Süd Strasse I"; the presence of several modern disturbances allows the identification of only a few buildings in the magnetogram.

The southern half of the New Town takes up an area of 6.4 ha, reaching from "Ost-West Strasse 12V 131" to the city wall. It is delimited in the east by hills that slope down westwards to a depression where water accumulates during the rainy season. In February 2023, bushes and grass sprouted here, which we had to remove during our survey to take the magnetometer measurements. In the New Town's southern half, the main streets follow the city wall to the south and a street that is oriented from northeast to southwest runs throughout the settled area.

This southern part of the New Town can be divided into four districts (**Fig. C2.8**). South of the "Ost-West Strasse 12V 131" lies the first district, an area of triangular shape that is marked in the southwest, downhill, by a complex with at least 19 pyrotechnological installations. This might indicate an area specialised in firing activities such as pottery kilns or metallurgy. The second district lies in the eastern part of the New Town's southern half and is occupied by a 2,782 m² large building complex. Its layout is comparable to that of the Parthian Palace, although this structure is twice the size. It seems that this building had a significant impact on the New Town's layout because the two north-south streets converge towards it. A third district with a large built-up area of 2,643 m² lies on an elevation in the southwest, and this is where the excavations of the State Board of Antiquities and Heritage (SBAH) of 2002 and the new work of 2023 (Trench NT1 2023: **§D2**) took place; the walls identified there are perhaps associated with different levels of occupation and/or a compact settled area. Finally, a fourth district lies on the elevation situated within the southwestern corner of the city wall, south of an area that seems not to have been developed. About a third of this area was excavated by SBAH in 1979-80, exposing a substantial building from the Neo-Assyrian period; the stone-footed walls of several rooms are still visible in the old trenches. The open area to its north is situated next to a badly preserved section of the wall; in the future, we want to test the hypothesis of whether a gateway led through the wall in this location.

C2.1.3.2 Some glimpses into the architecture of the New Town

Most of the built-up areas observed in the various districts take up between 100 and 250 m². For comparison, "Haus Y" and "Haus X", which Andrae excavated and dated to the Late Parthian period ("spätparthisch"), occupy areas of 380 m² and 345 m², respectively, and the largest house of that period ("Grosses Wohnhaus westlich des Palastes in h10"⁶²) an impressive 991 m². Still, the Parthian Palace, which is an older construction ("altparthisch"), is much larger and takes up an area of 4,656 m².⁶³ Based on the fact that many of the excavated Parthian-period houses command an impressive size we assume that at least some of the built-up areas represented in yellow in the annotated magnetogram (**Figs. C2.6-8**) are single buildings. In one case, it is possible to discern a rectangular building complex with a large rectangular space in the centre and rows of rooms on its eastern, western and southern sides (**Figs. C2.9a-b**). This layout is similar to that of the aforementioned "Grosses Wohnhaus", which has a central courtyard opening northwards to the adjoining street. The courtyard gives access to the eastern, western and southern wings of rooms.

As we already stressed above (**§C2.1.3.1**), the large building complex of 2,782 m² (**Figs. C2.10a-c**) identified in the second district of the southern half of the New Town, next to the Tigris, shares several features of its layout with the Parthian Palace. This tripartite complex lies south of an open area and at the southeastern end of the "Ost-West Strasse 12V 131". Its thick walls are 1.8 m wide and seem to be built with stones and fragments of baked bricks, parts of which are still visible on the site surface. The building's westernmost part features a rectangular area measuring 23 m in north-south orientation and 16 m in east-west orientation. Both at its northern and southern sides, this central area seems to open towards a square room, which would parallel the north and south iwans of the Parthian Palace. The rectangular area's longer sides are lined by what may be column bases, placed at a distance of about 3 m from the walls. West of this large central area, we identified several small rectangular rooms. To its east, at the centre of the complex, there are four rectangular suites with several rooms. To the northeast, a series of rooms seems to be organised around a square space, which might parallel the peristyle of the Parthian Palace. Due to the great structural similarities, we tentatively consider this complex a "Secondary Parthian Palace".

⁶² Andrae/Lenzen 1933, pls. 7-8.

⁶³ Andrae/Lenzen 1933, pl. 1.

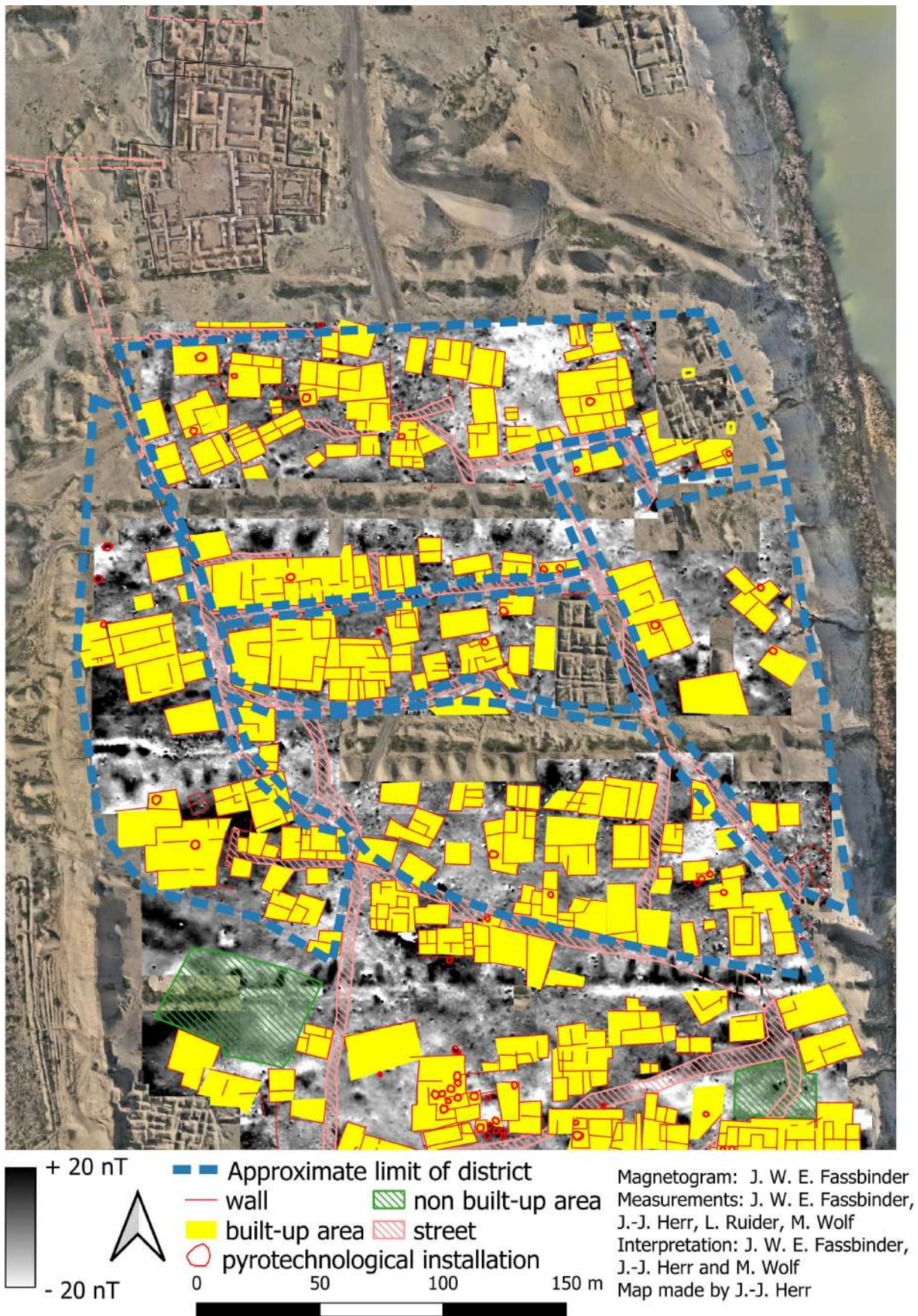


Fig. C2.7: The districts of the New Town's northern half.

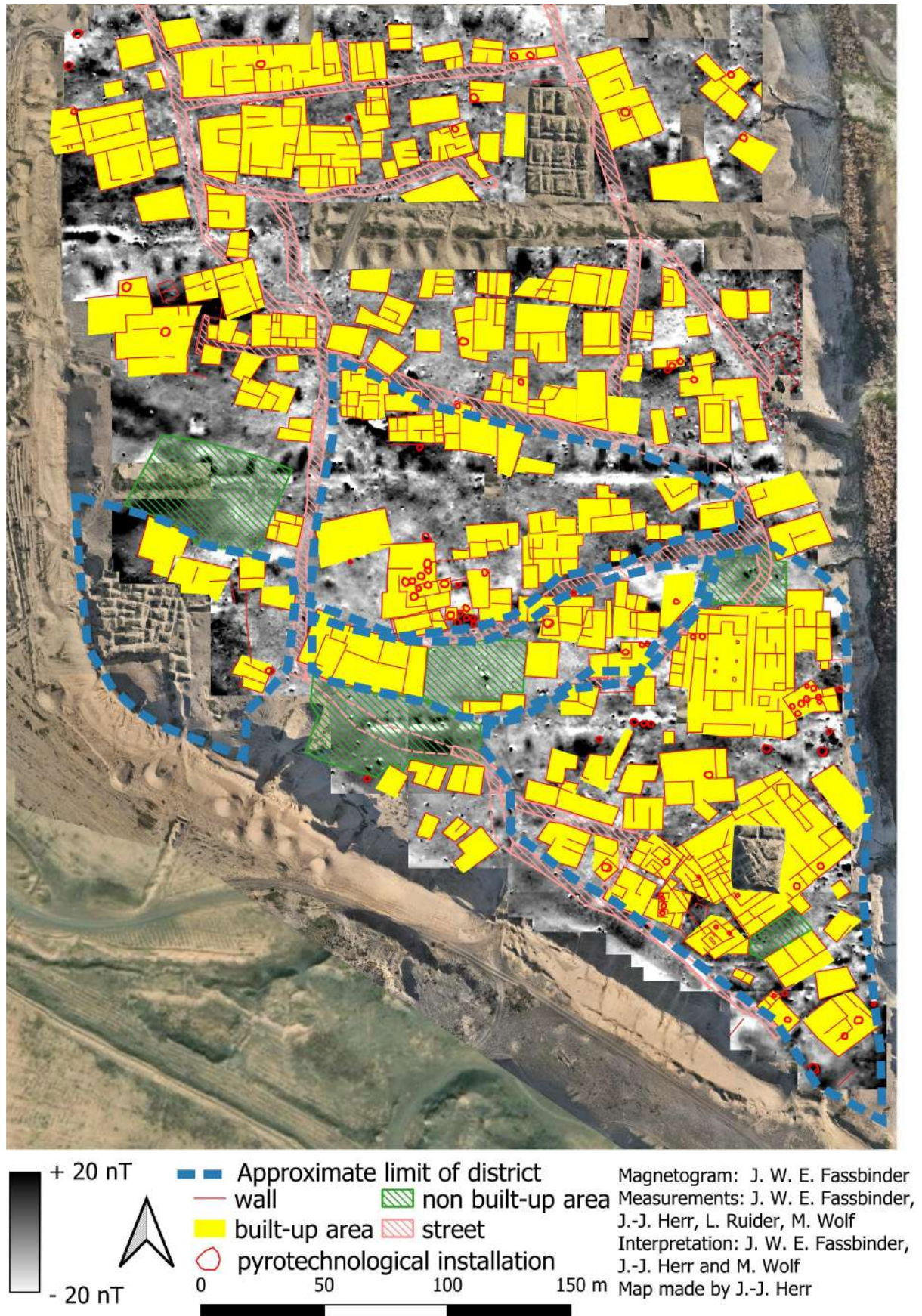


Fig. C2.8: The districts of the New Town's southern half.

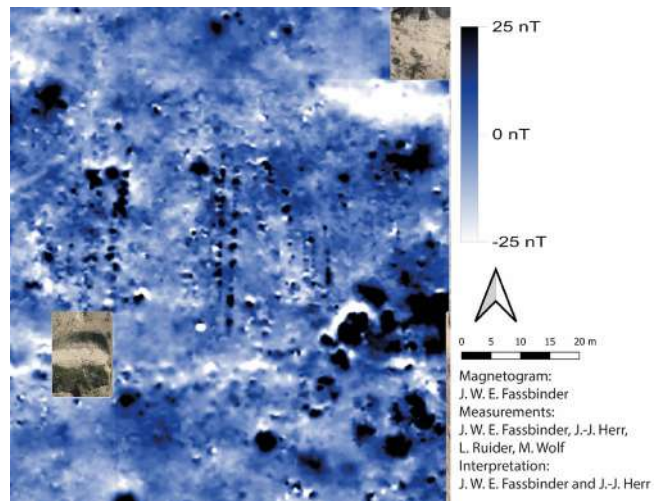
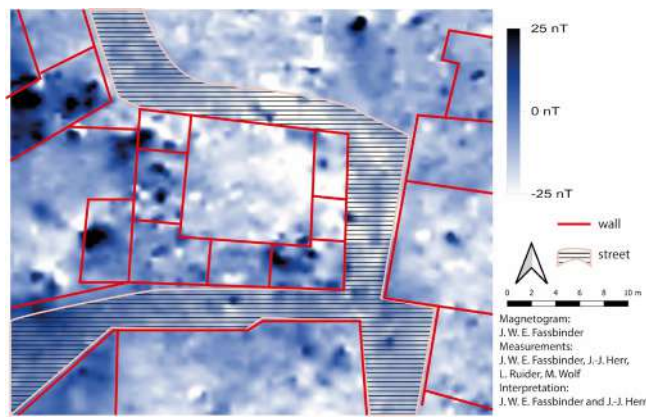
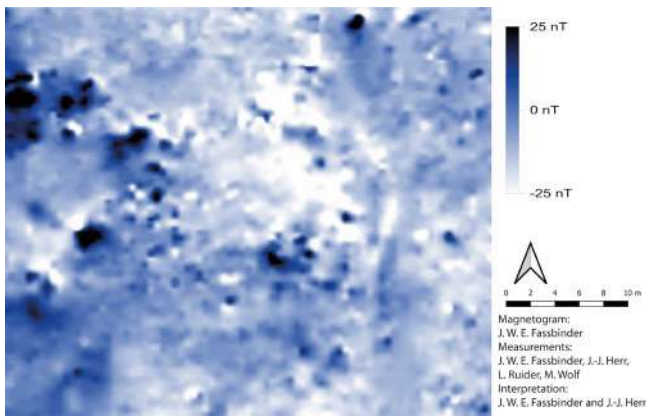


Fig. C2.9: A building with three wings of rooms around a central courtyard: a) magnetogram; b) interpretation.

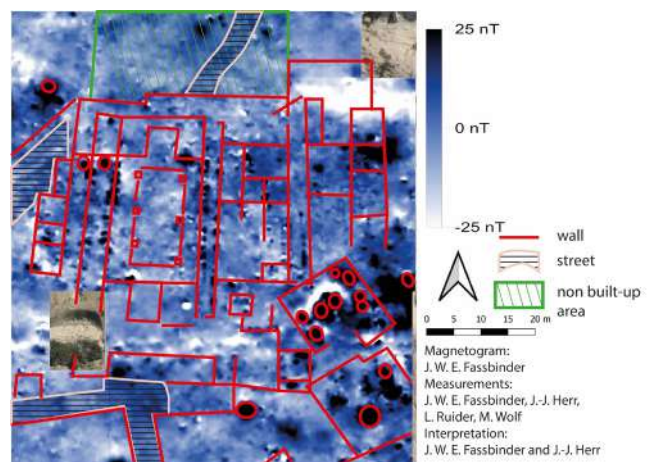
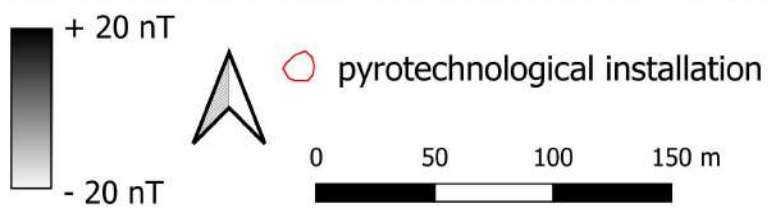


Fig. C2.10: Large residence building, comparable to the so-called “Parthian Palace”: a) orthophoto; b) magnetogram; c) interpretation.



Magnetogram: J. W. E. Fassbinder
 Measurements: J. W. E. Fassbinder, J.-J. Herr, L. Ruider, M. Wolf
 Interpretation: J. W. E. Fassbinder, J.-J. Herr and M. Wolf
 Map made by J.-J. Herr

Fig. C2.11: Pyrotechnological installations in red, battery kilns in white.

C2.1.3.3 Thoughts on the pyrotechnological installation

The analysis of the magnetogram revealed 101 pyrotechnological installations that are evenly distributed across the New Town of Assur (Fig. C2.11). The majority of the pretechnological installations have been identified within a built-up area or a building complex; only rarely are they situated in an open area. The installations are either in the centre of a building unit, most likely inside a courtyard, or in a location at the edge of a building unit. During the SBAH excavations of 2002 in what we have described as the third district in the southern half of the New Town (§C2.1.3.1), two two-chambered pottery kilns, with a vaulted firing box and preserved grate (Figs. C2.12 and



Fig. C2.12: Remains of a two-chamber pottery kiln with preserved grate. Photo by Jean-Jacques Herr.

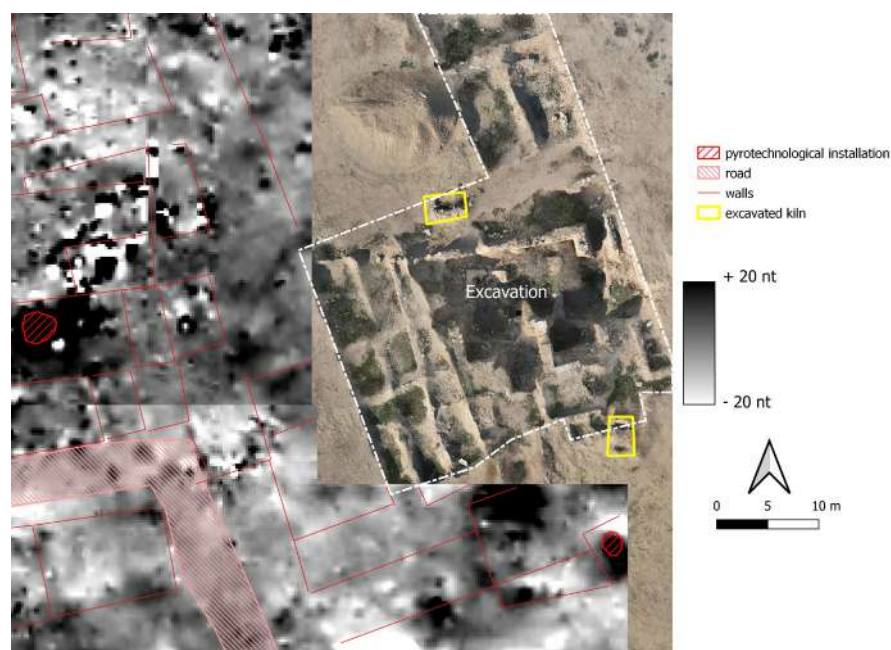


Fig. C2.13: Excavated kilns (in yellow) next to the SBAH excavation, possibly of Parthian date.

C2.13) illustrate how at least some of these pyrotechnical installations looked like.

In addition, there are two clear clusterings of pyrotechnical installations: the first to the west of our “Secondary Parthian Palace” (§C2.1.3.1), and the second to the east of it. This distribution suggests a battery-like kiln structure and might hint at an industrial workshop economy of production, either for pottery production or for metallurgy.

C2.1.4 Conclusions

Compared to other sites worldwide, the range of magnetic anomalies measured in Iraq, by now in more than 20 archaeological sites, is quite high. At Assur, too, archaeological features show up in the range of ± 30 nanotesla.

For the interpretation of the data, the total field caesium magnetometer has the marked advantage that it not only allows us to discern zones and areas of high activity but that the direction of remanent magnetization also enables us to differentiate between old and new structures. The orientation of areas with higher magnetization and linear anomalies that are aligned in parallel or orthogonal directions allow us to distinguish different building complexes and districts within the larger settlement. Another important aspect of a total field caesium magnetometer survey is the possibility of locating and providing clear evidence of “empty spaces”, i.e. areas that show no or almost no traces of buildings or accumulation of magnetic iron oxides.

However, unlike the magnetic measurements in the Dinka Settlement Complex in the Peshdar Plain in the Kurdish Autonomous Region of Iraq or in Uruk in southern Iraq, the results of the measurements from Assur are rather diffuse and complicated to interpret. Moreover, modern iron-containing waste is frequently left by visitors to this UNESCO-listed World Heritage site, and this heavily contaminates the area. The previous measurements taken in April 1989, which had yielded comparatively poor interpretation results, had made it clear in advance that the interpretation of the magnetic measurements would greatly benefit from the application of additional geophysical methods such as soil and mineral

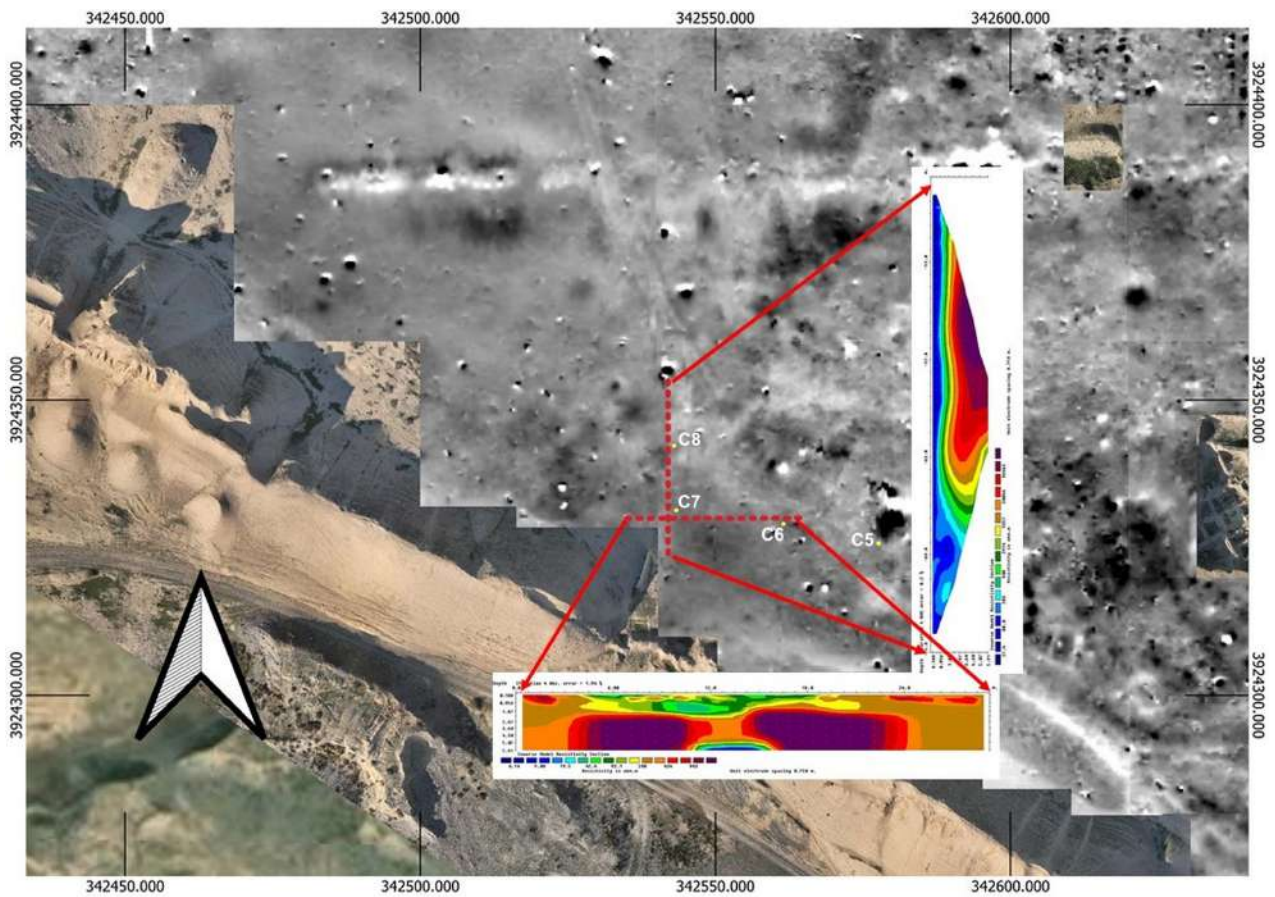


Fig. C2.14: New Town of Assur, ERT Profiles 2 and 3 (dipole-dipole): 30 m profiles cross sections and their location in relation to the magnetogram. Probe separation 0.75 m. Measured in dipole-dipole constellation. Note also the location of the cores C5-C8 (see §C3). Created by Jörg Fassbinder.

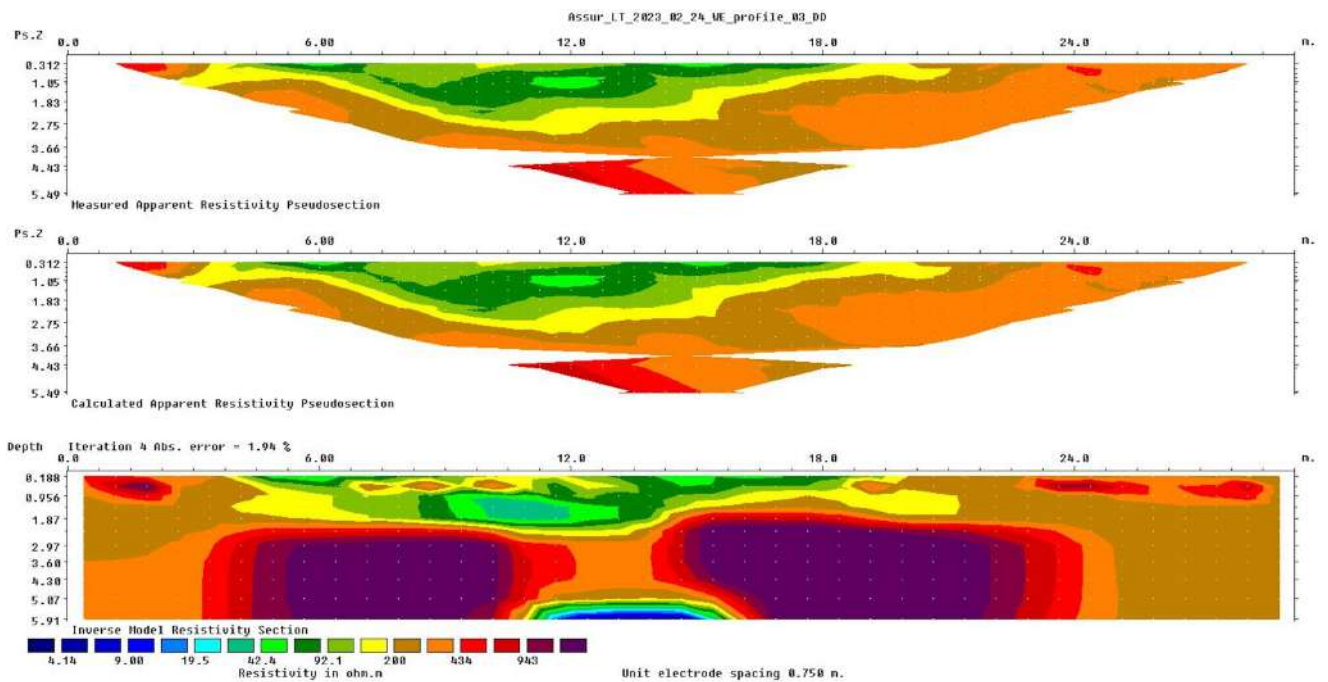


Fig. C2.15: New Town of Assur, ERT Profile 3 (dipole-dipole): 30 m profile across a building. Probe separation 0.75 m. Measured in dipole-dipole constellation. Created by Jörg Fassbinder.

magnetic analysis (§C4) and electrical resistivity tomography (ERT; §C2.2).

Beyond that, as the previous sections have demonstrated, the comprehensive interpretation of the data requires input not only from geophysicists but also from specialists with a comprehensive knowledge of relevant architectural layouts and ground plans. The mixed team working together in Assur in 2023 was ideally suited to tackle the difficulties presented by the site.

C2.2 Electrical Resistivity Tomography (ERT) prospecting in the New Town of Assur, 2023

Jörg Fassbinder & Marco Wolf

The first-ever electrical resistivity tomography (ERT) prospecting undertaken at Assur in February 2023 was a proof-of-concept campaign, designed to test the site's suitability for the method. We applied the ERT equipment model 4Point light 10W, manufactured by E. Lippmann.⁶⁴ The resulting measurements of ERT profiles allow us to distinguish different soil layers beneath the surface and to estimate the depths of these layers. We selected a probe spacing of 75 cm, which allows a penetration depth of up to 5 m. Judging from the excavated areas in the New Town, this depth should allow us to reach the undisturbed virgin soil and enable us to distinguish between different layers of occupation, at the very minimum represented by the earlier Assyrian and the later Parthian-period settlement identified by Andrae's work and later excavations.

In this first test campaign, we measured two profiles of a length of 3 m each: the first from west to east and the second perpendicular from north to south across a possible road in the lowest-lying area of the New Town of Assur (Fig. C2.14). Already now, these ERT profiles can be combined with the magnetogram created for this area (§C2.2) as well as the results of the coring undertaken in that same area. In the future, we plan to correlate the ERT measurements in Assur with the results of the geoarchaeological sediment analysis of the cores (§C3) and the mineral-magnetic analyses of selected samples taken from these cores (§C4). Integrating such data, and of course, also the results of the ongoing excavations, will improve our understanding of the areas under investigation.

This first trial run has been successful, and we intend to continue ERT prospecting in the New Town of Assur in the upcoming field season of spring 2024. Once more

data has been collected, further data processing will be performed in LMU Munich's geophysics laboratory to create more sophisticated 2D models. For now, as an example, the measured data of ERT Profile 3 is plotted in the two images on the top while the bottom image shows the inverse model of the same profile featuring the different resistance values (Fig. C2.15).

C3. Geoarchaeological coring in the New Town of Assur, 2023

Mark Altaweel

This work represents the very first geoarchaeological coring ever undertaken at Assur. Using the percussion coring system (Cobra TT) owned by LMU Munich's History Department, eight sediment cores were taken in the southern part of the New Town of Assur between 13 and 25 February 2023, after a car had been procured that was able to transport the very heavy equipment. The field team was led by Mark Altaweel, with the participation of Andrea Squitieri, Amer Mohammed Yasim, Omar Laith Allawi, and Ahmed Khidr Ahmed (known as Arabi).

The primary purpose of extracting sediment cores was to gain further data for the settlement history of the New Town area by identifying occupation levels in various areas. Most of our activity was focused on areas near or within the areas of the new excavation. The nearby excavations of the SBAH undertaken in 2002 had revealed Neo-Assyrian and later activity, but that work has never been completed nor has it been published; as the trench was never backfilled, the remains excavated there are still visible (Fig. C3.1). The coring was meant to enhance the results of the excavations in spring 2023, which demonstrated the existence of several levels of occupation as well as various burial levels within a trench of 120 m² in the southern part of the New Town (§D).

The second goal of the coring work was to investigate the presence and location of an ancient, north-south oriented street that likely connects to a city gate located in the southern stretches of the fortification walls encircling the city. Evidence for the existence of this street was observed in the results of the magnetometer prospecting (§C2), and coring was used to validate those results.

The third goal was to procure sediment samples for mineral magnetic analysis in order to support the evaluation of the results of the magnetometer survey (§C4).

The results of this initial round of coring, which we intend to continue in spring 2024, are detailed below.

⁶⁴ For a comprehensive description of the instrument and its application see Parsi et al. 2023.