Przegląd Archeologiczny
Vol. 67, 2019, pp. 177-230
PL ISSN 0079-7138
DOI: 10.23858/PA67.2019.009

ENRICO LEHNHARDT, ARTUR BŁAŻEJEWSKI, PAWEŁ MADERA, JULIA MEISTER

PIELGRZYMOWICE – A PRZEWORSK CULTURE IRON SMELTING SITE FROM THE ROMAN PERIOD IN SILESIA

In 2013 and 2014 fieldwork was carried out in the Widawa valley near Namysłów (Opole voivodeship) to investigate sites with iron smelting slag assumed to belong to Przeworsk culture. It was supposed that these surface sites dated back to the late pre-Roman Iron Age (phases A_1–A_3) and thus belonged to the earliest Przeworsk culture. To verify this chronological classification, we conducted surveys at various sites and investigated the structure of iron smelting and especially its chronological position at the Pielgrzymowice site (municipality Wilków) by trial trenching. This paper presents the results of geophysical and archaeological as well as archaeobotanical investigations. Our studies in Pielgrzymowice show that iron smelting was carried out during the middle to late Roman period and under no circumstances during the late pre-Roman period. This unambiguous result is based on radiocarbon data from the lowest charcoal layer of a furnace and is supported by further absolute data from features in the surrounding area. The furnaces are those with a 'very big' slag pit, which are typical for the Roman period in Silesia and are themselves a relative means for chronological classification.

KEY WORDS: Silesia, Przeworsk culture, iron metallurgy, archaeobotany, phytolith analysis, late pre-Roman period, Roman period

RESEARCH QUESTIONS AND OBJECTIVES

The issue of iron smelting by Przeworsk culture across the whole region of Silesia was studied most intensively in the late 1990s. In his PhD thesis submitted in 2001 to the University of Wrocław, Paweł Madera compiled from literature and local records (AZP) all prehistoric sites in Silesia with iron metallurgical remains. This catalogue lists 1,245 individual sites, of which the overwhelming majority, however, have not been excavated and are known only from surface finds of iron slag (Madera 2001). The list was revised and ultimately reduced to 628 sites connected to Przeworsk culture, starting from its origins in the pre-Roman period till the early migrations period (Madera 2002).

According to the Polish Archaeological Record (Archeologiczne Zdjęcie Polski, abbr. AZP), 34 sites with iron slag are cited for the Przeworsk culture of the younger pre-Roman Iron Age (Lt C_2-D resp. A1-A3), most of which belong (in accordance with the settlement area of Przeworsk culture) to today's Lower Silesian voivodeship. These sites would thus be the oldest evidence for iron smelting

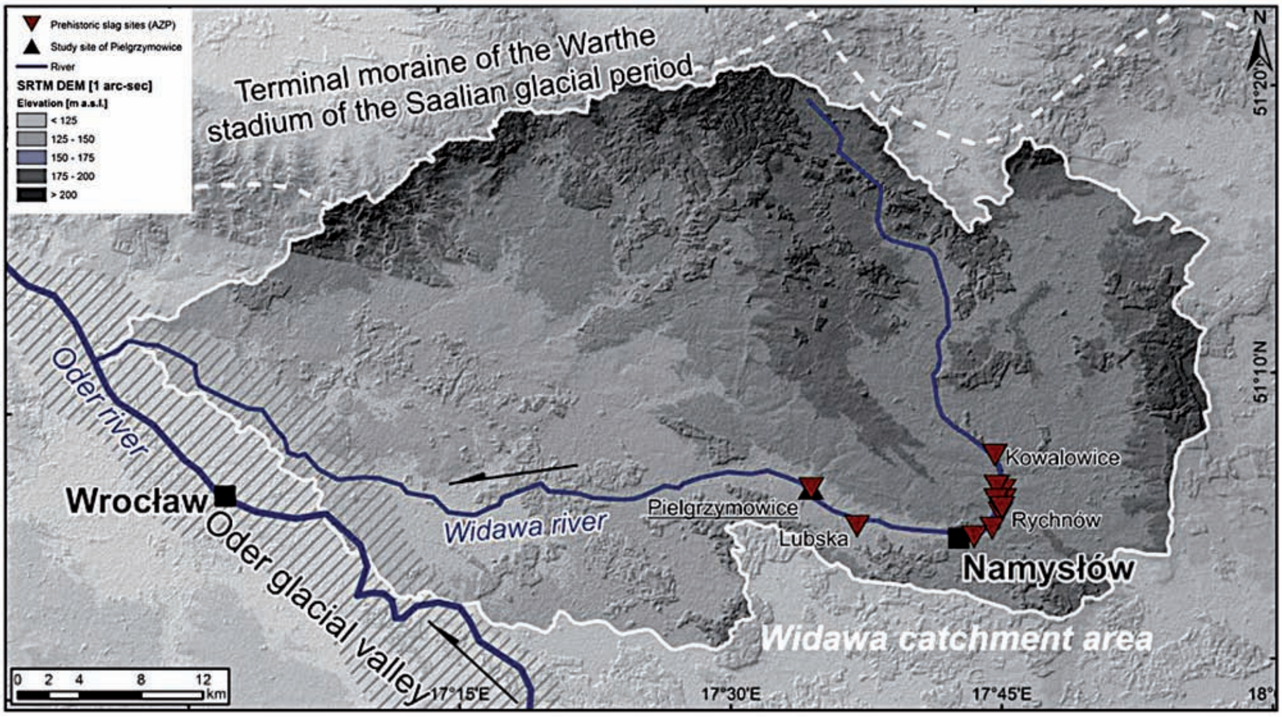

Fig. 1. Widawa catchment area and sites with iron smelting slags which are assumed to date back to the late pre-Roman Iron Age (modified to Thelemann et al. 2015, 111 Fig. 1, B)

in the scope of Przeworsk culture which at the end of the 3rd to early 2nd century BC (Lt C1/C2) emerged from groups of Pomeranian culture under the strong influence of the La Tène culture in Silesia (about the origins and development of Przeworsk culture see: Godłowski 1985, 15-25, 127; Dąbrowska 1988, 84-105; Dąbrowska, Woźniak 2005; Andrzejowski 2010, 60-62).

Overall, archaeological finds are very modest in comparison to the Roman period and consist almost exclusively of single findings of slag. Indeed, in only one case there may be a furnace – namely, in Wrocław-Kozanów (Pescheck 1939, 219; Madera 2002, 66). Since none of the sites was systematically excavated and consequently no absolute data are available, it is also impossible to say in which exact chronological order these sites are related to each other.

The number of sites and their regional distribution indicate several concentrations (cf. Madera 2002). With eleven individual sites, the largest and densest concentration is in the area of the river Widawa near the town of Namysłów (Fig. 1). Therefore, we chose this more rural region because we assumed that here we would have the best opportunity to explore at least some of these sites and to investigate them in greater detail.

The region in question is located about 60 km east of Wrocław on the northwestern fringe of the Opole voivodeship. Coming from the north, the Widawa river flows in a sweep further west towards the Lower Silesian voivodeship's capital (Wrocław) and joins the Odra River in the northern district Wrocław-Widawa. The Widawa river probably was an important communication route within the area under study and beyond to the area around Wrocław and especially to the river Odra during both the pre-Roman Iron Age and the Roman period proper (Pazda 1980, 36-37, 137).

The valley of the Widawa formed during the glaciation of the Warta River in the Saalian glacial period (Warta stadial) as the original river valley between Prosna and the Odra. At the bottom of the valley, periglacial processes during the Vistula glacial period led to deposits. However, as the Widawa's flow in the Holocene did not attain the extent necessary to flood the entire valley floor, favourable conditions for the formation of bog iron ores in the humid lowlands arose there. Thus, recent layers of bog iron ore have a thickness of approx. 50 to 70 cm near the Namysłów 69 site (Kosicki 1996; Kosicki 2002). Due to their low Fe content, however, these (recent) bog iron ore deposits would not have been suitable for prehistoric smelting. Before our test excavation in Pielgrzymowice, the Namysłów 69 site was the only one on the middle Widawa river valley where a settlement of Przeworsk culture with iron smelting had been uncovered and which is dated to the Roman period (cf. Kosicki 1996; Kosicki 2002).

Archaeological fieldwork around the city of Namysłów (Opole voivodeship) was carried out as part of a dissertation project financed by the Excellence Cluster Topoi (Berlin) and supervised by Prof. Dr. Michael Meyer (FU Berlin). The thesis deals with the beginnings of iron smelting in the area of Przeworsk culture with a focus on Silesia and was completed by the end of 2015 (Lehnhardt 2019).

To investigate the area, a set of archaeological, geophysical, physical-geographical, and archaeobotanical analysis methods was used to gain general insights into the region and specific sites. The general archaeological questions referred to the verification of the AZP smelting sites and the smelting products (iron slag). An essential part of this was the examination of the chronological classification into the late pre-Roman Iron Age. Physical-geographical research that was carried out as part of M. Thelemann's dissertation project also focused on the entire micro-region around Namysłów. The central questions concern landscape genesis and resource situation with regard to bog iron ores. The results have been published in several scientific journals (Thelemann et al. 2015; Thelemann 2016; Thelemann et. al. 2017; Thelemann et. al. 2018).

PIELGRZYMOWICE

The small village of Pielgrzymowice (municipality Wilków) is situated in the western part of Namysłów county directly at the border of the Lower Silesia voivodeship and close to the river Widawa. In the southern area of the village a number of archaeological sites, known from surface surveys, is concentrated (Fig. 2). According to the AZP files, sites no. 5 and no. 6 yielded iron slag.

Fig. 2. Location of Pielgrzymowice sites 4-6 according to the AZP (Google Maps)

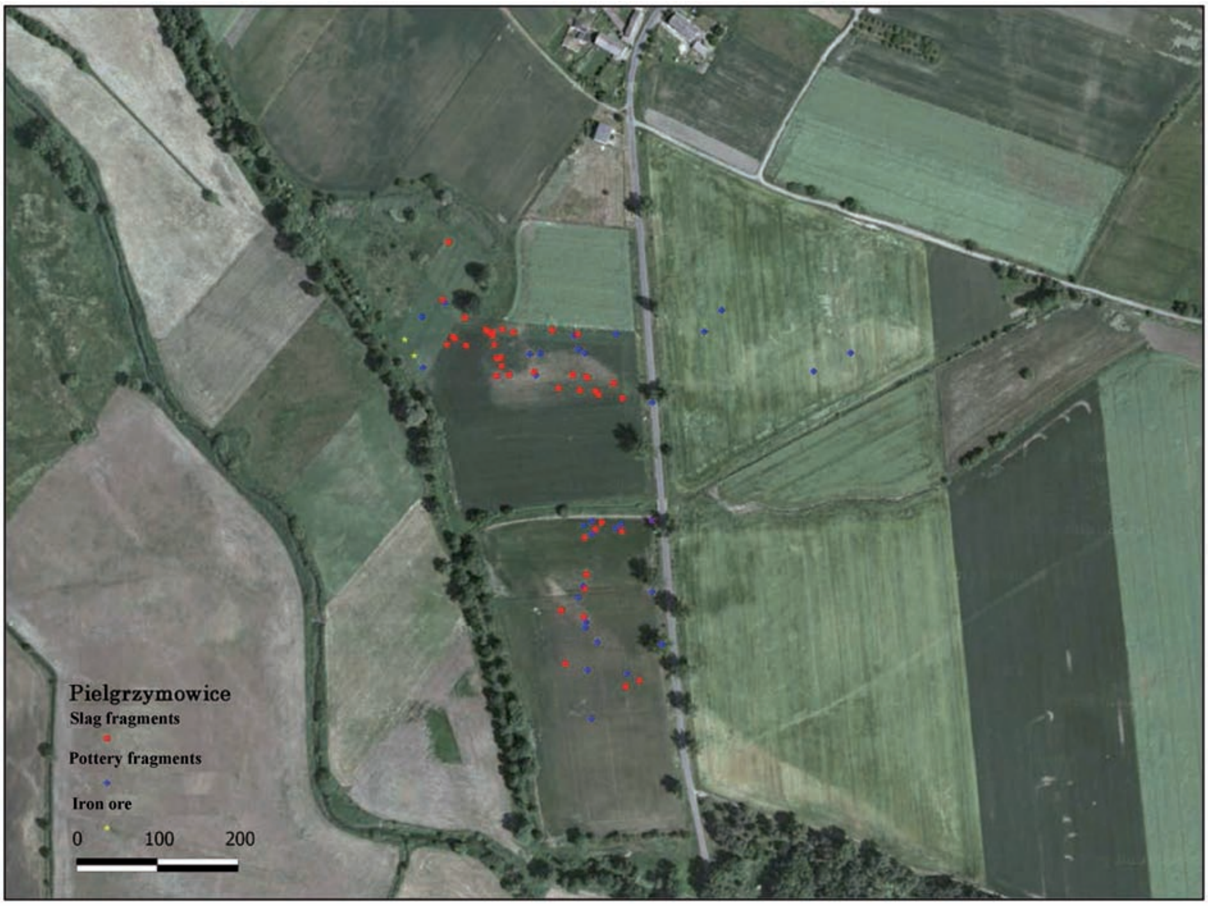

Fig. 3. Pielgrzymowice 4-6. Results of the archaeological survey. Red: iron smelting slags; blue: ceramic fragments; yellow: pieces of bog iron ore (Google Maps; QGIS)

As we enjoyed access to the two harvested fields on which the archaeological sites are located and no plants hindered our view, the opportunity for an archaeological survey (cf. Fig. 3) and a geomagnetic prospection was offered for both iron slag sites. In addition, prospection was extended to site no. 4.

The primary question of the archaeological investigation in Pielgrzymowice was to determine the exact dating of iron smelting, which according to the Polish Archaeological Record took place in the earlier pre-Roman Iron Age. Other questions relate to the technique then used, i.e. the type of furnace and the organization of iron production.

Pielgrzymowice 4

Pielgrzymowice 4 is located immediately south of Pielgrzymowice 5 (cf. Fig. 2). Both sites are separated from each other by but a small drainage ditch. It was not planned to survey this site since it was not known as a smelting site. What is striking, however, is that we are confronted with a similar terrain situation here at locations 4 and 5 as, for example, at the two directly adjacent smelting sites Rychnów 8 and Kamienna-Grabówka 8 northeast of Namysłów (cf. Lehnhardt 2019): slightly ascending slopes at the edge of the floodplain separated by a small stream that flows into the Widawa. Indeed, our survey already produced smaller slag fragments directly south of the ditch. The distribution of survey finds in figure 3, however, rather represents the part of the field that has already been harvested and was accessible for the survey. This refers to the northern part of the site and a strip running from north to south on which most of the finds were discovered. Several fragments of slag and ceramics were also found outside the harvested areas. However, the total weight of the individual pieces of iron slag is only 1.241 kg. Most of the ceramic is that of wall fragments of coarser material and of different colours; they do not really permit exact classification into a pre-Roman or younger phase.

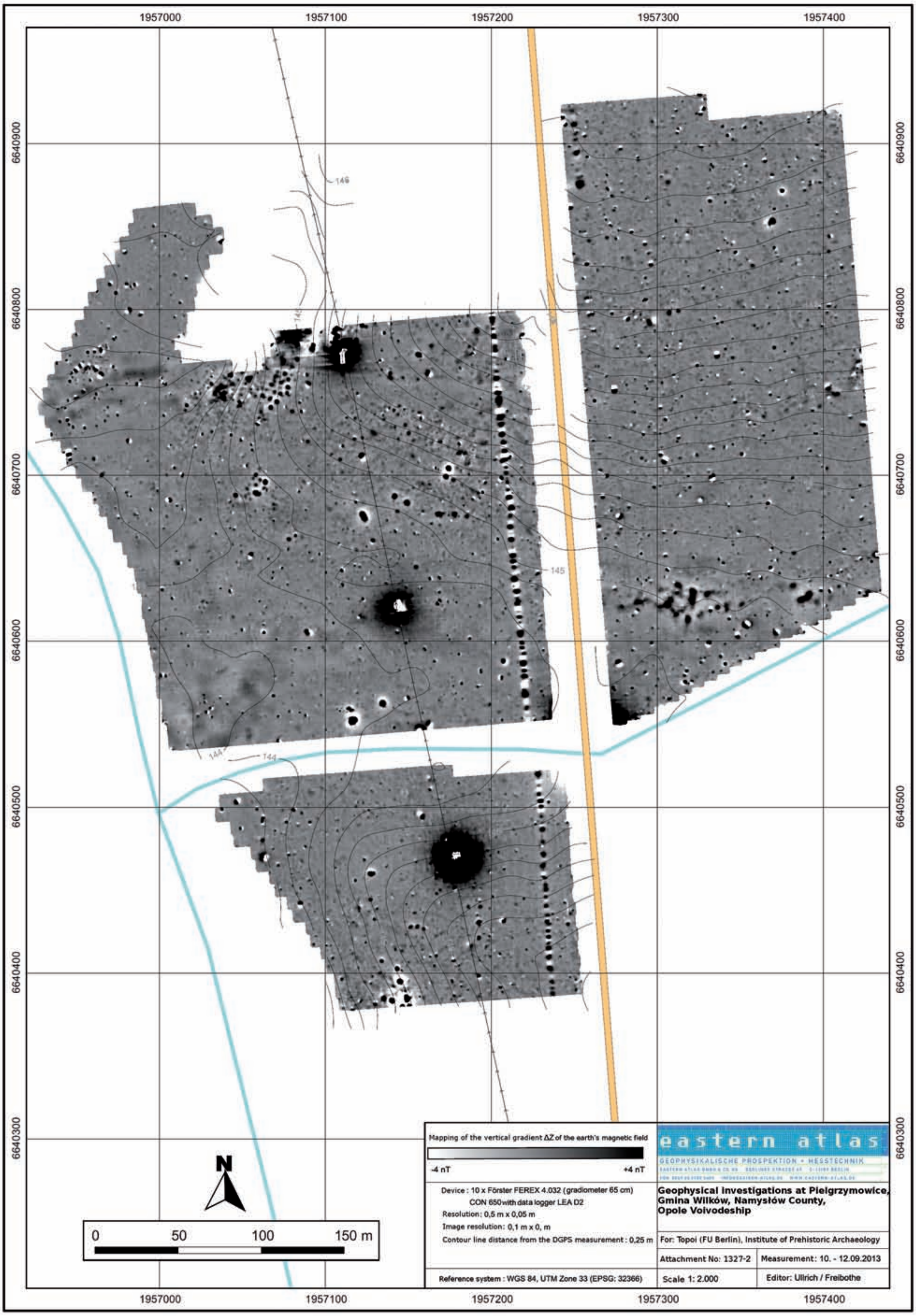

Fig. 4. Pielgrzymowice 4-6. Magnetic map (Ullrich and Freibothe 2013)

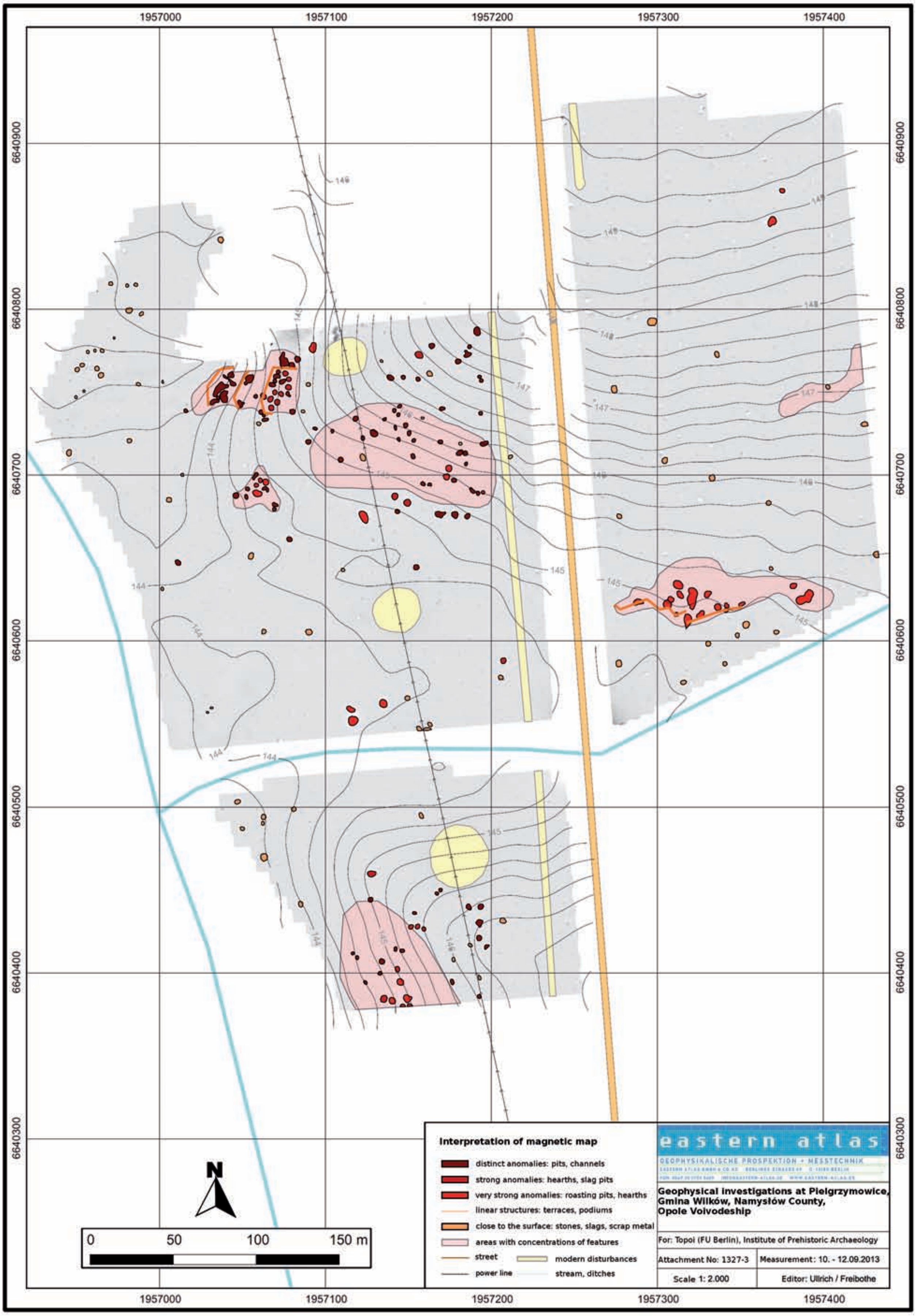

Fig. 5. Pielgrzymowice 4-6. Interpretation of magnetic map (Ullrich and Freibothe 2013)

The geophysical survey, which was partly carried out for the field of site 4, revealed a concentration of anomalies at the southwestern end of the magnetic map. In the preliminary interpretation, these are ‘very strong anomalies’, i.e., ones that are usually conspicuous, as they show a very high positive magnetization (black) and an evenly negative (white) fringe. This is caused by two-dimensional, highly magnetically effective structures such as those produced at hearths (Ullrich and Freibothe 2013; cf. Fig. 4).

Pielgrzymowice 6

Pielgrzymowice 6 did not yield any iron-metallurgical residues and only four ceramic fragments (Fig. 6), some of which were found far apart from each other (cf. Fig. 3). Therefore, iron smelting cannot be determined due to this negative result. And even the slag fragment picked up by the former AZP survey, archived at the Opole Heritage Office, does not necessarily have to be connected with an iron smelting process. Although it is an object that is slagged by heat, it does not have the typical structure and colouring of iron smelting slag and its chemical composition is questionable (modern material?).

Hardly any features of possible anthropogenic origin are visible in the magnetic map. Merely in the north-eastern part of the area are found two smaller features approximately 12 m apart from each other. However, only excavation can reveal what this is. The larger and contiguous anomalies at the southern end of the field are of natural origin. These are (iron-containing) manganese concretions. Soil samples (Pürckhauer) taken at three points prove this very well (Fig. 7).

Pielgrzymowice 5

The latest survey at site no. 5 clearly indicates settlement activity with iron smelting in the northern part of the field and corrects and extends the older localization by the AZP in the southern part of the field. As shown in figure 3, the southern part did not produce any finds at all. But Pielgrzymowice 5 yielded the largest amount of single pieces of smelting slag from all the sites we studied in the Widawa valley. Approximately 40 individual samples of smelting slag were collected, ones ranging

Fig. 6. Pielgrzymowice 4. Ceramic fragments (photo: E. Lehnhardt)

Fig. 7. Pielgrzymowice 4. Iron-manganese concretions in the Pürckhauer drill (photo: E. Lehnhardt)

from very small (weighing but 6 g) to relatively large (several kilograms). Boasting the largest dimensions and the heaviest weight (8.8 kg) is the slag block found in the undergrowth north of the field. The weight of the eleven larger pieces of slag ranges from 554 g to 3,019 g. The total weight of

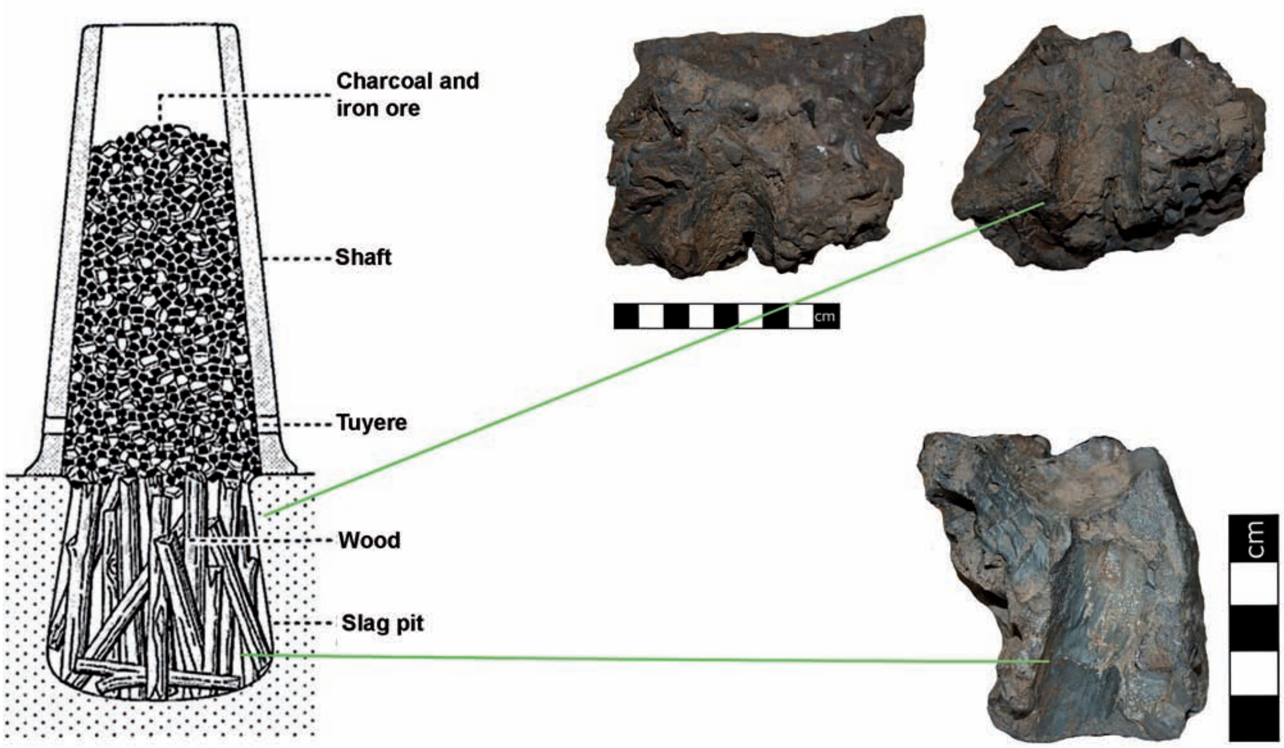

Fig. 8. Pielgrzymowice 5. Iron smelting slags from the survey, which clearly show by their wood imprints that the furnaces in question have a slag pit (according to Jöns 1997, 129 Fig. 79; photos: E. Lehnhardt)

all the slag collected is 25.46 kg. Some pieces show clear impressions of wood or branches (Fig. 8), which had certainly been put into the furnace pit before the smelting process. Such a wooden construction served as a sort of foundation for the iron ore and charcoal filling to temporarily prevent it from sinking into the slag pit during the smelting process (cf. Jöns 1997, 128-130).

The aerial photograph shows a larger area in the northern part of the field with a negative vegetation mark, which is almost identical to anomalies in the magnetic map and partly to the surface finds. The distribution of finds shows that the objects shifted by post-depositional processes are mainly grouped south and west of significant magnetic anomalies. This is probably also due to the hillside location to the west in the floodplain area of the Widawa.

At the southern edge of the field, two conspicuous anomalies visible in the magnetic map were investigated by colleagues from the Division of Physical Geography at FU Berlin using percussing drillings (for more detailed results on these samples see Thelemann et al. 2015, 118-120). Figure 9 shows both drillings (Pif 5-1 and Pif 5-2). From a depth of about 64 cm respectively 57 cm, residues of charcoal and reddish discolorations are visible. Pif 5-1 also contained very small reddish and magnetic grains. This gave rise to the suspicion that it could be the remains of a pit for roasting bog iron ores (for such roasting pits see Ganzelewski 2000, 21-23, Fig. 14), but this did not prove correct after excavation (see below). The fact that charcoal from both drillings dates to the younger pre-Roman Iron Age (Tab. 1) was essential for our question on possible pre-Roman iron smelting at this site.

RESULTS OF TRIAL TRENCHING

In late summer of 2014, a two-week trial trenching with students of the Freie Universtität Berlin was carried out at Pielgrzymowice 5. Our aim was to uncover some striking magnetic anomalies, especially in the area of slag finds, which indicated iron smelting furnaces. The focus was on questions concerning technical details of the furnaces (type, size) and the chronological classification of the iron production and the settlement. In the same way, also the drilled features (Pif 5-1, Pif 5-2) in the south of the field were to be clarified, although no iron

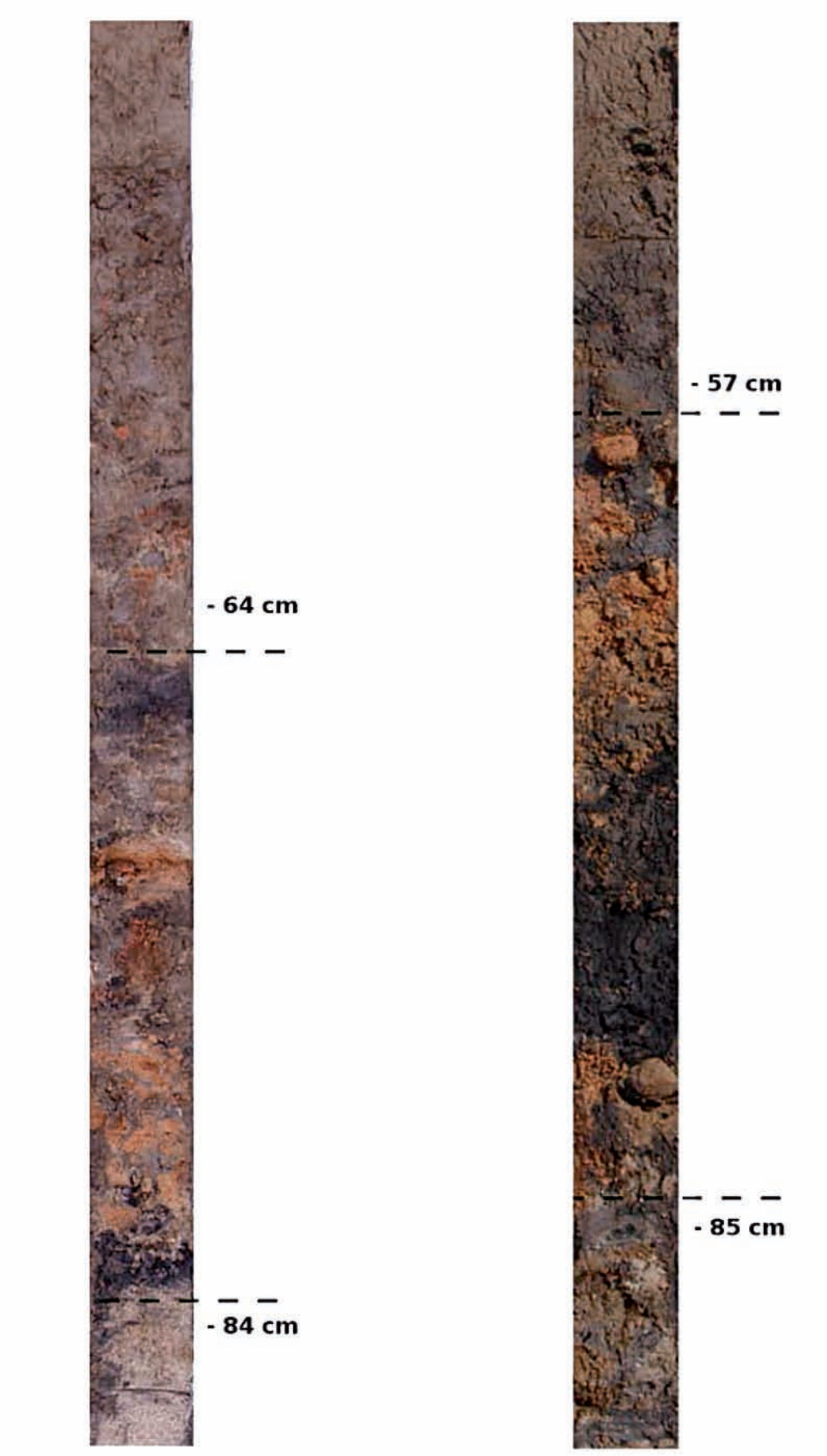

Fig. 9. Pielgrzymowice 5. Percussing drillings Pif 5-1 (left) and Pif 5-2 (photos: E. Lehnhardt)

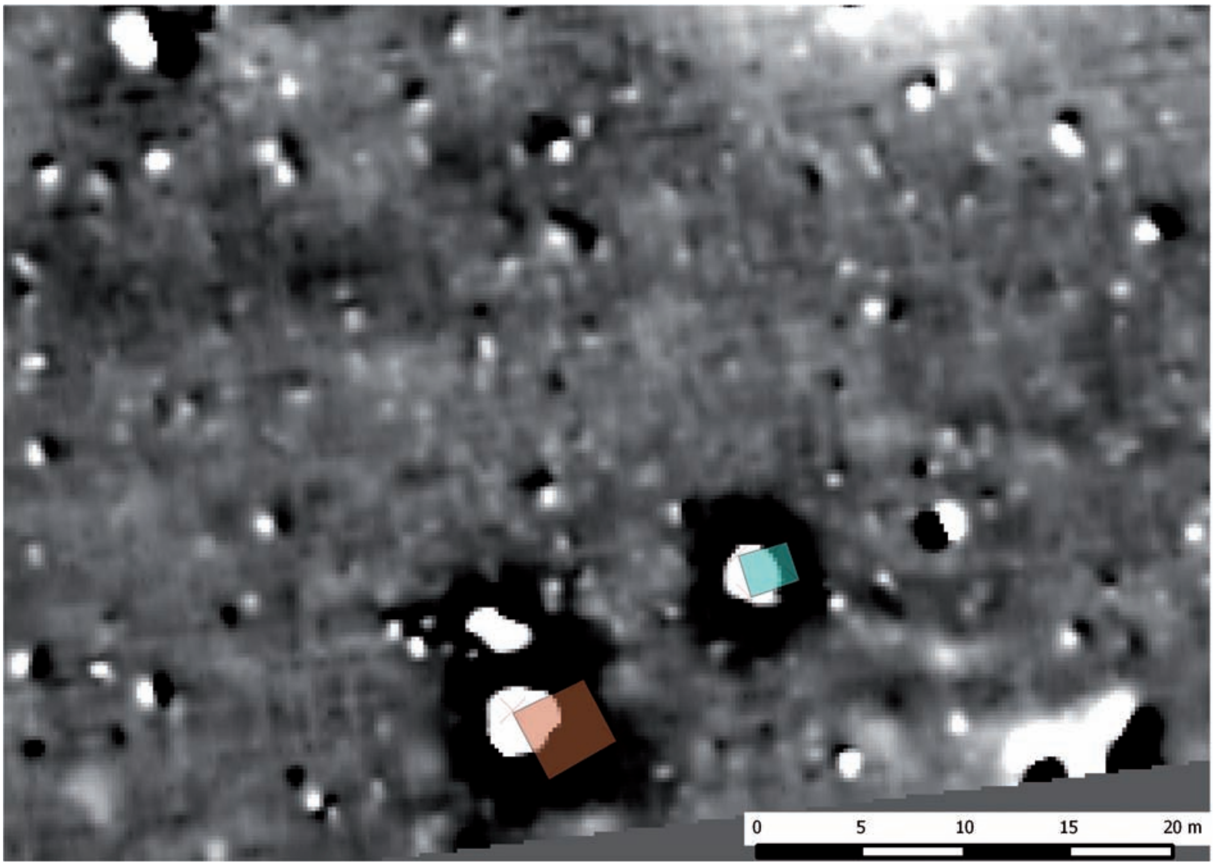

Fig. 10. Pielgrzymowice 5. Trench 1 (right in turquoise) and trench 2 (reddish) in the magnetic map (modified to Ullrich and Freibothe 2013)

slag was found in this area, but due to the ^{14}C-data, a classification into the younger pre-Roman Iron Age was already possible. Five trenches (test excavations) were dug, the results of which are presented below.

Trench 1

Trench 1 is located in the area of the drilling probe Pif 5-1 to clarify the cultural layers that were observed within the drilling core. In the geomagnetic map, a larger structure is visible, which was exposed in its eastern part by our test excavation with an approximate area of 2.15 m x 1.60 m (Fig. 11 and 12).

At a depth of about 30 cm a grey clay layer begins which is interspersed with a small amount of burnt clay and charcoal flakes. 10 cm deeper, this layer becomes a yellowish-grey clay layer containing many pieces of burnt clay and charcoal. From a depth of approx. 50 cm upwards, a larger feature was clearly visible which is heterogeneous in its composition (feat. 1/1). Plan 1 was laid out at a depth of 55 cm. The soil around the revealed feature is a homogeneous light to dark grey, natural clay layer. The whole feature is bounded by a narrow, darkly discoloured and elongated structure that encloses a large part of the excavation area in the western part with an area of approx. 150 cm x 100 cm. The narrow structure runs from the west in an eastward direction and, with a curve from about half of the section, leads slightly outwards to the north. It varies in some areas of the colouring and contains smaller segments. Thin bands of dark brown colouring are visible (Fig. 12 No. 6). No ceramic was found in the area of plan 1. Only a few fragments of various ceramics come from the upper soil layers including glazed ware.

A post pit (feat. 2/1) with a diameter of approximately 35 cm is to be found in the southern part of the elongated structure (cf. Fig. 11 and 12). The stone found there could have served as a wedge for the post. It was bonded on its bottom side with the layer underneath by heat. A compact layer of reddish burnt clay is directly in front of the elongated

Fig. 11. Pielgrzymowice 5. Trench 1. Probably a pit house (feat. 1 & 2), planum 1 (photo E. Lehnhardt)

structure in the southern part. This layer is up to 10 cm thick and 30 cm wide. Altogether, burnt clay of several centimetres in size is present, distributed in different layers, and often reveals a clearly intentional shaping.

This could be the remnant of a former pit house. The elongated structure (i.e., the clear limitation of the feature) is probably the remains of the former wall, which was probably made of wickerwork and covered with clay. The thin bands with darker colours in particular are probably the result of decayed wood. This is also indicated by burnt clay pieces with roundish impressions or negatives, which presumably originate from branches of the wickerwork. The red-burnt clay layer in the southern part of the enclosed area could be the former lining of the wall, which has fallen to the north. The post pit also makes the interpretation as a house plausible. However, it cannot be ruled out that below the yellowish layer (No. 2) in the northern part also lies a burnt clay layer. According to the radiocarbon dating of charcoals from drilling probe Pif 5-1 (see above), this feature dates from the younger pre-Roman Iron Age.

Trench 2

Test excavation number 2 was dug in the area of the drilling probe Pif 5-2 and thus circa 10 m southwest of trench 1 (cf. Fig. 10). Trench 2 is divided into two sectors that stretch from southwest to northeast. Sector A covers an area of circa 3 m x 1.10 m, sector B about 3 m x 1.8 m (Fig. 13 and 14). Altogether, three features have been identified. Feature 1 is a stone package, feature 2 a dark layer and feature 3 may be the remnant of a pit house.

As it became clear at an early stage that there are no iron metallurgical features, the trench was not extended. However, in order to clarify the stratum and terrain structure, a depth profile was added in the western part of sector B, which was later extended to the southeast (Fig. 14 and 15).

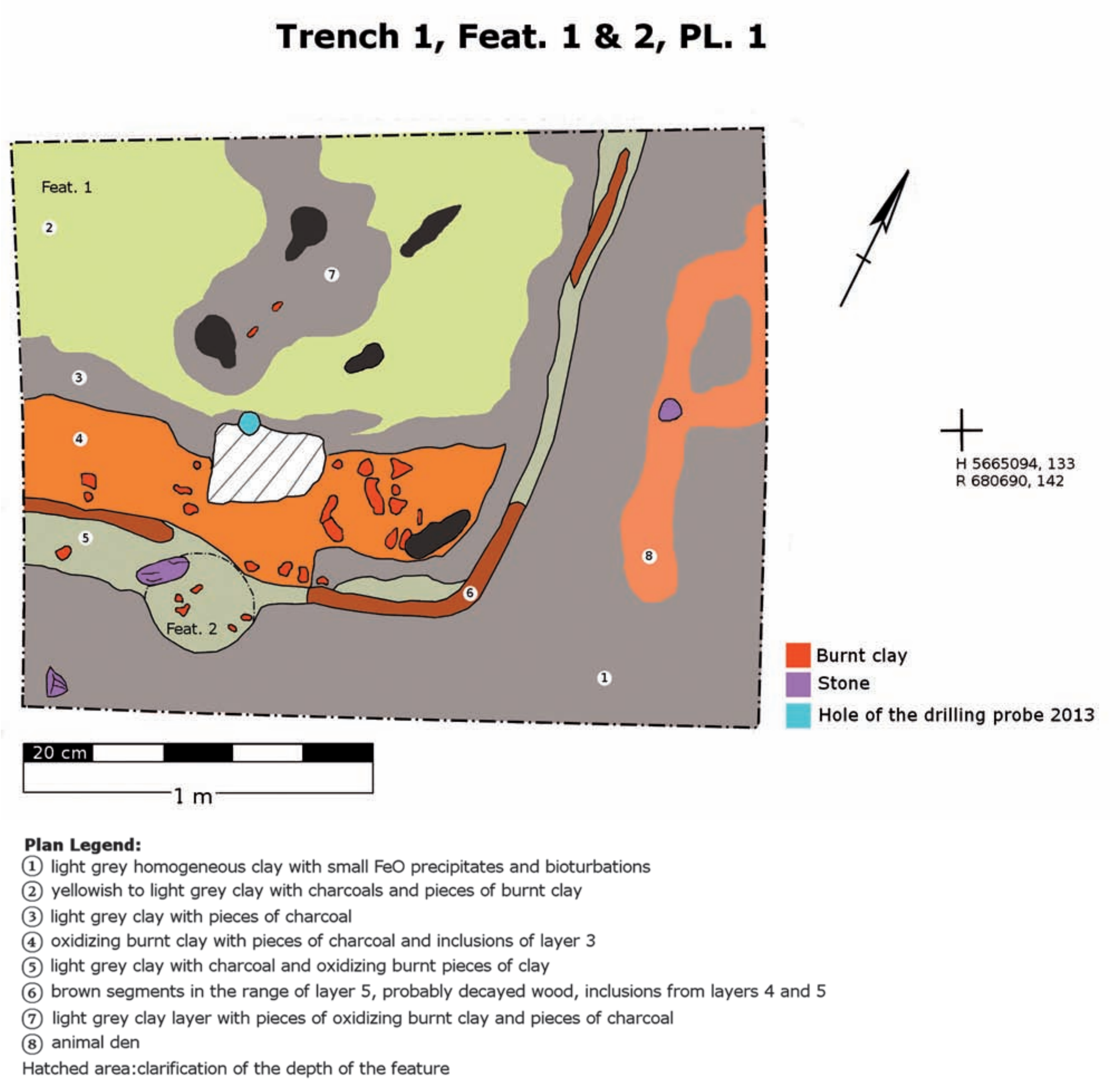

Fig. 12. Pielgrzymowice 5. Trench 1 post-excavation plan, planum 1
(drawing: M. Brumlich; graphic realisation: E. Lehnhardt)

Stone heap (feat. 1/2)

From a depth of approx. 35 cm in the central part of sector A at the northwestern edge, a stone heap was present (Fig. 13). The intentionally created heap consisted of fieldstones in varying sizes from about five to 30 cm. A brown clay layer (No. 4) was concentrated in plan 1 in the area of the stones and beneath them. The meaning and purpose of this package and its chronological classification remain to be resolved. Presumably, this feature is considerably younger than the deeper underlying features 2 and 3 and does not have to be related to them.

Dark layer (feat. 2/2)

A dark layer (No. 3) was clearly visible in sector A, interspersed with charcoal and burnt clay (Fig. 13 and 14). This feature came to light at a depth of about 40 cm and became more and more evident with the formation of plan 1. Charcoal was particularly concentrated in the west of sector A. In sector B, the dark layer was visible only to a very limited extent in the northwest, directly on the baulk (see Fig. 14). Burned clay such as in sector A was no longer detectable. Underneath feature 2 is a homogeneous layer of light grey clay (No 2) with precipitation of iron oxide.

Fig. 13. Pielgrzymowice 5. Trench 2, sectors A-B. Features 1/2 & 2/2, planum 1 (photo: E. Lehnhardt)

'Pithouse' (feat. 3/2)

The dark layer No. 3 (feat. 3/2) of plan 1 was only partially present in the 10 cm lower level of plan 2 (Fig. 17). However, a new feature in the western part of sector A was clearly visible (Fig. 16 and 17). This dark grey clay layer (No. 7) contains a large amount of charcoal, red and grey-brown burnt clay and some stones. In sector A, the layer was approximately quarter circle shaped, up to 10 cm thick and relatively compact.

The southwest profile of sector B clearly shows the shift of this layer down into the floodplain area towards the small stream resp. drainage ditch (Fig. 15). However, this layer is overlaid in the depth profile by different layers of clay, which suggests an accumulation of fluvial sediments due to flooding. Few fragments of oxidized and coarser ceramic were found during construction of the depth profile in sector B.

A soil sample from feature 3 resp. layer No. 7 was taken for archaeobotanical analysis as well as charcoal for an additional ^{14}C-dating. The macrobotanical material consist almost exclusively of millet grains. Whereas a large number of grass phytoliths has been found (see below).

Like the samples from the drill core, the absolute dating of charcoal with a radiocarbon age of **2150 ± 30 BP** also clearly points to the younger pre-Roman Iron Age (see below).

The entire feature 3 is probably the remnant of a former pit house. The reddish burnt clay pieces in sector A and B have similar intentional shaped structures as those in trench 1 (see above) suggesting a lining of wattle and daub.

Trench 3

Trench number 3 was laid out in the northwest of the field in the area of several closely adjacent geomagnetic anomalies (Fig. 18). We had already found several samples of iron smelting slag and ceramic fragments of coarse ware on the surface in the area of these anomalies during our field survey.

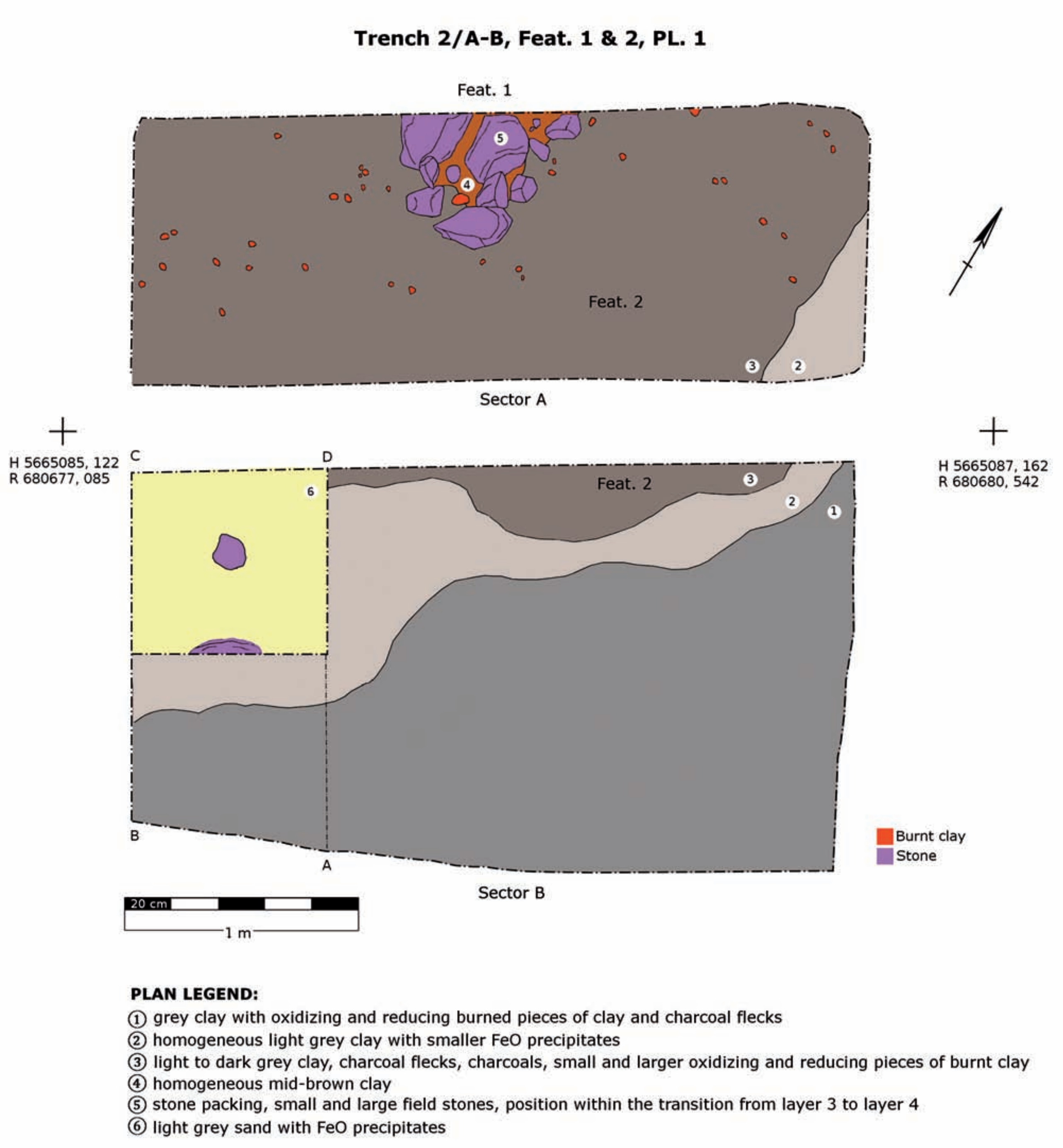

Fig. 14. Pielgrzymowice 5. Trench 2, 1 post-excavation plan, sectors A-B. Features 1/2 & 2/2, planum 1 (drawing M. Brumlich and B. Luban; graphic design E. Lehnhardt)

And slag was constantly picked up from the topsoil when the trench was dug. A total of five features were uncovered in three sectors (A-C), four of the features were already clearly visible in plan 1 (Fig. 19), which was laid out at a depth of approx. 30 cm. Feature 1 could be identified as a furnace pit (Fig. 19 and 20). Features 2 to 4 were characterized by darker circular discolorations, partly containing stones, ceramics, and iron slag. A certain symmetry can be seen in the arrangement of features 1 to 3. Many stones of different sizes were scattered throughout the subsoil. However, these stones are not of anthropogenic origin but are glacial deposits. The darker layer (No. 3) is probably the original surface during the settlement phase.

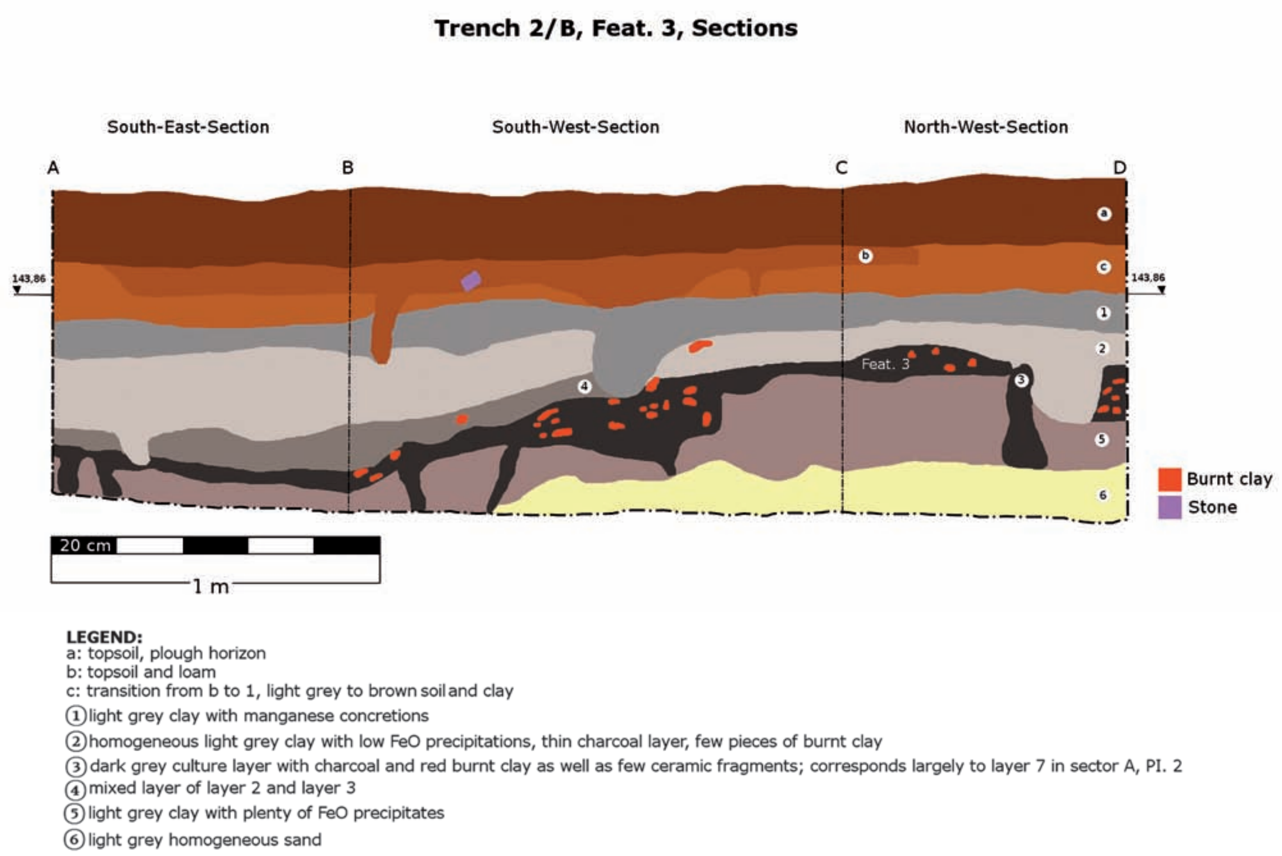

Fig. 15. Pielgrzymowice 5. Trench 2, sector B. Depth sections
(drawing: F. Fiebig, F. Höppner; graphic realisation: E. Lehnhardt)

Furnace (feat. 1/3)

Only the lower part of the slag-pit with a circular outline and an outer diameter of 100 to 110 cm was preserved. In the vertical section the feature has an irregular bowl-shape with a partially flat bottom and depth about 35 cm (Fig. 19-21). The pit walls are lined up with reddish-baked sandy loam with a maximum thickness of 10 cm. As a result the slag-pit has an inner diameter of 80 to 90 cm at the level of discovery.

Most of the pit-filling is a dark grey to a dark brown layer of soil (Fig. 21:5) and sand with iron slag of various sizes (Fig. 22), furnace shaft fragments (Fig. 23), burnt clay, and some ceramic fragments. Its heterogeneous composition clearly speaks for an anthropogenic backfilling. However, some larger slag finds are still *in situ* at the pit walls.

The slag pit bottom is covered by a 10 cm thick charcoal layer containing many small pieces of slag (Fig. 2:19). No burnt clay or ceramic was found in this stratum, one that seemed undisturbed. Single pieces of charcoal from the layer are up to 10 cm long and 4 cm thick. According to Dr. K.-U. Heußner (DAI Berlin), dendro-dating is not possible. Immediately beneath the slag pit, which is not covered with clay, lies the sandy subsoil horizons. Some 80 kg of iron slag was recovered from the slag pit. The heaviest piece weighs about 4.5 kg. The youngest absolute dating of charcoal from the charcoal layer (No. 19) results in a radiocarbon age of **1690 ± 30 BP**. Thus, the furnace was used in the late Roman period (see below).

Hearth (feat. 2/3) and post pit (feat. 5/3)

The second feature (feat. 2/3) in the southern area of sector A has a diameter of approx. 140 cm in plan 1. The dark grey sand layer contains stones, some fragments of differently fired pottery vessels, and a few finds of iron smelting slag. This feature is an oval hearth with many stones (Fig. 24), filled with a dark layer of sand which also contained small pieces of charcoal.

Immediately east of feature 2, a larger roundish discoloration (feat. 5/3) was observed in plan 2,

Fig. 16. Pielgrzymowice 5. Trench 2, sector A. Probably a pit house (feat. 3/2), planum 2 (photo: E. Lehnhardt)

with a rounded oval structure of approx. 30 cm in the middle. It was a very compact, unfired light grey to ochre layer. The high density of this stratum is evident in the fact that it could be easily removed from the ground as a single block. Presumably, this is the remnant of a post. It seems that the post pit was laid out a little later than the hearth, as the light to medium grey sand layer (No. 16) cuts and slightly overlaps the bottom layer (No. 17) of the hearth. Unlike in plan 1, the filling of the hearth

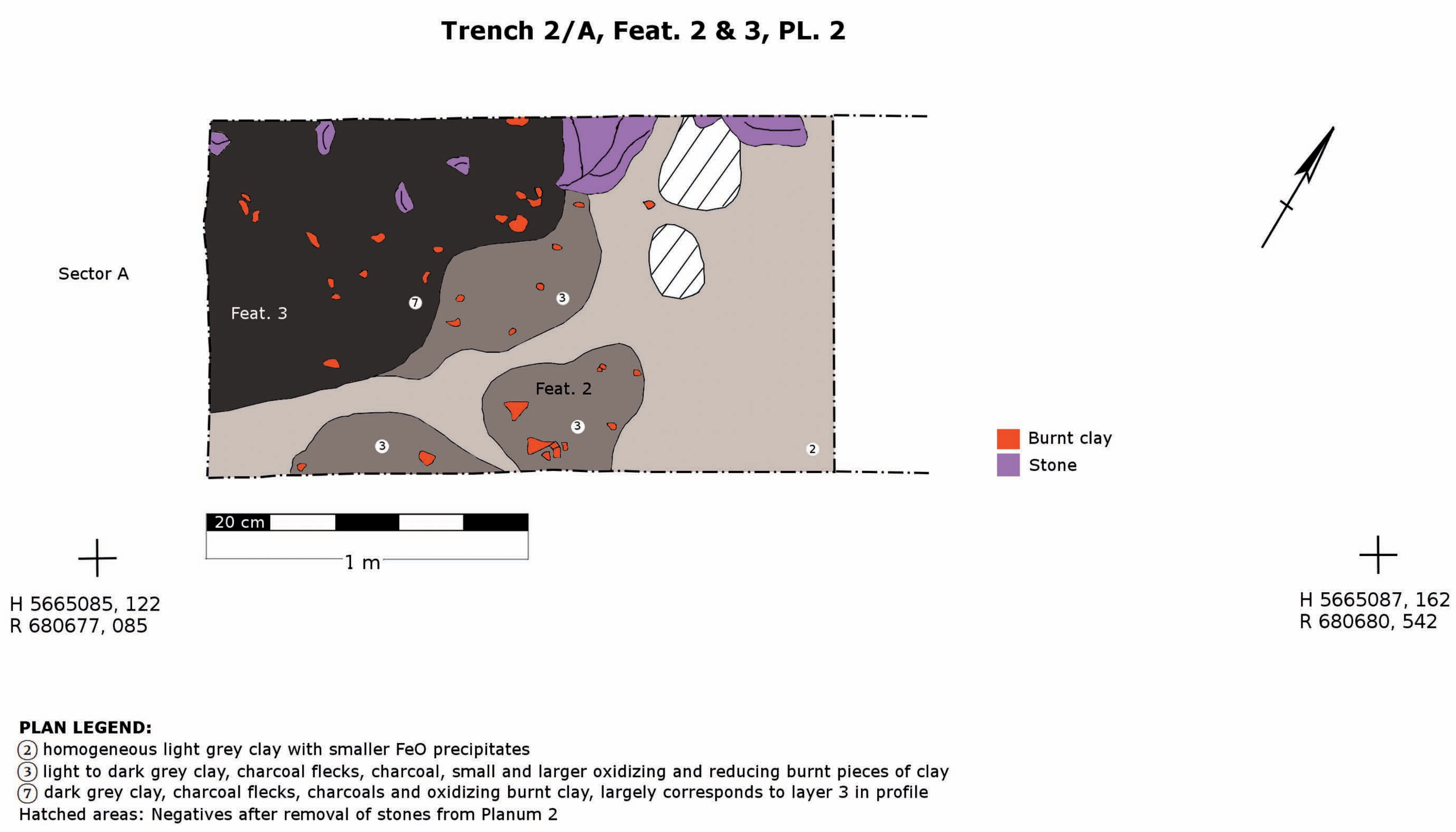

Fig. 17. Pielgrzymowice 5. Trench 2, sector A. Features 2/2 and 3/2 (pit house), planum 2 (drawing: M. Brumlich; graphic realisation: E. Lehnhardt)

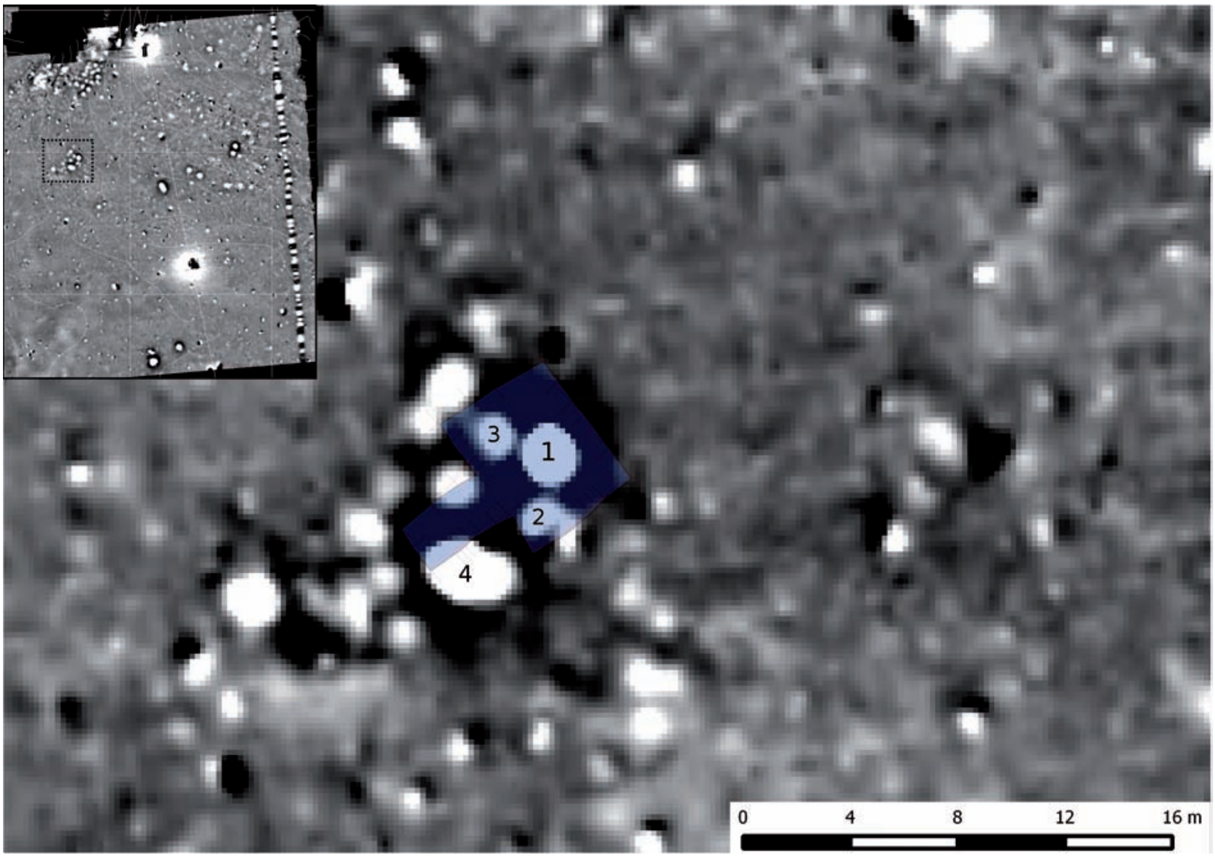

Fig. 18. Pielgrzymowice 5. Magnetic map with sondage 3 (according to Ulrich 2013)

did not contain any ceramics or slag. The absolute dating of charcoal from the hearth filling yieldss a radiocarbon age of **1715 ± 30 BP** and thus points to the later Roman period (see below).

Hearth (feat. 3/3)

In plan 1, the size and layer composition of the geomagnetic anomaly in sector B corresponds more or less to feature 2 of sector A (see above). The light to dark grey sand layer with a diameter of approx. 1.45 m contains a few ceramic fragments and some stones. It was not completely excavated.

In plan 2, the maximum width was still 1.15 m. In the southwest profile, the feature could be proven up to a depth of 35 cm. It is a stone-filled hearth (Fig. 26 and 27), which in terms of structure and size corresponds to the hearth in sector A (feature 2/3). All stones show significant traces of heat. In the middle of the hearth and on the bottom beneath the stones there is a homogeneous charcoal layer of up to 10 cm thickness, which thins out towards the edge of the feature, but also contains some larger pieces of charcoal. Neither the stone packing nor the charcoal layer contains any artefacts. The absolute dating of charcoal from the charcoal layer results in a radiocarbon age of **1705 ± 30 BP** and thus points to the same timeframe as the charcoal sample from the hearth in sector A (see above).

Pit (feat. 4/3)

A roundish dark grey layer with a maximum width of approx. 1.80 m, interspersed with iron slag, burnt clay and ceramic fragments of various types, was apparent in sector C in planum 1 (Fig. 28). This feature is probably the primary source of an iron slag concentration in the area of trench 3, which was already determined on the surface by our survey in 2013. The profile section reveals a 60 cm deep pit. Natural precipitations of iron oxides are clearly visible in the surrounding sand (cf. Fig. 28). The pit filling consists of several layers that partly merge into each other, and only the top layer contained various objects. Approximately 15 kg of iron smelting slag was recovered from this layer. The heaviest piece weighs 1.6 kg. It also contained some burnt clay and a few pieces of what was probably the former shaft of the furnace in sector A (see above).

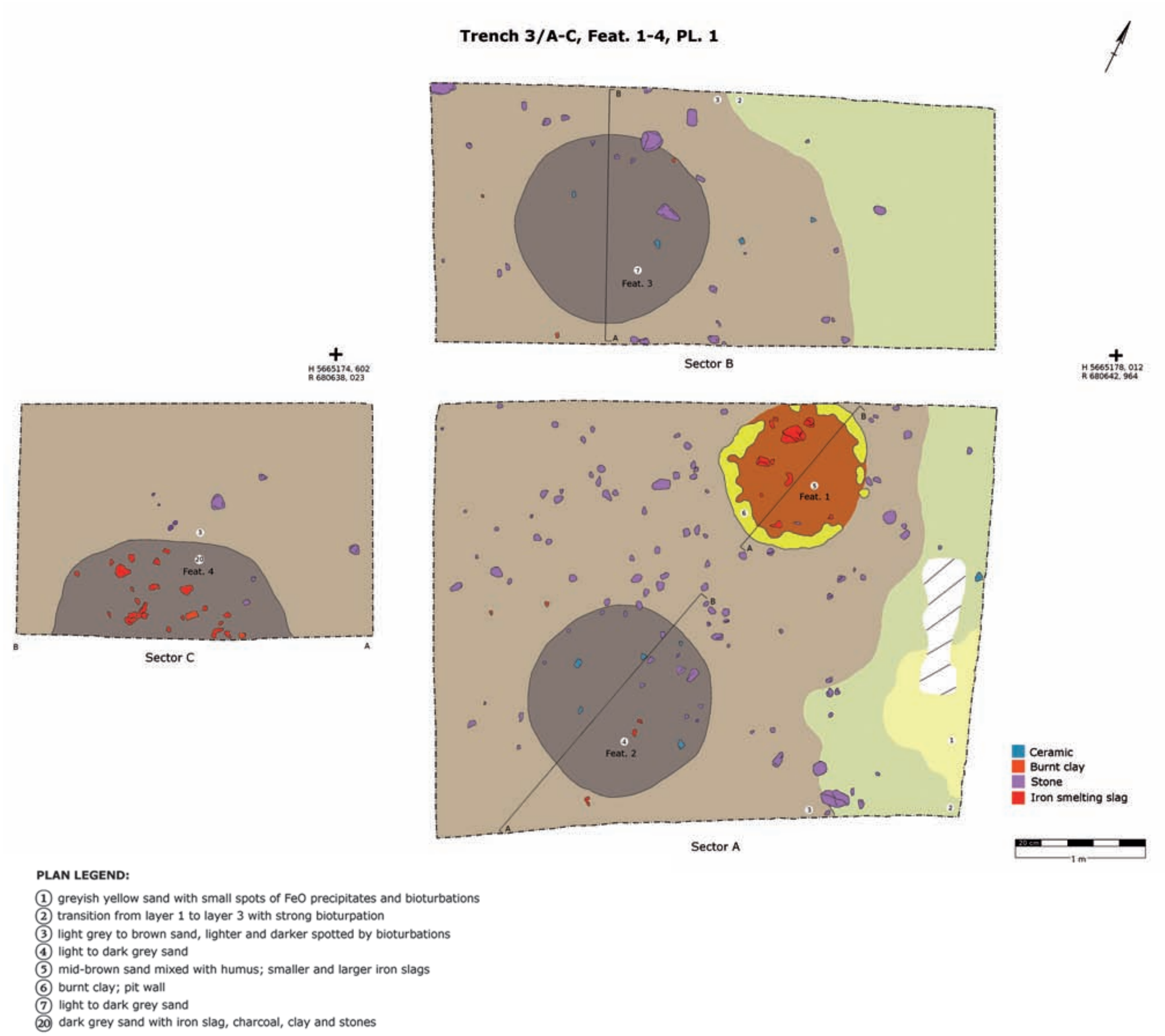

Fig. 19. Pielgrzymowice 5. Trench 3. Features 1-4, planum 1 (drawing M. Brumlich; graphic realization E. Lehnhardt)

A several centimetre thick charcoal layer mixed with sand (Fig. 29 No. 23) covers the pit bottom. This could be a former charcoal pile that was continuously backfilled and later served as a heap for parts of the furnace in sector A and then its iron slag. The dating of a charcoal sample from the bottom results in a conventional radiocarbon age of **1820 ± 30 BP**. The layer (no 23), therefore, dates from the older to middle Roman period (see below).

Trench 4

During the archaeological survey, we noticed that iron slag was also concentrated in the eastern part of the field. In the magnetic map, two round anomalies of almost the same size appeared in this area, which clearly contrasts with the magnetic surroundings. To clarify these anomalies, which in the context of the slag indicated one or two furnaces, a short trial trench of approximately 2.30 x 5.4 m was dug (Fig. 30 and 31).

During excavation, many smaller slag finds and a few ceramic fragments of different types were collected in the upper soil. At a depth of approx. 20 cm two features were found, of which the northern one was clearly recognizable as a furnace pit (Fig. 30 and 32). The second is an accumulation of reddish-burnt clay. In the first plan stones, a few ceramic fragments without rim or ornaments, and some burnt clay fragments were scattered in the sandy humus layer. In the northern part of trench 4,

Fig. 20. Pielgrzymowice 5. Trench 3/A. Furnace (feat. 1/3), northwest section (photo E. Lehnhardt)

a disturbance ran right through the furnace pit caused by the construction of a drainage system, as it later turned out.

Furnace (feat. 1/4)

As in the case of furnace 1/3, only the lower part of the slag-pit was preserved. It has a circular shape in plan and an outer diameter of up to 110 cm. In profile the feature appears to be trough-shaped (bowl-shaped) with a slightly curved wall. The wall clay lining thickness is between 4 and 9 cm and the inner diameter reaches 96 cm. The pit bottom forms a large round and flat stone with a diameter about 70 cm. Although the stone appears as a flat cylinder in projection view and profile (Fig 33.34), it goes even deeper into the ground and takes on the form of a flat and inverted truncated cone.

It lies in the surrounding sand, which was slightly reddish in colour due to the heat of smelting. Under the stone, no cultural stratum or a human-induced alteration could be detected. Most probably, it was placed at the bottom of the pit immediately after being dug up. The gap between the pit wall and the stone was very carefully lined with clay (see Fig. 33 B, C; 34).

About 106 kg of iron slag of differing size and structure was collected. The heaviest piece weighs 7.4 kg. Some larger slag finds have long tubular hollows with diameters of 2.5 to 4.5 cm originating from timbers, which were probably placed into the pit as a load-bearing element for the furnace charge before the actual smelting process. No suitable material for ^{14}C-dating was found in the slag-pit.

The character of the pit-filling, just like in furnace 1/3, indicates that the main part of a slag block was removed from it, most likely during field work, which was a common practice in this area of Silesia in the past. The modern laying of a drainage pipe may also have led to the relocation of material.

Pit (feat. 2/4)

The unexcavated feature in the southern part of the trench 4 revealed itself only as an accumulation

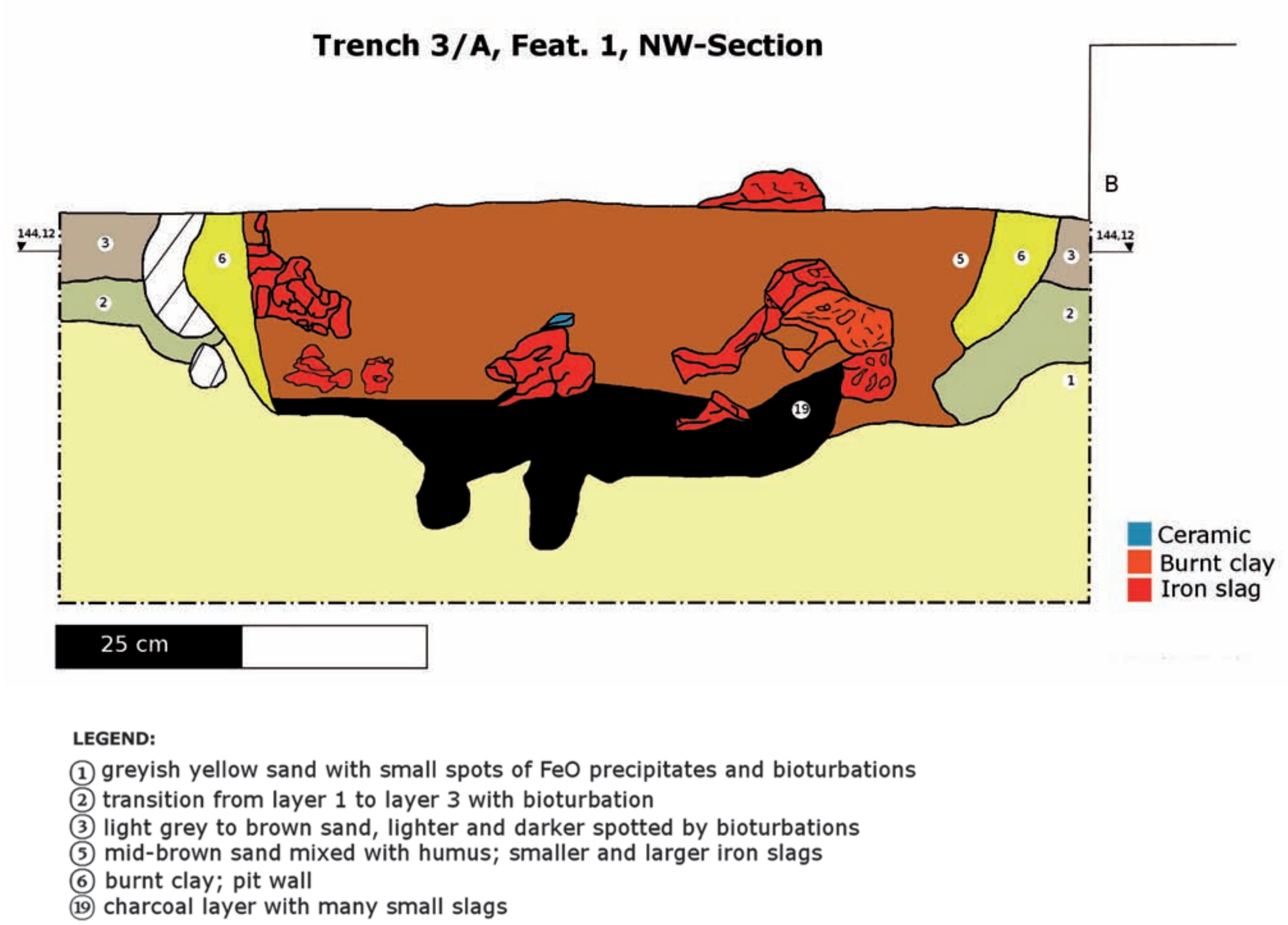

Fig. 21. Pielgrzymowice 5. Trench 3/A. Furnace (feat. 1/3), northwest section (drawing F. Fiebig, F. Höppner; graphic realisation E. Lehnhardt)

of fragments of reddish-burnt clay on the trench surface (Fig. 31). Slag was hardly noticeable. On the basis of the magnetic anomaly size and shape, which is almost identical to that of the furnace 1/4 (see Fig. 30), it can be assumed that this object was the remnant of the next slag-pit bloomer furnace. In this case the slag block would also be removed, and the pieces of burnt clay in the roof should be interpreted as fragments of the slag-pit clay lining thrown into its empty interior.

Trench 5

With a length of approx. 18.50 m and a width of approx. 1.80 m, trench 5 forms the largest excavated area within the scope of our test excavations. The trench was dug further north of trench 3 at the end of the magnetic survey in the area of many anomalies, which form a cluster with a seemingly northeast-southwest orientation (cf. Fig. 35). We have tried to expose as many of the geomagnetic anomalies as possible. Eight features are visible in plan 1 (Fig. 35; Fig. 37-40), that was laid out at a depth of approx. 30 cm. After removing the topsoil, the slightly clayey sand with a light greyish-yellowish colouring was already visible at this depth (cf. Fig. 35). During preparation of plan 1 in the southwestern part of the trench, isolated iron slag finds and some wall fragments and ornamentation came to light.

A disturbance in the southwestern part of the trench penetrates feature 6 (Fig. 37 and 39). As in trench 4, it can be assumed that these are also traces of a drainage pipe installation.

Features 3, 4 and 5, whose structures have been more clearly recognizable in plan 1, were excavated and determined to be almost rectangular hearths. The same can be assumed for features 1, 2 and 6. Feature 4 (Fig. 36) covers an area of approximately 1.30 m x 0.80 m in plan 1. Features 3 and 5 have similar dimensions.

Fig 22. Pielgrzymowice 5. Trench 3. Smelting slag from furnace (feat. 1/3) (photo E. Lehnhardt)

All three hearths were filled up to a depth of 30 to 40 cm with many field stones, all of which were clearly damaged by strong heat and often so porous that they fell apart when removed. Remains of thin reddish-burnt clay structures are still visible at the boundaries of features 4 and 5. These red bands are on average 3-4 cm wide, a few centimetres thick and up to 40 cm long. However, burnt clay was not found in the filling of any of the three excavated hearths. In addition to the many stones, they contained charcoal and brown to black loamy sand in the upper layers.

Some fragments of coarse ceramics, which are fired (oxidized) outside and reduced on the inside, lay in the filling of hearth 4, which according to the ^{14}C- analysis (**1915 ± 30 BP**) dates back to the 1st to 2nd century AD. In addition, it contained a stone artefact (Fig. 41) and a fist-sized piece of iron slag that clearly originates from a smelting furnace.

The stone artefact is about 19 cm long and 5 cm wide. The maximum thickness is 2 cm and it fits nicely in one’s hand. The surface is partly chipped on both broadsides. On one side, where the surface is still in good condition, two thin dragged marks running parallel at a distance of 2 cm are clearly visible. The narrow long sides are slightly rounded and softly ground. It has a distinct slate structure. Therefore, the broadsides also chipped off in layers. The rock is a mica schist with a silver-grey colouring. Such mica schists are found in Silesia in the area of Ślęża Mountain and in the Sudeten Mountains (cf. von zur Mühlen 1922). The raw material for this artefact probably also comes from this region.

Fig. 23. Pielgrzymowice 5. Trench 3. Furnace shaft fragments (feat. 1/3) (photo E. Lehnhardt)

Fig. 24. Pielgrzymowice 5. Trench 3/A. Hearth (feat. 2/3) northwest section and posthole (Bef. 5/3) at the lower edge of the photo (photo E. Lehnhardt)

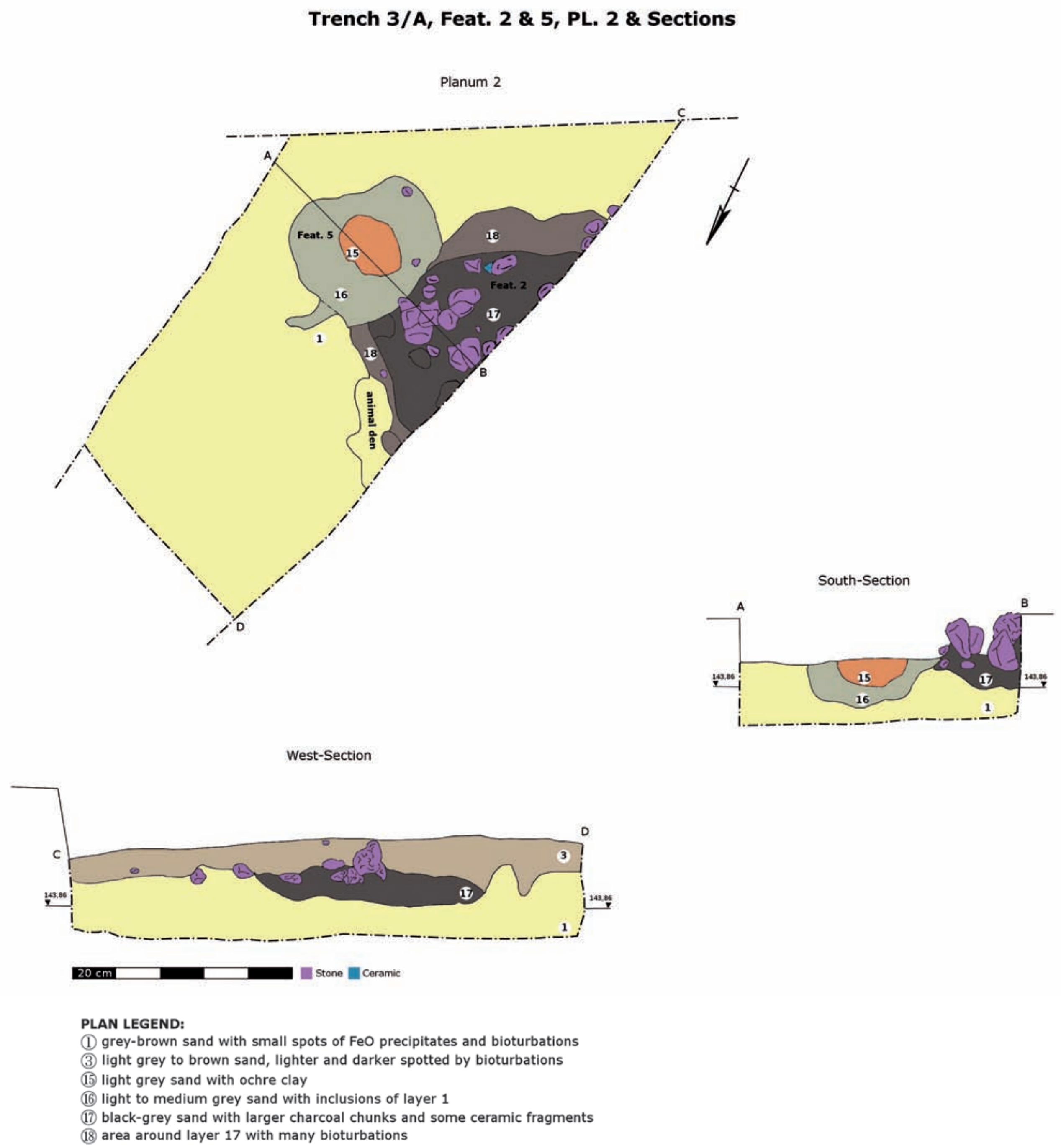

Fig. 25. Pielgrzymowice 5. Trench 3/A. Hearth (feat. 2/3) and posthole (feat. 5/3), south and west section (drawing: B. Luban; graphic realisation: E. Lehnhardt)

Smaller pieces of iron slag and the lower part of a ceramic vessel (Fig. 42) that dates back to the Roman period were found in the filling of hearth 3 (feat. 3/5) The ceramic was fired under oxidizing conditions, it has a medium coarse mineral tempered fabric and is hand-made. The bottom has a diameter of 10 cm and a thickness of 1.2 cm. Its wall thickness is 0.6 cm.

The precise function of the stone-filled rectangular hearths in trench 5 is unclear. Why are they rectangular? Why they are so relatively deep compared to the two rather round hearths in trench 3, and what was the purpose of the many stones which have been damaged due to the heat of the fire? In any case, it is noticeable that clear traces of red-burnt clay can only be found in the uppermost

Fig. 26. Pielgrzymowice 5. Trench 3/B. Hearth (feat.3/3), southwest section (photo: E. Lehnhardt)

preserved area as thin bands (cf. Fig. 5 and Fig. 39 No. 4). This means that the fire probably only burned on the surface and did not enter the hearth pit. This may well also explains why there is only little charcoal inside the hearth pits. An explanation, albeit hypothetical, could be that it was rather a matter of heating the stones in the pit by a fire and then using the waste heat of the stones, which probably gave off heat for a long time. The hearths could perhaps be the substructure of possible kilns for drying grain or anything else. The rectangular shape could indicate that, for example, rectangular wooden constructions or similar stood above the hearths after the fire had gone out. However, the question of corn-drying kilns in the Barbaricum during the Roman period is still an archaeological desideratum. Moreover, the fact that there are very different interpretations for the use of similar rectangular hearths in area of the Przeworsk culture and beyond does not make it any easier to interpret them just as possible kilns (cf. Kolník, Roth 2012; Muzolf, Muzolf 2015; Gindele 2015).

The sample from trench 2 (feat. 3/2, 'pit house') is the most productive and contained a large number of fruits and seeds (Tab. 3). The selection includes 1,521 millet grains, half of which are safely part of proso millet grains and the other half of which probably belong also to that plant. Only one grain belongs to the foxtail millet. However, the total quantity of millet grains from the sample is higher than that which was selected. The sample also includes three knotweed fruits and only one wheat grain.

Lady's thumb and black-bindweed are weeds that grow between cultivated plants such as cereals and vegetables. Black-bindweed belongs to the group of common weeds in cereal crops and grows up to one metre, while the lady's thumb belongs to the group of root crop weeds and attains an average height of between 40 and 80 cm. Lady's thumb is thus one of the relatively high-growing root crop herbs. Smaller root crop herbs are absent from the sample, so it can be assumed that the small number of knotweed fruits might be linked to the harvests

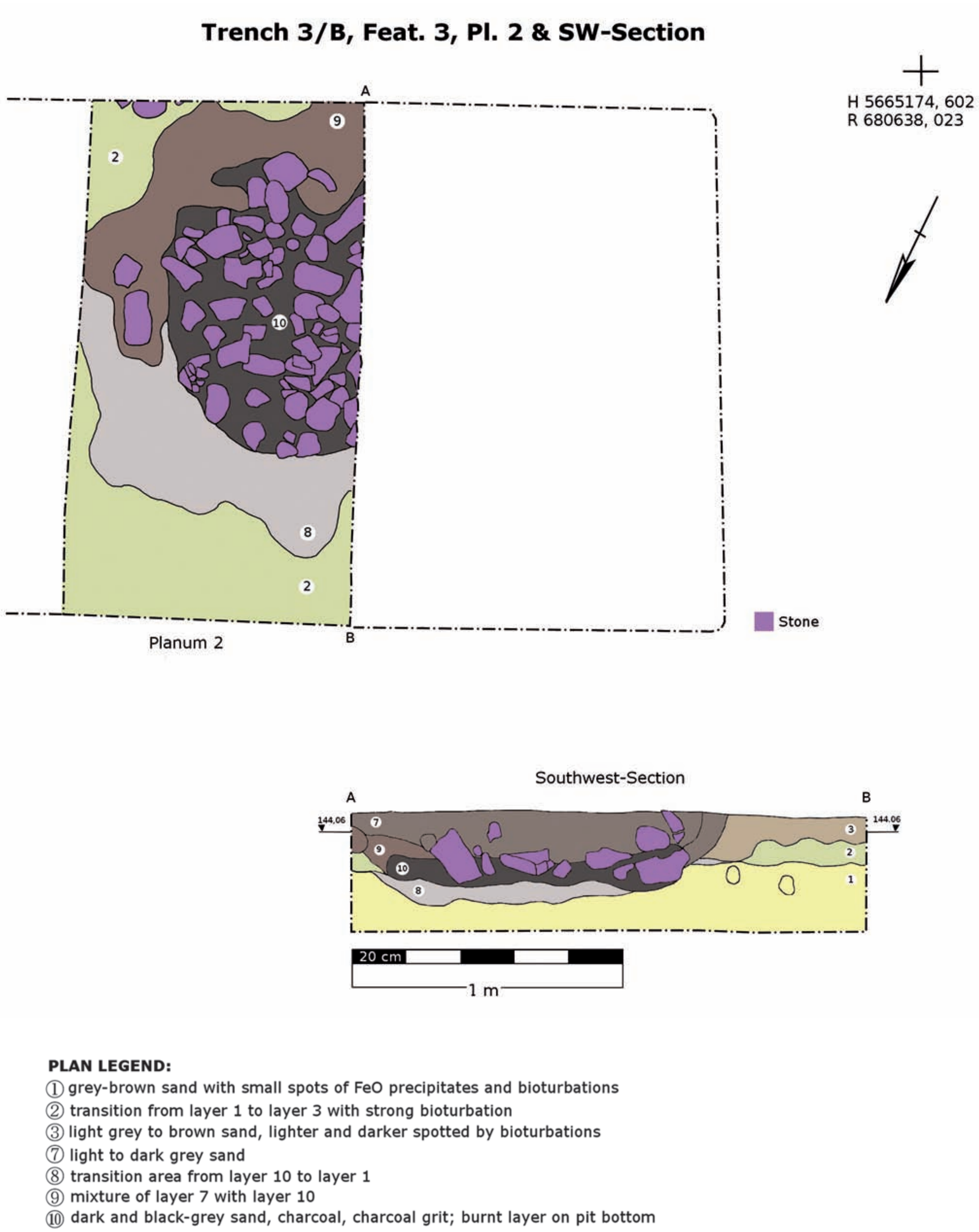

Fig. 27. Pielgrzymowice 5. Trench 3/B. Hearth (feat.3/3), planum 2 and southwest section
(drawing: M. Brumlich; graphic realisation: E. Lehnhardt)

Fig. 28. Pielgrzymowice 5. Trench 3/C. Pit (feat. 4/3), southeast section (photo: E. Lehnhardt)

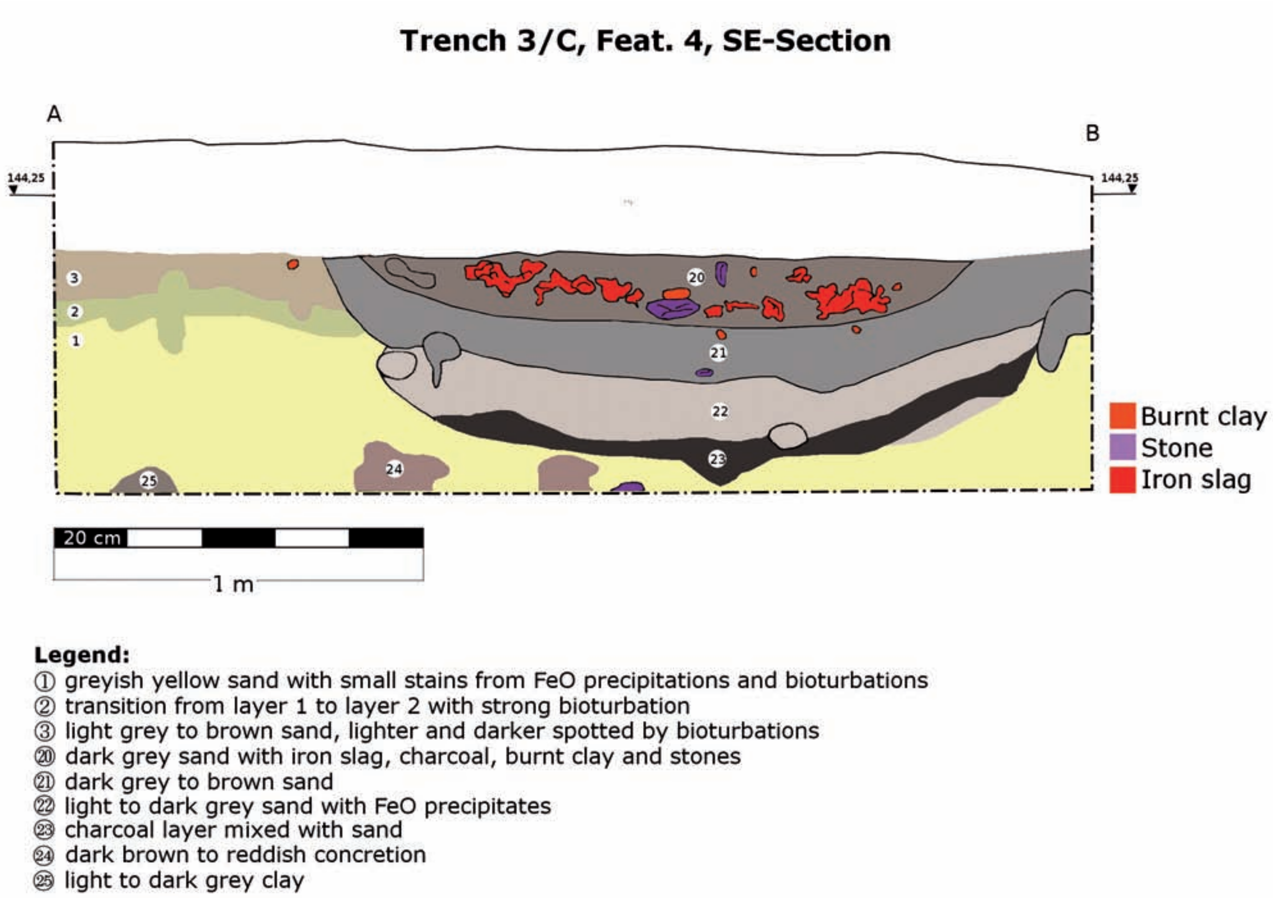

Fig. 29. Pielgrzymowice 5. Trench 3/C. Pit (feat. 4/3), southeast section
(drawing: B. Luban; graphic realisation: E. Lehnhardt)

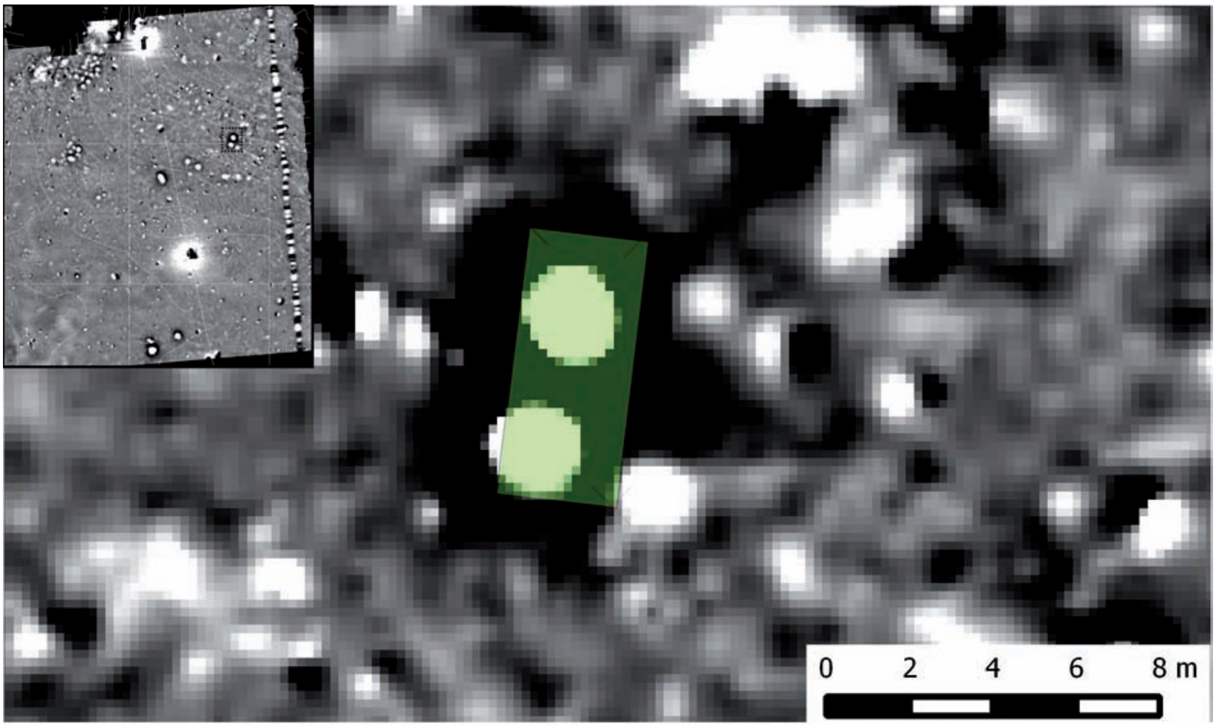

Fig. 30. Pielgrzymowice 5. Trench 4. Feat. 1/4 and 2/4 in the magnetic map, north-oriented (adapted from Ullrich and Freibothe 2013)

of millet, which were not cut close to the ground but only the panicles or spikelets were broken off or cut off.

Many millet finds are very pure, since the ripe panicles are cut individually. The panicles ripen in the order in which they appear so that multiple passes are often necessary until the millet is harvested. Furthermore, it follows that the charred millet finds from Pielgrzymowice probably originate from a single charring event. Otherwise, further discoveries would have been expected, i.e., more cereal grains and more weeds in higher numbers of species.

Millet is one of the summer crops with small fruits that are valuable for nutritional physiology and provide minerals in addition to carbohydrates, fat, and protein. Due to the lack of adhesive protein (gluten), however, it is hardly suitable for baking and is therefore used as mash, groat, and flatbread or as a whole grain for food. As mentioned above, harvesting can be done by simply cutting off or breaking off the panicles (Sigaut 1989, 523).

The state of research on agriculture with the help of archaeobotanical analysis differs greatly from region to region in the area of Przeworsk culture and from one era to the next. For the younger pre-Roman Iron Age, however, the database is considerably smaller than for the Roman period. In the older period, millet usually occurs alongside rye, emmer, and oats (Rodzińska-Nowak 2012, 98-99).

PHYTOLITH ANALYSIS

Phytoliths are bodies of opaline silica that are produced in cells and tissues of many plants (cf. Piperno 2006, 5-20). Next to their occurrence in several herbaceous and woody plant families phytoliths are particularly abundant and diverse in the grass family Poaceae (cf. Mulholland and Rapp Jr. 1992a; Pearsall and Piperno 1993; Piperno 2006). The shapes of phytoliths define a range of morphotypes, which are often diagnostic of specific plant taxa and of the plant parts where they formed (cf. Piperno 2006, 23-44). Most phytoliths are released into the soil from plant decay where they are stable under a variety of environmental settings (cf. Piperno 2006). Since plants are also particularly sensitive to climate and environmental change,

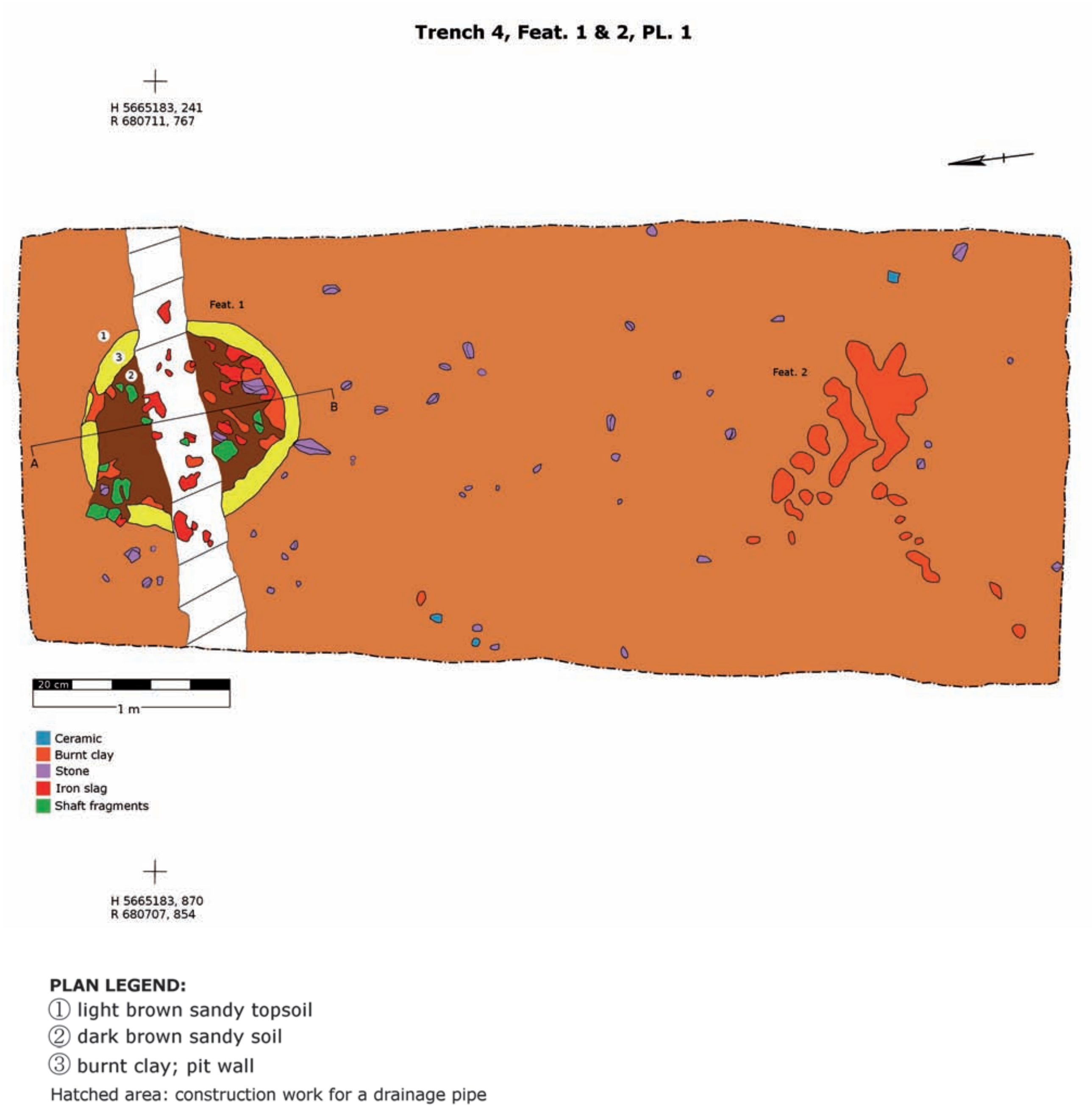

Fig. 31. Pielgrzymowice 5. Trench 4. Feature 1/4 and 2/4, planum 1
(drawing: P. Madera; graphic realisation: E. Lehnhardt)

phytolith assemblages are commonly used as proxies for reconstructing past vegetation patterns, as well as past environmental and climatic conditions (e.g. Coe et al. 2013; Cordova 2013; Neumann et al. 2009; Strömberg 2004).

In archaeology, the presence of phytoliths is well documented in numerous archaeological contexts and from different surfaces, including houses, rooms, or floors (e.g. Portillo et al. 2009; Sulas and Madella 2012; Tsartsidou et al. 2009), grinding stones (e.g. Dietrich et al. submitted; Öğüt 2016; Portillo et al. 2013), ceramic vessels (e.g. Saul et al. 2013), agricultural fields (e.g. Meister et al. 2017; Pearsall and Trimble 1984; Weisskopf et al. 2014) or livestock pens (e.g. Portillo et al. 2009; Shahack-Gross et al. 2005). Since biogenic opaline silica is generally unchanged by fire due to its high melting point (Canti 2003, 350), the examination of phytoliths in archaeological contexts related to fire and the use of fuel, i.e. hearths, ovens and ash layers,

Fig. 32. Pielgrzymowice 5. Trench 4. Furnace pit (feat. 1/4), planum 1 with a clearly recognizable disturbance (photo: E. Lehnhardt)

was done in several case studies (e.g. Albert et al. 2003; Portillo et al. 2017; Albert 2000; Esteban et al. 2018; Schiegl et al. 1994).

However, research on phytoliths from iron smelting contexts is lacking. In Poland, there are so far only a few phytolith studies in archaeology, which comprise only a small number of samples (Polcyn et al. 2001; Scott Cummings 2012; Saul et al. 2013). Therefore, the excavation in Pielgrzymowice is ideal to test the potential of phytolith studies in these contexts and to identify any evidence that might contribute to understanding them.

Phytolith analyses were carried out on a total of eight soil samples. Three samples were taken from one furnace and one sample each of three rectangular hearths, while two samples were taken from two potential pit houses (Tab. 4). Phytolith extraction was undertaken at the Freie Universität Berlin (Institute of Geographical Sciences, Laboratory of Physical Geography) and followed the procedures outlined by Albert et al. (1999). Approximately 1 g of air-dried sample material was treated with 10% hydrochloric acid, 13% nitric acid and 30% hydrogen peroxide solution to remove carbonates, phosphates, and organic material before it was mixed with a sodium polytungstate solution (density adjusted to c. 2.4 mg*g-3) to separate the phytoliths from other mineral components. Slides were mounted in Entellan New (Merck). The counting was performed using a Leica DM 2000 microscope at 400x magnification. A minimum number of 150 phytoliths with recognizable morphologies were counted in each sample. Unidentifiable phytoliths were counted and recorded as weathered morphotypes. The phytolith concentrations (number of phytoliths per gram of dry sediment) were estimated by relating phytolith amounts and weights of the processed sample material to the initial sample weights. Morphological identification of phytoliths and classification into plant groups, as well as subdivision into plant parts was based on standard

Fig. 33A. Pielgrzymowice 5. Trench 4. Iron smelting furnace (feat. 1/4): furnace pit section (photo: E. Lehnhardt)

Fig. 33B. Pielgrzymowice 5. Trench 4. Iron smelting furnace (feat. 1/4): furnace pit without backfilling (photo: E. Lehnhardt)

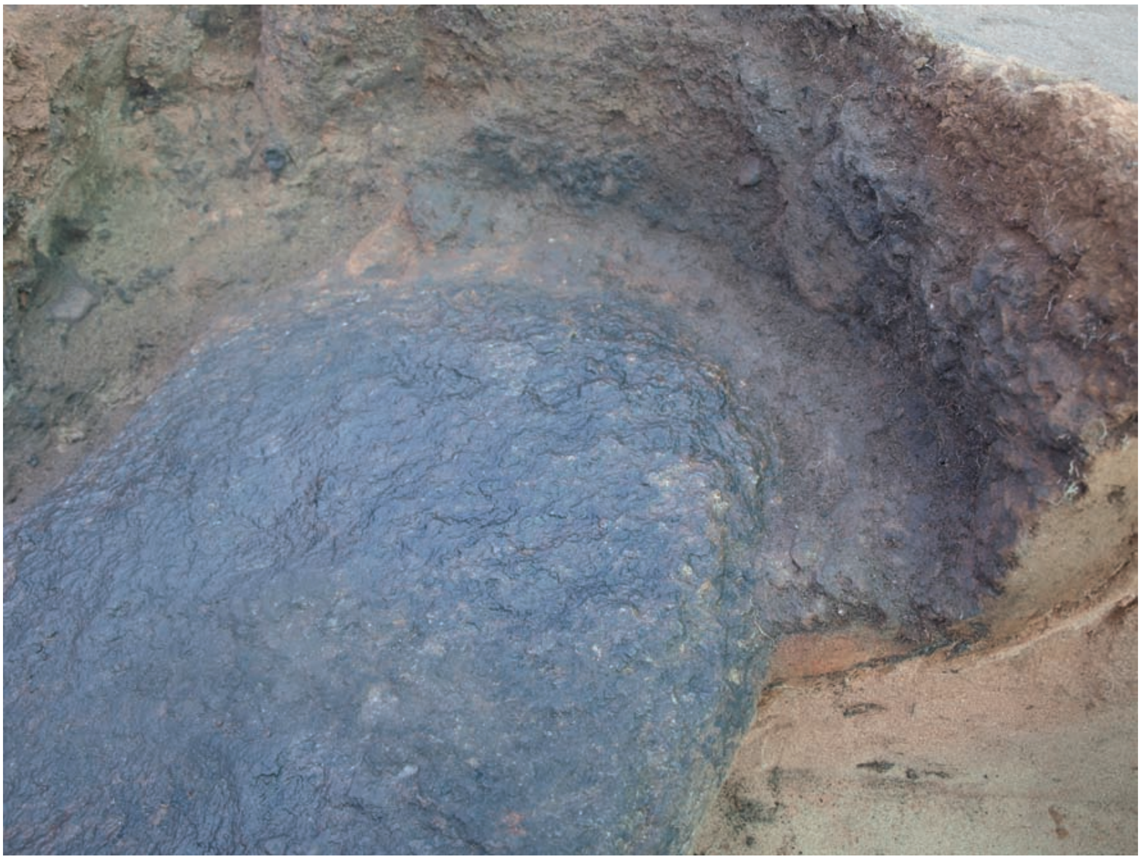

Fig. 33C. Pielgrzymowice 5. Trench 4. Iron smelting furnace (feat. 1/4): detail of pit bottom lining beyond the stone diameter (photo: E. Lehnhardt)

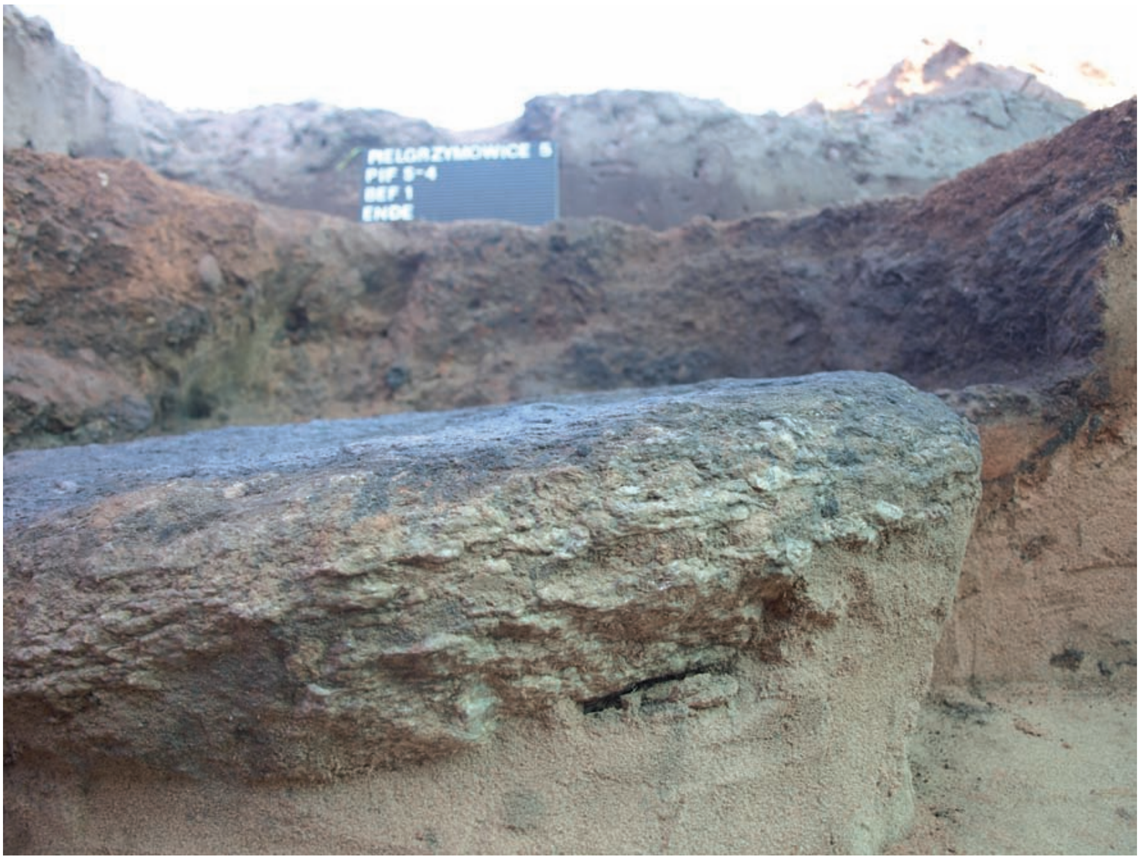

Fig. 33D. Pielgrzymowice 5. Trench 4. Iron smelting furnace (feat. 1/4): detail of the large stone on the pit bottom (photos: E. Lehnhardt)

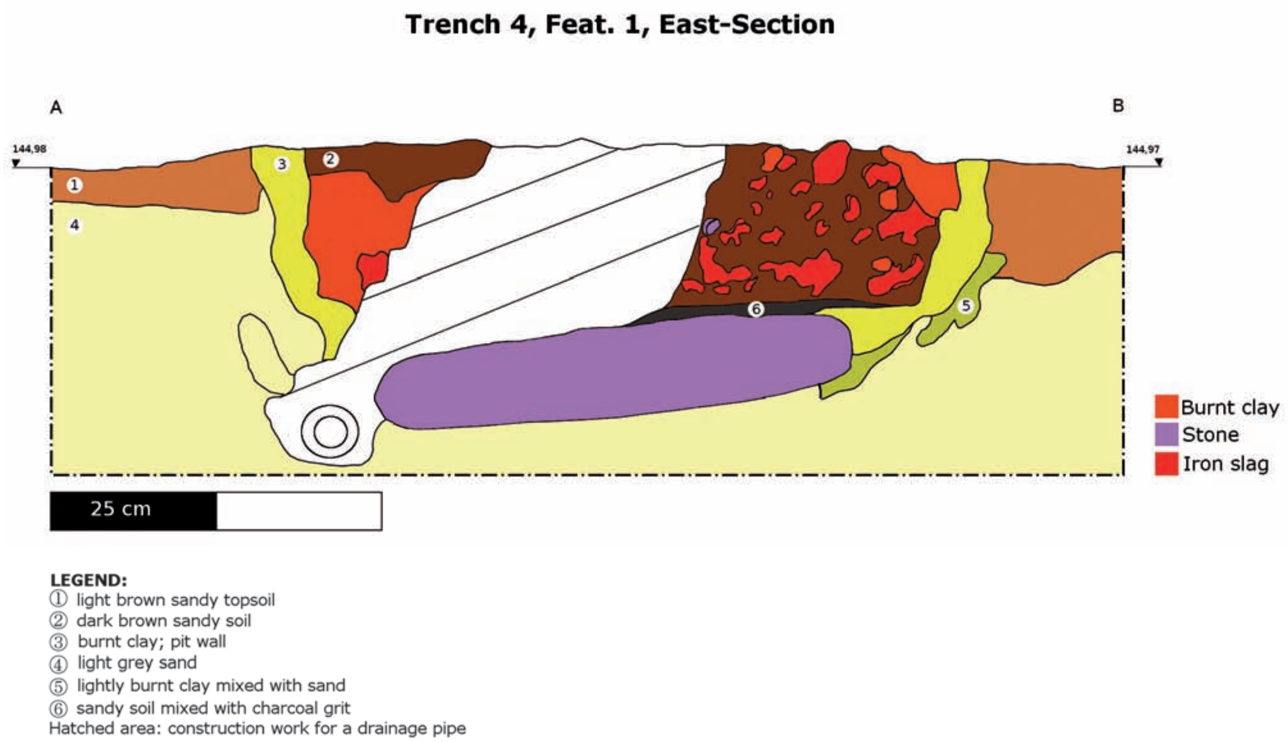

Fig. 34. Pielgrzymowice 5. Trench 4, Furnace pit (feat. 1/4), east-section (drawing P. Madera; graphic realisation E. Lehnhardt)

literature (Brown 1984; Mulholland and Rapp Jr. 1992; Piperno 2006; Twiss 1992; Twiss et al. 1969) and modern plant reference collections (e.g. Albert 2000; Portillo et al. 2014; Tsartsidou et al. 2007). The International Code for Phytolith Nomenclature was followed where possible (Madella et al. 2005).

Phytoliths were present in all samples examined, although phytolith abundances varied significantly ranging from 18,000 to about 1.4 million phytoliths per gram of sediment (Tab. 3). High proportions of weathered phytoliths in most samples (mean = 8.5%, σ = 6.0%, n = 8; Fig. 43a; Tab. 4), together with the general absence of multicellular phytoliths, are an indication of a poor preservation of the assemblages which can be attributed to a variety of depositional and post-depositional processes (cf. Alexandre et al. 1997; Cabanes et al. 2009; Fraysse et al. 2009; Jenkins 2009; Madella, Lancelotti 2012; Shillito 2011). The highest phytolith concentration of 1.4 million phytoliths per g of sediment is reported for a rectangular hearth (sample H-3) whereas the lowest phytolith amount was recognized from a pit house (sample PH-1).

According to the morphological analyses, the samples are overall similar in their morphotype assemblages (Fig. 43a; Tab. 4). Grass phytoliths, occurring at a rate of about 83.9% (σ = 7.7%, n = 8), were the most common group identified. According to their short cell morphologies, grasses belong mostly to the C3 Pooid subfamily. With an average value of 7.6% (σ = 2.7, n = 8), the amounts of woody dicotyledonous phytoliths are generally low.

The phytolith concentrations of the furnace samples vary markedly (Tab. 4), although all samples were taken from only one furnace and the same stratigraphic layer. This shows that, if possible, multiple sampling of an archaeological context is recommended in order to obtain a comprehensive picture. With regard to the high amounts of charcoal within the sampled furnace (see macrobotanical results), the very small amounts of woody phytoliths are somewhat surprising and not yet understood. However, the high abundance of phytoliths from grasses, together with the small amounts of shrubby and woody dicotyledonous phytoliths, might indicate that next to wood as major form of fuel, grasses, herbs and small branches derived from trees and brushes were used to light fires.

The two samples from the two potential pit houses have different phytolith concentrations, with one sample (PH-2; Tab. 4) containing about ten times more phytoliths than the other sample

Fig. 35. Pielgrzymowice 5. Trench 5 (feat.1/5–8/5), planum 1. Southwest view (photo E. Lehnhardt)

Fig. 36. Pielgrzymowice 5. Trench 5, Hearth 4 (feat. 4/5), planum 1 and east-section (photos: E. Lehnhardt)

(PH-1). While the observation of an almost complete absence of phytoliths in sample PH-1 belongs to a layer characterized by fired clay and charcoal flakes (see sections above), the pit house sample PH-2 is characterized by high phytolith amounts. Since the macrobotanical material of the latter sample consist almost exclusively of millet grains, it can be assumed that a large proportion of the grass phytoliths in this context derived from the targeted use and processing of millet as well. While proso and foxtail millet belong to the Panicoideae subfamily, the phytoliths short cell morphology also shows the presence of grasses from the Pooideae subfamily, which includes some major cereals such as wheat,

Fig. 37. Pielgrzymowice 5. General excavation plan of trench 5, Feat. 1-8, planum 1 (drawing M. Baranski; graphic realisation E. Lehnhardt)

barley, oats, and rye. The absence of the latter cereal residues in the macrobotanical dataset could be due to the differential degradation of organic material.

The phytolith contents of the three hearth samples vary enormously, ranging from the near absence of phytoliths in sample H-1 (Tab. 4) to 1.4 million phytoliths per gram in sample H-3. These results show that different hearths contain different phytolith concentrations and assemblages, presumably reflecting different types of fuels used for making the fires. Especially the high amount of grass phytoliths in sample H-3 speaks for the ignition of fires with grasses. The targeted burning of grass leaves to produce dense smoke may have been necessary to treat certain foods (Albert and Cabanes 2008).

DATING IRON SMELTING

The chronological classification of the site is based on different sources of relative and absolute dating. Because of ceramic fragments, the settlement period extends from the pre-Roman Iron Age to at least the end of the Roman period.

A very small faceted rim fragment remains singular, which was picked up when trench 4 was laid out. It was still in the area of the topsoil and thus in the plough horizon. The distinctive faceting is typical for ceramic vessels of phases A1 to A3, whereby such structures in A3 are not so distinct anymore (cf. Dąbrowska 1988, 14-62). The fragment of the former vessel should thus date into the early phases or at least to the transition from A2 to A3, but it can by no means date the furnace exposed in section 4, for which no ^{14}C data are available.

Ceramic vessels with a distinct foot ring, as found in one of the rectangular hearths in trench 5 (see below Fig. 42), do not appear in Przeworsk culture until phase B_2 at the earliest (cf. Dąbrowska 1988).

The radiocarbon data of charcoals from different features of trenches 1 to 3 and 5 (Tab. 5, Fig. 44) give a better understanding of settlement history. According to the ^{14}C data, the two potential pit houses in the southern part (trench 1 and 2) are from the 3rd to 1st century BC.

The radiocarbon ages of charcoal from the furnace (feat. 1/3) and the two adjacent hearths (feat. 2/3 and 3/3) in trench 3 are approximately the same.

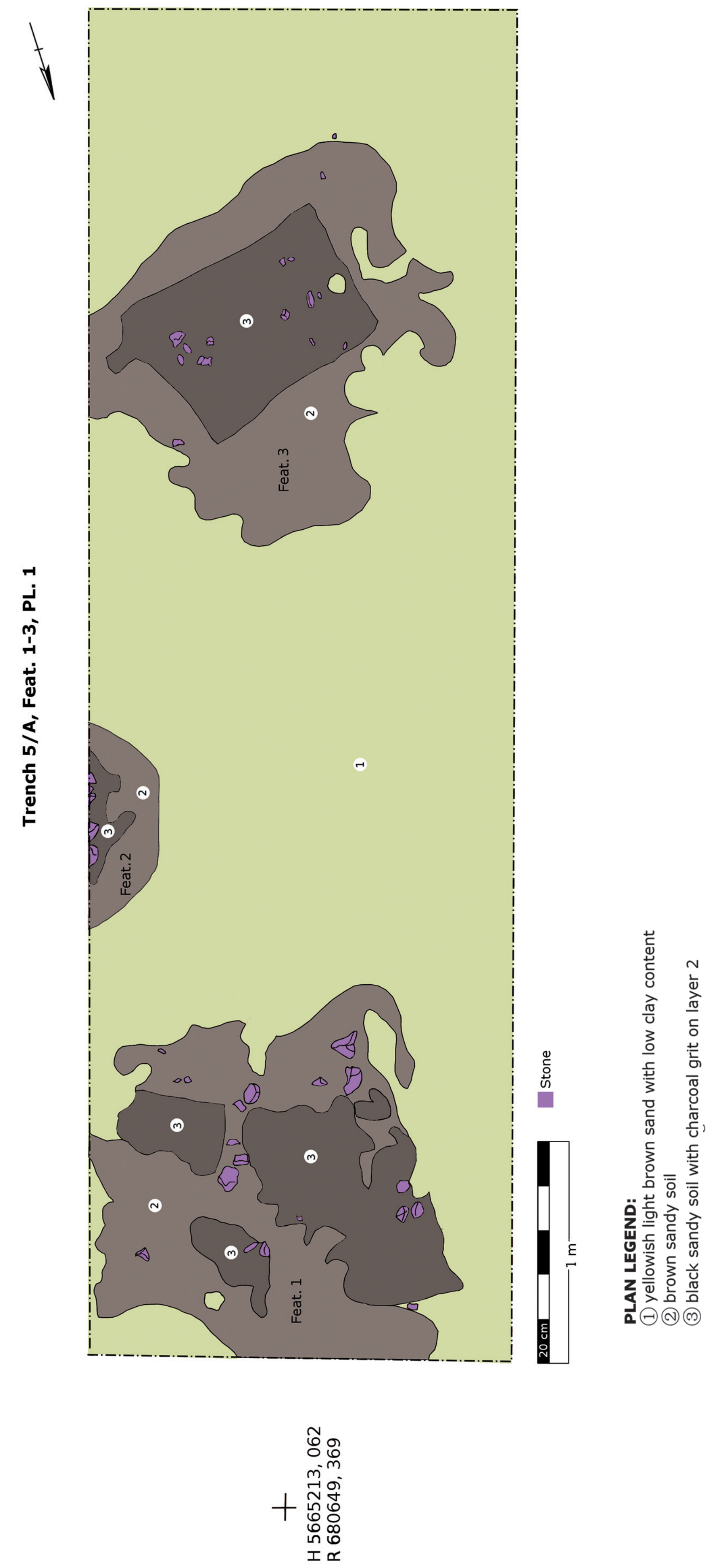

Fig. 38. Pielgrzymowice 5. Trench 5/A, Feat. 1-3, planum 1 (drawing M. Baranski; graphic realisation E. Lehnhardt).

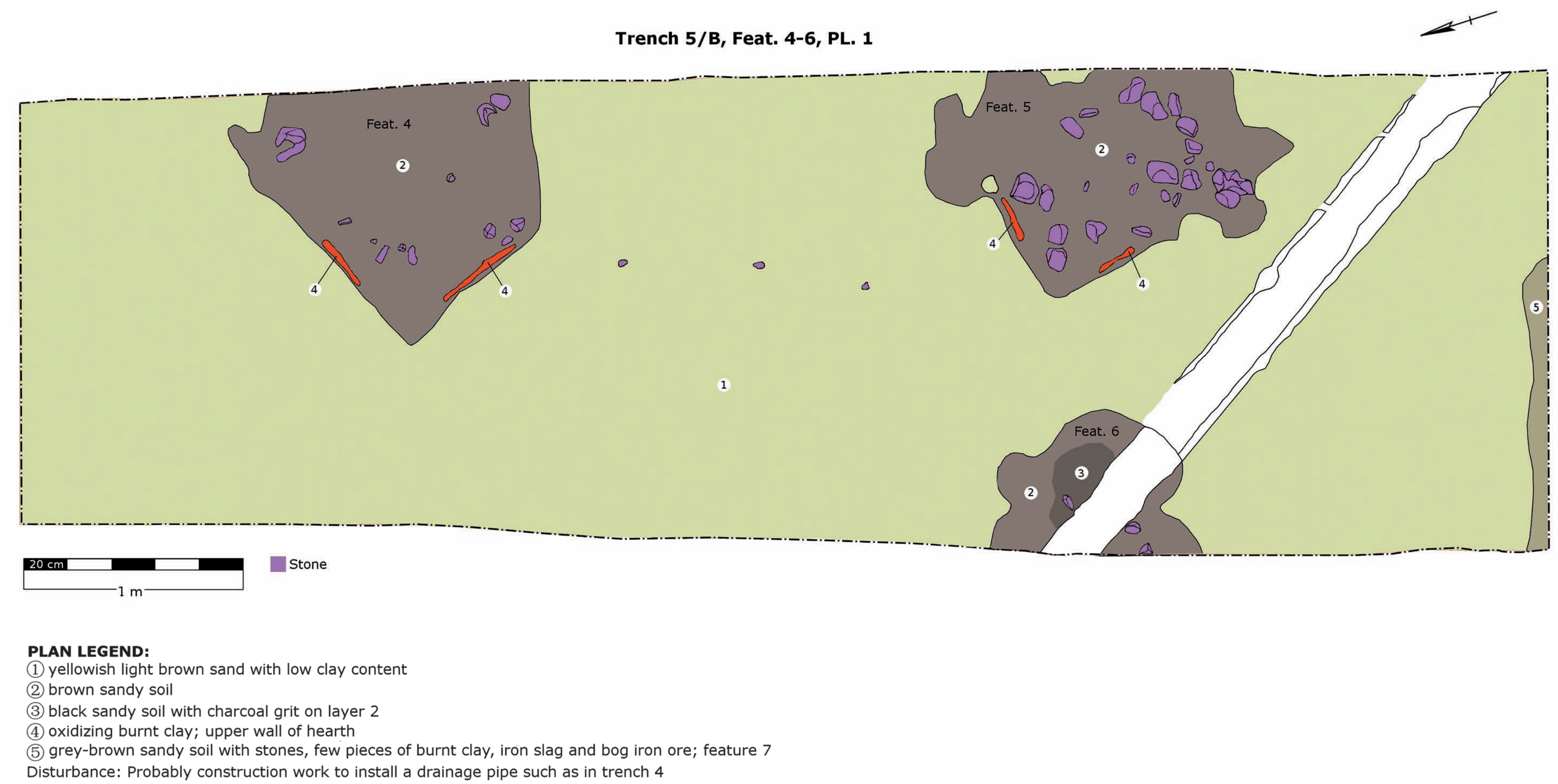

Fig. 39. Pielgrzymowice 5. Trench 5/B, Feat. 4-6, planum 1 (drawing M. Baranski; graphic realisation E. Lehnhardt)

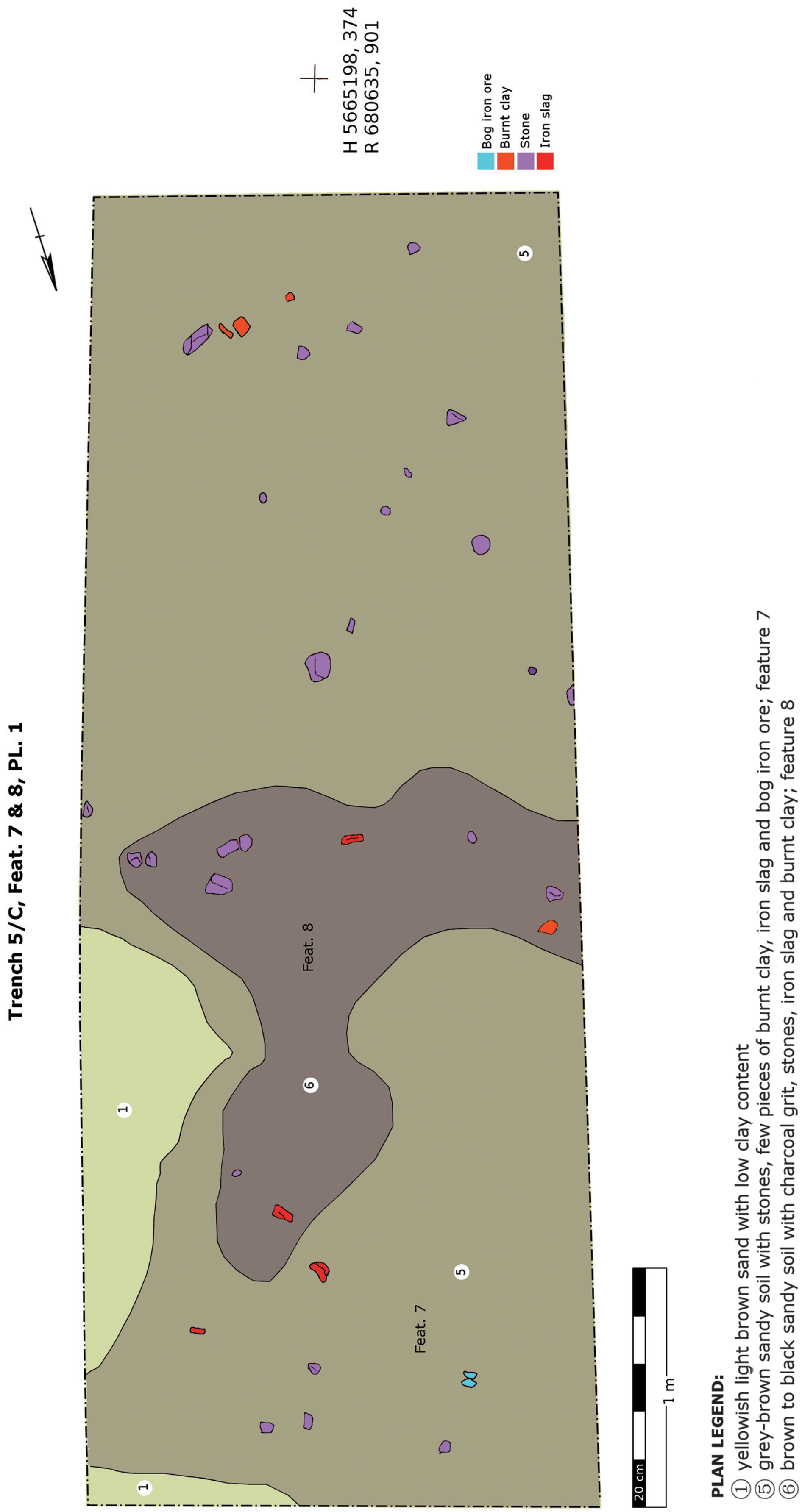

Fig. 40. Pielgrzymowice 5. Trench 5/C, Feat. 7&8, planum 1 (drawing M. Baranski; graphic realisation E. Lehnhardt)

Fig. 41. Pielgrzymowice 5. Trench 5. Stone artefact from hearth 4 (feat. 4/5) (photo: E. Lehnhardt)

Fig. 42. Pielgrzymowice 5. Trench 5. Ceramic vessel from hearth 3 (feat. 3/5) (photo: E. Lehnhardt)

They were definitely used in the 3rd or 4th century AD. The bottom layer of the pit (feat. 4/3) in the same trench has a slightly older date, which might be explained by older woods. However, a relative contemporaneity at least for the 3rd century AD arises for all excavated features in trench 3.

Due to its similarity in size and structure to the furnace from trench 3, the furnace in trench 4 can probably also be dated into the middle to late Roman period.

The radiocarbon age of the charcoal sample from the hearth (feat. 4/5) in trench 5 is the oldest date from the Roman period, but it still dates within the two-sigma range into the middle of the 2nd century AD. Since smelting slag, which presumably originated from the furnace of the adjacent trench 3, was found in planum 1 of trench 5 and in two hearths (feat. 3/5 and 4/5), the hearths might be slightly younger or more likely contemporaneous with the features in trench 3.

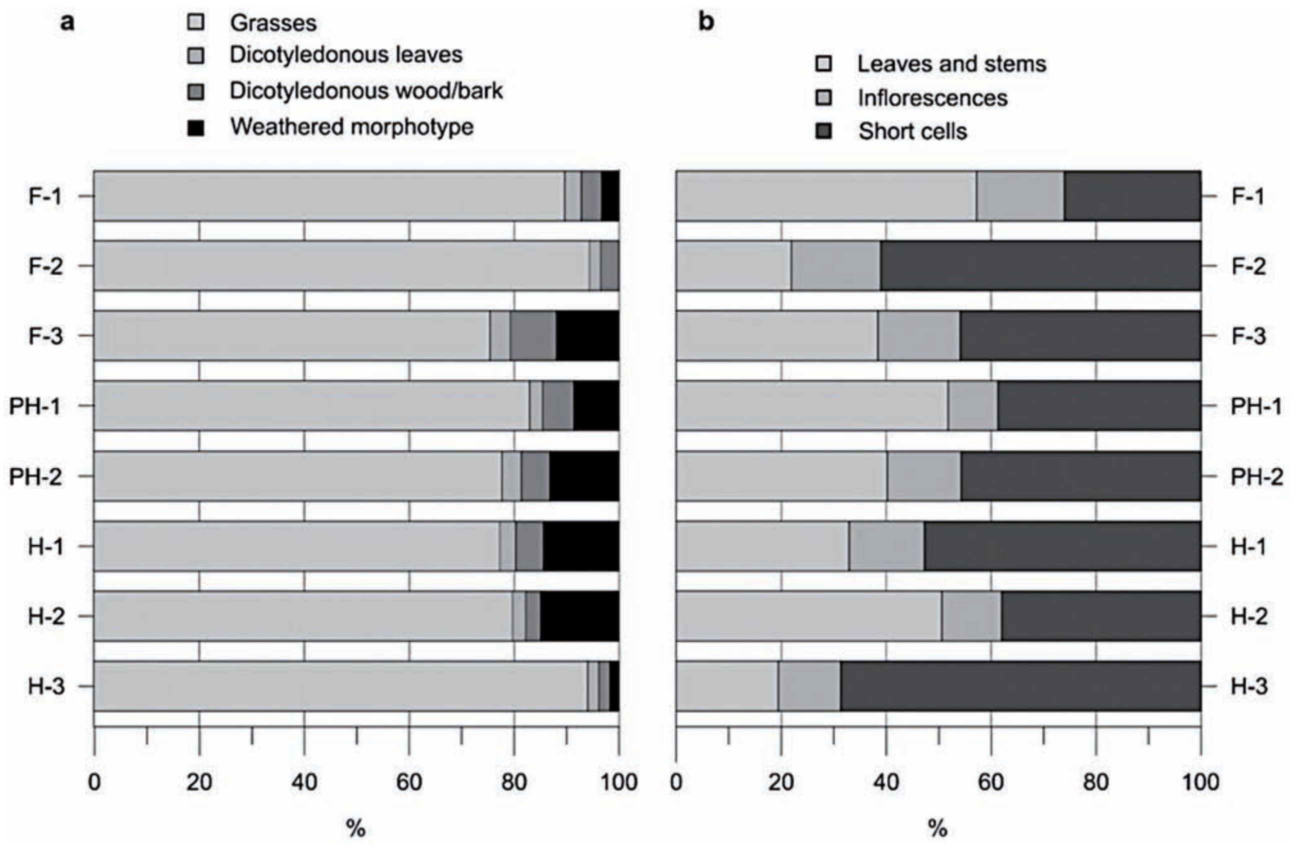

Fig. 43. Pielgrzymowice 5. a: Relative abundances of phytoliths; b: Anatomical origin of grass phytoliths (graphic: J. Meister)

The charcoal sample Poz-68384 from the furnace in trench 3 with a radiocarbon age of **1900±30 BP** comes from the outermost layer of a 4 cm thick and 10 cm long heartwood. According to information from K.-U. Heußner (German Archaeological Institute, Berlin), the total diameter of the former tree must have been at least 30 cm. This would also explain the temporal deviation (old-wood effect) to charcoal sample Poz-68385 from the same furnace and the same charcoal layer with a radiocarbon age of **1690±30 BP**.

According to the available data, it is evident that the AZP dating of the site into the younger pre-Roman Iron Age is in principle not wrong. However, this can only refer to the two possible pit houses in the south of Pielgrzymowice 5. The iron smelting and thus the surface finds of slag belong to the much younger settlement phase, which presumably cannot be deduced from a continuous settling since the younger pre-Roman Iron Age. The present state of research, which results from our trial trenching, shows a clear chronological and spatial separation of settlement phases between the younger pre-Roman Iron Age in the southern part and the middle to younger Roman period in the northern area.

POSSIBLE PRODUCTION VOLUME

Our investigation yielded iron slag with a total weight of approx. 230 kg, which could be recovered by the field survey and the excavation. Including losses of slag removed from the field in the course of time by agricultural activities and slag, which may still be present in unrevealed features in the vicinity of the furnaces (such as the partially excavated pit, feat. 4/3, in trench 3), allow to estimate the assumed total weight of slag from both furnaces to at least 250 kg.

An ideal-typical calculation (cf. Brumlich 2010, 81) would result in a theoretical bloom weight of 50 kg, which in turn could theoretically have provided 25 kg of wrought iron. After deducting the losses from forging into a bar and finally to various devices, weapons or tools, both furnace campaigns

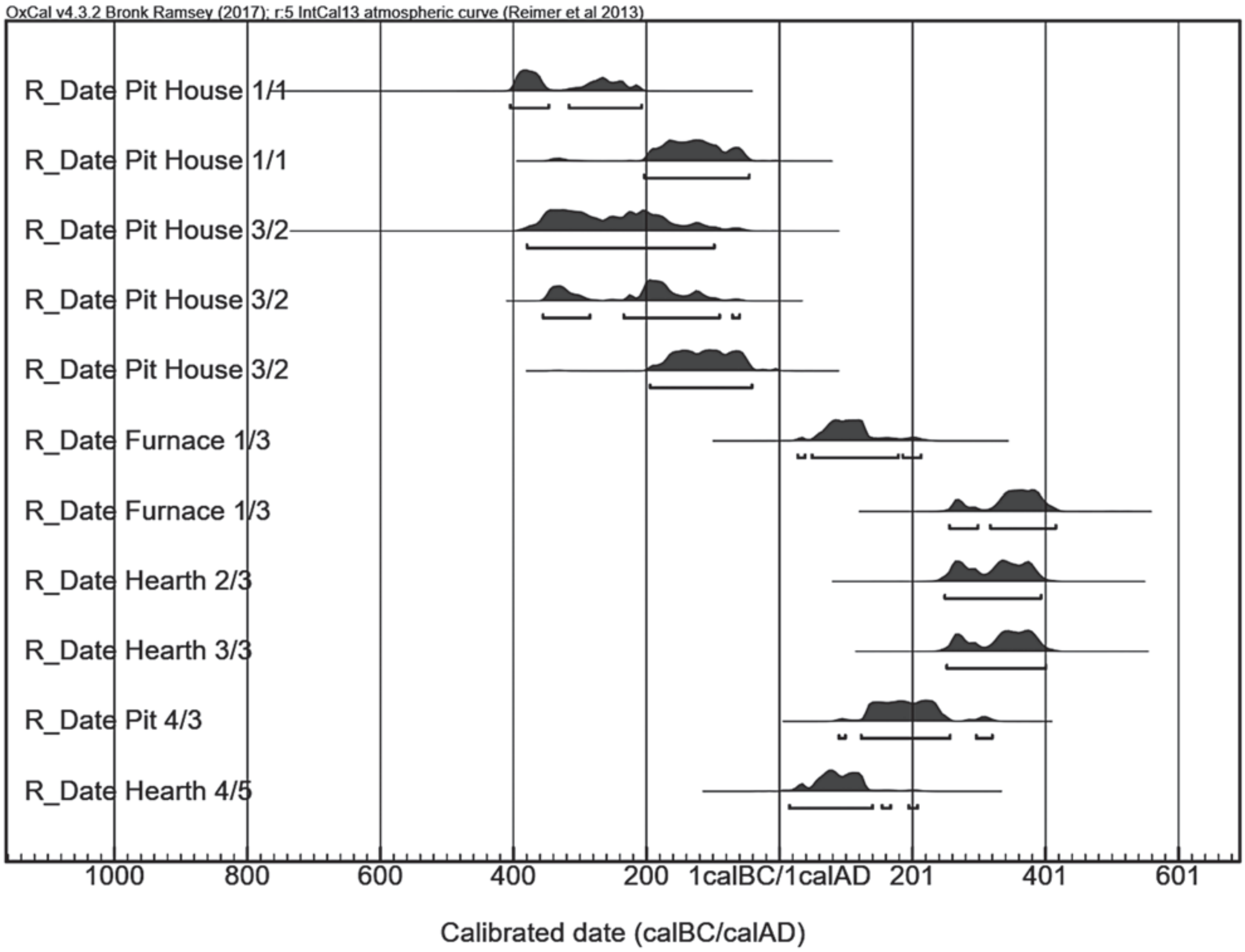

Fig. 44. Pielgrzymowice 5. Radiocarbon dating multiplot (Oxcal. V4.3.2 Bronk Ramsey 2017; rr:5 intelCal13 atmospheric curve Reimer et al 2013)

could have produced the raw material for iron objects weighing a total of 14 kg. Since the spatial position of both furnaces certainly also reflects a temporal dimension of iron smelting, the assumed 7 kg of iron objects that eventually could have been produced per furnace campaign would indicate that iron smelting was probably focused on local supply (cf. Brumlich 2010, 81). This assumption would have to be examined by further excavations.

CLASSIFICATION OF FURNACES IN THE REGIONAL CONTEXT

The furnaces of Pielgrzymowice 5 belong to a group that P. Madera has subsumed under the classification of furnaces with a “very big” slag pit (Fig. 45; Madera 2008). Furnaces with this characteristic have so far been found at 25 sites in Silesia, among all 57 sites with the furnaces relics, from very beginning of Przeworsk culture till its final stage (Pazda 1994, 103-105). Even though the furnace pits are very big and have diameters between 80 cm and 140 cm, they are not a uniform group in detail. In addition to different diameters, it is above all the construction of slag pits whose profiles cover a spectrum from cylindrical to conical to bell-shaped and domed. Moreover, this is not a phenomenon that can be observed only between different sites. Also, within a single site, such variants occur in the slag pit shape (cf. Madera 2008).

In addition to the recently excavated furnaces in Pielgrzymowice, other specimens from the settlement of Domasław (Wrocław county) can be added, ones which were excavated between 2006 and 2008. During that excavation work, features of La Tène culture from phase Lt B2 and Przeworsk culture from the younger pre-Roman Iron

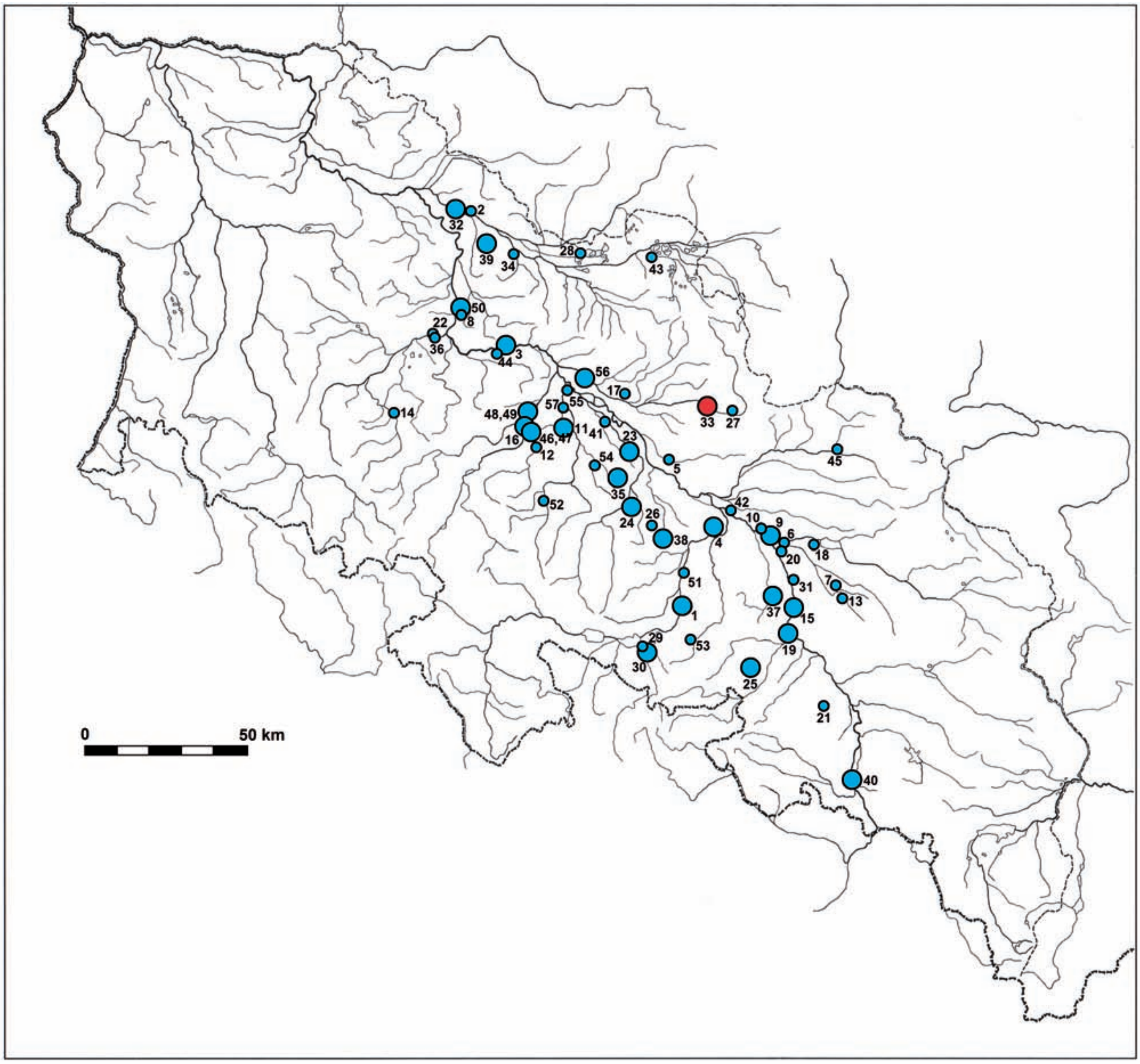

Fig. 45. Sites with remains of the Przeworsk culture bloomery furnaces within the borders of Silesia. Locations of furnaces with 'very big' slag-pit are distinguished by larger circles. Pielgrzymowice 5 site is marked in red (preparation: P. Madera).
Sites: 1 – Bielice 1; 2 – Borszyn Mały No. ?; 3 – Brzeg Dolny 60; 4 – Buszyce 9; 5 – Bystrzyca 4; 6 – Czarnowąsy 18; 7 – Daniec 7; 8 – Dębno 14; 9 – Dobrzeń Mały 8; 10 – Dobrzeń Wielki 2 (Chróścice 1); 11 – Domasław 10-12; 12 – Gniechowice 4; 13 – Izbicko 2; 14 – Jawor No. ?; 15 – Kąty Opolskie 8; 16 – Kąty Wrocławskie No. ?; 17 – Kiełczów 2-3; 18 – Kotórz Mały 1; 19 – Krapkowice 12; 20 – Krzanowice 23; 21 – Ligota Wielka 5; 22 – Lisowice 62; 23 – Lizawice 3; 24 – Miechowice Oławskie 12; 25 – Mionów 1, 2 and 13; 26 – Młodoszowice 1; 27 – Namysłów 69; 28 – Niezgoda 2; 29 – Niwnica 2; 30 – Niwnica 9; 31 – Opole-Malina 114 (Opole-Groszowice 1); 32 – Osetno Małe-Kietlów (Kietlów) 1; 33 – Pielgrzymowice 5; 34 – Płoski 3; 35 – Polwica 4-5 and Skrzypnik 8; 36 – Prochowice 59; 37 – Prószków 2; 38 – Przylesie Dolne 6; 39 – Psary 1; 40 – Racibórz 426; 41 – Radwanice 2; 42 – Rybna 3; 43 – Sławoszowice 16; 44 – Słup 5; 45 – Smardy Górne 12; 46 – Sośnica No. ? (I); 47 – Sośnica No. ? (II); 48 – Stoszyce 5; 49 – Stoszyce No. ?; 50 – Tarchalice 1; 51 – Tłustoręby 1; 52 – Trzebnik 2; 53 – Wielkie Łąki (Niewola) No. ?; 54 – Wilkowice 8 and Stary Ślęszów 16; 55 – Wrocław-Kozanów 3; 56 – Wrocław-Widawa 21; 57 – Wrocław-Żerniki 1

Age (phase A2) up to the Migration period were exposed. Among the features of Przeworsk culture are numerous houses, limekilns, fireplaces, etc., as well as 61 furnaces. The diameters of the slag pits are between 30 x 28 cm and 108 × 98 cm. Thus, all those with more than 80 cm can be classified as furnaces with a 'very big hearth'. However, it is not possible to date the smelting furnaces of Domasław into a certain relative chronological phase of Przeworsk culture. Unfortunately, radiocarbon data are not available (Suchan 2009, 196-197; Żygadło 2012, 492-493).

Another furnace with a 'very big' slag pit was found in the settlement of Wrocław-Widawa apart from other furnaces (cf. Baron 2014, 283-285). Since radiocarbon dating is missing, it is not possible to date the iron smelting exactly. Due to its remote location in relation to the residential area, it is believed that all furnaces date to the Roman period.

It is difficult to match the feature from Pielgrzymowice to an exact variant of the furnace with 'very big' slag pit. In this case we can observe the use of a stone as the support of the slag's construction in the bottom of the pit, it seems therefore that a close analogy is known from the site at Dobrzeń Mały 8 (Tomczak 1979). The spatial position of the bloomeries excavated at our site most likely represents the temporal type of iron production. However, the workshop represents a very innovative trend of smelting, something typical in general for the region of Silesia in the Roman period in comparison with other production centres (cf. Orzechowski 2013, 187-211).

PIELGRZYMOWICE 5 AND ITS SETTLEMENT CONTEXT

For a proper discussion of the metallurgy site in Pielgrzymowice it is necessary to describe its settlement and cultural context. As described previously, it is situated in the Widawa river valley, and the area should be associated with the Widawa region of the Przeworsk culture's settlement activity, as distinguished by S. Pazda (1980). It must be emphasized that settlement activity in the lower course of the river, in the area closest to the Oder river, is identified with the region of Bystrzyca and Oława (Pazda 1980, 142-147). The Widawa region includes three smaller micro-regions. The sites in Pielgrzymowice belong to the biggest one, the Namysłów micro-region, and are located near its western border.

The region emerged in the pre-Roman period, the oldest archaeological sites seem to come from phase A2 – there is no evidence for earlier settlement activity connected with this culture. Prior to that, a well-developed concentration of settlements of Pomeranian culture functioned in this area (cf. Pazda 1970, map).

Quite a high number of sites dated to the pre-Roman period, located in this micro-region, form smaller groups concentrated near the Widawa river. The biggest group existed in the vicinity of the modern town of Namysłów, in the area of the confluence of several tributaries of the Widawa River: the Łózka, Strzałka, and Chęszcząca. The sites in Pielgrzymowice constitute a smaller, western group where many small tributaries of the Widawa form a dense network of marshes along its main course (Fig. 46). Additionally, more than ten sites are scattered in the periphery of the micro-region, especially in the north and south-east. It is very difficult to establish the chronology of the sites. They include just a few cemeteries (not confirmed during regular excavations), where artefacts which could be used for dating the site with a high degree of precision can usually be found. Apart from that, very few sites have been excavated, most are known only from surface surveys (Kosicki 1996; Kosicki 2002).

Many fewer sites of the Namysłów micro-region are dated to the early Roman period. This area is another case of very few excavated sites. It is difficult to distinguish between phases B1 and B2. Nevertheless, it is obvious that the Namysłów micro-region and the whole settlement activity associated with the Widawa river were subjected to processes and transformations comparable with the ones experienced by the main population of the Przeworsk culture in Lower Silesia (Pazda 1980, 4146, 98; Godłowski 1985, 139-142). Although, as already mentioned, we do not know many precisely dated sites, it can be supposed that phase A3 of the pre-Roman period was a time of marked demographic regression that persisted until phase B1. The settlement network was re-established only in phase B2, however, not always in the areas occupied previously.

This development was even more intense in the subsequent phases of the Roman period, particularly in phase C1. In phase C2 – that is, in the late 3rd and early 4th century – settlement activity continued to develop, but it is clear that the biggest concentration of settlements transferred towards the confluence of the Widawa and the Odra rivers. This is definitely connected with the functioning

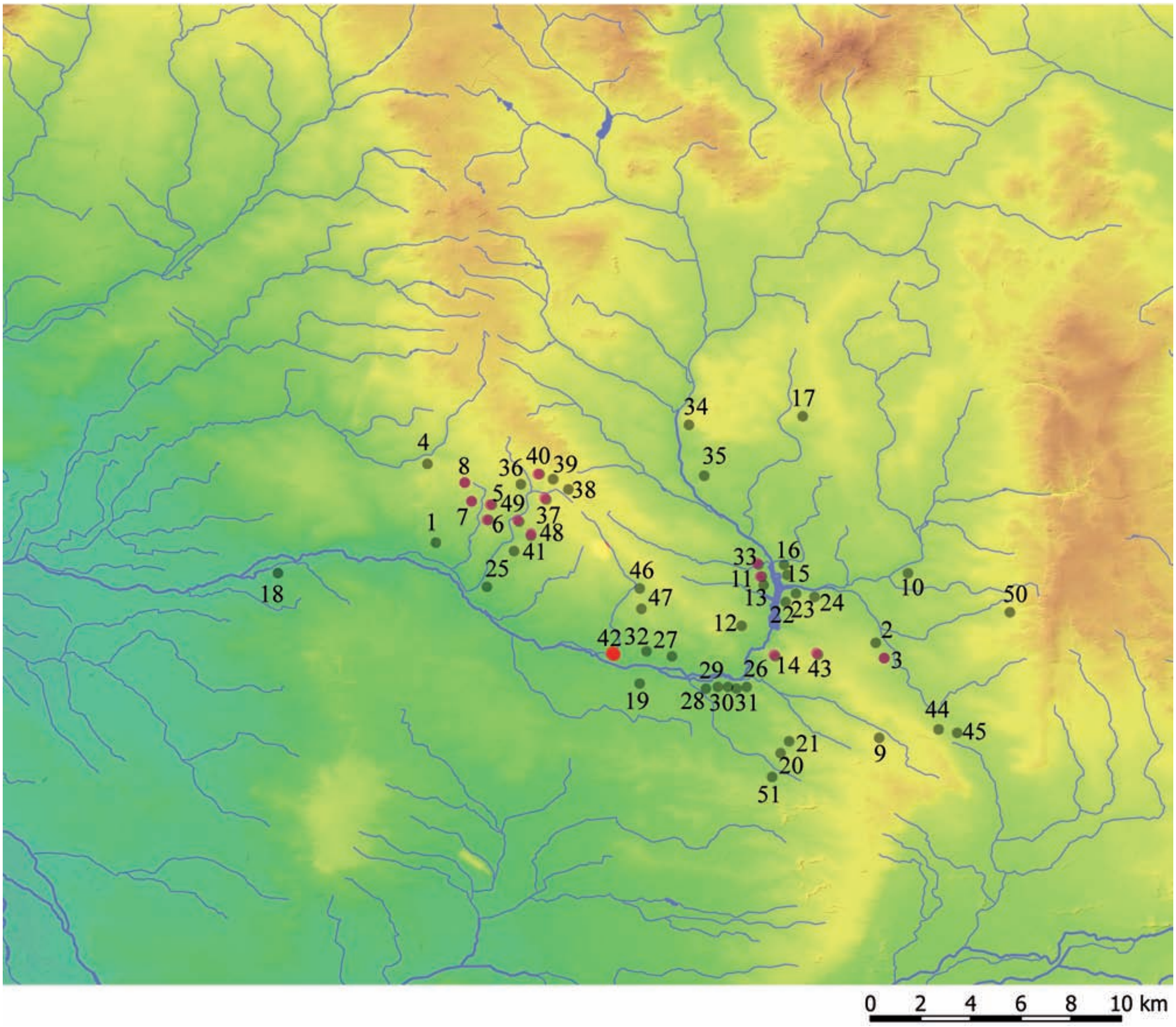

Fig. 46. The Namysłów micro-region of the Przeworsk culture settlement. Pielgrzymowice marked in red, sites with iron smelting traces marked in violet. Sites: 1 – Bierutów 8; 2 – Bukowa Śląska 30; 3 – Bukowa Śląska 31; 4 – Bukowie 8; 5 – Bukowie 16; 6 – Bukowie 17; 7 – Bukowie 19; 8 – Bukowie 20; 9 – Gręboszów; 10 – Igłowice 2; 11 – Juskie 4; 12 – Juskie 5; 13 – Juskie 6; 14 – Kamienna 6; 15 – Kowalowice 21; 16 – Kowalowice 23; 17 – Kowalowice 35; 18 – Kruszowice 1; 19 – Ligotka 2; 20 – Łęczany 4; 21 – Łęczany 5; 22 – Michalice 6; 23 – Michalice 11; 24 – Michalice 12; 25 – Młokicie 3; 26 – Namysłów 25; 27 – Namysłów 31; 28 – Namysłów 37; 29 – Namysłów 38; 30 – Namysłów 39; 31 – Namysłów 57; 32 – Namysłów 69; 33 – Objazda 2; 34 – Pawłowice 17; 35 – Pawłowice 23; 36 – Pągów 5; 37 – Pągów 6; 38 – Pągów 9; 39 – Pągów 10; 40 – Pągów 11; 41 – Pągów 13; 42 – Pielgrzymowice 5; 43 – Rychnów 7; 44 – Strzelce 1; 45 – Strzelce 3; 46 – Wilków 2; 47 – Wilków 5; 48 – Wojciechów 4; 49 – Wojciechów 5; 50 – Woskowice Małe 15; 51 – Ziemiełowice

of a centre of power, at least at a regional level, in this area. The relics of this centre of power include the famous tombs of princes at Wrocław-Zakrzów (Błażejewski 1998, 100-101,192; see former literature). In the migration period, the shift of the settlement activity of the whole region southwards was even more notable, but it did not result in a complete depopulation of the Widawa river basin or of the researched micro-region. This is in accordance with the tendency observed in the whole territory occupied by Przeworsk culture (Godłowski 1985, 91-92; Błażejewski 2013).

As indicated above, iron production at Pielgrzymowice should be associated with the Roman period, and more precisely, with its middle and late part. The absence of well dated and archaeologically researched sites among the ones located in the micro-region, especially of cemeteries with precisely dated burial assemblages, poses a certain difficulty in confirmation of this supposition. Nevertheless, it can generally be concluded that settlement activity developed with greatest intensity in this period, mainly in phase C1. This is indicated by discoveries of Roman coins which come exclusively from this period (Ciołek 2008, 154-155).

The relatively high number of discoveries of iron slag and iron ore in the area of the Namysłów micro-region were also made mainly at sites dated to the beginning of the late Roman period. Thus it is most likely that a considerable number of Przeworsk culture settlements emerged and developed there in connection with the production of this metal. The sites in Pielgrzymowice also belong to this group. It can be concluded that this is an analogy to the situation observed in the Barycz river basin, or generally – in other regions of the Przeworsk culture settlement activity in (Błażejewski 2011, 132-133). It is impossible to evidence connections between the metallurgy of the area of the Widawa river and traditions of the La Tène period, or, even less, with technologies used by Celts. The results of the research at the sites in question confirm facts established in this field by S. Orzechowski (Orzechowski 2013, 285).

SUMMARY

Two settlement phases can be distinguished on the field of site no. 5, which, according to the current state of research, are also spatially separated. In the south there is a small settlement complex of the younger pre-Roman Iron Age, which has been proven so far by two archaeological features that are presumably pit houses.

In the northern part of the field, the magnetic map shows many anomalies. Three sondages reveal that iron smelting was carried out at two different locations. In the third section, however, several rectangular hearths filled with stones were excavated. Radiocarbon dating from one furnace and other features clearly indicate a settlement complex of the Roman period from the 3rd to 4th century AD.

Pielgrzymowice 6 does not provide evidence of iron production. However, it was possible to prove that Pielgrzymowice 4 is an iron smelting site that was hitherto unknown. Iron smelting there could also date back to the Roman period, as is the case at site no. 5. This is supported by the spatial proximity of both sites and the very similar topographical location as well as from the same ceramics. Of course, this thesis would have to be verified by excavation and radiocarbon dating of the furnaces.

Surface finds of ceramics only indicate a possible time frame (from pre-Roman period to Roman period) of settlement activities at a certain location. Highly problematic is, therefore, the dating of iron smelting at settlement complexes of the Przeworsk culture areas, ones which were inhabited during different times or continuously, from the younger pre-Roman Iron Age to the Roman period. Our studies in Pielgrzymowice have once again demonstrated that it is actually not possible to date iron production only on the basis of ceramic fragments that have been found on the surface. A systematic excavation of furnaces is essential. As far as possible, dating should always be carried out by determining the radiocarbon age of charcoal or, for example, charred grains from the slag pits or by sampling charcoal from the slags themselves. Thereby it is necessary to date at least two different charcoal pieces because the result of only one sample can lead to incorrect conclusions. This can also be shown exemplarily for Pielgrzymowice 5 where the two different charcoal samples from the bottom of a furnace have an offset of 210 years in the conventional radiocarbon age (**1900±30 BP** and **1690±30 BP**).

Archaeobotanical analysis shows the use of proso millet during the younger pre-Roman Iron Age. What is still somewhat questionable is the function of the Roman period rectangular stone-filled hearths, whose soil samples contain a large number of cereal phytoliths but no macrobotanical material. These could be possible kilns for drying grain in wooden structures placed above it, which unfortunately cannot be proven and thus remains a pure hypothesis.

Pielgrzymowice 5 is the second (partly) excavated settlement of the Przeworsk culture with iron production in the Widawa river valley around Namysłów. Both sites: Pielgrzymowice 5 and Namysłów 69, date back to the Roman period. According to the present state of research, there is no proof of a pre-Roman iron smelting for the entire micro-region. More archaeological research, as presented here, is necessary in order to determine other sites with iron slags for their precise chronological position.

Acknowledgment

Special thanks go to Grzegorz Molenda M. A. and the Department of Archaeological Monuments in Opole, Dipl.-Geophys. Burkart Ullrich and Dipl.-Ing. Ronald Freibothe from Eastern Atlas (Berlin), Prof. Dr. Michael Meyer (Institute of Prehistoric Archaeology, Department of History and Cultural Studies, FU Berlin), Dr. Michael Thelemann (Senate Department for the Environment, Transport and Climate Protection, Berlin), DR Helmut Kroll for macro remains analysis and all colleagues and students who supported our fieldwork in 2013 and 2014.

Tab. 1. Pielgrzymowice 5. Radiocarbon dating of charcoal samples from percussing drillings Pif 5-1 and Pif 5-2 (Thelemann et al. 2015, 120 Tab. 1)

Feature	**Lab code**	**Depth**	**Radiocarbon age (BP)**	**1-Sigma calibrated age (68,2%) [calBC/calAD]**	**2-Sigma calibrated age 94,5%) [calBC/calAD]**
Pif 5-1	Poz-58590	66 cm	2280±40	399BC (43.8%) 357BC 283BC (18.4%) 256BC 246BC (6.0%) 236BC	405BC (48.3%) 348BC 317BC (47.1%) 208BC
Pif 5-1	Poz-58506	83 cm	2110±30	181BC (68.2%) 92BC	204BC (95.4%) 46BC
Pif 5-2	Poz-58507	60 cm	2180±50	357BC (36.4%) 282BC 257BC (4.9%) 244BC 236BC (27.0%) 175 BC	380BC (95.4%) 98BC
Pif 5-2	Poz-58508	69 cm	3270±35	1608BC (22.5%) 1581BC 1562BC (45.7%) 1506BC	1626BC (89.8%) 1492BC 1481BC (5.6%) 1454BC
Pif 5-2	Poz-58509	99 cm	2090±30	163BC (26.5%) 128BC 120BC (25.6%) 88BC 77BC (16.0%) 56BC	195BC (95.4%) 42BC

Tab. 2. Pielgrzymowice 5. Result of macrobotanical analysis (H. Kroll)

Feature	**‚Pit house‘ (feat. 1/1)**	**‚Pit house‘ (feat. 3/2)**	**Furnace (feat. 1/3)**	**Hearths (feat. 3-5/5)**
Macrobotanical remains	charcoal	**proso millet**, foxtail millet, lady‘s thumb, black-bindweed, common wheat	charcoal (**pine**, ash), tar(?)	charcoal, tar(?)

Tab. 3 Pielgrzymowice 5. Result of archaeobotanical analysis from soil sample of feature 3 (‘pit house’) in trench 2

Scientific name	**n**	**n %**	**mg**	**mg %**	**eng. name**
Panicum miliaceum	1521	100	2771	99	proso millet
Setaria italica	1	r	2	r	foxtail millet
Triticum aestivum	1	r	11	+	common wheat
Persicaria maculosa	2	+	3	+	lady’s thumb
Fallopia convolvulus	1	r	2	r	black-bindweed
summae	1526	100	2789	100	

Thousand Grain Weight Panicum miliaceum 1,82 g. r: 0,1 %; +: 0,1-0,9 %

Tab. 4. Pielgrzymowice 5. Sample ID, sample information and phytolith amounts (J. Meister)

Sample ID	**Sample location**	**Number of phyt. per 1 g of sediment**
F-1	furnace (feat. 1/3; Fig. 20)	77,000
F-2	furnace (feat. 1/3; Fig. 20)	57,000
F-3	furnace (feat. 1/3; Fig. 20)	152,000
PH-1	‘pit house’ (feat. 1/1; Fig. 11)	18,000
PH-2	‘pit house’ (feat. 3/2; Fig. 16)	182,000
H-1	hearth (feat. 3/5; Fig. 35. 38)	198,000
H-2	hearth (feat. 4/5; Fig. 36)	19,000
H-3	hearth (feat. 5/5; Fig. 35.39)	1,437,000

Tab. 5. Pielgrzymowice 5. Radiocarbon dating (Thelemann 2015; Lehnhardt 2019; Poznańskie Laboratorium Radiowęglowe; Oxcal. V4.3.2 Bronk Ramsey 2017)

Feature	**Feat.no./ Trench no.**	**Lab code**	**Radiocarbon age (BP)**	**1-Sigma calibrated age (68,2%)[calBC/calAD]**	**2-Sigma calibrated age 94,5%)[calBC/calAD]**
‚pit house‘	1/1	Poz-58590	2280±40	399BC (43.8%) 357BC 283BC (18.4%) 256BC 246BC (6.0%) 236BC	405BC (48.3%) 348BC 317BC (47.1%) 208BC
‚pit house‘	1/1	Poz-58506	2110±30	181BC (68.2%) 92BC	204BC (95.4%) 46BC
‚pit house‘	3/2	Poz-58507	2180±50	357BC (36.4%) 282BC 257BC (4.9%) 244BC 236BC (27.0%) 175 BC	380BC (95.4%) 98BC
‚pit house‘	3/2	Poz-68383	2150±30	350BC (22.3%) 311BC 209BC (38.9%) 158BC 133BC (7.0%) 116BC	356BC (30.2%) 286BC 234BC (64.3%) 90BC 71BC (1.0%) 60BC
‚pit house‘	3/2	Poz-58509	2090±30	163BC (26.5%) 128BC 120BC (25.6%) 88BC 77BC (16.0%) 56BC	195BC (95.4%) 42BC
furnace	1/3	Poz-68384	1900±30	69AD (68.2%) 130AD	28AD (1.9%) 39AD 50AD (88.5%) 180AD 186AD (5.0%) 214AD
furnace	1/3	Poz-68385	1690±30	332AD (68.2%) 397AD	256AD (16.3%) 299AD 318AD (79.1%) 416AD
hearth	2/3	Poz-68387	1715±30	258AD (18.9%) 282AD 324AD (49.3%) 384AD	249AD (95.4%) 394AD
hearth	3/3	Poz-68388	1705±30	260AD (13.1%) 278AD 326AD (55.1 %) 390AD	252AD (95.4%) 401AD
pit	4/3	Poz-68389	1820±30	138AD (45.4%) 198AD 138AD (45.4%) 198AD	90AD (1.0%) 100AD 124AD (90. 7%) 257AD 296AD (3. 7%) 320AD
hearth	4/5	Poz-68391	1915±30	62AD (68.2%) 125AD	16AD (93.3%) 140AD 155AD (1.0%) 168AD 195AD (1.1%) 208AD

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Otrzymano (Received): 11.02.2019; Zrecenzowano (Revised): 25.02.2019; Zaakceptowano (Accepted): 28.02.2019

Authors' addresses:

Dr Enrico Lehnhardt
Institute of Prehistoric Archaeology,
Department of History and Cultural Studies,
Freie Universität Berlin
Fabeckstr. 23-25
14195 Berlin, Germany
Exzellenzcluster 264 – Topoi 'The Formation
and Transformation of Space and Knowledge
in Ancient Civilizations', Freie Universität
Berlin, Topoi Building Dahlem
Hittorfstraße 18
14195 Berlin, Germany
e-mail: enrico.lehnhardt@topoi.org
https://orcid.org/0000-0002-7716-5036

Dr hab. Artur Błażejewski, prof. UWr
Department of Archaeology of the Barbaricum
and Roman Provinces, Institute of Archaeology,
University of Wrocław
ul. Szewska 48
50-139 Wrocław, Poland
e-mail: artur.blazejewski@uwr.edu.pl
https://orcid.org/0000-0002-1734-3945

Dr Paweł Madera
Iron Age Department,
Archaeological Museum Wrocław
ul. Cieszyńskiego 9
50-136 Wrocław, Poland
e-mail: pmadera@mmw.pl
https://orcid.org/0000-0003-0938-9171

Prof. Dr. Julia Meister
Chair of Geography I – Physical Geography,
Institute of Geography and Geology
Am Hubland
97074 Würzburg, Germany
https://orcid.org/0000-0003-1385-4112