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Gojda, Martin; Trefný, Martin; Schußmann, Markus; Šumberová, Radka

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Article

Air-Surveyed Cropmarks of Early Iron Age Heritage in Central Europe—Integrating Remotely Detected Data and Excavated Evidence

Martin Gojda ^{1,*}, Martin Trefný ², Markus Schussmann ³ and Radka Šumberová ¹ 

¹ Institute of Archaeology, Czech Academy of Sciences, Letenská 4, 118 01 Prague, Czech Republic; sumberova@arup.cas.cz

² Institut für Ur-und Frühgeschichte, Friedrich-Alexander-Universität Erlangen-Nürnberg, Koch str. 4/18, 91054 Erlangen, Germany; trefny.martin@seznam.cz

³ Otto-Friedrich-Universität Bamberg, Kapuzinerstraße 16, 96047 Bamberg, Germany; markus.schussmann@keltenwelt-glaueberg.de

* Correspondence: gojda@arup.cas.cz; Tel.: +420-725-956-548

Abstract: This paper aims to present the potential of observations of the Earth's surface by means of remote sensing (survey), specifically via direct (active) visual prospection from low altitude to identify and map small components (such as postholes) of archaeological contexts, namely above-ground post-built structures dated to the Early Iron Age (appr. 800–380 B.C.). This work gives an example of archaeological data on buried settlement constructions identified by aerial reconnaissance (i.e., by a non-invasive method), the interpretation—and primarily dating—of which is based on information achieved by excavation practice (recently performed predominantly during rescue campaigns). This research points to the fact that nonetheless to the traditional idea on the limited potential of crop-marked archaeological heritage in terms of dating (the ability of cropmarks displayed over pits, ditches, graves, etc., to produce exact ground-plans of even small buried features, so that their original function and dating can be determined) the number of more or less precisely datable archaeological sites and features buried under the surface is growing, including wooden structures once constructed on the ground (i.e., not sunken under the ground) and leaving on cereal crops just tiny spots/dots regularly spaced into lines. These are features (constructions) with identical ground plans (postholes placed in 4 × 3 and/or 3 × 3 patterns) of which commonly just one in a group of them situated on one site is enclosed by a perimeter line—a foundation for a wall or a trench for a palisade. Consequently, a retrospective survey of air-photo analog archives and digital repositories now brings new evidence on the chronological setting of many crop-marked Early Iron Age sites that previously remained undated.

Keywords: archaeological remote sensing; Central Europe; cropmarks; Early Iron Age settlements; post-built structures; excavation-based dating



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1. Introduction

The aim of this work is to show the major potential of remote sensing in determining the function and (relatively accurate) age of prehistoric and historical features or the archaeological sites at which these features are located. The means for acquiring this type of knowledge are 'cropmarks,' which form under suitable conditions over features sunk below the ground; they copy their ground plan and, thanks to the different height, density and color of the crop (mostly cereals), make the features visible (Figure 1). As a result, it is possible to photograph them from above—from the air and from space—in a photographic way and then orthorectify, georeference and transform them into large-scale maps [1–7]. Attention is focused in this study on a group of archaeological features that were repeatedly identified by aerial survey (and also by means of excavation) over the last thirty years in

Central Europe—specifically in the Czech Republic—where this non-destructive method began to be systematically applied in the 1990s after the fall of the Iron Curtain [8]. These features are the floor plans of aboveground structures, which appear in aerial photographs as regularly arranged small points—postholes—typically forming a rectangular floor plan, in some cases surrounded by a demarcation line—a foundation/palisade trench. Their chronology was unclear for many years, and only recent rescue excavations in several places with the occurrence of these features permitted their dating to the Early Iron Age (Ha C—LT A, 800–380 B.C.), most frequently to the transitional horizon of the Late Hallstatt and Early La Tène periods. Thanks to excavations at the sites (in Bohemia and southern Germany) clearly described in this article and with the help of indirect evidence (e.g., proximity to burial grounds of the same age), it was possible to date a group of sites in Bohemia with the occurrence of this type of feature recorded by aerial survey.



Figure 1. A 3D model of the principle of crop-marking process over sunken archaeological features, such as (from left to right) waste and storage pits and ditch (positive cropmarks), and relics of a stone wall (negative cropmarks; author: J. Unger, Institute of Archaeology, Czech Academy of Sciences).

2. Materials and Methods

2.1. Morphological Classification and Archaeological Interpretation of Crop Marks

Photographic images collected by both active (direct) and passive (indirect) ways of remote sensing [9,10] are analyzed with the aim of identifying lines and areas corresponding in their character to immovable features of anthropogenic origin, which are then classified in terms of shape and size and finally interpreted from the perspective of their (original) function and age. The ability to interpret aerial photographs depends directly on knowledge of the morphological range of prehistoric and historic immovable relics, possible natural elements, and recent interventions in the landscape. It is important to be able to distinguish, for example, lines of defunct paths from modern utility lines, clusters of cultural pits from anomalies caused by increased fertilizer concentrations, circular or oval trench lines from groups of fairy circles, and patterns caused by ‘frost wedges’ from multiple enclosures. Aerial photographs can also be interpreted from the perspective of past and present natural components and processes (that had a direct or indirect connection to former settlement and subsequent post-deposition processes), traces of which can be found on them (e.g., riverbeds, erosion furrows, etc.).

The classification and interpretation of formations documented in aerial photographs are one of the most important parts of remote sensing, one that requires the archaeologist to be aware of the formal range of immovable features of prehistoric and historical age in the territory under study. It is also necessary to understand the context, i.e., the relationships between individual features and the landscape and between the features themselves [11,12].

The basic parameter by which aerial archaeological survey is able to identify archaeologically positive sites is the morphology (shape, ground plan) of features. All marks, be they direct (e.g., shadow marks and soil marks) or indirect (vegetation), copy the ground

plan of the feature hidden beneath the surface or are preserved in relief form as an earthwork. We distinguish two basic types for classifying the formations recorded during the aerial survey: (1) spot and area features, i.e., formations of diverse yet mostly geometrically regular shapes; (2) linear features, i.e., either actual lines or a space demarcated by lines (Figure 2).

BOHEMIA: MORPHOLOGY OF LINEAR AND SPOT FEATURES (MACULAE)





































A.1.1.									
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B.									
C.									
I-IV.									

Figure 2. Types of features and their morphology as documented during aerial reconnaissance campaigns in Bohemia. A.1.: enclosures; A.2.: lines; B.: system of lines; C.: spot features; I: solitary spot feature; II: structured/non-structured cluster of spot features of the same type; III: combination (intentional, coincidental) of spot features and enclosures. Early Iron Age structure belongs to type I-IV-II.2. (author: M. Gojda, the permission of reproduction of this figure was given by courtesy of the Institute of Archaeology, Czech Academy of Sciences).

Although it might seem that a significantly higher percentage of archaeological features datable by their floor plan relate to linear objects, experience in Central Europe thus far has shown that this may not be the case. The dating of spot/area features (i.e., non-linear features, such as settlement pits and sunken-floored buildings) according to their size and ground plan is difficult because (their plans are most frequently circular or oval in most archaeological cultures in Bohemia. However, for instance, large accumulations of cultural pits indicate settlements from the Late Bronze Age, as many excavations at these sites have been documented [13] and as finds of ceramics from surface surveys that were carried out at them have also been shown [14]. A very probable dating can be made on certain other forms of spot features. For example, square and rectangular formations (recessed dwellings) with a size of 10–20 m² with rounded corners (in some cases including entrance halls) are more or less reliably dated to the latest phase of agricultural prehistory (Iron Age—the beginning of the Early Middle Ages). In the case of rectangular formations (corresponding in size to grave pits) arranged essentially in rows, it is possible to determine at least alternatives to their age using current knowledge of burial customs in individual prehistoric cultures (size of burial grounds, the orientation of graves, grouping of burials, etc.).

2.2. Spatially Arranged Groups of Postholes in Early Iron Age Settlements (Bohemia)

In the last fifteen years, the age of aboveground (not recessed below the ground surface) excavations has repeatedly documented structures formed by a regularly arranged set of postholes in the Czech Republic. One variant of this type is represented by features formed by regularly spaced postholes in a 4×3 pattern. In contrast, other features have a set of postholes enclosed by lines indicating either the former trench for the foundation of the structure or a trench for a palisade enclosing an aboveground structure with twelve posts.

This type of structure has been repeatedly identified by aerial survey in Bohemia in the middle and especially the lower reaches of the Elbe (most often in the flat alluvial valley of the river between Neratovice and Litoměřice and on elevated plateaus of the wider surroundings of solitary Mt. Říp—a central point of the historical Bohemian landscape, shrouded in legend and traditionally linked to the arrival of the Slavs in Bohemia [15], and also in the eastern part of central Bohemia (Figure 3, area 1). From the first discovery of vegetation marks of the described type of immovable relics in the late 1990s up until the previous decade, it was not clear how to interpret them and—above all—how to handle their dating. This was possible to determine due to results achieved by excavations. In this period during the rescue excavation of the Kolín bypass road, the grouping of several of these features was examined by field excavation. Within the framework of a number of development-led excavations in 2004–2016, the presence of postholes arranged in the same way was discovered near Roudnice nad Labem, in Prague-Miškovice and at several sites in the Pitkovický Stream valley on the southern edge of Prague (for additional details, see the next chapter). All are dated to the late phase of the Early phase of the Iron Age (Bylany culture, Ha C—D1, 800–550 B.C.) and to the transitional horizon between the Early and Late Iron Ages (Ha D—LT A).

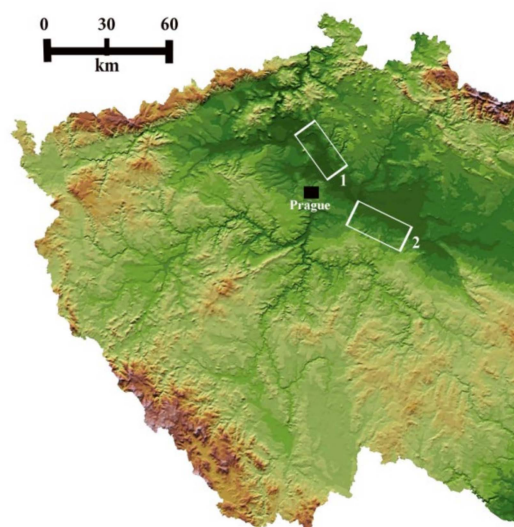


Figure 3. Map of Bohemia with indicated territorial units in which Hallstatt-period post-built structures have been documented by means of aerial prospection: 1—a lowland territory on the confluence of three Bohemian rivers—the Vltava (Moldau), Labe (Elbe) and Ohře (Egger); 2—a lowland territory in the Labe basin in the eastern part of central Bohemia.

The site with the greatest concentration of recorded aboveground post structures detected by vegetation marks during a visual aerial survey is *Straškov* (Litoměřice district). As it is clear from the overall plan of this area (Figure 4A,B), in addition to the variants described above, the occurrence of other floor plans of aboveground structures is documented, in summary:

Variant 1—three rows of four posts enclosed by a trench with an entrance interruption on one of the shorter sides (Figure 4);

Variant 2—three rows of three to five posts without an enclosure trench (Figure 4A-2)

Variant 3—posts regularly arranged in rows, the layout of which creates a ground plan distinct from variants 1 and 2 (Figure 4A-3)

Combination of variants 1 and 2—always one structure of the first variant and in its vicinity several (two or more) structures of the second variant—is safely documented at the sites investigated by excavation (see the following chapter), especially at the Kolín and Roudnice nad Labem sites (the latter is only 5.3 km due north of *Straškov*, while Mt. Říp is equally distant from both areas—about 3.5 km). The occurrence of all three variants recorded at the *Straškov* site seems to confirm the former significance of this location within the settlement structure of the landscape under Mt. Říp in late prehistory. The validity of this opinion, specifically for the Late Iron Age, is supported by the presence of a large burial ground only about 1.5 km away, which has been documented by both excavations (before and after the Second World War [16]) and aerial survey. In the immediate and more distant surroundings of the *Straškov* settlement, both types of research (in several cases their joint utilization [17]) have documented a number of other manifestations of prehistoric and early medieval residential activities.

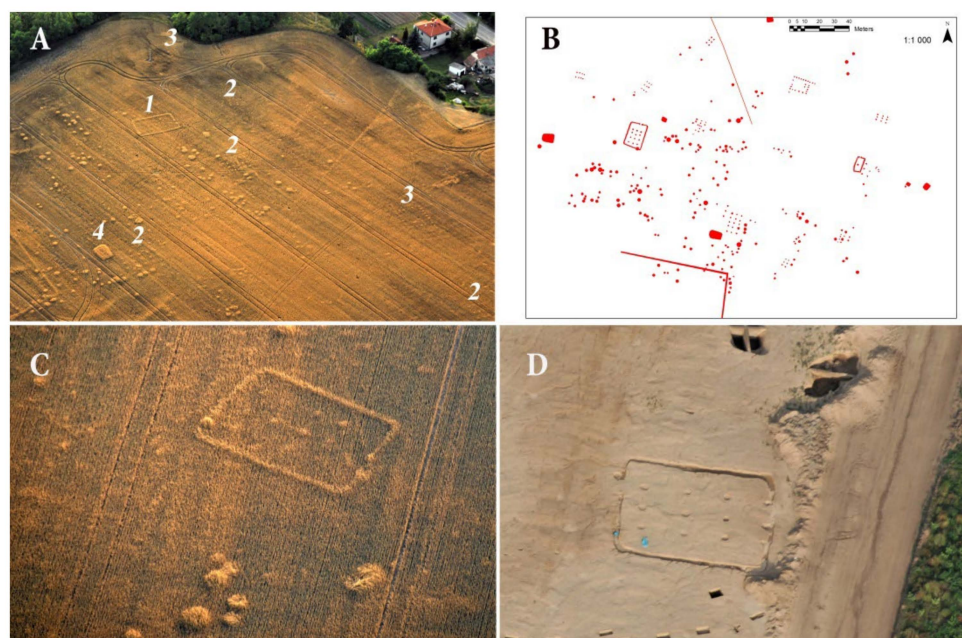


Figure 4. *Straškov*—Early Iron Age (Bylany culture) site made visible by cropmarks on a barley field in mid-June; (A): aboveground structures (1,3), sunken house (4), and irregularly dispersed settlement pits (2); (B): the site as mapped in GIS ArcMap; (C): detail of the *Straškov* variant 1 structure; (D): Kolín: aerial photo of the structure A (see Figures 13 and 14B) during excavation (all aerial photographs in this paper were taken by M. Gojda. the permission of their reproduction was given by courtesy of the Institute of Archaeology, Czech Academy of Sciences).

A characteristic element of the area in *Straškov*, as well as most other sites, is the presence of several sunken houses, irregularly scattered near all three variants of aboveground structures (Figure 4A—marked 4). Other sites in the Mt. Říp region include:

Račíněves (Litoměřice district), one of the largest prehistoric settlements (c. 30 ha) discovered in Bohemia by vegetation marks detected during an aerial survey and also captured on orthophoto maps published on the website www.mapy.cz (accessed on 18 January 2022). In addition to a large number of sunken houses and pits, several spot features—postholes—arranged in parallel rows and representing the floor plans of the third variant of aboveground structures are visible on the surface of this area (Figure 5).

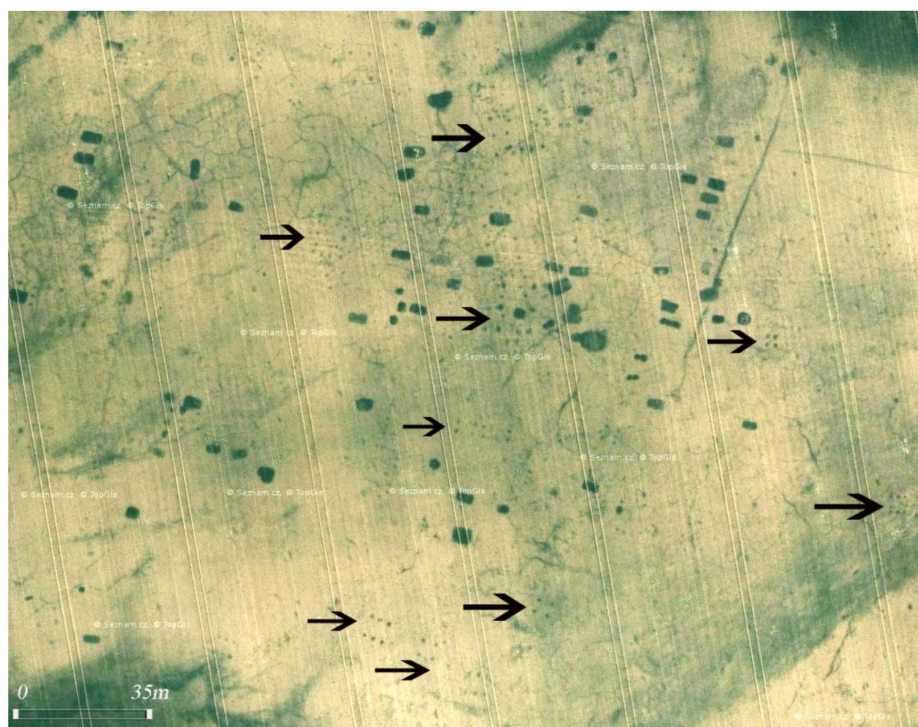


Figure 5. Račiněves—Early Iron Age settlement with regularly spaced lines of postholes (indicated by black arrows), remains of aboveground post-built structures dispersed among sunken houses.

Rovné (Litoměřice district) is located in the immediate vicinity of Mt. Říp, on a distinctive flat elevation near its northern base. In addition to many pits and several sunken houses, aerial photographs of this settlement also show spatially arranged postholes creating a more or less regular floor plan of the defunct aboveground structure. Undoubtedly the most interesting feature is a rectangular enclosure (dimensions 12×9 m, width of the ditch/trench c. 1 m, rounded corners) with an entrance interruption on the south side, the ground plan of which is complemented by a group of large postholes (diameter 0.5–1 m) arranged in three rows. The longer axis of this likely single unit is perpendicular to the longer side of the enclosure, and approximately two-thirds of the ground plan of the feature is located inside the enclosure. Their spatial relationship clearly indicates that these are at least features whose existence was linked to one other or, even more likely, that they represent a single structural unit. It is not possible to rule out the possibility that both features ‘respect’ one another completely randomly (with each coming from a different period), though its probability is minimal (Figure 6A,B). Field excavation would significantly help in the interpretation of this double feature. In any case, we can state that the actual enclosure (ditch/trench), including the entrance interruption, is formally nearly identical to the features detected during the aerial survey in Straškov and uncovered during the excavations near Roudnice n. L. and in Kolín.

In the Mělník district, two sites have been recorded so far with the occurrence of the categories of structures we examined, namely in *Zálezlice*—the first ever settlement discovered in the late 1990s by aerial survey in Bohemia, with features of both variants of aboveground structures accompanied by sunken houses (Figure 6C), and in *Lobkovice* (Figure 6D).

The second area, where aerial survey revealed concentrations of sites with aboveground structures with regularly distributed postholes, is the central Elbe region in the Kolín, the eastern part of central Bohemia (Figure 3, area 2). All of the previously discovered sites in this region documented by aerial photography are solitary features—postholes arranged in two or more rows forming an incomplete floor plan of structures with dimensions comparable to features recorded in the Mt. Říp and Mělník regions. Their functional

interpretation and dating to the Late Hallstatt period are therefore highly uncertain. These are the sites of *Cerhýnky* (Figure 7A), *Ovčáry* and *Chotutice*.



Figure 6. Crop-marked Early Iron post-built aboveground structures at Rovné (A,B), Kozárovice (C), and Lobkovice (D) in area 1 (see Figure 3).

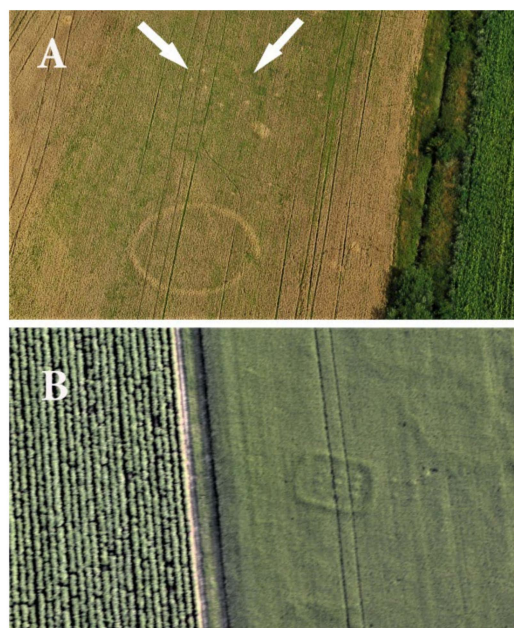


Figure 7. Crop-marked plans of Early Iron post-built aboveground structures at Cerhýnky (A) and Pasohlávky (B).

It is interesting to note that vegetation marks above the features of the modified variant Straškov 1 (floor plan 3×3 , absence of entry interruption in the perimeter trench, smaller size) were also detected during 2020 aerial survey by M. Gojda in southern Moravia (eastern part of the Czech Republic) in Pasohlávky (Figure 7B).

2.3. Aboveground Structures Dated by Field Excavations in Bohemia

The features presented in this part of the paper, all of which were investigated during rescue archaeological excavations, provided very important data for the knowledge of floor

plan construction details and chronology, which confirms the assumption of their dating to the Early Iron Age.

A post-construction with an oval palisade enclosure discovered in Prague-Miškovice (Figure 8, indicated by the upper placed red arrow) was part of a Bylany culture settlement, where there were also at least thirteen other post-built structures, thirteen sunken houses, ten pits and five clay pits [18] (see page 697), [19]. The main structure at this settlement differed somewhat in terms of floor plan from most of the structures discussed in this work. Its palisade trench was not in the shape of a rectangle with rounded corners but in an ellipse. There were nine posts in three rows slightly outside its center, and a group of regularly spaced postholes situated east of the palisade trench ([19] see Figure 19). The palisade was interrupted on its northern side for the entrance to the area. Possible interpretations of the construction include cult functions, an assembly space for the council of elders, a granary, and a 'house of the dead' [19] (see page 267). However, these possibilities are mere conjecture at this point, as none of them can be either confirmed or refuted.

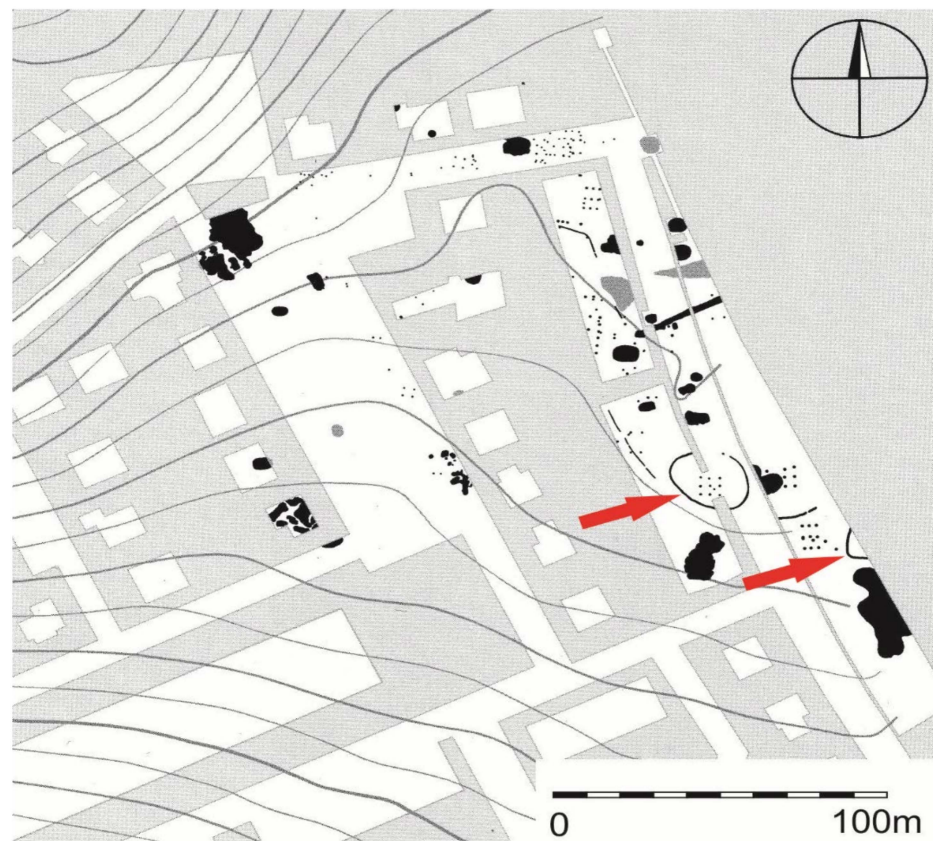


Figure 8. Bylany culture settlement in Prague-Miškovice. Red arrows indicate a feature encircled by an oval ditch and feature No. 1048—rectangular trench According to P. Trebsche ([19], Figure 2).

In terms of floor plan characteristics of the features studied in this paper, feature no. 1048 at the settlement in Prague-Miškovice seems to be a far more suitable candidate (Figure 8, indicated by the lower placed red arrow) ([19], see Figure 13). The floor plan of the palisade trench of this feature corresponds much more closely to the form characteristic of the investigated features. However, we do not find any traces of a post-construction on the inner surface of feature no. 1048. Nevertheless, this need not be a complete obstacle since even with the features of this type described below, we often observe the absence of postholes, which have not been preserved due to their shallow depth. Moreover, feature no. 1048 in Prague-Miškovice was not fully investigated, as part of it lay outside the excavated area.

Another site where we encounter features of the studied type is the Hallstatt settlement in Čestlice [20]. Some finds from this settlement could be dated to the Bylany culture period (Ha C—D1, 800–550 B.C.), others only in general to the Early Iron Age. On the other hand, other earlier or later artifacts were not found at the site, so the mentioned age can perhaps also be applied to one type of feature identified here in two construction phases (Figure 9): a trench with a rectangular ground plan with rounded corners, the internal surface of which has postholes in a regular configuration ([20], see Figure 5).

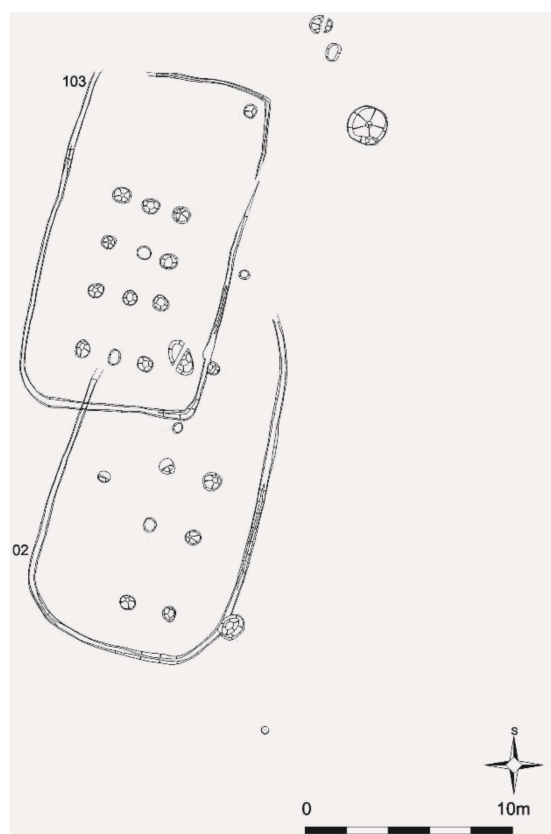


Figure 9. Two phases of the posthole houses, surrounded by a rectangular ditch with rounded corners in the settlement from the Early Iron Age in Čestlice. After: ([20], Figure 5).

Regarding the reconstruction of the appearance of the described structures, the structure from the Prague-Miškovice settlement was interpreted as a post-built house surrounded by an elliptical palisade [19] (see pages 266–267). As such, the palisade and the post-built structure formed two structurally unconnected units between which free movement was possible. The feature in the settlement in Čestlice can perhaps be reconstructed as a post-built house surrounded by a palisade of a rectangular floor plan with rounded corners. However, we are not able to discern from the archaeological context whether it was a structure with a post-built construction, the outer walls of which are formed by a palisade, or whether it is a free-standing post structure with a daub outer wall that is surrounded by a palisade fence. While it cannot be ruled out that the described structures were dwellings or small farmsteads, this interpretation seems less likely in light of some specific findings. The surface with postholes, which we regard as relics of a structure, is relatively large in relation to the area defined by trenches. If these structures were dwellings, the lack of free space between the walls and the fence would certainly complicate many of the activities associated with the settlement, as well as movement around the structure itself. Based on the above facts, it is possible to consider a different function for both structures, e.g., one involving their economic use. Evidence of any workshop activities, such as the processing of metal or other raw materials, was not observed at the site. As such, animal pens or

granaries can be considered. The protection of stored material (crops) or farm animals would also correspond to the presence of a fence as a barrier preventing, for example, pests from entering the structure, etc. In this respect, it is interesting that a post-built structure of a similar character uncovered in the Bylany culture residential area in Prague-Miškovice ([21], see annex 2) was also interpreted as a granary. Thus, although the presented interpretation of the feature does not seem unlikely, it is clear that another role or even a combined use of these structures also cannot be ruled out completely. In this sense, it is possible to recall interpretation variants for a similar feature in Prague-Miškovice [20] (see page 267).

The latest archaeological discovery of an aboveground structure of the described structure occurred in 2019 during an archaeological rescue excavation of the Roudnice nad Labem bypass (unpublished). The structure was part of a Bylany culture settlement (Figure 10). A rectangular palisade trench with rounded corners formed its perimeter, and the demarcated surface had two rows of three posts (Figure 11). In the north-western part of the feature, these two rows were followed by four postholes. Unfortunately, the entire floor plan of the structure could not be uncovered, as part of it was already outside the excavated area. As a result, we do not know if there were one or more longitudinal rows of posts on the inner surface, though it is probable. Again, no conclusive archaeological finds were made directly in the palisade trench of this structure or in its postholes. However, there were settlement features in its immediate vicinity for which the said cultural affiliation could be proven. Moreover, no later features were found in the area.

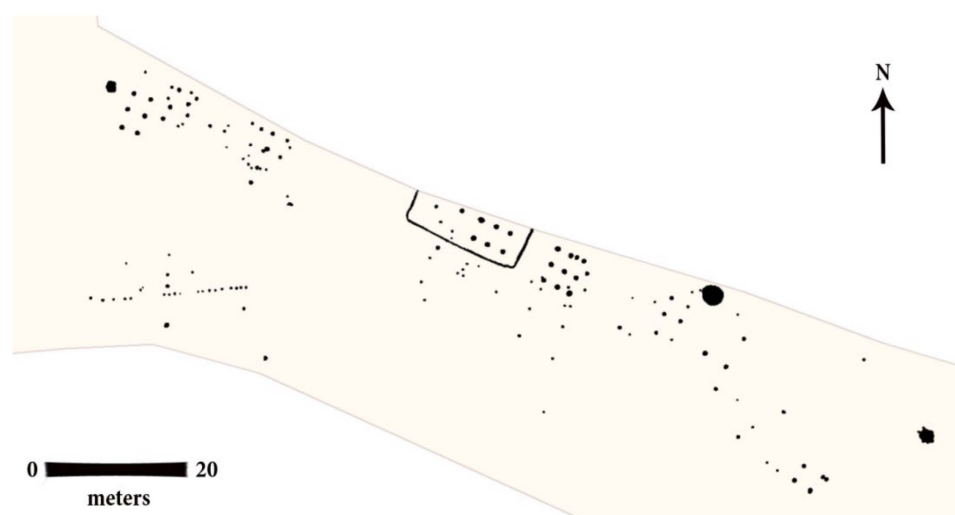


Figure 10. Map of the rescue excavated Early Iron Age settlement at Roudnice nad Labem with a group of aboveground post-built structures; the centrally placed one includes a perimeter trench for either a palisade or a wall—see also Figure 11 (authors: P. Lissek and J. Šály (the permission of reproduction of this figure was given by courtesy of the Institute for Archaeological Heritage Management in Most)).

Interesting data come from the assessment of the spatial relationships of structures with palisade enclosures within individual settlements. As already indicated above, these structures at Hallstatt settlements appear very often near post-built structures with a regular arrangement of posts, so that one structure with a palisade fence is always accompanied by several post-built structures without a fence. In Prague-Miškovice, these are features MIS 1 and MIS 9 ([19], see Figures 2 and 8), post-built structures with a rectangular floor plan, with the main load-bearing posts in a 3×3 configuration.

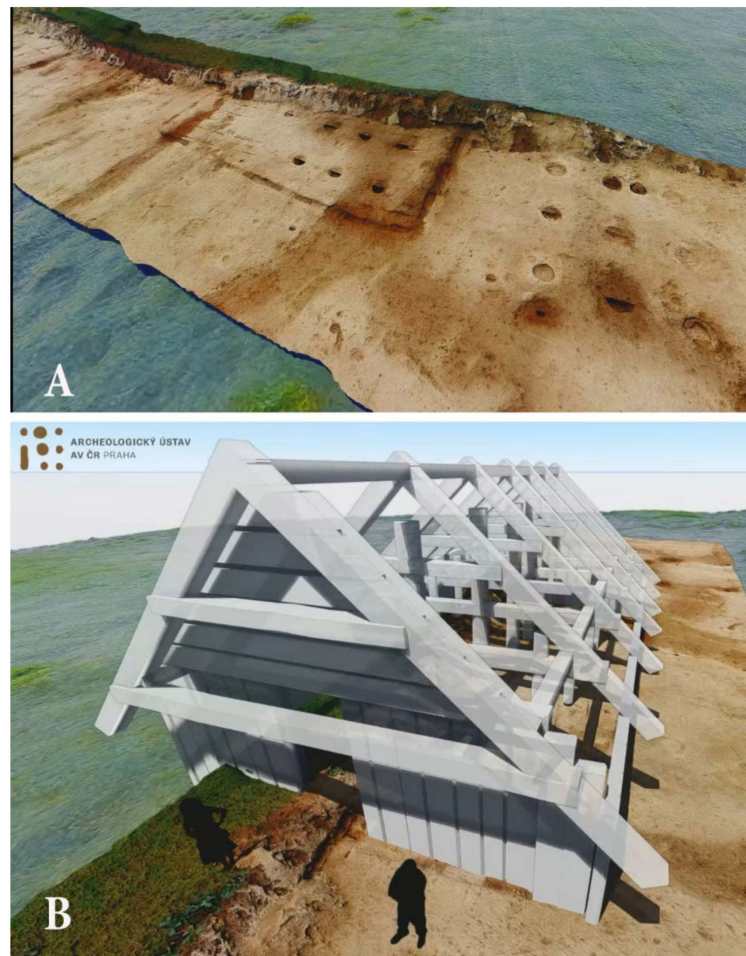


Figure 11. 3D model of the Roudnice nad Labem site in the final period of its excavation (A), and 3D reconstruction of the probable appearance of the structure surrounded by a linear trench (B)—in this case, interpreted as a base for its wooden perimeter wall (author: J. Unger, the permission of reproduction of this figure was given by courtesy of the Institute of Archaeology, Czech Academy of Sciences).

The situation is similar in the case of a Čestlice feature captured in two phases. The Čestlice settlement is part of an agglomeration of five settlements (Prague-Křeslice, two settlements in the cadastre of Prague-Pitkovice, Prague-Benice and Čestlice) dating to Ha C—LTA ([22], see Figures 1 and 2. It cannot be ruled out that all five settlements covering an area with a length of roughly 3 km may belong to one larger Early Iron Age agglomeration. The Čestlice site, where we record the aforementioned feature with a palisade enclosure found in two construction phases, is only tens to hundreds of meters away from the settlement in Prague-Benice. It is at this Hallstatt period settlement that we also record several post-built structures (Figure 12) with regularly arranged load-bearing posts in two or three rows ([23], see Figure 4).

The situation around the structure with a palisade enclosure in Roudnice nad Labem is quite characteristic. In its immediate vicinity are four aboveground features with a rectangular floor plan formed by regularly spaced posts in several rows. The structure adjacent to the feature with a palisade enclosure from the southeast side has a supporting system consisting of main posts in a 3×3 configuration. Another feature, located at a greater distance and also to the southeast, has two clearly visible rows of postholes, but it cannot be ruled out that it was originally a 3×3 configuration, with one row of posts not having been preserved. The basic 3×3 configuration may also have been used for two features northwest of the feature with a palisade trench. Here, however, this configuration was

supplemented by additional posts, which could represent extensions of the basic floor plan of the structure (Figure 10).

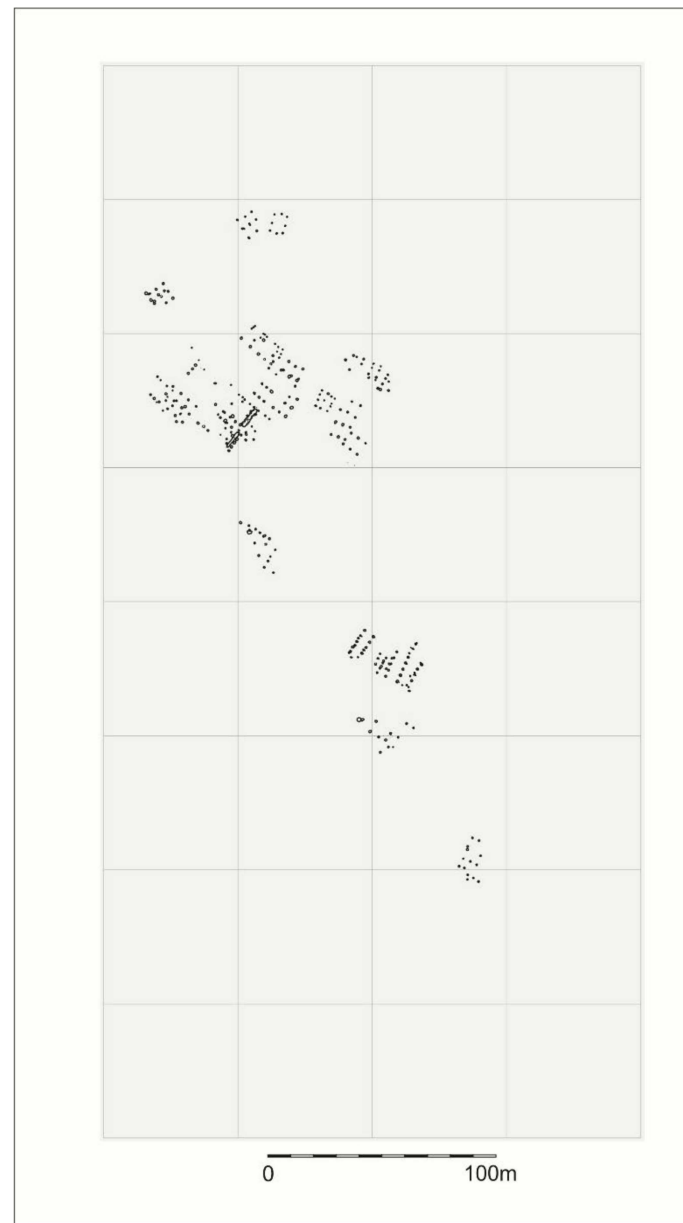


Figure 12. Posthole houses in the settlement from the Early Iron Age in Prague-Benice (according to Trefný—Polišenský ([23], Figure 4)).

The excavation in Roudnice nad Labem captured only a peripheral part of the Bylany settlement, which probably stretched further northward. However, even this outer part of the settlement provides some indications of regularly arranged development. All five described features are situated in a single line, and the axes of all four post-built structures are oriented in the NW-SE and SW-NE direction. The longitudinal and transverse axis of the structure with the palisade enclosure is oriented in the same direction. The orientation of the axes of these structures was therefore chosen with regard to other structures in this settlement based on a unified system. In this sense, we can only regret that the excavation did not capture other parts of this settlement so that we could either confirm or refute the suggestion of a certain floor plan.

In summary, structures with a palisade enclosure/palisade perimeter wall studied during the last two decades in Prague-Miškovice, Čestlice and Roudnice nad Labem represent an important form of Hallstatt settlement architecture appearing in the environment of significant settlements of supraregional importance with evidence of long-distance contacts or more complex settlement forms, including the center (refuge) and the adjacent external settlement. The fact that we are still unable to advance the interpretation of these structures from the level of hypothesis to more specific conclusions does not diminish its significance in any way. On the contrary, it emphasizes the need for further research using interdisciplinary analytical methods, which can bring us significantly closer to a final interpretation.

Rescue archaeological excavations conducted in the years 2008–2010 in connection with the construction of a road bypass for the central Bohemian town of Kolín produced a great deal of evidence of the settlement of the landscape in its vicinity in late prehistory. The Early Iron Age settlement component was located at the edge of the terrace above the Polepka River (sector VI of the archaeologically investigated area, Figure 13); the investigated features were situated no more than 100 m from the south-facing edge of the slope above the river floodplain, though some features are also situated on the slope and almost in the river floodplain [24].



Figure 13. Map of the rescue excavated Early Iron Age settlement at Kolín with a group of above-ground post-built structures; the centrally placed structure includes a perimeter trench for either a palisade or a wooden wall. This feature has a floor plan identical to one at Straškov (author: R. Šumberová, the permission of reproduction of this figure was given by courtesy of the Institute of Archaeology, Czech Academy of Sciences).

Across the hidden area, two apparently concentric (slightly curved) palisade trenches ran with a distance of 34–43 m between them; they were captured in lengths of 40.8 m and 44.3 m. The inner palisade was evidently also repaired and provided with a partition. The walls of the trenches were angled, the bottom was flat, and the depth in places was up to 50 cm (Figure 14A). Inside the enclosed area, less than 5 m from the inner palisade, stood a large post-built structure with a perimeter trench (structure A, Figure 14B). Nearby, at a distance of 10 m, a concentration of large clay pits with Bylany culture material was recorded. In the space between the palisades, a post-built structure without a perimeter trench (structure B) and a number of smaller structures with a post-construction were captured; another large feature with a post-built construction (structure C) was identified in superposition with the outer palisade. One large settlement pit with Bylany culture pottery was captured in superposition with this palisade, and another pit and a storage

pit were in the space between the palisades. The palisade trenches themselves did not contain any dating material, and their connection with the Hallstatt settlement is rather hypothetical. However, there is no other settlement component in the mentioned area for which an enclosure could be assumed. A multi-phase settlement should be considered for the Hallstatt farmstead.

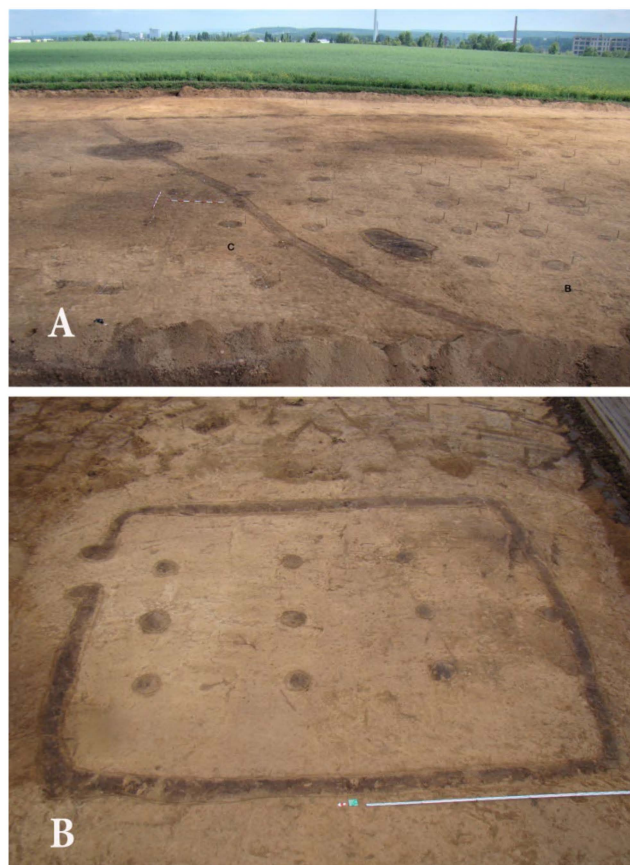


Figure 14. (A)—Part of the rescue excavated area at Kolín; visible are postholes of structures B and C (see the text) and one of the two palisade trenches and pits (see Figure 13); (B)—post-built structure with a perimeter trench (structure A, photo: R. Šumberová).

Structure A: a rectangular feature with a post-construction and a perimeter trench, a length of 12 m, and a width of 9.4 m. The northern wall has a slightly asymmetrically placed entrance with a width of 0.94 m; the trench at the entrance ends with postholes that extend slightly outwards. The trench width is c. 0.5 m, depth 0.26 m, with smooth angled walls, flat to concave bottom and fill mostly dark brown. The internal structure consists of three rows of four postholes, the rear (southern) row in contact with the perimeter trench spacing between rows 1.6–1.9 m, spacing between three posts 2.8–3.2 m, spacing of rows from the perimeter trench 2.4–2.6 m. Dimensions of the internal structure without the perimeter trench are 9.7 × 4.4 m (Figure 14B).

Structure B: a rectangular feature with a post-construction, length 890 cm, width 520 cm, structure composed of three rows of four postholes; spacing between rows 230–240 cm, spacing between the three posts 2.6–2.9 m (Figure 14A).

Structure C: a rectangular feature with a post-construction, length 9.1 m, width 5.5 m, structure composed of three rows of four postholes. Spacing between rows 2.4–2.6 m, spacing between the three posts 270–300 cm (the outer floor plan dimension of the features is stated at the level of the excavated surface and their depth is measured from this point; the excavated level in this space was 30 cm beneath the surface of the topsoil (Figure 14A).

It is clear from the above data that structures B and C have the same construction and dimensions as structure A; only the peripheral trench is missing. Other structures are rather hypothetical and indicate the existence of smaller, perhaps economic, post-built structures, especially in the space between the palisade trenches. Several charcoals were analyzed from the fill of the perimeter trench of structure A, all from oak (identified by P. Kočár), and a larger number of charcoals from oak wood were also captured in the fill of features near the palisade, so it is possible that oak wood was used both for the enclosure and the walls of structures.

Large features captured near post-built structures can be assigned to the Bylany culture (800–550 B.C.) based on the ceramic material in the fill. They belonged mainly to common settlement pits; in one case, we can talk about a storage pit. Another storage pit was part of a larger group of pits, which, according to the dimensions, orientation and profile, could perhaps be regarded as a sunken house. Clay pits and pits with a fireplace in a niche in the wall and other unspecified pits were also uncovered. A preliminary analysis of the ceramic material makes it possible to assign the settlement to the middle to the late phase of this culture; finds that would clearly indicate the use of the site even in the Late Hallstatt period of Ha D2—LTA is still missing. The most common forms here are various types of pots, bowls, amphorae, cups, and fine ceramics with polished or painted decoration are also represented. There are also ceramic discs, various spindle whorls and bobbins, spoon handles, and in one case, a clay model of a wheel with spokes. For now, it is not possible to distinguish the developmental stages of culture in the ceramic material, the representation of which is shown by the horizontal stratigraphy of the site.

2.4. Post-Built Aboveground Structures Enclosed by a Perimeter Trench—The Southern German Perspective

Despite a remarkable number of large-scale excavations during the last two decades, individually trench-enclosed structures with large postholes indicating an aboveground floor construction still remain quite rare in southern Germany. The responsibility for this situation does not lie solely with modern agriculture, which would have led to the faster loss of the mostly shallower trenches because, in other periods, they are quite common. All examples have been documented only by means of excavations, while evidence from aerial photography is still missing. The geographical distribution of the few well-known structures of this kind suggests a cultural background (Figure 15). All examples dating to the Early Iron Age come from the northeast of Bavaria, where relationships with the “Osthallstattkreis,” especially Bohemia and Moravia, were maintained. There, this type of construction has been documented more often. Apparently, these contacts did not remain on a superficial level but were even somewhat strengthened in some aspects. This is suggested, for example, by distinctive features of cult and by expressions of art, which have close parallels in Moravia.

The design of the individually enclosed structure occurs almost without an immediate precursor during the Hallstatt period. There is only one representative from Ilmendorf in Upper Bavaria, which, due to its surrounding structures, likely belongs to the Middle Bronze Age, even if it cannot be dated by artifacts [25]. It consists of a circular trench of 5.2 to 5.5 m in diameter, which had a 1.27 m wide opening facing south. The trench was 54–78 cm wide and dug relatively close to a 2.2 m square layout with four posts. An asymmetrically placed fifth post is interpreted as a repair, the feature itself as the supporting structure for a roof or a raised platform. It differs slightly from the actual type, and as there were both clear settlement structures and other empty circular trenches and even grave mounds in the close vicinity, its interpretation is uncertain. Even if it were a storage structure with a raised floor, it hardly would have established a tradition. No links to the Hallstatt period can be identified, so even in its time, it would quite likely have been regarded as a special form.

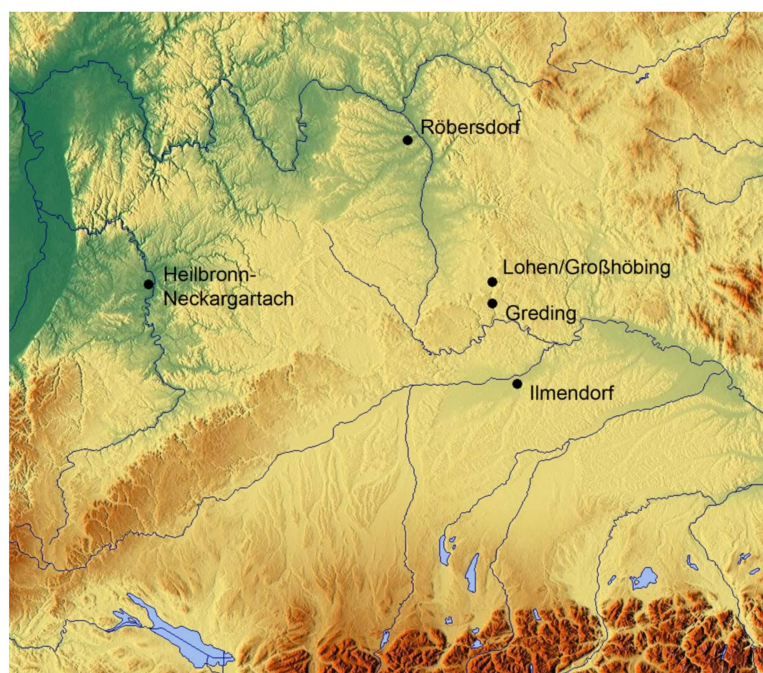


Figure 15. Distribution of the sites in southern Germany is mentioned in the text.

Between the modern villages of Lohen and Grosshöbing in Central Franconia, a small settlement, presumably consisting of just a few farmsteads, was investigated during a rescue excavation in the year 2000 [26] (see pages 100–101). Due to erosion damage, the find conditions were not good (Figure 16A). However, several layout plans of posthole structures were revealed completely or partially and showed, in general, a north-south orientation. A probably square trench with rounded corners measuring 18×18.5 m was a complementary structure. While its northern part was largely missing and therefore can only be reconstructed schematically with an area of 333 m^2 , its southern section ended to the east by connecting to a small six-post construction of 4×6.7 m. In the western half, the 30–50 cm wide trench had several narrow gaps, of which only a 1.6 m wide opening in the southwest corner can be safely interpreted as an entranceway. In this western half of the group, one more six-post construction was placed together with only a few more finds. Although the number of finds was not particularly high and metal objects were completely missing, the ceramic fragments—of which some came from the postholes—cover a spectrum typical for a rural settlement of the (Late) Hallstatt period.

Several campaigns in the period between 1995 and 2006 saw the excavation of a 1.6-hectare settlement area on the outskirts of the nearby town of Greding. This site was occupied between the Late Neolithic and the Hallstatt period, while the Early La Tène period left no traces [25] (see pages 90–92). Only parts of the structures have been analyzed to date so that only individual find complexes and certain areas of the settlement can be addressed chronologically. However, in the area not yet analyzed, there is an oval trench without openings measuring about 15×21 m (Figure 16B). While most of the included postholes appear to belong to different settlement phases, and no systematic arrangement can be recognized among them, the trench seems to surround an 11×6 m six-post construction, which is also characterized by larger posts. With its alignment from northwest to southeast, the construction follows the preferred orientation determined for the Late Urnfield and Hallstatt periods. More specifically, the group cannot be dated for the time being.

Due to several overlaying settlement phases and subsequent disturbances, a find near Röbersdorf in the Bamberg district is different in a similar way [27]. There, a trench measuring 11.6×12.6 m with rounded corners and several disturbances on the south side was found (Figure 16D). In the northwest of the 30 cm wide trench, a 1.8 m wide opening

was recognizable and flanked on each side by a posthole. Furthermore, postholes were found in the trench itself at regular intervals. The included area was around 140 m² and contained further trench portions, pits as well as a number of postholes. Five of them complimented each other exactly in the center of the trench structure to a—unfortunately disturbed—rectangular post-construction of about 3.5 × 5 m. Due to the low sensitivity of settlement pottery to precise dating, the complex cannot be dated more accurately than to the Hallstatt period in general. However, other finds from the immediate surrounding are certainly slightly younger and already belong to the transitional horizon between the Late Hallstatt and Early La Tène periods.

Since the interpretation of these finds cannot be solved satisfactorily based on finds (artifacts), various observations on the settlement system of the Early Iron Age in the relevant region can contribute. Therefore, it should be noted that storage pits and silos of a cylindrical or conical shape were quite rare before the Early La Tène period [25] (see pages 103–104). A fair reason could have been a change in climatic conditions, which also affected soil hydrology. B. Sicherl stressed the link between the occurrence of conical storage pits and climatically favored phases, with higher crop yields, population growth and the prerequisite for ground storage as decisive factors [28]. His observation that in Bavaria after LT A, conical storage pits were no longer used cannot only be confirmed but also supplemented by the fact that they—at least in the northern parts of the country—first came into use with the beginning of the Hallstatt period and had their climax in LT A [29] (see page 165). Their occurrence is recognizably framed by the two sudden climate changes around 800 and 400 B.C. and seems to be coupled in its intensity reciprocally at the course of the climate curve.

Without silo and storage pits, the problem of keeping stocks of cereal reserves must therefore have been solved in another way. Here, the small six-post structures gain meaning because, with some likelihood, they can be interpreted as raised floor structures [26] (see pages 97–98). In addition to the comparatively small usable area, the commonly observed concentration in certain settlement areas speaks for this interpretation. Of course, the 66 m² structure of Greding is far from ordinary in this respect. Incidentally, it should be mentioned that this also means a modified economy because, for long-term storage on or above ground level, additional preparation measures such as the drying of crops are required [26] (see page 104). In southern Germany, six-post structures of the presented squat-rectangular type were built since the Late Bronze Age and the Urnfield period and remained a common type in the following periods of prehistory [30] (see page 103), [26] (see page 97). Together with four-post structures, in the Final Bronze Age and Early Iron Age, they were by far the most common form of structure [26] (see page 104), though not only because they can be detected easier as more complex structures in the tangle of the excavation plans. In the discussed region, the six-post structure seems to appear even more frequently than the four-post edifices that were typical for the La Tène period [26] (see page 97).

During the La Tène period, this distinctive and rare design no longer appeared in southern Germany. Perhaps its idea was caught one last time when a singular find complex was unearthed in 1993 at Heilbronn-Neckargartach [31]. In the center of an approximately 33 m wide and not very accurate circular ditch, a structure of nine posts and dimensions of 6 × 7 m and another with four posts and dimensions of 2.5 × 2.5 m was found (Figure 16C). The circular ditch had a 3 m wide opening to the northeast, which was flanked by four posts, probably belonging to a small gatehouse structure. Although not a single find could be obtained from these structures, ceramics from a nearby pit help interpret the complex as a small rural homestead of the Late La Tène period.

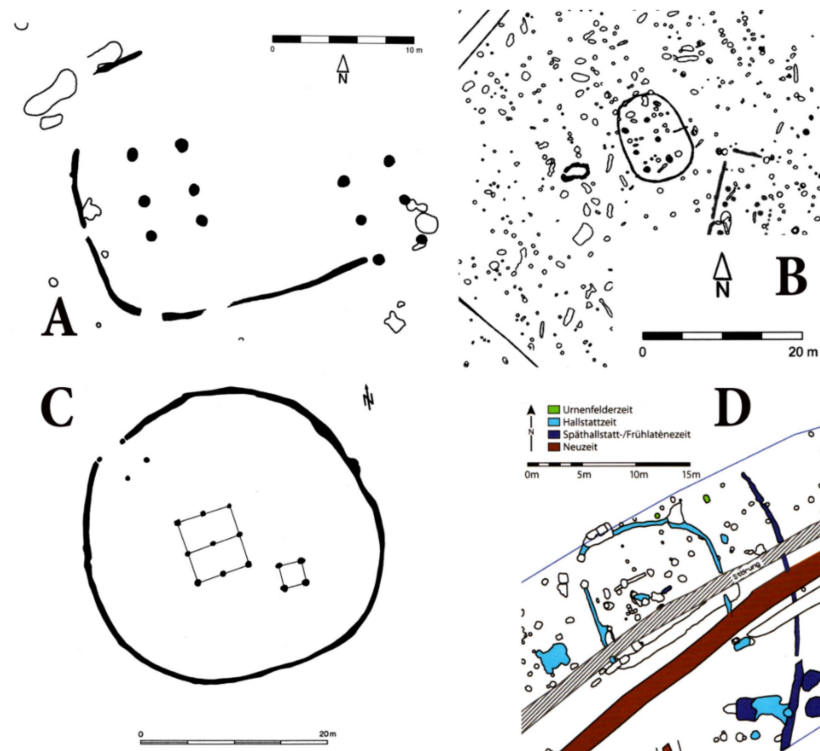


Figure 16. (A)—Lohen/Grosshöbing. Detail of the site plan showing the two structures with the remainders of the perimeter ditch. After: ([26], see plate 197); (B)—Greding, detail from the site plan showing the six-post structure with its oval-shaped perimeter ditch. After ([26], see Beil/supplement 13); (C)—Heilbronn -Neckargartach. Plan of the Late La Tène site. After: ([31], see Figure 62); (D)—Röbersdorf. Detail from the site plan showing the perimeter ditch and linked structures in their chronological context. After: ([27], see Figure 97).

However, the mostly square or squat rectangular four-post structures with a surrounding trench, which were presented for the first time in more detail as a structure type in the ‘Viereckeschanze’ of Bopfingen-Flochberg [32] (see pages 103–112) and since then have been relatively numerous in Late La Tène-related contexts, certainly have nothing in common with them. Their trenches only served to accommodate the structure’s wall.

3. Results

Extensive investigations of the Earth’s surface conducted in Central European post-communist countries by means of a direct (active) survey from low-flying aircraft have significantly expanded existing knowledge about the past (prehistoric, medieval, modern and industrial) landscape. In the Czech Republic, the very heart of Europe, aerial survey campaigns based on the detection of buried sites using vegetation marks have increased both the number of sites registered thus far with archaeological evidence of past settlement activities and the range of features at these sites. Thanks to current knowledge of the morphology of features of anthropogenic origin—significantly expanded as the result of continuous rescue excavations since the 1990s—the possibilities of a correct determination of the age and former function of features (especially linear) detected during aerial surveys are gradually improving. In addition to the long-known ground plans of a number of monuments, including Neolithic rondels, rectangular and trapezoidal houses of the Linear Pottery and Stroked Pottery cultures, Early Eneolithic long barrows, temporary (field) military camps from the ancient Roman Empire, and various types of modern field fortifications, it has been possible in recent years to record a number of sites where the specific floor plans of features whose age is known thanks to rescue archaeological excavations are more or less regularly distributed. These are aboveground structures dated to the Early

Iron Age Hallstatt culture (Ha C—D1). Their ground plan is demarcated by postholes arranged most often in three to four rows, with one from the cluster of features typically being surrounded by a peripheral ditch. From the perspective of interpretation, excavations conducted thus far have not provided knowledge that permits a positive determination of the original function of these features. Certain circumstantial evidence suggests an economical use of these aboveground structures rather than a function as dwellings (though this cannot be completely ruled out). Due to the absence of finds related to any craft activities, we preliminarily interpret them as structures associated with the storage (or processing) of agricultural products, especially grains.

Structures with a palisade enclosure/palisade perimeter wall studied during the last two decades by means of remote sensing and excavations represent an important form of Hallstatt settlement architecture appearing in the environment of significant settlements of supraregional importance with evidence of long-distance contacts or more complex settlement forms, including the center (refuge) and the adjacent outer settlement. The fact that we are still unable to advance the interpretation of these structures from the level of hypothesis to more specific conclusions does not diminish their significance in any way. On the contrary, it highlights the need for further research using interdisciplinary analytical methods (geochemistry, palynology, micromorphology, etc.), which can help us get much closer to a final interpretation. Thanks to the documented age of sites with described types of features, we have now begun a more detailed revision of images stored in the archive of aerial photographs of the Prague Institute of Archaeology of the Czech Academy of Sciences in order to identify in images with visible postholes sites where these postholes are arranged in ground plans datable to the Early Iron Age. This revision has already revealed several of these sites, the age of which has thus far been described in the databases as 'later prehistoric,' whereas now it is possible to significantly pinpoint their dating.

4. Discussion

When speaking of the mutual spatial connections of individual aboveground structures at Hallstatt settlements, it is undoubtedly important to pay attention to the spatial relationships of these sites with their hinterlands. Roughly 500 m north of the captured relics of the settlement in Roudnice nad Labem lies the hilltop site of Slavín. This site was inhabited in the Middle and Late Eneolithic, in the Early to Middle Bronze Age, significantly in the Hallstatt period (Bylany culture). A small amount of the discovered material is also related to the Hillfort period. Bylany culture settlement is naturally important for the issue under study. The relationship between the position of the Bylany hilltop site of Slavín and the newly discovered settlement in the immediate vicinity below it very strikingly indicates the hypothetical link between these two sites as the acropolis and its extramural settlement. Moreover, in 2015, a plundered princely chamber tomb of the Bylany culture was discovered at the north-eastern edge of the nearby airport, with poorly preserved relics of a funeral wagon; the burial is dated to Ha C2/3 or the second half of the 7th century BC [33]. The site with this grave is roughly 900 m from the center of the newly discovered settlement. Therefore, its connection with the strategically located settlement in Slavín and the mentioned rural settlement situated near it cannot be ruled out. It is also possible that these three synchronous components indicate the existence of a small settlement of the Bylany culture of the Early Iron Age, represented by the hilltop settlement, the adjacent extramural settlement and the burial ground (Figure 17).

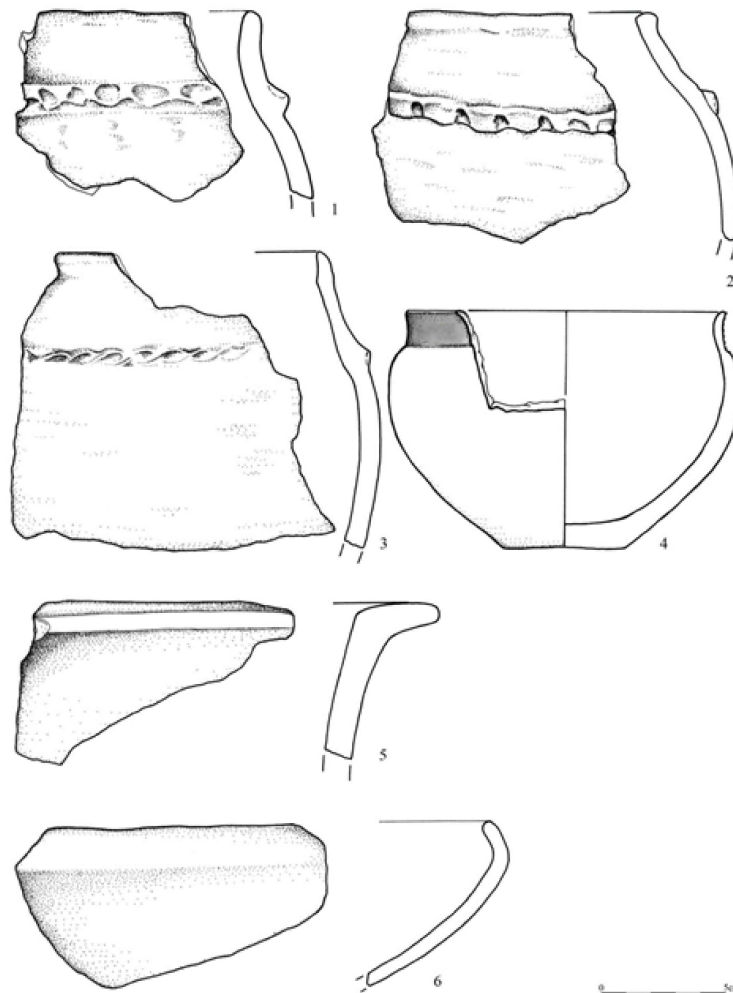


Figure 17. Pottery fragments and a bowl from the excavations at the Říp—Roudnice nad Labem early Iron Age settlement area.

This conjecture is not only based on the simple proximity of the three settlement components. It is supported by many previous findings from a number of important sites in broader Central Europe and in the Czech Republic. The importance of the extramural

settlement (Aussensiedlung) adjacent to the acropolis of the fortified settlement began to be emphasized for the first time in the case of the famous central site of the Early Iron Age in Baden-Württemberg—the fortified settlement of Heuneburg. From the very beginning of the excavation, it was clear that the size of the area delimited by the ‘brick wall’ was too small to accommodate all of the activities associated with the fortified settlement. This assumption was clearly confirmed by later excavations revealing the existence of an extensive hillfort annex, including a sophisticated fortification system [34–37]. The importance of the extramural settlement or the nearest hinterland below the acropolis was also confirmed at other important Central European central locations of the Early Iron Age. Examples include the Ipf hillfort with documented development of a farmstead character and with burial grounds in the area adjacent to the hillfort ([38], see Figure 1), and Hohenasperg hillfort with an adjacent settlement to the south, southeast and east ([39], see Figure 2). The existence of an extramural settlement at Early Iron Age hillforts can also be assumed for Bohemia. Evidence supporting this claim is, for example, the existence of the Hallstatt occupation (unpublished) below the acropolis of the Rubín hillfort [40–42], which can be interpreted with a high degree of probability as a hinterland or extramural settlement of the Hallstatt acropolis. The same spatial connection can be assumed at the Late Hallstatt settlement in Prague-Zbraslav [43] and the Late Hallstatt occupation of the acropolis of the Závist hillfort on the southern edge of Prague. The fact that occupied surrounding areas may belong to vertically exposed hilltop positions or hillforts was also documented in the Mt. Říp region. In addition to settlement in the Eneolithic, the Early Bronze Age and the Early Middle Ages, the local multicultural hilltop site of Sovice was also occupied in the Hallstatt period [44]. When also verifying the presence of anthropogenic activities in the area adjacent to Sovice Hill from the northwest side, it was determined (unpublished) that this area was inhabited in the Early Middle Ages and prehistory.

When trying to evaluate the significance of archaeological situations in which features with a palisade enclosure were found, one more aspect cannot be neglected, namely their occurrence in settlements with significant evidence of long-distance contacts. The Čestlice site, where a structure of the described type with two construction phases was discovered, is part of an agglomeration—a central place of the Late Hallstatt to Early La Tène period located in the Pitkovický Stream basin in the southeast suburb of Prague. The individual settlements of this agglomeration are characterized by finds that can be understood as luxury goods or exogenous artifacts that arrived at the site at which they were found as long-distance imports [22,23], ([45], see Figure 3 and photo 3:1–2:4), and ([46], see Figure 2).

Although some of these artifacts belong chronologically to the Late Hallstatt and Early La Tène period (Ha D2—LTA), it cannot be ruled out that the settlement with this type of structure already had a certain supraregional significance during the early phase of the Early Iron Age (Ha C—D1), as it can be assumed that the long-distance contact routes running in its vicinity were already used in this earlier period ([33], see Figure 5).

5. Conclusions

The long-term application of aerial archaeological reconnaissance practiced in central Europe (Bohemia, Czech Republic) since 1992 resulted in the collection of a large amount of information concerning prehistoric, medieval and post-medieval human activities. Data on almost eight hundred lowland archaeological sites (whose existence remained unknown before the air survey program/ASP was included in the mid-1990s to the research curriculum of the Institute of Archaeology, Czech Academy of Sciences) was included in the Archaeological Map of the Czech Republic (AMCR), an official archaeological information system of the country. Almost 16 thousand processed and interpreted oblique photographs have been placed in the database called Digital Archive of AMCR (https://digiarchiv.aiscr.cz/results?kategorie_dokumentu=lfoto&entity=dokument (accessed on 18 January 2022)), another portion of 6.5 thousand digitized negatives are to be included by mid-2022. In addition to the quantitative aspect (the number of new sites), there are many other important achievements acquired during the course of ASP. One of

them is the evidence on the dating of crop-marked sites according to their ground plans. A generally accepted opinion among Czech archaeologists on the very limited ability of crop-marked sites to be dated has recently been corrected. As we have presented in this paper, due to extensive rescue excavation campaigns in the last 30 years in Bohemia and neighboring Bavaria, many archaeological features detected via aerial prospection undatable in the early period of ASP can now be properly dated. Concretely, our study brought evidence on the existence of a specific type of post-built (i.e., once above-ground) constructions of the late Hallstatt period composed of patterned postholes which are detectable only under proper light conditions, namely because the size of postholes is generally small; as a consequence, they can be easily overlooked. Furthermore, the size of the construction is relatively small (compared, for instance, with the early Neolithic buildings—the so-called longhouses). As a result, after the recently performed revision of hundreds of crop-marked Czech sites recorded on aerial photos in earlier times, a few tens of post-built constructions were identified on them and properly dated (to the late Hallstatt period). A certain problem is the interpretation of them. In this paper, we collected data on rescue excavated examples and suggested ideas on possible explanations of their original function.

Author Contributions: The general concept of the paper was prepared by M.G., who also worked on parts concerning remotely acquired data, their processing, analysis and interpretation. Chapters/paragraphs concerning data gathered, processed and analyzed via rescue excavation campaigns in Bohemia (Czech Republic) were submitted by M.T. and R.Š.; Data on the Hallstatt period settlement sites from Germany were collected and analyzed by M.S. All four authors have read the final format of this paper ready prior to its submission to the MDPI manuscript submission system and agreed with its publication. All authors have read and agreed to the published version of the manuscript.

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Data Availability Statement: Aerial photographs documenting sites that are analyzed and published in this paper are deposited in the Digital Archive of the Institute of Archaeology, Czech Academy of Sciences, Prague, Czech Republic, and are accessible at <https://digiarchiv.aiscr.cz/home> (accessed on 15 March 2022). 3D models and individual site plans with no bibliography reference are in possession of the Institute and individual authors, and are currently not accessible on the internet.

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