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Built Knowledge – Spatial Patterns and Viewsheds of Middle Neolithic Circular Enclosures in the Northern Foreland of the Harz Mountains, Saxony-Anhalt, Germany

After a decade of research the functions of circular enclosures of the middle Neolithic are still debated. In a project funded by the German Research Foundation (DFG) two of these roundels were excavated in order to learn more about their structure, history of construction, their function as well as their spatial characteristics. Based on high-resolution digital elevation models, possible orientations towards topographical and astronomical features are systematically investigated using a GIS-based visibility analysis and a self-developed tool in Wolfram Mathematica. In this article preliminary results of two (partially) excavated roundels in the northern Forelands of the Harz Mountains are presented.

Visibility; GIS; Skyline diagram; Kreisgrabenanlage; astronomical and topographical alignments.

1 Introduction

In our project we are rather minding the gaps¹ – gaps in palisades of middle Neolithic circular enclosures that is. This distinctive type of monument arises with the beginning of the middle Neolithic (since 4900 BC) and can be found throughout Central Europe – occurring between western Hungary and central Germany and being incorporated in a range of different cultures. Often featuring massive diameters, they are characterized by a more or less round ground plan, concentric v-shaped ditches with one or more narrow entrances or causeways, and accompanying palisades around a noticeably empty interior.² Though sharing many similarities in their appearance, each roundel has its very own adapted construction hindering their overall interpretation.³ It appears though, that there might be a general idea, like a blueprint, behind them. Thus, their function is still unknown and highly debated amongst scientists with views ranging from fortification

We would like to thank the German Research Foundation (Deutsche Forschungsgemeinschaft/DFG) for the generous funding as well as the Landesamt für Denkmalpflege und Archäologie Sachsen-Anhalt for supporting the excavations in Quedlinburg financially from 2010 to 2012. We wish to express special thanks to Gerd Graßhoff for interesting debates of ideas as well as his team for the Mathematica Package References “Ancient Astronomy” to transform modern star coordinates into ancient times. The test for Complete Spatial Randomness was carried out by Norbert Anselm, M.Sc. with valuable advice from Dr. Daniel Knitter. Finally, we are grateful to our reviewers, who gave us inspiring comments that led to a significant improvement of our manuscript. Corresponding author: Christina Michel.

- 1 This paper is a transcription of a talk that was held at the 3rd Landscape Archaeology Conference 2014 in Rome during session 6 “Bridging the gap – Integrated approaches in landscape archaeology”. In addition to the talk, new results of the neighboring roundel Quedlinburg II are presented here.
- 2 Petrasch 1990, 418–419; Trnka 1991, 11–12; Petrasch 2012, 46–47.
- 3 Trnka 2005, 12–13; Neubauer, Doneus, and Trnka 2010, 17–18.

sites⁴ to market- and meeting places⁵ as they are always integrated with associated Middle Neolithic settlements. However, with their strong symmetry of layout, the distinct positioning of causeways and gaps in the palisades indicates a link to certain astronomic dates. This has been proven for several of these monuments⁶ and led to the consideration of them as possible astronomic observatories and central cult or calendar buildings.⁷ Currently, they are interpreted as multifunctional constructions predominantly used for cultic-religious purposes but also performing economical, strategic and societal tasks.⁸ Nowadays they can only be traced via aerial archaeology and geophysical prospection, as no remains are visible on the surface.⁹ The fall of the Iron Curtain and the increased availability of aerial photographs led not only to newly discovered circular enclosures but also showed a concentration of these monuments in central Germany (Fig. 1).

2 Conceptual framework

In a project funded by the German Research Foundation (DFG) since 2012, two roundels (Quedlinburg I and Hopferstadt) have been excavated aiming to shed light on their structure, history of construction and use. Based in two research areas in Northern Bavaria and Saxony-Anhalt their location characteristics and possible visual connections relative to the surrounding landscape and astronomic aspects are considered. Additionally, their affiliations to coeval settlements and resulting spatial patterns are investigated.

3 Case study: Roundels Quedlinburg I and II in the Northern Foreland of the Harz Mountains

In this article first preliminary results will be presented for the research area in the northern foreland of the Harz Mountains (Saxony-Anhalt, Germany), where in the past decade two of these circular enclosures have been discovered in close proximity to each other. The fertile Loess soils and the mild climate in the rain shadow of the Harz Mountains proved favourable for settlement since Neolithic times as documented by a broad range of finds (Fig. 2).

Though both enclosures are situated nearby, their topographic position could not be more different – with Quedlinburg I¹⁰ being situated on the edge of the high terrace of the river Bode, 15 to 20 meters above the floodplain whilst the other enclosure, Quedlinburg II¹¹, is situated on a gentle slope north of a small creek called the Zapfenbach. The latter was discovered during road construction works and completely excavated in 2005. Aerial photographs led to the subsequent discovery of QLB I in 2003. After a geophysical survey,¹² the Institute of Prehistoric Archaeology of Free University Berlin has been excavating the enclosure since 2010.

Both enclosures consist of two ditches and a third incomplete one with an irregular form (Fig. 3 and 4).

4 Němejcová-Pavúková 1995, 215.

5 Stäuble 2002, 307.

6 Bertemes 2008, 41–43; Schier and Schmidt-Kaler 2008, 50–54; Zotti 2008, 61–66; Schier 2012, 190–192.

7 Becker 1996, 173; Schlosser 2007, 282–284; Bertemes and Schlosser 2004, 51; Zotti 2005, 75–79.

8 Bertemes and Meller 2012, 8; Schier 2012, 193.

9 Neubauer, Doneus, and Trnka 2010, 19–30.

10 Hereafter referred to as QLB I.

11 Hereafter referred to as QLB II.

12 Schweitzer (unpublished).

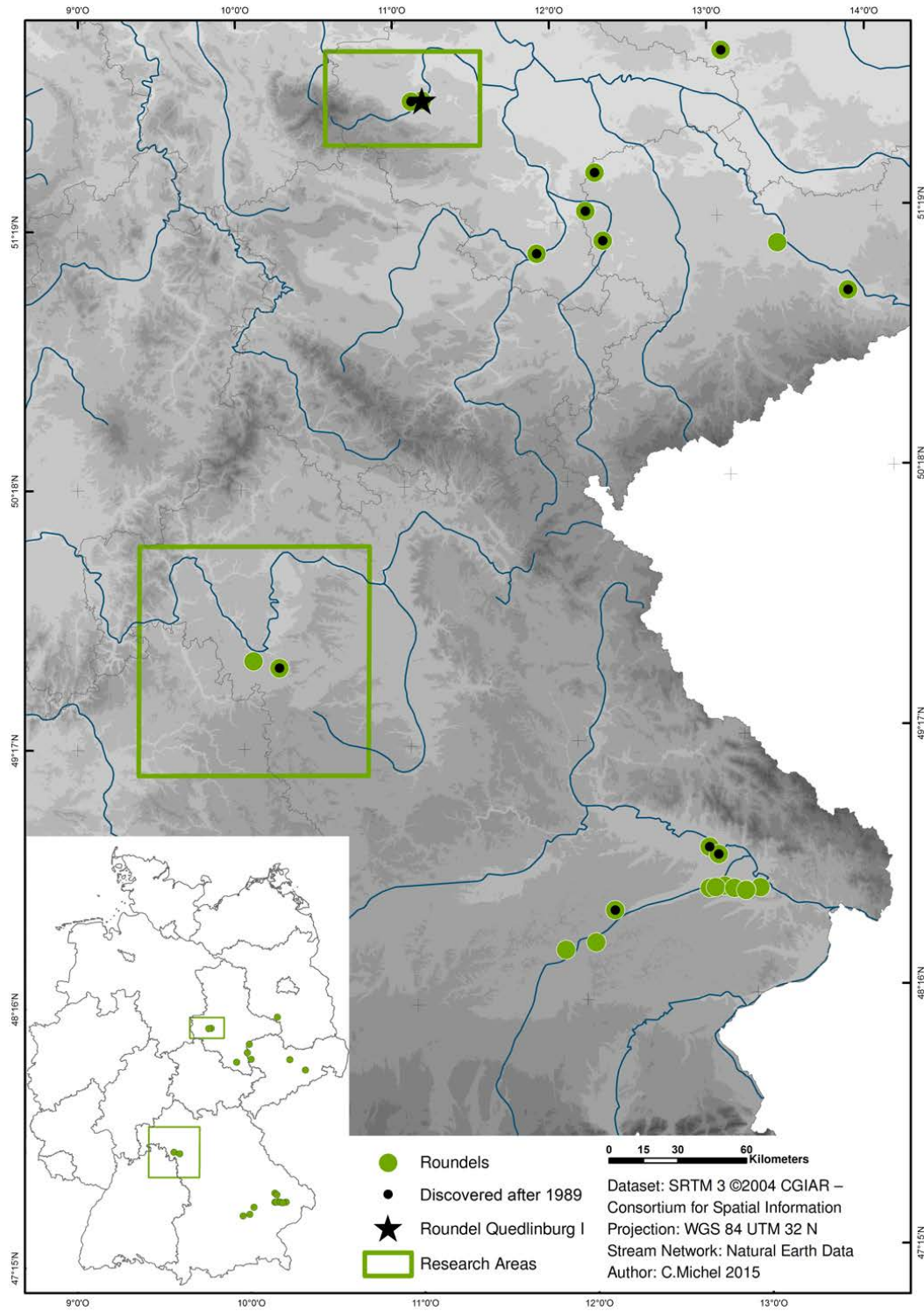


Fig. 1 | Map of circular Palisade and Palisade-Ditch-Systems in Germany. Highlighted in black are the ones that were discovered after 1989, green squares indicate the location of the two research areas investigated in the project “Gebautes Wissen”.

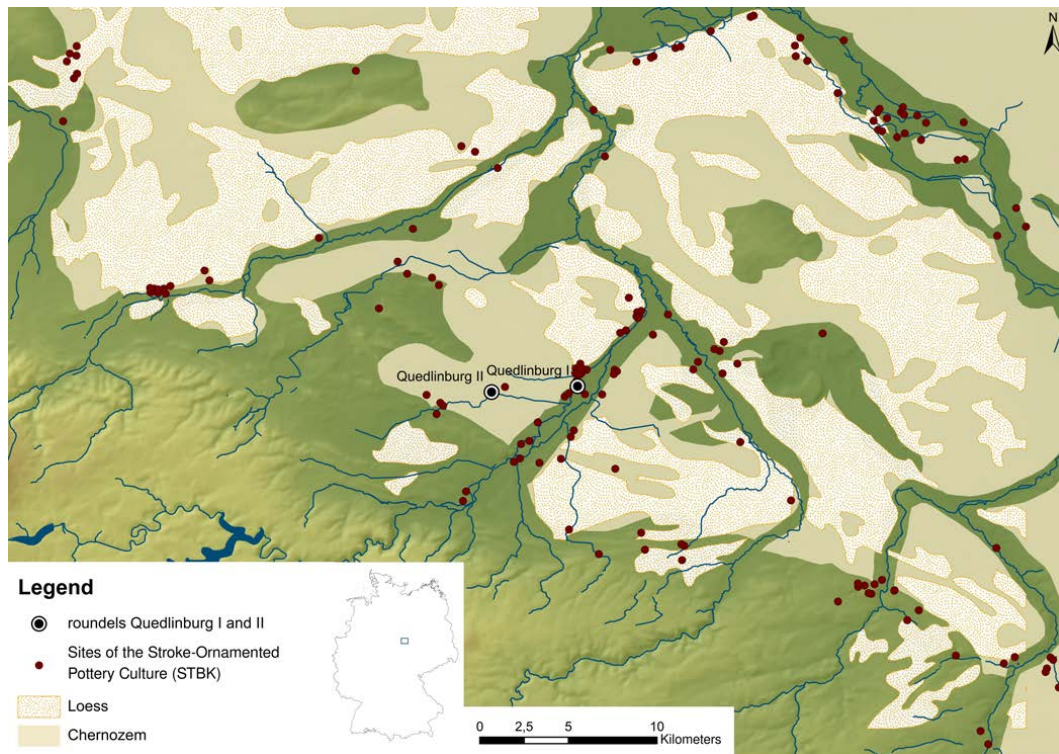


Fig. 2 | Map of the Middle-German Research Area with location of the roundels Quedlinburg I and Quedlinburg II and sites of the Stroke Ornamented Pottery Culture in the northern foreland of the Harz Mountains. Indicated are areas where Loess and Chernozems nowadays occur.



Fig. 3 | Excavation plan of the roundel QLB II, light green indicates features that can be dated to the stroked pottery culture.

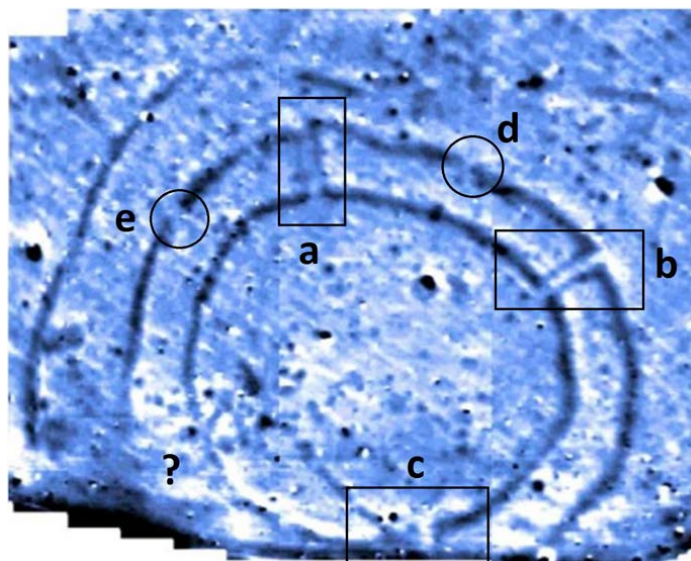


Fig. 4 | Plan of the geophysical prospection in QLB I.

The ditch-diameters of Quedlinburg II range from 47 meters at the innermost ditch to 62 meters with widths of the ditches of QLB II ranging from 1.50 to 4 meters at the internal ditch.¹³ Disruptions and segments complicate the identifications of voids in QLB II, but gaps in the ditches in the northwest, northeast and southwest most likely represent causeways (Fig. 3). The enclosure Quedlinburg I shows an inner diameter of approximately 65m and a maximum outer diameter of 98 m with ditches ranging between 2.30 and 3.60 m in width. As the map of the geophysical survey shows, there are three causeways (Fig. 4 marked a, b, c) where the ditches are connected. A possible fourth causeway might have been present in the south-western part of the enclosure but was, most likely, destroyed by backward erosion of the Bode-terrace and will be under investigation in the next excavation campaigns. There are at least two more gaps in the outer ditch that do not have an equivalent in the inner circle (Fig. 4 marked d and e).

Both enclosures can be dated to the *Stichbandkeramik* (Stroked Pottery) Culture on the basis of the ceramic assemblage – with QLB I being identified as the older one.

4 Materials and methods

The most daring task in our project is the investigation of potential orientations towards topographic and/or astronomic points from the enclosures, as this has never been done systematically for the German roundels. Previous studies have focussed solely on the results of geophysical prospections that, depending on the state of conservation, allow us to estimate azimuth angles of possible causeways in the ditches. The identification of palisade ditches via geophysical prospection however is clearly more complicated if not even impossible in most cases. Certainty about the exact location of causeways and gaps in the palisades, assuming windows of visibility from the roundel, can, in our opinion, only be obtained through excavations.

Geographic Information Systems (GIS) and particularly visibility-analyses have been proven to be powerful tools in (landscape) archaeology.¹⁴ In ArcGIS the visibility-toolbox holds a variety of tools that prove useful to our research questions. *Lines-of-Sight* are the fastest way to check the intervisibility between an observer and a target and have been

13 Northe (unpublished), 93–96.

14 Wheatley and Gillings 2000, 1–2; Gillings and Wheatley 2001, 25–26; Posluschny 2008, 367 and 379.

used stating the observer height at 1.70 m and the target height at 1 m, that includes already an estimated erosion rate.¹⁵

For further research the tools *Skyline*, *Skyline diagram* and *Viewshed* have been utilized. The input data consisted of a high-resolution digital elevation model with a grid size of one-meter, the georeferenced map of the geophysical prospection as well as the detailed excavation plans. Based on the excavated features so called *windows of visibility*¹⁶ have been identified. Assuming that gaps in palisades, ditches and single posts most certainly served as blinds, visible regions of the actual horizon with the incorporated surface can be defined. As there are no clear indicators for a marked centre within the interior of the roundels, the actual position of the (assumed) observer is undisclosed. Therefore, within our research, we modelled differently defined lines of sight along the butts of ditches or postholes at the end of palisade ditches resulting in wider windows of visibility for the viewshed analysis. Additionally, in preparation for the investigation of astronomical orientations, the zenith and horizontal angles were derived from the prior computed skyline.

In a next step, the skyline of the site was modelled in Wolfram Mathematica 10.0. That virtual horizon is based on the elevation data of the DEM and the derived azimuthal and horizon angles of the gaps in the palisade. As a result we are able to obtain two skylines, one of the natural horizon and one of the artificial skyline of the palisades with gaps. First, we considered the possibility of observations of rises and settings of the sun and the moon. The obliquity of the ecliptic was modelled by 24.2° following the model of Laskar.¹⁷ With regard to the ecliptic, the moon's path is inclined by 4.8° to 5.2° , i. e. the northernmost azimuth angle of the moon is roughly 5° further north than that of the sun and the southernmost is about 5° further south than the southernmost angle of the sun. For identifying star trails that coincide with the palisade gaps, we transformed the coordinates of all stars of the Bright Star Catalogue¹⁸ to the epoch -4700 by the AncientAstronomy package for Wolfram Mathematica developed in the research group Topoi DI. Afterwards we wrote a routine to select stars of more than 3.5 mag and with a declination that rises or sets in either one of the entrances.

5 Results – Skyline Analysis of both roundels

The resulting *theoretically* visible horizon¹⁹ from the unobstructed centre of both roundels stretches 40 kilometres to the west up to the highest peaks of the Harz Mountains (Fig. 5).

In Quedlinburg I the visibility is limited in the north and northwest due to the micro-topography of the cretaceous *Heidberg* but allows a high visibility to all other orientations of the northern foreland of the Harz Mountains (Fig. 5, grey line) up to the Hakel (244 m asl). The western part of the computed visible horizon of QLB II (Fig. 5, green line) basically corresponds with the one from QLB I, offering a wide-range view to the highest peaks and along the foothills of the Harz Mountains. The visual field north and east of the enclosure, though, is much more limited by the micro-topography than in Quedlinburg I, as the second roundel is situated closer to the *Harslebener Berge*. The view in the north-eastern direction is focused on an incision, resulting from the extensive gravel mining in this area, between *Steinholz* and *Petersberg* (cf. Fig. 13). To the south the hillslopes of the

15 See Petrasch 2012, 49.

16 Silva 2014, 27.

17 Laskar 1986, 68.

18 <http://tdc-www.harvard.edu/catalogs/bsc5.html> (visited on 04/03/2016).

19 As opposed to the actual range of the human eye and visual restrictions e.g. due to atmospheric phenomena.

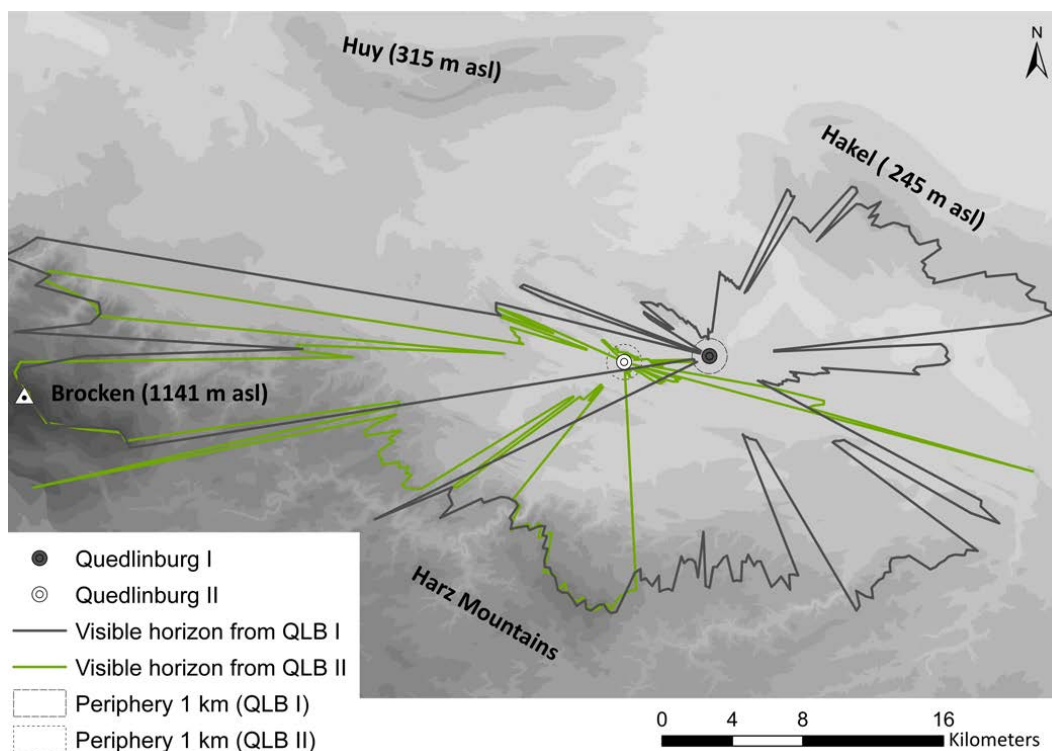


Fig. 5 | Computed theoretical horizons from the unobstructed centre of the roundels Quedlinburg I (grey line) and Quedlinburg II (green line).

Harz Mountains are mostly visible, except for those parts of the horizon where hogbacks are in the way.

6 Results – Viewshed Analysis of Quedlinburg I

Based on the plan of the geophysical prospection 10° - viewsheds were estimated (going from North at 0 degrees via East), locating the north-eastern causeway at 20 to 30 degrees, the south-eastern causeway at 140 to 150 degrees, a possible south-western causeway at 215 to 225 degrees and the north-western causeway at 310 to 320 degrees. Even relying upon these very coarse windows of visibility an orientation towards the neighbouring hillcrest is already noticeable. During the course of our excavations we were not only able to verify the causeway of the ditches but could also locate at least two palisade rings that allowed the calculation of a more precise viewshed through the actual gaps in the palisades that most certainly served as blinds. With widths of 1.50 meter at the north-eastern gap and 1.70 meter at the south-eastern gap the azimuth angle decreases to 2.5 degrees and 3.5 degrees respectively. Our most recent excavation revealed an outstanding passage at the north-western causeway that lacks any equivalent for roundels of the type Lochenice-Unternberg²⁰ so far (Fig. 6). The trench stretches along the causeway and covers all three ditches as well as the corners and the associated palisades. What makes this construction significant is that both the corner pieces, indicated by post-holes, point to different directions forming a narrow path of hardly one-meter width. The azimuth angle is between 312 and 313 degrees and points directly to the highest point of the nearby *Heidberg* (Fig. 7). The north-eastern palisade causeway has an azimuth angle between 21

20 As defined by Podborský 1988, 244.

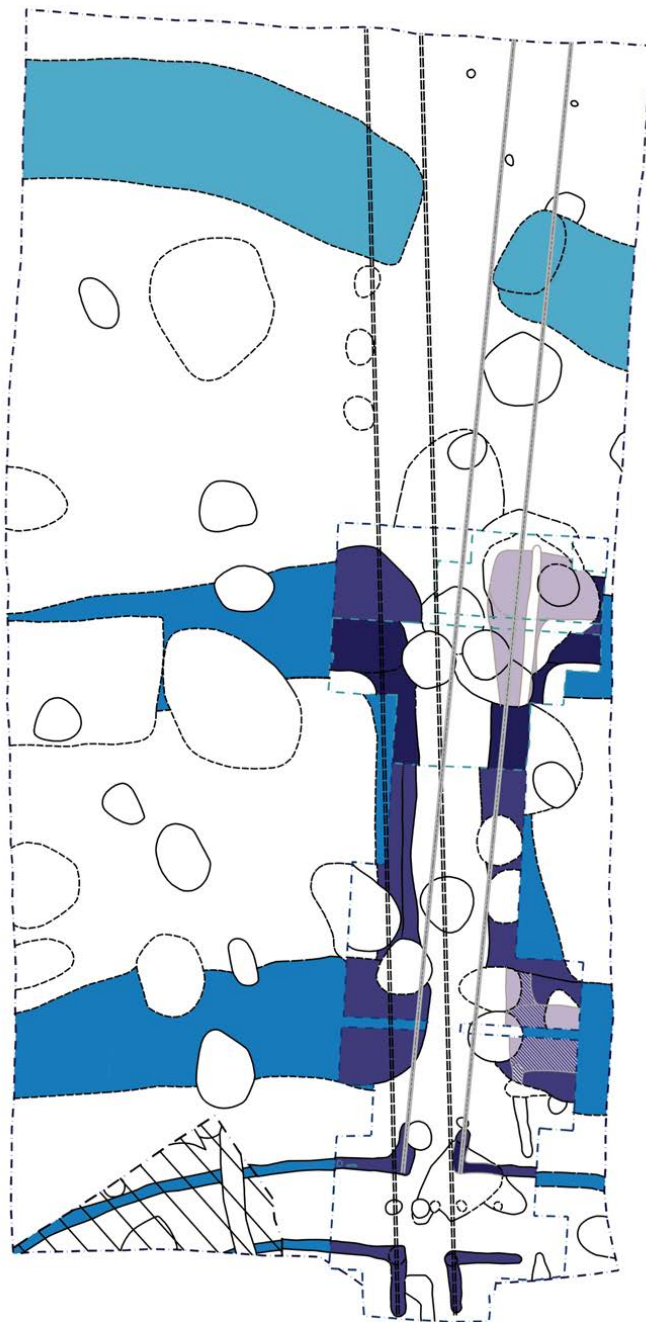


Fig. 6 | Plan of the north-western entrance of Quedlinburg I with two differently modelled lines-of-sight.

and 23 degrees pointing to the highest peak in that direction, the *Köhlerberg*. The south-eastern causeway with azimuth angles between 134 and 136 degrees points to the highest peak in that direction: the *Ruhmberg*, which is located eight kilometres away.

The very distinct construction of the north-western causeway with the respective different orientations might also indicate an adjustment of the palisade gap during the existence of the roundel. The resulting viewsheds prove an adjusted bias towards the *Heidberg* according to the different azimuth angles for the flanks of the palisade that now range between 307.5° to 312.6° at the inner palisade (Fig. 7, grey marks) and between 317.6° to 323.9° at the outer palisade (Fig. 7, white marks). Whilst the flanks of the inner palisade orientate towards the left flank of the *Heidberg*, the outer palisade is orientated to the right flank of the *Heidberg*.

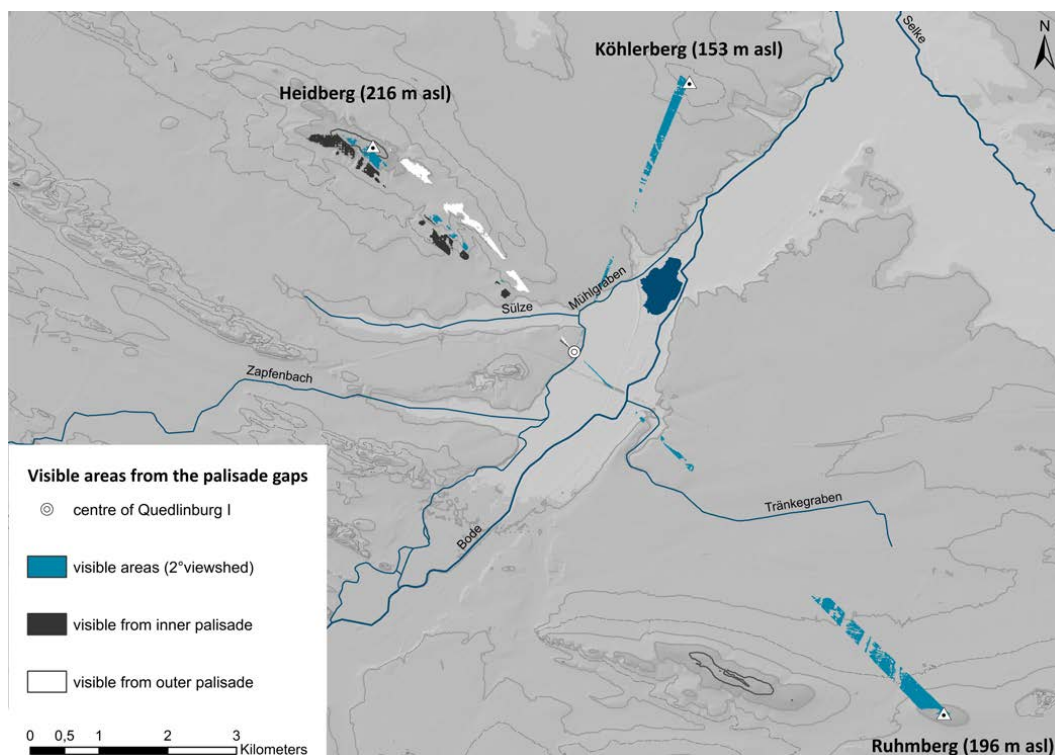


Fig. 7 | Visible areas from the palisade-gaps of Quedlinburg I (blue fields) and adjusted viewsheds of the inner palisade (grey mark) and the outer palisade (white mark) of the north-western entrance according to the excavation results.

It is still unclear if there was a change of beliefs, knowledge or necessities that led to the adaptation of the palisades. Thus, in an additional step the gaps in the palisades were checked for astronomical sightings (Fig. 8). Using the visible horizon line from the viewsheds (black line) and integrating different palisade heights²¹ (2.50 and 3.50 meters indicated by the grey parts) it was checked whether any of the causeways could be connected to solar, lunar or stellar occurrences.

Figure 8 displays the trails of the sun (orange line) and the moon (green line) depending on the season: In summer, the sun takes its northern path, in winter the southern one. The moon's trail always covers all angles during one month. The full moon is always opposite the sun, which means that the full moon in winter is visible on a high trail and the full moon in summer is visible on a low path. The new moon is always in the vicinity of the sun's trail and all other phases of the moon take place on any other of the possible trails in the range of lunar paths. That is why we do not intend to suggest the knowledge of long periodic cycles of the lunar orbit, like the Meton cycle of 19 years which is the return of the full moon to its northernmost or southernmost possible position. Instead, we can only draw conclusions about the observation of the sun's and the moon's extreme positions. Given the observed gaps in the palisades as shown, the paths of the sun do not emerge at any of them.²² Hence, at the current state of our research we can conclude that QLB I was obviously not constructed to *exclusively* observe the sun,²³ as this could be proven for other roundels (e. g. Goseck). The Moon however, on its northernmost position, misses the northwestern gate of the roundel on his setting only slightly. It also appears that the

21 Based on Kaufmann and Leineweber 2012, 106–107.

22 As long as there is no proof of a south-western entrance, where the sunset at the winter-solstice seems feasible.

23 And therefore the seasons.

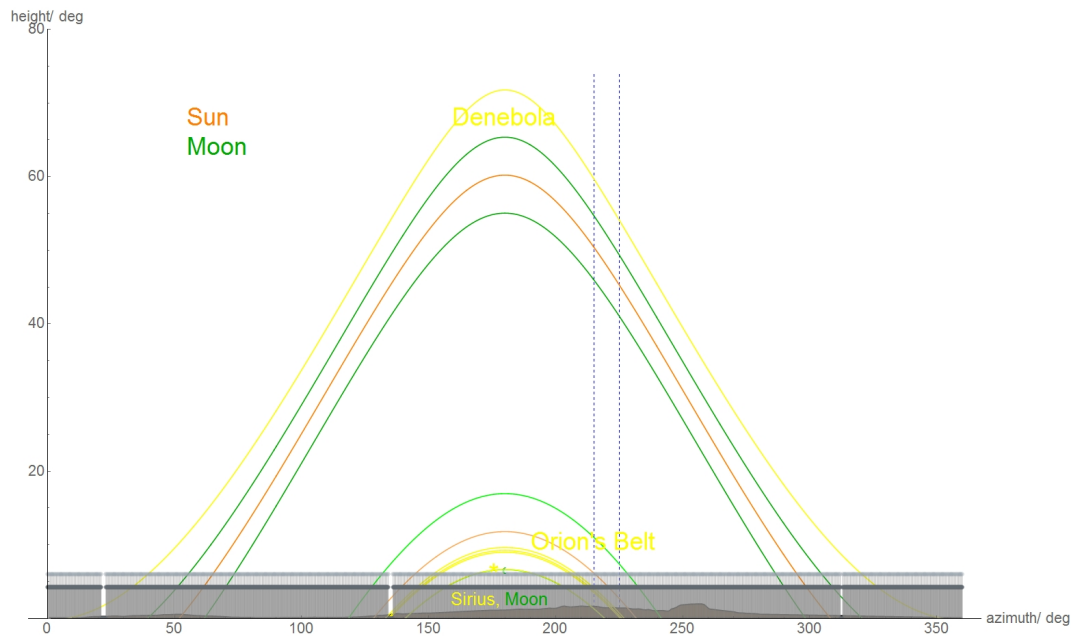


Fig. 8 | Horizontal profile of QLB I (black line); assumed minimal and maximal height of the palisade (grey) at 2.50m and 3.50m respectively and palisade gaps as evidenced by the excavations, position of the by Northe assumed south-western causeway (dotted blue lines), paths of the sun at solstices (orange), range of lunar paths at min/max distance from the ecliptic (green), star trail of Denebola (smaller yellow line on the outside) and Orion's Belt or Sirius (thicker yellow lines); azimuth angles from north=0° via east=90°.

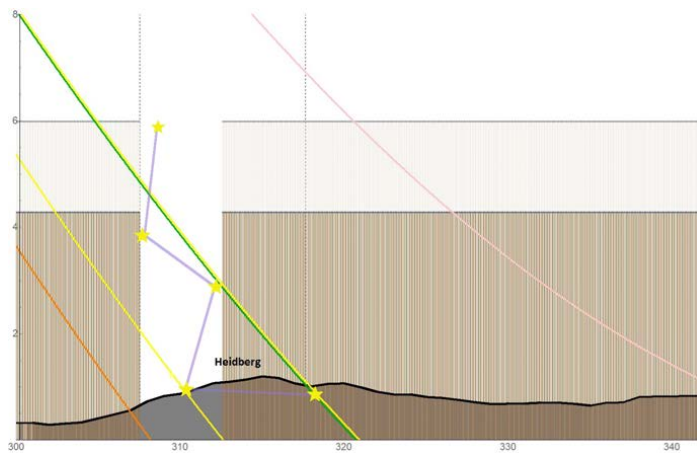
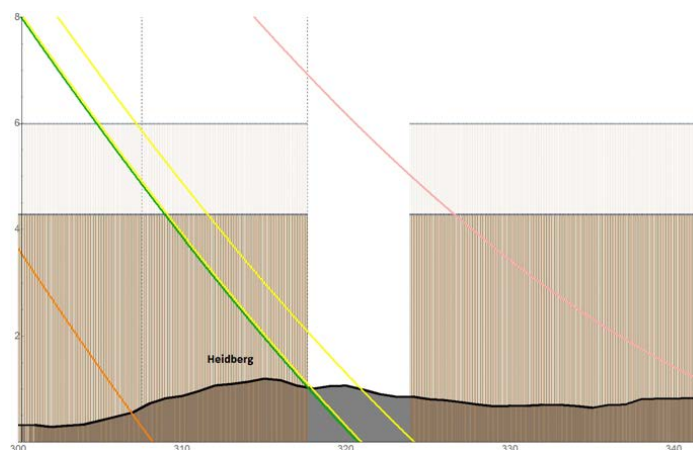


Fig. 9 | Horizontal profile of the north-western causeway of QLB I, *Hypothesis 1*; with northernmost paths of the sun (orange) and the moon (green) as well as star trails of Cassiopeia (yellow) and Denebola (pink).

rising and setting of some stars (visualised by the yellow lines) might correspond with palisade gaps and topographic features. As the latest excavations at the north-western causeway of the roundel allow us to model two differently aligned gaps in the palisade, this warrants closer scrutiny being visualized in figures 9 and 10. As mentioned above, in both hypotheses the moonset occurs scarcely adjacent to the palisade. Whereas in phase 2 (Fig. 10) the trail of the moon is completely missing the causeway, it can be observed in the gap of phase 1 (Fig. 9) – the moonset itself however remains invisible to the observer.

The examination of stellar occurrences provides striking observations as the five bright stars of the constellation of Cassiopeia cross both modelled palisade gaps with alpha Cassiopeiae, being the brightest star of the constellation, even setting in the palisade gap. In hypothesis 2 this star sets behind the palisade and only the two northern most stars of the w-shaped pattern are setting in the gate. Interestingly, it is the same constellation but

Fig. 10 | Horizontal profile of the north-western causeway of QLB I, *Hypothesis 2*; with northernmost paths of the sun (orange) and the moon (green) as well as the northern most star trails of Cassiopeia (beta&eps Cas, yellow) and Denebola's star trail (pink); azimuth angles from north= 0° via east= 90° .



different stars of the easily recognizable pattern which definitely had cultural meanings in many (later) ancient civilizations. We do not know if this has any meaning for Neolithic cultures and should come back to that after having analyzed other roundels.

In the south-eastern gate, again two options for the azimuth angles of the visibility windows have been modelled, based on varying lines of sights due to conflicting excavation results. In a first scenario, the azimuth angles oscillate between 130° and 136° , whereas at a deeper stratum, the course of the palisade features seems to shift, while becoming unclear at the same time, resulting in azimuth angles between 135° and 143° .

Visualising the first, more northern possibility (Fig. 11) we find no strong evidence for a celestial sighting: The sun at winter solstice misses the palisade gap by 1–2 degrees and the extreme position of the moon is hidden behind the palisade. Regarding possible celestial sightings there are two stars of Orion's Belt rising in the gate. Modelling the more southern option for the gate (Fig. 12), the moon and the brightest star of the night sky, Sirius, are visibly rising in the gate. That entails more questions than providing answers: why should they have observed this rising of Sirius and why should the southernmost rising of the moon be of interest? The moon rises at this particular azimuth angle roughly once a month, so it is easy to observe. Is it only by accident that Sirius rises in the gap or is there more to it? Perhaps further investigations and comparisons of celestial sightings at other roundels will provide us with more information. The observed correlation with the path of Sirius is an unexpected and potentially significant discovery though.

6.1 Results – Viewshed Analysis of Quedlinburg II

To compute initial windows of visibility for the neighbouring roundel QLB II, the azimuth angles, as stated by Northe,²⁴ have been taken into consideration. Based on the excavation results he suggests four palisade gaps being located at 24° (NE), between 128° – 140° (SE), 235° (SW) and 332° (NW).²⁵ We, however, use the exact azimuth angles based on the flanks of the passages for our calculations, resulting in wider windows of visibility as the passages are rarely aligned.

Accordingly, the azimuth angles of the north-eastern gap range between 7 and 14 degrees, in the south-western gate between 224 and 246 degrees and in the north-western passage between 311 and 338 degrees, resulting in the viewsheds shown in Fig. 13 (light green). The south-eastern passage has not been computed due to disruptions, which made

24 Northe 2012, 100.

25 He does not specify how exactly he measures the azimuth angles.

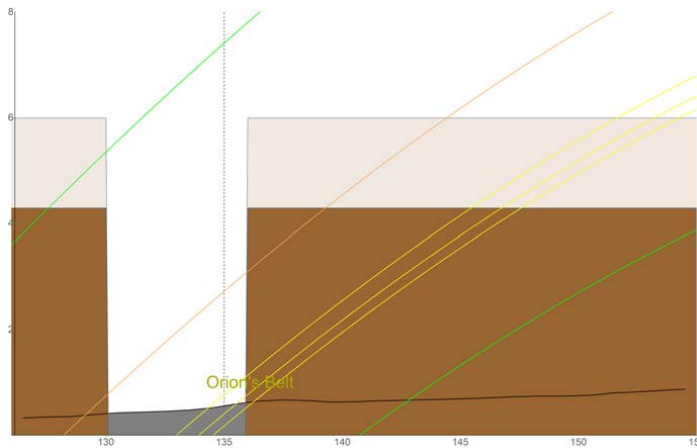


Fig. 11 | Horizontal profile of the south-eastern causeway of QLB based on *hypothesis I* with azimuth angles between 130° and 136° ; with southernmost paths of the sun (orange) and the moon (green) as well as star trails of Orion's Belt (yellow); azimuth angles from north= 0° via east= 90° .

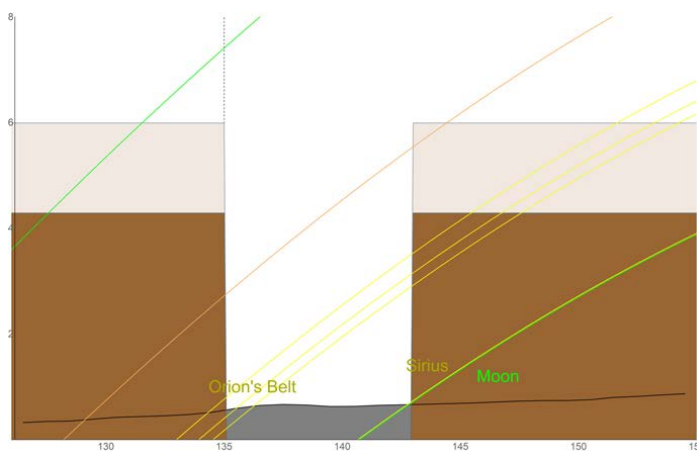


Fig. 12 | Horizontal profile of the south-eastern causeway of QLB based on *hypothesis II* with azimuth angles between 135° and 143° ; with southernmost paths of the sun (orange) and the moon (green) as well as star trails of Orion's Belt and Sirius (yellow); azimuth angles from north= 0° via east= 90° .

it impossible to detect the exact location of the passage. However, for a better understanding of the spatial characteristics of the roundel, the viewsheds as estimated by Northe, have been incorporated (Fig. 13, dark green marks). Furthermore, special emphasis has been placed on feature 29153²⁶, that is situated in the north-western passage between both ends of the ditches. With a range of ± 0.5 degrees at 329° it is directly orientated towards the highest point of the *Steinholz* (Fig. 13, red marks) correlating with the observations made at Quedlinburg I.

If we consider the roundel QLB II without any palisades (Fig. 14), it is striking that the sun at winter solstice rises exactly at the mountaintop of the *Helmsteinberg*. With heavy disruptions at the position where a gap in the ditches and palisades would most likely be, we can only assume possible azimuth angles. The estimated position of the gap, according to Northe, is indicated by the perpendicular blue lines, proving that the assumed gate most certainly orients to the direction of sunrise. Additionally, the sunset at winter solstice is observable in the southwest gate of the palisade circle (Fig. 15). As a result, of the discovery of two connections to the sun's path in the south, it seems very likely that this roundel was built to observe the winter solstice.

It remains unclear why there was obviously no intention to observe the summer solstice. The northern gates do not show any sightings of the sun or the moon. Since the azimuth angles of the gates in the northeast and northwest are similar to those in QLB I, there are similar stars which rise and set there. Again, we would find some stars

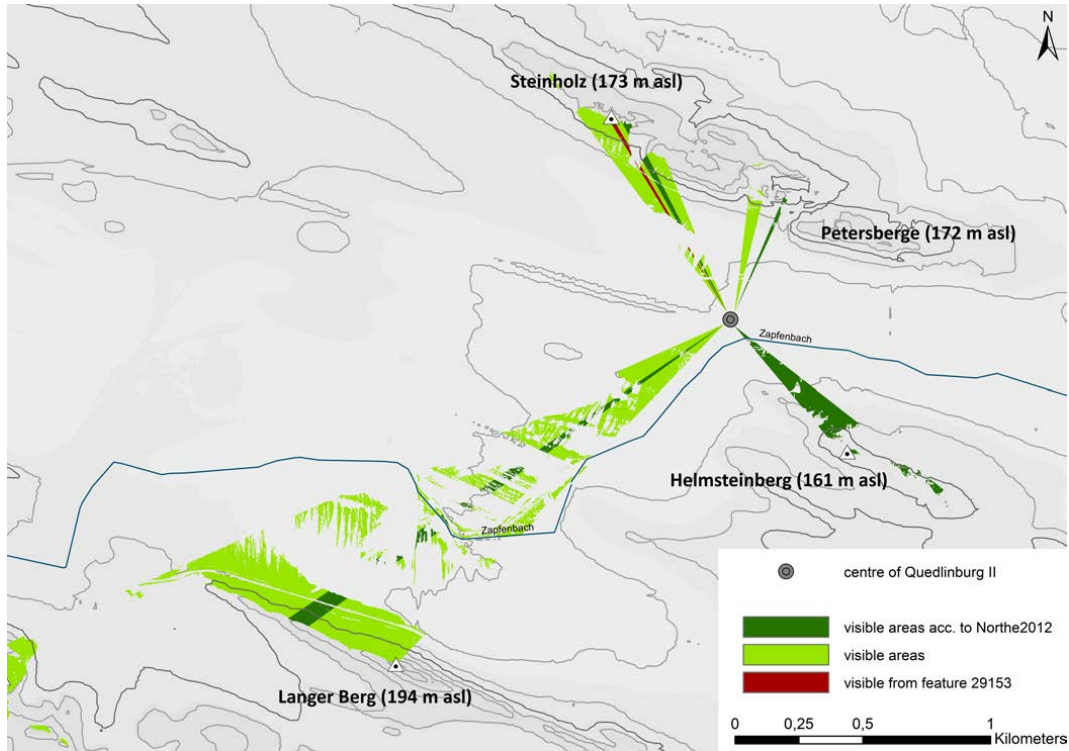


Fig. 13 | Visible areas from the palisade gaps of Quedlinburg II according to Northe (dark green fields) in comparison to our research (light green fields) with special emphasis on feature 29153 (red marks).

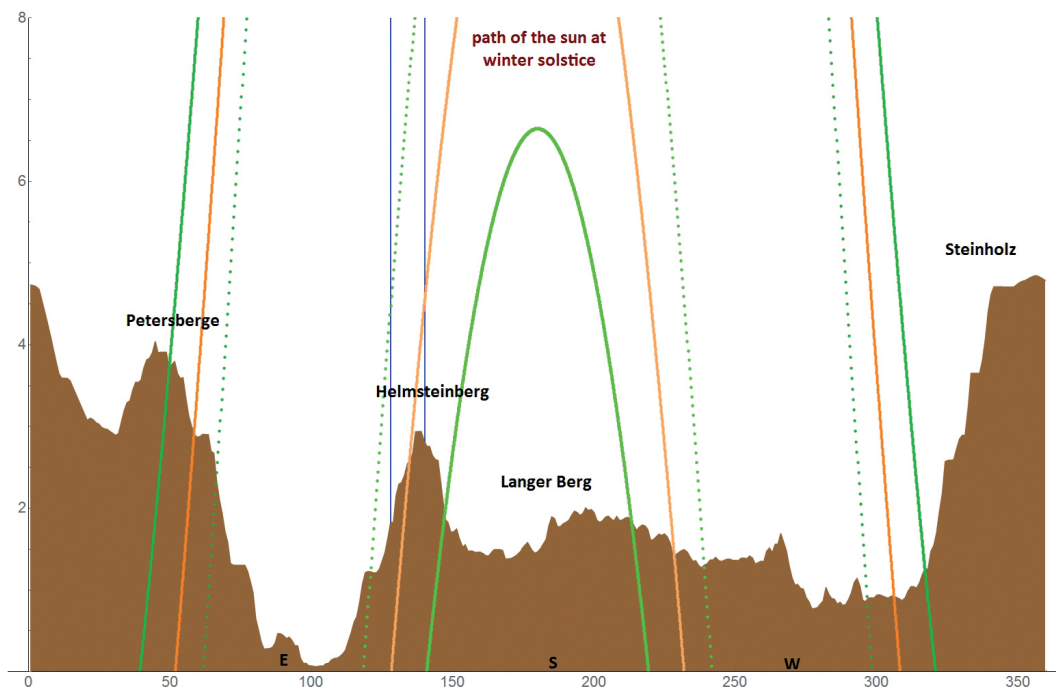


Fig. 14 | Horizontal profile of QLB II with northern most paths of the sun (orange) and the moon (green); azimuth angles from north=0° via east=90° without any palisades, indicated in blue is the location of the assumed south-eastern causeway.

of the constellation of Cassiopeia in the gates if the view would not have been obstructed by the micro-topography. Actually, there is no astronomical reason to construct palisade-

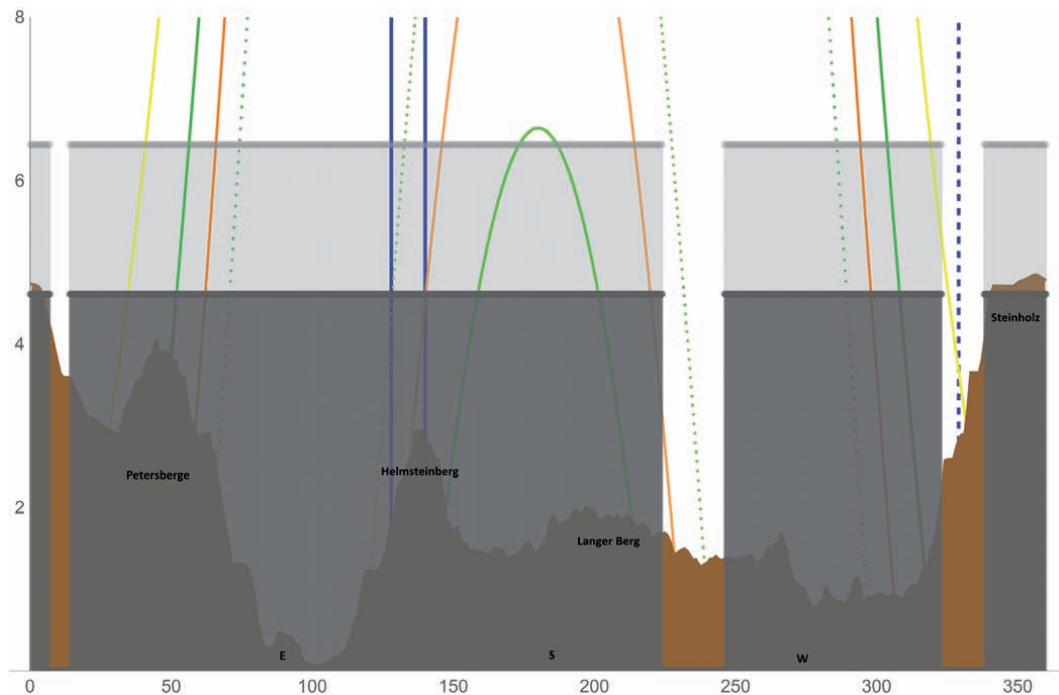


Fig. 15 | Horizontal profile of QLB II with northern most paths of the sun(orange) and the moon (green) and corresponding star trails (yellow); azimuth angles from north= 0° via east= 90° with palisades, indicated in blue is the location of the assumed south-eastern causeway, the dotted blue line indicates the line of sight from feature 29153 to the *Steinholz*.

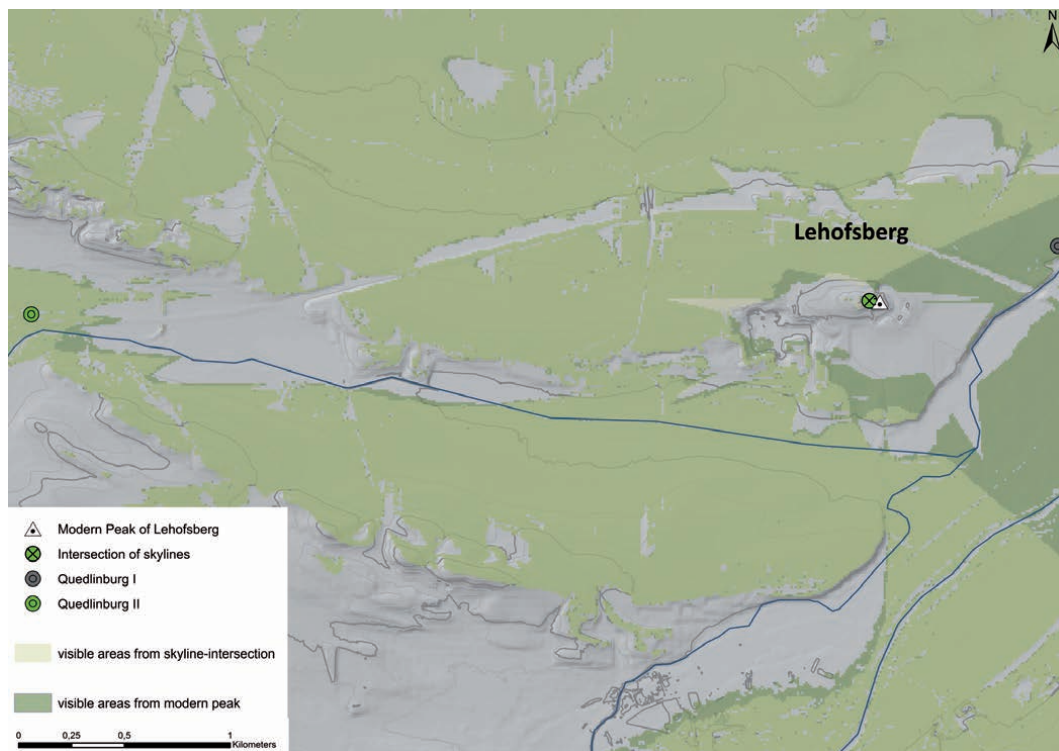


Fig. 16 | Visible Areas from the modern peak of the Lehof and the intersection of the roundels skylines.

gaps to these northern directions because nothing rises or sets in the north. Additionally, from the position of QLB II, both the *Steinholz* and the *Petersberge* are situated merely 500

meters north of the roundel. At a range that close, an assumed palisade height of 2.5 m could not have served as an effective blind.

6.2 Results of combined viewshed between both roundels

According to the skyline analysis, the highest peaks of the Harz Mountains were (theoretically) visible from both roundels. Additionally, our research shows that both skylines intersect at the same place: the very distinctive *Lehofsberg*. Its striking yellow-coloured fine grain sandstone²⁷, having been mined for gravel since antiquity, seems to have had a special prominence in the area due to its appearance. Hence, an additional viewshed was calculated to check visible areas from the highest point of the *Lehofsberg* and the place where both the roundels skylines intersect.

At the intersection of both skylines only QLB II is visible, whilst from the peak of the *Lehofsberg* both enclosures can be seen (Fig. 16). Strangely enough, none of the roundel causeways seems to be orientated towards the hill. However, four kilometres apart, QLB II is situated almost exactly at an angle of 90° west²⁸ of the *Lehofsberg*. We believe it played an important role in the placement of the roundels as both enclosures can be seen from its (supposed) peak. Unfortunately the extensive gravel mining changed the visual nature on the eastern slope of the *Lehofsberg* radically. With a massive part of the rise missing, one must also take the (probable) palaeorelief into consideration when calculating viewsheds. With the help of historical maps the deviation can be estimated which will be done in another step.

Until now all the observations concerning the visibility to and from the roundels – both astronomically and topographically – raise more questions than providing answers. It can be stated though, that it seems rather unlikely that the construction of both roundels at their respective locations was done randomly. The clear orientation towards the highest peaks in the closer vicinity at both roundels shows that incorporating the local topography was crucial to the construction of roundels.

6.3 Spatial Patterns

We did not only focus on roundels as isolated monuments but also investigated their spatial relationship to coeval settlements. Therefore, a point pattern analysis was undertaken. Analysing 30.000 pages from more than 100 local site-files, a total of 166 sites were identified that can be dated to the Stroke-Ornamented Pottery Culture. At least three of them appear to have a funeral context, 84 sites are characterized as stray finds and 79 are believed to be settlements.

To test the settlements for complete spatial randomness, G-, F- and K-functions have been performed. The test results, plotted against the same amount of automatically generated random points for the Complete Spatial Randomness, show that the identified settlements are not randomly distributed (Fig. 17). Both the G- and the K- function show that the empirical values are larger than the theoretical values indicating a clustered pattern. The results of the F-function indicate higher theoretical values than empirical ones also pointing to a clustered distribution.

Additionally, this was supported by the results of a kernel density estimation (Fig. 18), which also showed that the circular enclosures are located in certain settlement clusters. Several test-runs with different radii have been conducted, proving that the monumental

27 *Involtus-Sandstein*.

28 Where the sun sets at equinox.

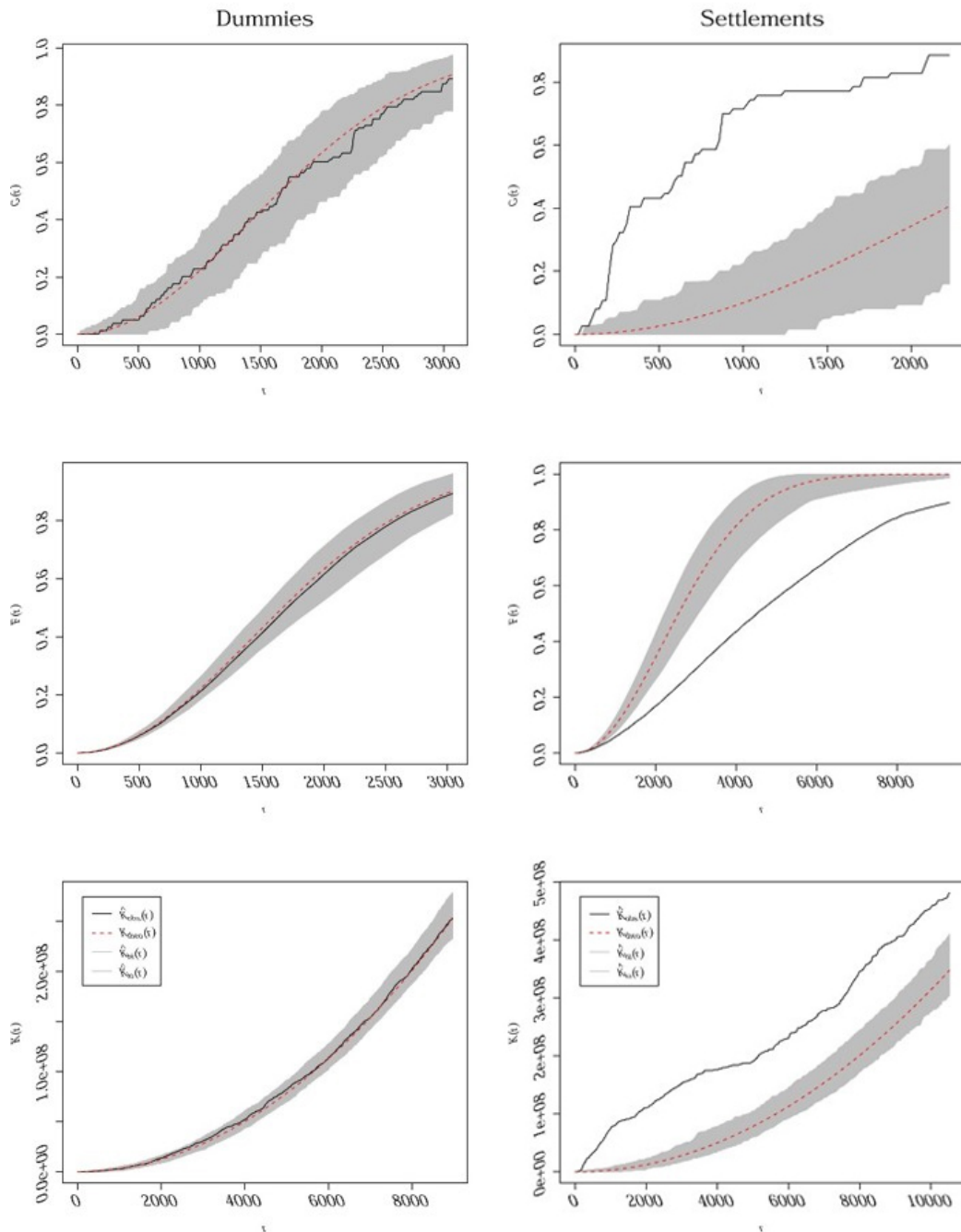


Fig. 17 | Results of the test for complete-spatial-randomness with G-, F- and K-function for random points (left) and settlement points (right).

roundel Quedlinburg I is located in the centre of what appears to be a settlement cluster whilst other enclosures in the research area seem to be isolated.²⁹ As clustered patterns might suggest a different set of structuring principles such as a tendency to locate the sites near to special places, this begs the question as to how those monuments were integrated in a potentially well-defined social structure. It is evident that the construction of such enormous monuments not only required a significant amount of human effort but also

29 Like Quedlinburg II.

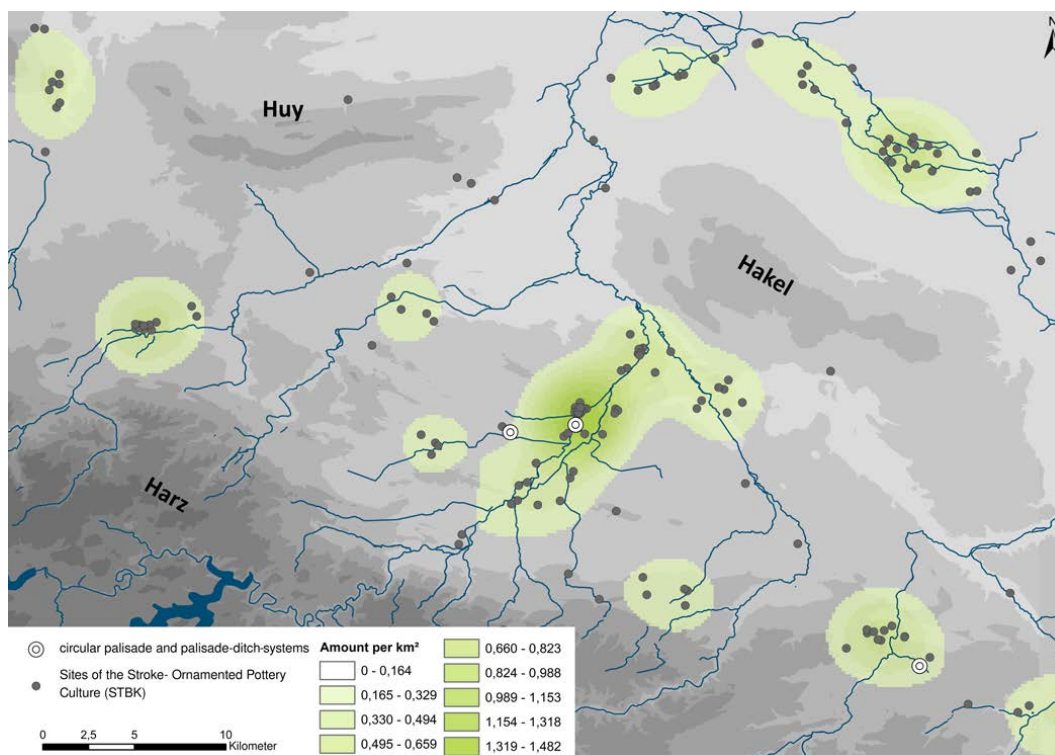


Fig. 18 | Results of the kernel-density-estimation incorporating settlement sites of the Stroke Ornamented Pottery Culture in the research area.

necessitated a high degree of organizational skill and a corresponding social structure through which to implement it.

7 Synthesis and conclusion

In this article preliminary results of a skyline and viewshed survey of two circular enclosures in the northern foreland of the Harz Mountains (Saxony-Anhalt, Germany) have been presented. The established workflow, that comprised GIS-based skyline and visibility analyses as well as a self-developed routine to match possible astronomical features to palisade gaps, seems promising for research questions like ours. Considering previous studies that were often solely based on the results of geophysical surveys and/or rather coarse digital elevation models, we argue that for precise results, it is necessary to utilise high-resolution data. Specific features like narrow palisade gaps can often be only obtained through excavation. Additionally, one has to take the prehistoric relief into account. Both our research areas are highly affected by anthropomorphic change – be it due to mining that alters the appearance of whole landscapes or extensive agriculture that leads to erosion and subsequently changes the elevation of surfaces and therefore our way of perceiving landscape.

Still, at this point of our research, especially in regard to astronomic alignments, more questions arose than we are currently able to answer. During the next phase of our project we intend to apply our workflow to all German circular enclosures to have a valid statistical population to check patterns of corresponding astronomic and topographical properties.³⁰ Thereby, we hope to shed light on the question of whether they only observed

³⁰ Where data is obtainable.

the sun as it changed during the year, the sun and the moon to establish an astronomical calendar with lunar months and solar years, or even extreme positions of the moon for reasons as yet unknown. Additionally, we will even be able to distinguish if a systematic observation of star trails had been carried out. Therefore, we will be able to estimate whether the German enclosures in general have a common function to primarily observe the sky, as suggested by Schlosser,³¹ or if the gaps in the palisades have other functions.

The preliminary results of our research indicate that during middle Neolithic times, knowledge of the path of the sun, moon and stars may have manifested itself in the construction of roundels. The specific orientation of gaps in the palisades to both astronomic *and* topographic sightings apparently implies that the constructions of those monuments is not random but follows certain patterns. Whether and to what extent the roundels might be indicating borders of territories or strategic points within a settlement cluster will also be part of our future investigations.

“Bridging the gap” between the humanities and natural sciences was essential for the success of our research project. Though the idea for the project, the shaping of research questions and the application for funds was solely in the hands of archaeologists certain questions within the project like possible lines of sight to astronomic features could not be answered without profound knowledge of astronomy. In establishing a routine for the calculation of solar, lunar and stellar occurrences *together*, we launched a successful project that integrates not only archaeological and geographical methods but also expertise in the broad field of astronomy.

Finding a willing cooperation partner to join an already running project with good levels of both interest and understanding was the hardest part followed by the time-consuming task of establishing a common language. Not only are there different *termini technici* between researchers of the humanities and natural sciences but also different understandings of the same words. Colleagues with a mathematical background have a different idea about the term *vector* for example than a person using the same term in a GIS-based environment. Still, in our opinion, reflecting these differences is crucial for interdisciplinary projects. Hence, we would rather suggest to always minding the gap whilst bridging it.

31 Schlosser 2007, 284.

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