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The vitrified wall of Broborg hillfort in Uppland, Sweden – Response to the comments by Mr. Anders Bornfalk Back

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A B S T R A C T

The authors thank Mr. Anders Bornfalk Back for reading Sjöblom et al. (2022) and for presenting his comments. We also thank the Editor for granting the authors the opportunity to respond. We have chosen to limit our comments to some of what is said in the sources quoted, including Sjöblom et al. (2022).

1. Introduction

The purpose of the work in (Sjöblom et al. 2022) was not to "*contextualise*", but "*(a) to add to the Swedish heritage, and (b) to support the development of an anthropogenic analogue for the disposal of vitrified nuclear waste*". Knowledge of the genesis of the vitrified materials constitutes a part of such an analogue.

2. Broborg revisited

"Sjöblom et al. (2022) *do not offer any further suggestion of their own*". As referenced in (Sjöblom et al., 2022) there has been a long-lasting debate among archaeologists internationally as to whether there has been any vitrification at any prehistoric hillfort for constructive purposes. This has led us to scrutinize the work by Kresten and co-workers more carefully than might otherwise have been warranted considering the objectives of our work as stated above. For the very most part, the findings of Peter Kresten and co-authors were corroborated, and this includes findings made during the excavation at Broborg in 2017. However, further suggestions were put forward in Sjöblom et al. (2022) that it was likely the oxidation state of iron, rather than the presence of water vapour, in combination with a very high temperature that facilitated the melting of the rock.

On the findings of Peter Kresten et al.: "*This suggestion has not been widely accepted in Swedish archaeological research.*" Engström (1984) did not discard the idea of vitrification for constructive purposes. Instead, and with the support of Peter Kresten, he found that the calcareous rock at Torsburgen had become calcined (*i. e.* not vitrified) as a result of fire in the reinforcing timbers. David Damell and Olle Lorin worked closely together on a number of hillforts, including Kollerborg. Damell and Kresten (1996) investigated the vitrified material at Kollerborg and compared it with that at Broborg which they acknowledged to have "*been explained as a construction*". They found the following: "*At Broborg, the vitrified material is found as a massive cake on top of the rampart (Fig. 5), while at Kollerborg, vitrified masses are comparatively small and scattered. At Broborg, amphibolite, the fusible material, was apparently selected material, concentrated on the crest of the rampart. At Kollerborg, no such selection has occurred (Fig. 6). Accordingly, vitrification at Broborg occurs in a seemingly planned way all around the inner rampart. By contrast, vitrification at Kollerborg seems to occur where there happened to be amphibolite.*" Moreover: "*Vitrification at Broborg may be interpreted as forming the solid backbone of the rampart. At Kollerborg, this function is maintained by the*

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[1] Until recently

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rocky hill itself and vitrification is not a reinforcement of the structure, but the contrary. Therefore, the vitrified rampart at Kollerborg is tentatively classified as the result of destructive firing." Actually, any reluctance on the part of David Damell and Olle Lorin to recognize any vitrification as a result of construction (apart from at Broborg) is due to the fact that no such vitrification was found in any of the forts that they had excavated. The question of the differences between hillforts is dealt with in (Sjöblom et al. 2022).

"*However, to explore Broborg as an alien entity isolated from the traditions and trajectories of 5th century East Middle Sweden is a luxury not afforded to archaeology today*." The rationale for the approach in Sjöblom et al. (2022) is explained in the article. Hillforts burned and were burned rather frequently as a result of accidental fires and hostile action. Careful analyses and solid proof are appropriate in order for a vitrification to be identified as constructional, and in the present approach, three prerequisites are to be fulfilled: incentive, competence and the wall itself. These prerequisites are sufficient to support constructive vitrification but are not necessary for the vitrification to have been constructive.

The present authors agree with Mr. Back that it is warranted to put Broborg in its regional perspective, but that is beyond the scope of Sjöblom et al. (2022). A chapter "*Broborg in the perspective of other prehistoric forts in Sweden*" has been submitted for review with a view to publication in an upcoming book "*Towards an international archaeology of fortifications: methodologies and interpretations*" (Sidestone Press). This chapter puts Broborg in a more general perspective and includes additional information.

3. Broborg revisited

3.1. Why vitrify?

"*The notion that Långhundraleden was a maritime highway linking the heartland of Uppland with the Baltic Sea in the east as late as AD 500 is a modern myth*". Here Mr. Back refers to Risberg & Alm (2011) who wrote about land rise. The water downhill from Broborg might well have been fresh rather than somewhat brackish (as in the Baltic Sea as well as then in Lake Mälaren) at the time when the fort was constructed and in operation. However, this does not imply that the Långhundraleden Waterway is a myth. Risberg and Alm (2011, p. 40) maintain that (translation by the corresponding author) "*The fact that the Långhundra Waterway no longer had a continuous water surface*" … "*did not imply that the waterway ceased to function for transport*", and "*thanks to these lakes, the waterway has functioned as such long after the watershed divide had come to impede the traffic*". It is added that with the types of boats used, portaging was feasible. Actually, the entire Långhundra Waterway might be identifiable on Carta Marina from the year 1539, one early copy of which is kept at the library (Carolina Rediviva) at Uppsala University. A part of this map is shown in Fig. 1.

"*As for the area being a borderland, the authors seem to assume that the districts (folkland) of medieval Uppland had been established already by the 5th century*". The authors did not assume that, and references are provided to literature on state formation in Sweden. However, the text would have been clearer if we had mentioned that these ancient districts/folkland/counties referred to in Sjöblom et al. (2022) coincide largely with two major watersheds which existed long before Broborg was built.

"*Hence, there was no site-specific need to melt stones together to construct the walls of Broborg.*" Sjöblom et al. (2022) consider that prehistoric forts

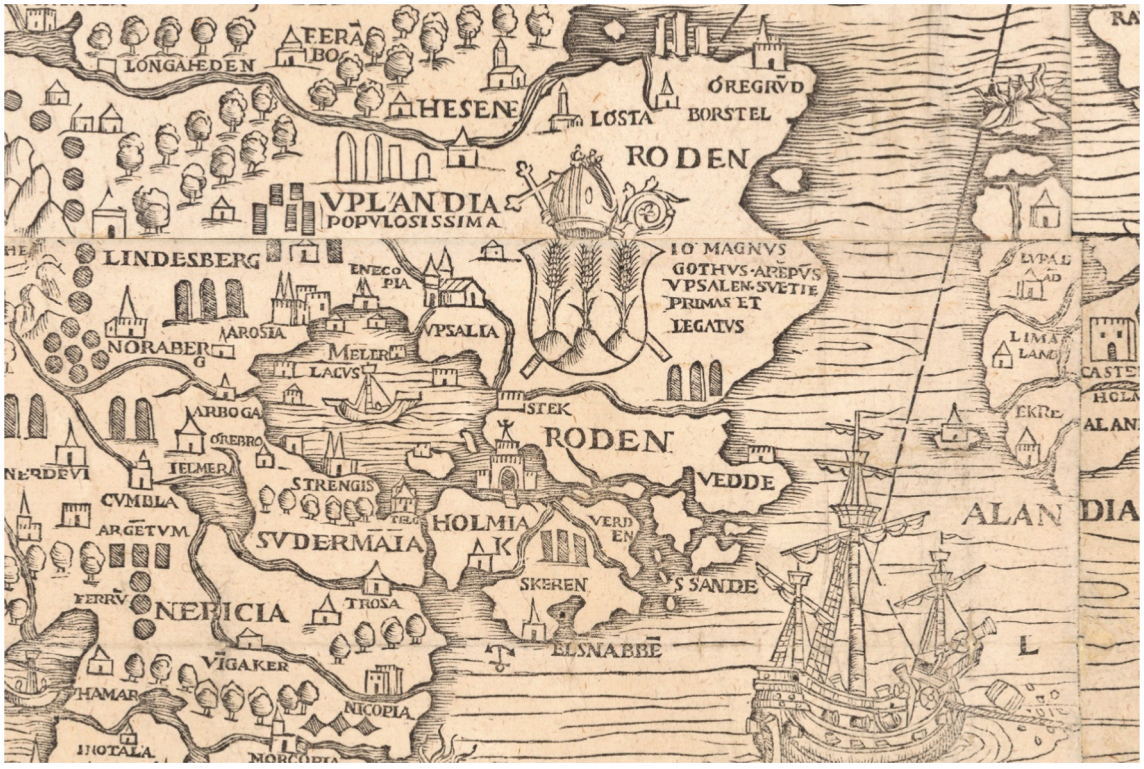

Fig. 1. Excerpt from Carta Marina, originally a woodprint created during the years 1527–1539. The Långhundra Waterway can be identified as a continuous waterway just above the word "RODEN" (the lower one). When comparing with modern maps, please note that there has been a substantial land rise of ≈ 2.2 m at the site of the Waterway since the map was prepared, *cf.* (Risberg and Alm 2011). The map is available at Wikimedia Commons, https://commons.wikimedia.org/wiki/File:Carta_Marina.jpeg. See also https://en.wikipedia.org/wiki/Carta_marina and https://www.alvin-portal.org/alvin/view.jsf?aq=%5B%5B%7B%22A_FQ%22%3A%22carta+marina%22%7D%5D%5D&c=6&aqe=%5B%5D&af=%5B%5D&searchType=EXTENDED&query=carta+marina&pid=alvin-record%3A88495&dswid=2488#alvin-record%3A88495.

may be different in terms of the stone material that was available and refer to Wadsworth et al. (2017). E. g., amphibolite is a rock type, the chemical and mineral composition of which may vary considerably with different outcrops and locations. It is thus important to resist any temptation to regard different hillforts as having similar prerequisites for constructive vitrification.

3.2. Who vitrified?

"Instead, they argue that competence in large-scale constructional vitrification" … "is indicated by knowledge of widespread crafts such as iron production, forging, casting and tar production. The relevance of this analogy escapes me." Iron production, forging and casting are not mentioned in Sjöblom et al. (2022), only iron beneficiation, which includes roasting and reduction of iron ore. As explained in the article, these crafts include the ability to achieve high temperatures and specific redox conditions at the same time. The combination of such physical and chemical conditions is important in determining the onset and genesis of the vitrification as mentioned above in the response to the first point.

3.3. What indicates constructional vitrification?

"*If the wall was enriched with amphibolite, it is yet to be verified*." As referenced in Sjöblom et al. (2022), Peter Kresten (a Professor in Petrology) and co-workers carefully determined the relative abundance of the rock types in the section of the wall that they excavated. Their findings of amphibolite enrichment were qualitatively corroborated on another section of the wall in the present project during the 2017 excavation. Conversely, at Kollerborg (*cf*. above), amphibolite is sufficiently rare such that a continuous body with a high mechanical integrity could not be formed consistent with no deliberate lithological enrichment.

Sjöblom et al. (2022) also state that "the vitrification forms an even surface suitable for carrying an appreciable load such as a dry-stone wall", and that this surface accounts for about 75 % of the circumference of the inner wall. This was determined by Kresten et al. using magnetometry, and in both of the excavations by ocular inspection and mechanical probing, see (Sjöblom et al. 2022) for details.

No rationale is presented by Mr. Back as to why these clear observations from two different excavations at Broborg are called into question.

A glass bead found at the site and typologically dated to the 8th century indicates later occupation (Fagerlund 2009, p. 19–21). The bead was mentioned also in Löfstrand (1982) who put forward that the bead was found within what was assessed to be a house foundation, and that it could be dated to the 5th – 6th centuries, possibly somewhat earlier. This data was not included in Sjöblom et al. (2022) since the location was at some distance from the wall and since the dates constitute a very wide range that includes the more precise dates quoted.

This may be supported by the result of two thermoluminescence analyses of fire scarred stones (gneissic granite) sampled from the area by the burnt wall, both dated to AD 740 ± 100 (Mejdahl 1983, p. 362–363; Kresten & Kero 1992, p. 32; for reservations on the TL-dates see Kresten et al. 2003*).* The latter reference says that the method is unreliable at temperatures above 900 °C, with increasing error the higher the temperature. The error is systematic and gives rise to dates that are too young. Consequently, the thermoluminescence measurements are not mentioned in Sjöblom et al. (2022).

4. Conclusion

The present authors refrain from commenting on the conclusions made by Mr. Back, including the "*likely interpretation in keeping with the available data*", but conclude that they do not follow from what is presented in Sjöblom et al. (2022).

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

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