The mystery of the vitrified ancient hillfort

The enigmatic vitrification at the ancient hillfort Broborg and its utilization as an analogue for nuclear waste glass is being investigated in an international research project.

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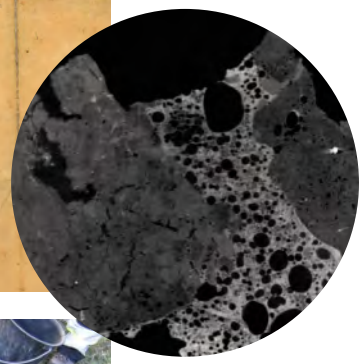
Map from the years 1769 and 1804 showing the Broborg hillfort, the river Storån and the Grimsa ford ("Grimsa wad") which is part of a road hosted by the ridge Vallbyåsen (extending south-north). The map is not to scale, and in reality the fort is much closer to the ford. The map is from the archives of the Swedish Lañmäteriet.



X-ray tomographic image of a sample from the vitrified wall at Broborg. Two pieces of rock are joined by vesicular vitrified material. The vesicules (Sw. blåsor) are filled with gas.

The base of the ancieñ wall with pieces of rock held together with vitrified material, cf. text.

ALTHOUGH THE MODERN understanding of chemistry dates back only a couple of centuries, many of the processes and products used today were actually originally developed by ancient people. However, much of such ancient knowledge has been lost, as is the case of the vitrification of stone walls in pre-historic hillforts (≈ *Sw. fornborgar*). This far, there exists no consensus on the process(es) used, and for the last ≈ 200 years, the archaeologists have even argued about whether the vitrification was for constructive or destructive purposes.

IN SOME COUNTRIES, long-lived radioactive waste may be vitrified in order to obtain a durable waste form. The assessment and assurance of the long-term behaviour of such glass is highly dependent on suitable analogues, i. e., artefacts that are similar to the waste form in question and which have been exposed for very long times to environments that are similar to that in the repository.

Recently, it has been realized that the ancient hillfort glass could constitute an analogue that – at least in some respects – might be superior to those studied previously, i. e. natural glasses and glasses of ancient domestic objects. Thus, the United States Department of Energy has initiated a project with the dual objective of unveiling the secrets of hillfort vitrification, and utilizing hillfort glass as an analogue to nuclear waste glass.

The work is focusing on Broborg in Sweden, which is a hillfort located around 10 km east of Knivsta. It overlooks an ancient major waterway (Långhundraleden) leading to the interior of Uppland, as well as a road, see Figure 1. The location thus suggests that, in pre-historic times (and before too much elevation of the land), Broborg could have controlled access for trade as well as any military activities.

THE INNER WALL of the fort comprised a base with vitrified rocks, a dry-stone walled (*Sw. kallmurad*) structure and likely also a palisade on top. Today, the stone wall structure has disintegrated and only the base is left in place, see Figure 2. The base consists of a granite type of stones joined by molten rock, likely amphibolite, see Figure 3.

The photo in Figure 2 was taken during the excavation carried out in October 2017. It was observed that the stones of granite, which are normally very resistant to weathering, were fire-cracked (Sw. skörbrända) and heavily fractured or even disintegrated whilst the glass appeared to be intact. KB

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