



PALEOSEISMIC FRACTURING OF ROCK CARVINGS 1000 BC IN SE SWEDEN

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Abstract (Paleoseismic fracturing of rock carvings 1000 BC in SE Sweden): At about 1000 BC, a major ($M > 6$) earthquake struck SE Sweden. This event fractured several rock carvings from the Bronze Age in a radius of, at least, 5 km from the centre of fracturing. At the centre, the Cambrian quartzite was heavily deformed and fractured-up in loose blocks and deep fractures, dominated by a strong extensional force. This fractured bedrock was, by the local people, converted into a quarry used to obtain flat blocks for the nearby grave known as “Brantarör” (which had, at least, 60 curb-stones and 12 blocks for the central sarcophagus) and for the huge bow and stern stones in the large stone-ship of Ales Stones, 30 km away. The quarrying seems to have in operation around 800 BC.

Key words: Earthquake 1000 BC, fracturing Bronze Age rock carvings, quartzite quarry, the Brantarör grave, Ales Stones, SE Sweden

INTRODUCTION

A total of 61 major ($M > 6$) earthquakes have been identified in Sweden (e.g. Mörner 2003); 3 during the pre-LGM interstadial (32-28 ka), 46 during the period 13,000–5000 BP, and 12 during the last 5000 years. The latest event documented was found in 2012. It has number 61 in the Swedish Paleoseismic Catalogue and it occurred 1000 BC. It fractured several rock carvings from the Bronze Age in SE Sweden (Fig. 1).



Fig. 1. The 1000 BC earthquake had its centre at Brantevik where the Cambrian quartzite was fractured-up in blocks, used by the locals as a quarry for archaeological monuments. The earthquake fractured many rock carvings within a radius of, at least, 5 km (e.g. Järrestad).

The Bronze Age in SE Sweden is characterized partly by the early influence of visitors arriving by big ships from the East Mediterranean trading bronze for amber and partly by a strong Sun-cult (Mörner et al., 2009; Lind & Mörner, 2010; Mörner & Lind, 2010; 2012; Mörner, 2012).

There are large astronomical calendars; one in the form of a stone circle named Heimdall's Stones (Mörner et al., 2009) and one in the form of a 67 m long stone-ship named Ales Stones (Lind & Mörner, 2010; Mörner & Lind, 2012). The bow and stern stones of Ales Stones consist of two large blocks of quartzite (about 5 tons each), which must have been brought from Brantevik, 30 km to the NE (Lind & Mörner, 2010).

At Järrestad, there is a flat bedrock surface of quartzite, which is covered by rock carvings from the Bronze Age. The pictures have a very strict alignment with respect to the solar motions of the year (Mörner, 2012).

Already a decade ago, it was observed that the surface was fractured in postglacial time (Mörner, 2003, p. 267). In 2012, new data emerged (this paper) indicating that, indeed, an earthquake had fractured the surface after the carvings were made.

THE BRANTEVIK EARTHQUAKE 1000 BC

In connection with studies at Brantevik (Lind, 2012), I came to visit a swampy depression in the quartzite, later named “Brante Träsk” (the Brante Swamp).

After much cleaning, digging and coring, a new picture emerged: the bedrock surface was cut-up in large blocks by a network of fractures (Fig. 2) indicating strong extensional forces by a large earthquake ($M > 6$). Later, people had used this “pre-fractured” bedrock as a quarry, removing loose blocks and breaking-up flat blocks into a 1 m deep quarry (now overgrown by peat as recorded by coring at 21 points).

The quartzite is a sandstone from the Cambrian time. Its extension is limited to the Simrishamn–Brantevik region. The lithology differs along the coast. Only at Brantevik itself (including the area around Brante Träsk), the bedding structures are clear, exhibiting the irregular building up of a sandstone bed (of quartz grains). These bedding characteristics, like the weathered glacially polished rock surface, are identical to those of the bow and stern stones at Ales Stones (Mörner, in Lind, 2012).



Fig. 2. The fractured bedrock of quartzite at Brante Träsk. It is traversed by fractures, all recording multi-directional extension generated by earthquake forces (cf. Fig. 5). Then, the broken-up surface was used by Bronze Age people for collecting loose blocks and for breaking up new ones; i.e. the seismically "pre-fractured" bedrock was turned into a quarry. Flat stones were needed for the building of the Brantarör grave (which, on a drawing from 1777, had, at least 60 curb-stones, and 12 large block for the central sarcophagus). The bow and stern stones of Ales Stones seems also to originate from this area (Mörner, in Lind, 2012).

The Brante Träsk quarry and stone industry

On a drawing from 1777 (Fig. 3), the Brantarör grave is very well recorded; today, it is gone (Lind, 2012). The high number of curb-stones (flat and trimmed) and the sarcophagus blocks must have called for a place of "industrial" quarrying; and now, we have found it at Brante Träsk (Fig. 2).

From the sarcophagus in the Brantarör grave, an urn (Fig. 4) was taken (together with the hilt of a bronze sword) in 1767. This urn has been kept in the family all though the years, and was "refound" in 2012, when it was handed over to B.G. Lind (Lind, 2012). The urn has been professionally examined by E. Jonsson and assigned an age of 800-500 BC (Lind, 2012). Consequently, the Brantarör graves (there was at least 5 of them) were built in the Late Bronze Age.

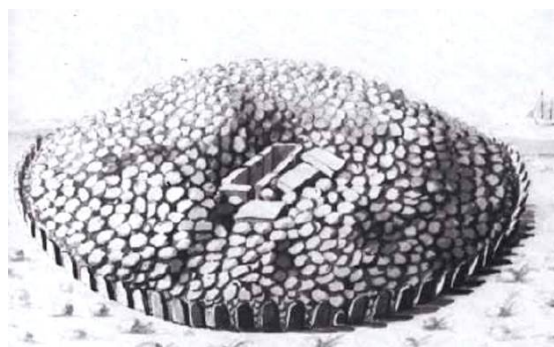


Fig. 3. The Brantarör grave as drawn by Hifeling in 1777 (from Lind, 2012).



Fig. 4. The urn taken from the sarcophagus of Brantarör in 1767 and kept in the family up to today (from Lind, 2012). The urn has been assigned an age of 800–500 BC.

In the period 1000-700 BC, sea level was 2.1 m higher than today in the Brantevik area. The land/sea line has been carefully reconstructed (Mörner, in Lind, 2012) and a natural harbour existed right in present-day Brantevik; with 50-60 m to the Brantarör grave and some 400 m to the quarry at Brante Träsk.

It seems highly reasonable that the shipping of the large blocks of quartzite, now as bow and stern stones in Ales Stones, were transported from the quarry to the harbour (400 m) and then by ship/raft to the shore at Kåseberga (30 km) and up to their present place (400 m). This happened prior to 600 BC, and probably around 800 BC.

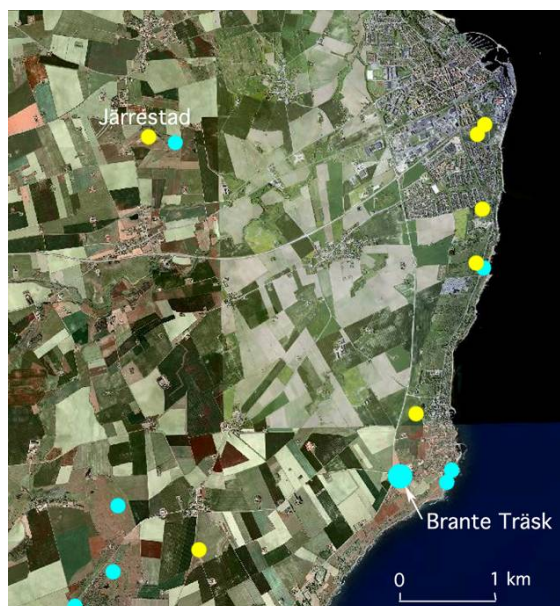


Fig. 5. Earthquake deformations in the Brantevik–Simrishamn area as recorded by deformed and tectonized bedrock (blue dots) and fractured pictures carved into the bedrock surfaces in the Bronze Age (yellow dots).

Fractured rock carvings

The Simrishamn–Brantevik–Järrestad area is full of rock carvings from the Bronze Age. Already a decade ago, I observed (Mörner, 2003) that the glacially well-polished quartzite surface had been fractured in postglacial time. After the finding of the Brante Träsk earthquake, seven sites were investigated (yellow dots in Fig. 5). At all sites, post-carving fracturing was recorded. The Järrestad site, 5 km from Brante Träsk, has a quite remarkable gallery of pictures (Mörner, 2012). Some examples of fractures crossing rock carvings in a manner that they must post-date the carvings are given in Figs. 6–10.



Fig. 6. The bedrock surface at Järrestad; a Cambrian quartzite, strongly polished by the glacial ice movements, leaving glacial striae and crescent-marks in the smooth surface. The fractures were induced in post-glacial time, even in post-carving time as evident from all the pictures now cut by fractures (Figs. 7–10).



Fig. 9. Fractures cutting crescent-marks from the glacial time (seen in the central upper part) and a rock carving from the Bronze Age (two sun-symbols connected by a line).



Fig. 8. A pair of shoes cut by fractures in post-carving time. There are 19 pair of shoes and 45 single shoes on the rock surface at Järrestad; 95.3% of them point to the sunrise at winter-solstice (Mörner, 2012).



Fig. 9. A foot and 3 cup marks (circular depressions) cut by fractures, which must have been created after the foot and the marks were carved.



Fig. 10. The "sun boat" (Lind & Mörner, 2010; Mörner, 2012) at Järrestad. The bedrock surface is heavily fractured. This cannot have been the case when the carving was done. Hence the fracturing must post-date the carving.

These examples of fractured rock carvings (Figs. 6-10, and many more not shown) indicate that the bedrock must have become fractured after the carvings were done. The connection with the earthquake fracturing at Brante Träsk (Fig. 2) seems obvious. Whilst the fractures are fresh and sharp-edged at the inland sites (Figs. 2 and 11), they are wave-washed at the coast (Fig. 12).



Fig. 11. Strongly fractured bedrock at Järrestad consisting of sharp-edged individual blocks, which are likely to have been dislocated by the glacial shearing, if they had been in this stage at the deglacial time. This suggest a postglacial origin.



Fig. 12. At the shore, the fractures are smoothened by the wave action. At this site located about +2.5 m, only the waves of the +2.1 m shore dated 1000-700 BC have acted. This indicates that the earthquake pre-dates or co-insides with this sea level.

CONCLUSIONS

An earthquake struck the Brantevik–Simrishamn area in Mid-Bronze Age time. It post-dates the age of the rock carvings fractured, and it pre-dates or co-insides with the high sea level position 1000-700 BC. The strongest deformation occurred at Brante Träsk (Fig. 2). Fractured bedrock (e.g. Fig. 11) and fractured rock carvings (Figs. 6-10) occur in a radius of, at least, 5 km from Brante Träsk. At the shore, the fracturing seems to pre-date or co-inside with the high sea level at 1000-700 BC. The seismically fractured bedrock at Brante Träsk was turned into a quarry, delivering stones to the Brantarör graves (from 800-700 BC) and to the bow and stern stones in Ales Stones. The natural harbour at Brantevik only existed during the high sea level 1000-700 BC. The Ales Stone monument must have been build before the period of aridity and sand drift dated at 600-500 BC.

In conclusion, the earthquake must have occurred in the period 1000-800 BC (900±100 BC).

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