



Karina Grömer, Margarita Gleba, Mathieu Boudin & Hans Reschreiter

# Linen twills from the Hallstatt salt mine re-dated

## Introduction

As the field of textile research enters into a more mature stage, previously published textile finds require reassessment using updated scientific analytical methods. This is particularly important for the finds for which it is claimed they are 'the earliest' or 'unique' since their dating or identification determines how textile history is written. Several cases of such recent re-examination demonstrate that we cannot rely on old data and that 'first' or 'exceptional' finds must be revised.

As an example, the late 4th millennium BC find from a burial at Alişar Hüyük, Turkey, has previously been published as a twill but the latest investigation suggests it is a stretched tabby (Bender Jørgensen & Rast-Eicher 2016, 83-84). This is important, because this find has been used to claim early twill production in the Near East, although it is the only example of twill dating to the prehistoric period found in the region, which otherwise produced only balanced and weft-faced tabbies (Gleba 2017). The earliest twills are now those recovered from the Bronze Age salt mines of Hallstatt in Austria (Grömer et al. 2013) and in roughly contemporaneous burials excavated in the Tarim Basin of China (Barber 1999) – both areas where twills are well attested in the subsequent periods.

The textiles from Ditzfurt, Latdorf and Unterteuschental, regarded as among the earliest wool finds in Germany, have recently been reassessed (Hertel & Grömer 2019). Scanning electron microscope (SEM) analysis of the textiles from Latdorf and Ditzfurt demonstrated that they are made in plant fibres rather than wool and thus are no longer relevant for the prehistory of wool in Central Europe. Radiocarbon dating of textiles from Unterteuschental placed one fragment in the Middle

Bronze Age while the 'iconic' blended weave, the fabric with wool in one thread system and flax in the other (Textile No HK:5882,1) turned out to be modern. The SEM analysis of fibres from North Cairn Farm in Scotland, originally published as a Bronze Age apron made of hair moss, demonstrated the fibres are silk, and therefore highly unlikely to be Bronze Age (Harris & Gleba 2015). All other old finds of presumed hair moss textiles across the British Isles should be reassessed considering this result.

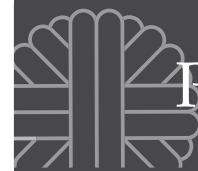
Lise Bender Jørgensen (2013) has traced the origins of early prehistoric silks in Europe, demonstrating that none can be substantiated as silks: most of the identifications relied on impressions and wishful thinking rather than scientific evidence.

In all these cases, careful track of the find history, new scientific analyses, and deep knowledge of textile (pre)history have been of utmost importance in reassessing these old finds and correcting data in the archaeological literature.

Here, we present a re-assessment of two linen 2/1 twill fragments from the early excavations of Hallstatt in Austria, which were for a long time assumed to date to the Bronze Age.

## HallTex 26 and 27: find context and research history

The salt mine at Hallstatt in Austria is an important source of prehistoric textiles in Central Europe. More than 750 individual textile fragments (belonging to about 350 larger textile complexes) have been found in the different parts of the salt mine, dated to the Bronze and Iron Ages, roughly the timespan from 1400-400 BC. Few textiles from Hallstatt are directly dated using Radiocarbon dating (see van Strydonck & Grömer 2013). Most are dated using the archaeological



context – the find spot in the mine. One of the Bronze Age find spots is the so-called Grünerwerk site. Various artefacts from this site have been dated using  $^{14}\text{C}$  (Stadler 1999) and these dates have also been applied to the other artefacts found there.

The Grünerwerk site was opened as a brine production plant from 1895 to 1902, and was in operation from 1903 to 1944 in a zone of the mountain that also contained remains of prehistoric mining. Thus, many archaeological finds were collected by modern miners and local researchers, including a number of textile fragments. From 1985 on, archaeological excavations took place at the Grünerwerk site (Barth 1986). Together with the Christian-von-Tuschwerk site and

the Appoldwerk site, the Grünerwerk belongs to the lower end of a huge Bronze Age shaft system reaching to a depth of up to 200 m below ground (Reschreiter & Kowarik 2019).

Hans-Jürgen Hundt was the first to describe and publish the two textiles HallTex 26 and 27 in detail as deriving from the Grünerwerk site (Hundt 1960, 129-130). He published them as 2/2 twills, with HallTex 26 having a thread count of 6/12 threads per cm. Both textiles have recently been re-assessed by Karina Grömer and Helga Rösler-Mautendorfer, updating the identification of seams and hems, and also changing the identification of the weave type (Grömer et al. 2013, 61, 251-252). Both textile fragments are in fact



HallTex 26



HallTex 27



Fig. 1: HallTex 26 and 27, overview and details, Hallstatt salt mine (Images: Natural History Museum Vienna, photos: Andreas Rausch, DinoLite photos: Karina Grömer)



|                 | HallTex 26 |          | HallTex 27 |          |
|-----------------|------------|----------|------------|----------|
|                 | system 1   | system 2 | system 1   | system 2 |
| single/plied    | single     | single   | single     | single   |
| twist direction | z          | z        | z          | z        |
| twist angle     | 40-50°     | 40-50°   | 50-60°     | 30°      |
| thread diam.    | 0.6-0.8    | 0.5-1    | 0.8-1      | 1.2      |
| thread count    | 8          | 11       | 9          | 6-7      |
| weave type      | 2/1 twill  |          | 2/1 twill  |          |

Table 1: Technical characteristics of HallTex 26 and 27

made in dense 2/1 twill, using single z-spun yarn in both directions (fig. 1). The threads are medium-coarse with a diameter ranging between 0.5 and 1.2 mm. The thread counts vary between 6 and 11 threads per cm (Table 1). Both textiles are made of undyed flax (*Linum usitatissimum*), as noted already by early investigations in the 1960s (Hopf 1960). Since the two textiles are similar in their technical characteristics, they may have belonged to the same cloth.

Rast-Eicher et al. noted the well prepared and separated fibres of the textiles, arguing that this indicated a change in flax fibre processing as the material looks different in comparison to Late Neolithic and Early Bronze Age textiles in Central Europe (e.g. Leuzinger & Rast-Eicher 2011, 540 and fig. 3h; Bender Jørgensen and Rast-Eicher 2016, 71; Rast-Eicher & Dietrich 2015, 36).

### Dating of textiles from Hallstatt

In the salt mine at Hallstatt, several hundreds of textile fragments have been found so far, most of them dated by context as is also done for archaeological textiles from other sites. The chronology and dating of the different parts of the salt mine at Hallstatt is based

on a complex system of archaeological find spots,  $C^{14}$  (Stadler 1999) and dendrochronological dating. Some years ago, the first direct  $C^{14}$  dates were obtained for several textiles from the salt mine (van Strydonck & Grömer 2013). As it was not possible to date all of them (sometimes for reasons of preservation), two groups of textiles were selected for the dating: a) Bronze Age textiles with highly developed technical characteristics, and b) textiles from disturbed layers (*verlaugtes Heidengebirge*) of the Kilbwerk site, chosen to resolve problems of possible Baroque period intrusions in the mine. The research team was aware at the time that some textiles deriving from the Bronze Age contexts looked very advanced in terms of fibre type, dyeing and weave type (e.g. chevron twills in HallTex 211 and 275). Testing was therefore recommended since they appeared more appropriate to the Iron Age. Their  $C^{14}$  dating confirmed them to be Bronze Age. Doubts about the Bronze Age origins of the flax twills HallTex 26 and 27 arose later (Gleba & Harris 2018, 2340, 2343).

### New questions arising

In 2016-2017, within the framework of the PROCON project (Gleba 2015), the discovery of numerous spliced bast (plant) fibre textiles from various sites across Mediterranean Europe dating to the early 1st millennium BC led to a review of the evidence for the use of splicing in prehistoric Europe (Gleba & Harris 2018). The survey demonstrated that practically all of the European Bronze Age textiles made of bast fibre were woven with plied and spliced thread. The only exceptions to this general trend are the two linen twills from Hallstatt, which are woven in single z-twisted thread, which is clearly spun. The well

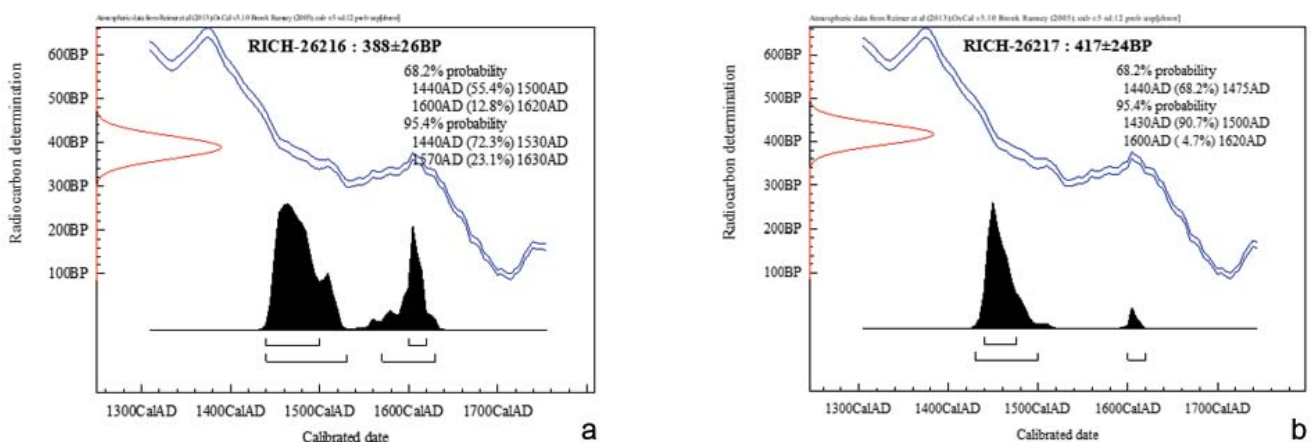


Fig. 2: Radiocarbon curves of a) HallTex 26 and b) HallTex 27 (Images: Mathieu Boudin)



Fig. 3: Linen twill from Lengberg Castle (FNr. 273.16), 15th century CE (Image: Beatrix Nutz)

separated fibres are atypical for the Bronze Age, with the vast majority of all other examples having spliced single yarns with intact fibre bundles and parallel nodes (Rast-Eicher & Dietrich 2015; Bender Jørgensen & Rast-Eicher 2016, 71; Gleba & Harris 2018).

The textiles are also unusual in terms of their structure for the Bronze Age, since all other known linen 2/1 twills in Europe date to the middle of the 1st millennium CE or later.

The exceptional features – for the Bronze Age – of the two linen twill textiles from Hallstatt and the fact that they did not come from the scientific excavations of the salt mine led to the decision to carry out  $C^{14}$  dating of both fragments.

#### HallTex 26 and 27: $C^{14}$ dating

Thread samples of about 1 cm were cut directly from the textiles. The two linen samples were pre-treated with the bleaching method to remove exogenous contaminants. Thereafter, the samples were transformed into graphite using the automatic graphitisation device AEG (Němec et al. 2010; Wacker

et al. 2010).  $C^{14}$  concentrations were measured with accelerated mass spectrometry (AMS) at the Royal Institute for Cultural Heritage in Brussels, Belgium (Boudin et al. 2015). The results are presented in Figure 2. Both textiles date to either the 15th or the early 17th century CE and are therefore not Bronze Age but of Early Modern period.

#### Discussion

The two linen textiles on display at the local Hallstatt Museum. They are listed in the inventories as originating from the findspot Grünerwerk, found during modern salt mining activities and entering the museum in the 1930s.

The new  $C^{14}$  data presented here raise several questions about the origin of these textiles. The pieces are Early Modern, dating to about 1600 CE. As far as known, the Grünerwerk was not in operation before the early 20th century CE and therefore the textiles cannot derive from the construction or operation of this plant. The Grünerwerk is located in the Kaiser-Josef horizon of the salt mine Hallstatt, in which there



are many archaeological and modern mining sites. However, since the Kaiser-Josef tunnel was not used until 1687, this area can be excluded as the origin of the textiles.

Nevertheless, it seems likely that the two Early Modern linen textiles were found somewhere in the Hallstatt salt mine and then ended up in the museum collection (albeit with wrong location of origin within the mine recorded). Where could textiles dating to the 15th or early 17th century have been found in the 1930s? At this time, mining work was still being carried out in a number of tunnels that had been used since the 1600s, e.g. Kaiser-Maximilian-Stollen site and Ferdinand-Stollen site. Do the two textile fragments come from these areas and were mistakenly thought to be prehistoric? Or did someone deliberately give these pieces to Friedrich Morton, curator of Hallstatt Museum from 1925 to 1967 (Urstöger 2000, 677), with false information? These questions will probably never be resolved. Yet, it is all the more important that the new data is presented here.

### Conclusion

Then new dating and reassessment of the possible find context of the two linen twills from Hallstatt has important implications for textile research as – up to now – these textiles have been counted among the oldest of their kind (e.g. Grömer 2012, 32; Grömer 2016, 135; Bender Jørgensen & Rast-Eicher 2016, 83). Although wool twills from the Christian-von-Tuschwerk site at Hallstatt indeed date to the Bronze Age and are the earliest in Europe, the linen twills must now be excluded from the list of prehistoric finds.

Instead, according to the C<sup>14</sup> dates, they have to be placed in much later times. Such linen twill textiles are common from the end of the Medieval and beginning of the Early Modern period in Central Europe, as demonstrated by the artefacts from Austria, e.g. from Lengberg castle, 15th century CE (fig. 3; Nutz 2015, fig. 7; Nutz 2021) or Schloss Tirol, 17th century CE (Nutz & Tomedi 2015, 49-50). Comparable finds suggest both dates (15th or early 17th century CE) are possible as indicated by the peaks in fig. 2.

Although the results change our long-standing assumptions of early 2/1 linen twills made of spun (not spliced) flax in the Bronze Age, such corrections of our textile history are important.

Archaeological textiles are few and precious – it is our responsibility to give them their rightful place in human history using the best means available at any given time – and to correct the information when new data become available. As Lise Bender

Jørgensen noted: “Documentation should be transparent and include exact provenance of samples and description of the methods applied, and results should be discussed and compared to those of other scholars, in a way that is understandable by the general archaeologist as well as relevant specialists” (Bender Jørgensen 2013, 587).

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## Authors:

*karina.groemer@nhm-wien.ac.at*  
*mygleba@yahoo.com*  
*mathieu.boudin@kikirpa.be*  
*hans.reschreiter@nhm-wien.ac.at*