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# Tablet weaves and more: textile news from Hallstatt

## Introduction

Hallstatt, located in the Salzkammergut in Upper Austria, with its salt mines and cemetery represents one of the most significant prehistoric sites of Central Europe, coining the term “Hallstatt period” (circa 800 to 450 BCE = Early Iron Age). This status is largely due to the exceptional preservation of organic finds in the mines, which have greatly contributed to our knowledge of textiles from the Bronze Age and Early Iron Age. Many of these textiles were documented by Hans Jürgen Hundt in the mid-20th century (e.g. Hundt 1959; 1960; 1967). Extensive research on the textiles from the salt mines was then carried out by Karina Grömer and Helga Rösler-Mautendorfer, together with specialists on dyestuffs, wool analyses, and C14 dating. All textile finds excavated in the salt mine of Hallstatt, up to 2010, have been published with an extensive and detailed catalogue in 2013 (Grömer et al. 2013), together with scientific discussions. This revealed the vast technological changes and creativity from the Bronze Age to the Iron Age (Grömer 2016, fig. 140). The Iron Age textiles exhibit a plethora of colours, patterns (twill variants, spin patterns, chequered patterns), remarkably fine threads, and patterned ribbons. Up to the publication of Grömer et al. 2013, 306 textile complexes, consisting of more than 500 single pieces of textiles had been analysed. However, excavations in the salt mines (fig. 1 and 2) have been carried out every year since then, bringing to light yet more textiles.

Here we present a small insight into two recent finds of tablet woven bands from the Hallstatt salt mines, which have interesting, but quite different, connections to previous finds.

## Tablet weaves of Hallstatt

Tablet weaving, though likely evidenced already in the Bronze Age salt mines (Grömer et al. 2013,

87; though a twining technique cannot be excluded with certainty), can be considered a “speciality” of the Early Iron Age, with complex patterns and motifs woven on these narrow bands. In Hallstatt, as opposed to, for example, the Early Iron Age examples from Hochdorf (Banck-Burgess 1999, 71), all tablet weaves are woven separately and then either sewn onto the edges of larger fabrics or used discretely. As sewn-on borders they could serve a practical purpose – “stiffening” the edges as well as protecting them from damage thanks to the sturdy, dense structure of tablet woven bands. However, the main purpose of the bands from Hallstatt was decorative, as evidenced by the many intricate patterns and colours used. Interestingly, large woven fabrics from Hallstatt never use more than one colour in their patterns, but ribbons (both tablet-woven and repp bands) can exhibit more (Grömer



Fig. 1: Excavation process in the prehistoric salt mine in Hallstatt (Image: Natural History Museum Vienna and Salinen Austria)

et al. 2013; Saunderson 2020). As of 2024, 12 tablet weaves have been found (HallTex 43B, 123A, 136-1, 152A, 186, 287B, 288C, 364, 376, 383, 385B, 390), of which two are presented in the following, with patterns ranging from complex geometric motifs to

simple stripes, using two or four threads per tablet. As these textiles were not found in a particular context in the mines and are all fragmented, it is difficult to determine their exact use. Clothing must definitely be considered. HallTex 123, with its ends sewn

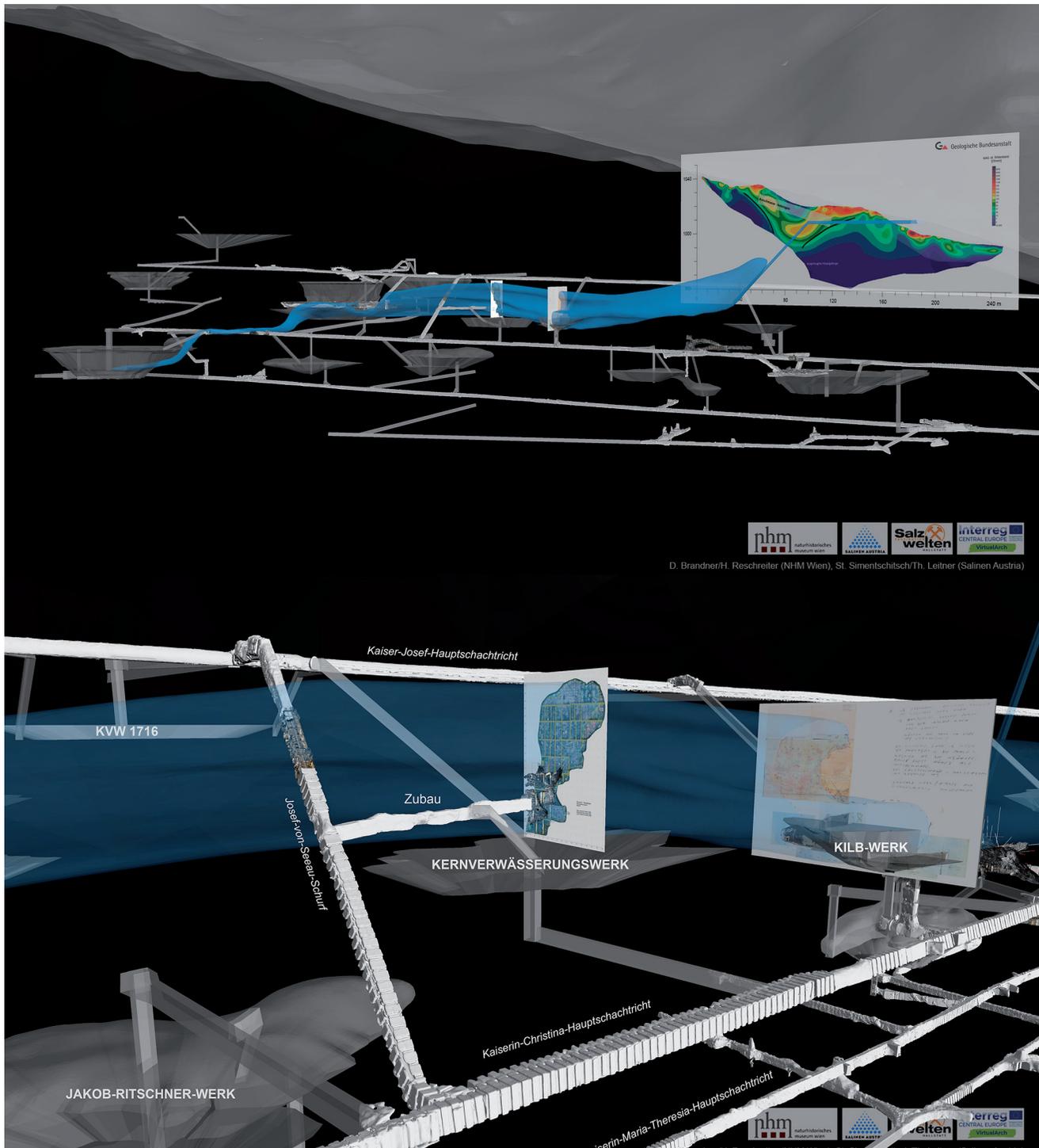


Fig. 2: Reconstructed overview of the different findspots in the Hallstatt salt mine (Image: Daniel Brandner, NHM)



together with a 22 cm circumference and attached to a twill fabric probably represents a sleeve (Grömer et al. 2013, 449–450). Given the decorative use, it can be deemed likely that many of these tablet-woven borders derive from clothing. Separate ribbons, i.e. those that are not sewn or woven onto another fabric, are difficult to interpret. They might have been used as headbands or belts or might have been meaningful objects in and of themselves.

### Recent research at the salt mine Hallstatt

In course of the mining operations of the last 300 years, traces of prehistoric salt mining were discovered in more than 100 places in the mines of Hallstatt, in some cases reaching more than 200 metres below surface. They are mostly parts of large Bronze and Iron Age mining chambers, shafts, and tunnels, in which the rock salt was mined dry. Almost all of them were filled up in prehistoric times by recurring landslides with material from the surface. On the floor of these chambers, we find the mining waste in layers up to 8-metres-high still *in situ*, perfectly preserved over the millennia due to the salty environment and lack of oxygen (fig. 1). This “heathen-rock”, as it is called by the miners, bears a huge number of organic finds, such as burnt down lighting tapers, broken tools, mining equipment, clothing, food remains, and even human excrement. Hence, this material allows insights into prehistoric living- and working conditions in exceptional detail.

Since 1960, the Natural History Museum of Vienna in close cooperation with the mining company Salinen Austria AG, has conducted archaeological research in the prehistoric salt mines of Hallstatt. Starting from the “accidental” findspots, hundreds of metres of excavation tunnels were dug through these filled up prehistoric mining chambers. Thousands of organic finds were discovered and analysed, and specialised techniques were developed to deal with these very special finds. Together with the constant improvement in excavation and documentation

methods, highly precise dendrochronological dates, and interdisciplinary research, this is leading to an ever better understanding of prehistoric salt mining in Hallstatt.

Precise dendrochronological dates of stratified wooden objects (Grabner et. al 2021) from the prehistoric find spots together with geoelectric measurements enable the connection of individual sites in the mine and create a fine chronology of the mining phases. They also give evidence for mining phases that are missing in the archaeological record. A comprehensive 3D-documentation of all accessible sites under ground and the integration of further research data visualises the current state of research and presents the basis for the development of further research questions. For instance, in recent years prospection drillings were carried out, giving insights into previously unknown areas of the salt deposit and proving a large mining chamber dates to the 6th century BCE (Ha D). This phase is scarcely known in the Hallstatt salt mines, most of the well-researched sites date to Ha C. New research tunnels were opened at this site to analyse the prehistoric mining waste, which will lead to a finessed chronology of Iron Age materials in Hallstatt.

In a 10-year project, funded by the Republic of Austria and the federal state of Upper Austria, archaeologists of the NHMW, together with miners of the Salinen Austria AG are restoring and maintaining the access to underground sites. This should enable the access for future generations to this unique part of the UNESCO-World Heritage site. In 2021, restoration works were conducted at a site, which is key in understanding Iron Age salt mining. At the location “Kernverwässerungswerk” (fig. 2) the only undisturbed cross-section through a filled-up mining chamber of the eighth to seventh centuries BCE was excavated between 1989 and 1996, proving the massive size of these structures (Barth and Reschreiter 2019). The prehistoric miners followed a large rock-salt vein (“Kernstrich”) and produced a



Fig. 3: Patterned tablet-woven band HallTex 383 (Image: Benedict Seidl)

HallTex 383	Warp				Weft
	dark green	dark red	yellow	light green	dark red
Single/plied	plied	plied	plied	plied	plied
Twist direction	Z2s	Z2s	Z2s	Z2s	Z2s
Twist angle	30–40°	30–40°	30–40°	30–40°	30°
Thread diameter	0.3–0.4	0.3–0.4	0.3–0.4	0.3–0.4	0.25–0.35
Thread count	13 tablets per 9 mm = 26 threads on each face				11 per 10 mm

Table 1: Technical data of HallTex 383

huge chamber of more than 20 m in height, 15–30 m width and a length of 300 m. It was filled in around 660 BCE, due to a landslide of clay and limestone from the surface layer (Grabner 2021).

In the course of restoring the research tunnels and renewing the timbering, the prehistoric layers, situated on the floor of the mining chamber, were researched once more and new finds came to light, including the two textile pieces discussed below.

#### Case study 1: A new patterned tablet-woven ribbon

HallTex 383 (fig. 3, table 1) was found in the “Kernverwässerungswerk, rottoniges Heidengebirge – level -1” during the maintenance work in 2021 and can be dated to 720–660 BCE. It shows a yellow geometric motif, which is repeated 5 times across the fragment of the band, on a light green and dark red background and with dark red and dark green borders. Both warp and weft are made from plied wool. Its preserved length, with torn ends, is 9.4 cm, and it is 0.85 to 0.95 mm wide. Reconstructing the pattern with all tablets warped in the same direction reveals a relatively simple sequence (fig. 4), repeating every 16th turn.

#### A lost piece?

The width, colours, and thread features of this fragment HallTex 383 (fig. 4b) are the same as those

of HallTex 186 (Grömer et al. 2013, 518–519), found in Kernverwässerungswerk in 1993, of which two fragments are preserved (one of which has a hem). However, the pattern of HallTex 186 (fig. 4c) is different, with a triangle ornament, though it is simple to switch between these two ornaments while weaving (fig. 4a). Given these facts, it is very likely that HallTex 186 and Inv. Nr. 127423 were once part of the same ribbon, but found 28 years later. Switching between different ornaments is also known from Hallstatt’s Inv. Nr. 126520. However, one cannot completely exclude the possibility that these were woven separately, meaning that this could have been a kind of standard setup or series of bands by a particular weaver or workshop. Inv. Nr. 127423 and HallTex 186, as well as Inv. Nr. 126520, do not exhibit traces of being sewn onto another fabric, thus they were probably used separately.

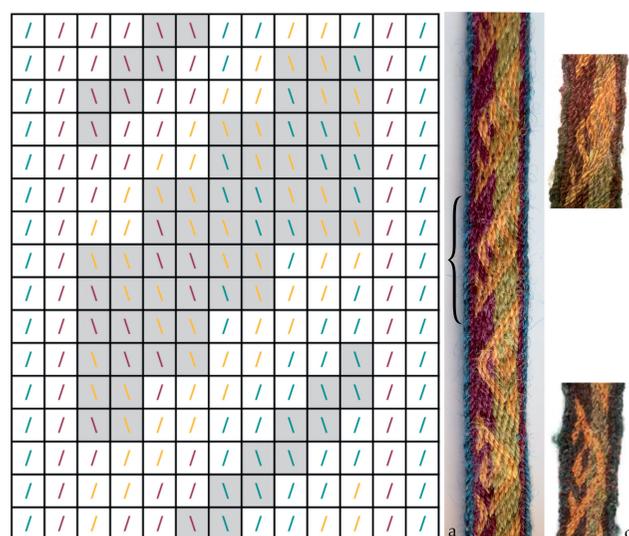
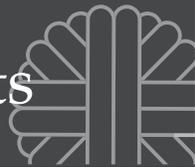


Fig. 4: Reconstructing the band. The weave pattern of HallTex 383 showing the colours and twist directions (/ = Z-twist; \ = S-twist). With all tablets threaded in S-direction, the white boxes can be read as tablets to be turned forwards (i.e. away from the weft) and the grey backwards (i.e. towards the weft). Each row represents one weft. a: Reconstruction of HallTex 383 (top half; with marked section of the shown weave pattern) combined with HallTex 186 (bottom half); b: ornament of original HallTex 383; c: ornament of original HallTex 186 (Image: Kayleigh Saunderson)



## Case study 2: A new simple tablet-woven border

The second tablet-weave, HallTex 385B (fig. 5, table 3), was found in “Kernverwässerungswerk, Vorkammer – level 1, Kerniges Heidengebirge” during the maintenance work in 2021 and also dates between 720

and 660 BCE. It is relatively simple, without ornament, using three tablets warped with four dark red threads each next to two with two bluish green threads each, all continuously turned in the same direction (S/S/S/S/Z). After weaving, the band (Textile B) was sewn onto a



Fig. 5: HallTex 385 with its tablet-woven border. Top: complete textile fragment (Image: Benedict Seidl); left: probably the outside of the piece showing the patterned stitches; right: probably the back side showing the hem and the placement of the stitches (DinoLite Edge digital microscope, 20x-magnification; Images: Kayleigh Saunderson)

HallTex 385A	System 1	System 2
Single/plied	single	single
Twist direction	s/z	s/z
Twist angle	40–50°	40–50°
Thread diameter	0.3–0.4	0.3–0.4
Thread count	24–26	14–15

Table 2: Technical data of HallTex 385A, the tabby base weave  
 Table 3: Technical data of HallTex 385B, the tablet-woven band

HallTex 385B	Warp		Weft
	dark green	dark red	dark red
Single/plied	plied	plied	plied
Twist direction	S2z	S2z	S2z
Twist angle	40°	40–50°	30°
Thread diameter	0.35–0.4	0.35–0.45	0.3–0.4
Thread count	7 tablets per 4 mm = 14 threads per face		7 per 10 mm

385	Seam/hem		Sewing thread				Stitch	
	type	width	colour	material	type	diameter	type	length
S1	hem	3.8 mm	Not visible	-	-	-	not visible	-
S2a	seam	-	blue	wool	plied yarn Z2s	0.3–0.4 mm	back stitch/ dot stitch	1.4 mm
S2b	seam	-	yellow- olive green	wool	plied yarn Z2s	0.3–0.4 mm	back stitch/ dot stitch	1.4 mm

Table 4: Technical data of seams, hems and stitches on HallTex 385

yellowish/olive green spin-patterned (with a sequence of four s and four z single yarns, both in the warp and weft system), tabby-woven fabric (Textile A, technical data see table 2). The seam (table 4) connecting the two textiles was also created in a decorative way – alternating three blue threads and three yellow-olive green threads, with a very short distance on the outside (opposite the hem of Textile A), thus creating “dots” in alternating colours (fig. 5).

Pattern: spin pattern with a sequence of 4s and 4z single yarns alternately, both in the warp and weft system

#### Visual similarities

As opposed to the previously presented ribbon, no other parts of this tablet weave are known. However, there are visual similarities to other textiles, which could suggest a certain fashion in colour combinations and design. One is HallTex 43 (Grömer et al. 2013, 360), also a yellowish textile (but a 2/2 twill) with a sewn-on simple tablet-woven border, which is also greenish blue and dark red. The other is HallTex 163 (Grömer et al. 2013, 492–493), also a yellowish tabby-woven fabric with a sewn-on border, which, however, is a repp band and not tablet-woven. Again, the warp is dark red and bluish green. HallTex 153 (Grömer et

al. 2013, 482–483) is interesting as a comparison for the decorative stitches. Two pieces of this blue tabby with a spin pattern were connected by short stitches, also creating these “dots”, with alternating three yellowish and three brownish-red threads, thus not just acting as a functional seam, but also a decorative element.

#### Current studies on Hallstatt textiles

Since the 2013 publication on the Hallstatt textiles (Grömer et al. 2013) that contains all textiles from the salt mine Hallstatt found until the year 2010, more research has been carried out.

The ongoing excavations brought to light new textile complexes with 110 textiles and 165 loose threads. Their documentation and the recording of all technical details will be undertaken in the coming years.

Moreover, the dendro- and C14 dating of the salt mines (Brandner et al. 2022) have been refined due to the research of the last 10 years, which also impacts our understanding of the textiles and their chronology. In particular, the dates for specific parts of the Iron Age mines, which formerly have been roughly set into the timeframe between 800 and 450/400 BCE, are a huge step forward. Now we know that the Kernverwässerungswerk and the Kilbwerk (fig. 2)



Fig. 6: Research as conducted on the textiles from the saltmine Hallstatt in summer 2024. More than 110 textiles have been analysed, deriving from the excavation campaigns 2010–2023 (Image: Benedict Seidl)

date to the eighth and seventh centuries BCE, whilst the Enderwerk is dated to the sixth and fifth centuries BCE. Attempts to define an inner chronology of the Iron Age textiles from Hallstatt are currently running. Also, the ongoing work of re-dating of the Bronze Age parts of the mine will bring interesting new results that impact our understanding of the developments of textile technology in continental Europe.

Margarita Gleba suggested the re-dating of the linen twill fabrics that have been found in the Bronze Age parts of the salt mine (HallTex 26 and 27, Grömer et al. 2013, 250–252), as the textiles in question did not fit her studies on raw material preparation and splicing techniques in prehistoric periods in Europe. The new C14 dates brought to light that HallTex 26 and 27 are not prehistoric, but Early Modern intrusions (Grömer et al. 2020).

Other studies that involved the textiles from Hallstatt have been carried out for research in restoration/conservation (Almstädter et al. 2021). New cleaning and drying procedures and standard protocols have been worked out for the textiles excavated in the context of hard salt rock.

In 2024, studies on dyestuffs and colours were resumed. In the project, HallTexRed+, the team of dyestuff experts from Vienna and Amsterdam and C14 dating from Fribourg will look at specific red shades.

## Conclusion

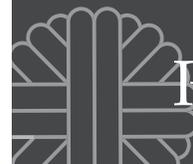
Although a large part of the textiles from the Hallstatt salt mines was published in 2013, new textiles are still brought to light by the excavations every year, continuing to raise new questions in textile research. The recent more precise dating also results in new research questions of typo-chronology in textiles. The two tablet weaves presented here are interesting case studies, showing strong similarities to previously found textiles, with one most likely belonging to a fragment found in 1993 with a slightly different pattern, and the other exhibiting various decorative elements and perhaps a common colour combination.

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