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# Textile archaeological analyses of the finds from the Dürrnberg salt mine

## Introduction

The Iron Age salt mine at Dürrnberg near Hallein, Austria, offers ideal conditions for researching prehistoric textiles because of their preservation in salt. Dürrnberg dates mostly to the early La Tène period and was the economic centre of the region. The analyses of the over 600 colourful textiles from the salt mine and the mineralised fragments from the burials will determine the technical details of the fabric, fibre analysis, chronology and colour analyses. This project is being carried out as part of a doctoral thesis at the Ruhr University, Bochum, and is funded by the German National Academic Foundation (*Studienstiftung des Deutschen Volkes*).

The data generation is based on the microscopic examination of each find and records the following details (CinBA undated): information about warp and weft, yarn or ply, thread twist, thread diameter, twist angle and thread count.

One of the research questions deals with the textile traditions. Local or regional textile traditions in certain areas can usually be recognised by specific factors of these technical fabric details. For the Iron Age in and around Austria, there is already evidence for certain thread twists and patterns in fabrics and they differ from textile traditions in other regions (von Kurzynski 1996, 34; Grömer 2012, 44; Grömer 2014).

An important aspect will be the question of resources in and around the mine, examining where the resources for textile production on the mountain come from. Local textile production requires the use of a wide range of resources, including both plant and animal products.

## Methodology

The basis of textile research has been standardised in recent decades (Grömer 2014, 9–16; Wild 1988). These include methods such as fibre analysis using scanning electron microscopy (SEM), microstratigraphy and wool fineness measurements (Grömer 2015, 90).

The differentiation of plant and animal fibres has so far only been possible with limited insight (Stöllner 2005, 168). As the Dürrnberg salt mine has a large number of linen fabrics, SEM images can lead to a detailed analysis of the fibres and, for the first time, enable questions to be asked about cultivated fibre plants (Banck-Burgess 2012, 38).

Preservation in salt enables further investigations, such as colour analyses using High Performance Liquid Chromatography (HPLC) (Banck-Burgess 2012, 38). The range of colours can be determined using the Natural Colour System (Natural Colour System 2023). Both radiocarbon 14 dating and isotope and material analyses extend and enrich this work. Existing dating provides an initial overview and categorisation of most textiles. Strontium can be used to reconstruct the place of origin and habitat of living organisms. Pilot studies have already analysed recent sheep's wool as well as prehistoric finds from Denmark and Sweden (Frei et al. 2009, 255).

## Findings

The rich spectrum of finds provides an insight into the craftsmanship, aesthetic demands, design concepts and variability in fabrics.

In the 1960s, Hans-Jürgen Hundt (Hundt 1961) and in the mid-1990s, Katharina von Kurzynski were

working on the textiles (von Kurzynski 1996). Von Kurzynski recognised some differences in direct comparison with the prehistoric Hallstatt salt mines (von Kurzynski 1996, 33). The textile research in Hallstatt offered researchers a unique insight into textile production, manufacture and aesthetics in the Early Iron Age (Grömer et al. 2013). Although some of the finds were published for the first time around 20 years ago (Stöllner 2002), every textile and organic fragment still offers detailed possibilities for documentation and analysis according to the current guidelines in textile archaeology. The finds from the recent excavation seasons are now being included in textile research for the first time. In contrast to Early Iron Age (Hallstatt period) Hallstatt, the Dürrnberg dates to the Late Iron Age, the Early La Tène period, and is usually regarded as the replacement of Hallstatt as the economic centre of the region (von Kurzynski 1996, 33). The significance of the finds can therefore be equated with those of Hallstatt.

There are currently 1,186 entries of textiles from 1970 to 2000 from the salt mine. This is the number of individual fragments to date, which belong to around 567 different textiles. The textile finds from 2000 to the current excavations in 2023 are stored in the Bergbaumuseum, Bochum and the salt mine depot. An overview of the quantity of finds is not yet available. During the processing, “new” finds are sometimes discovered that have not yet been documented as separate textiles. The number of finds will therefore continue to grow. It is estimated that there are more than 600 textiles from the salt mine. In addition, around 200 mineralised textile fragments have so far been found in the graves, as identified by the staff of the museum in Hallein.

### Mineralised Textiles

As the salt mine forms a problematic archaeological context for the adequate interpretation of textile finds (above all due to the secondary use of the fabrics), mineralised finds from the graves should be consulted. Mineralised textile remains offer various possibilities. As they are found in the context of a burial, the interpretation of the finds is usually clearer and is related to humans and possible clothing. Furthermore, textiles in burials can reveal other uses that represent the everyday or ritual need for fabric. These include pouches for cremated remains, wrappings for objects or shrouds (Banck-Burgess 1999, 2012; Gleba 2014; Grömer 2015, 99; Rebay-Salisbury, 2016). It is highly likely that the textile details reveal similarities and differences to textiles that may have served another purpose.

The social appearance of the population on the Dürrnberg can be built up piece by piece on the basis of the contexts, features and finds. Potential questions arise, for example, in relation to practice-specific clothing in mining and the supposedly higher quality worn as special funeral clothing. Can these differences be verified on the basis of quality, material and appearance, thus providing a differentiated social insight into a closed population group? However, the difference between the textiles of “poorer” burials and “richer” burials cannot be determined, as textiles from the “poorer” graves are not preserved due to the lack of metal artefacts (Grömer 2016, 267). As the mineralised textile fragments are in direct contact with other archaeological finds, further methods can be applied to examine them specifically. The mapping and depiction of microstratigraphy is already an integral part of the study of mineralised textiles. Terminology and specifications from various institutions (Bayrisches Landesamt für Denkmalpflege 2023, CTR 2020) enable comparable values, representations and statements.

### Preliminary results

The preliminary results already provide a good overview of the existing finds and the possible analysis. For example, the weave types can be correlated with the fibres used. Figure 1 shows the distribution of weaves on wool and linen textiles. Without exception, the linen textiles are woven in tabby. Almost as many tabby wool fabrics can be seen, but they are in strong competition with 2/2 twill fabrics (fig. 2). No other twill variants have yet been identified. In most cases, the tablet weaves listed are woven selvages with just one to three tablets per border.

Around 72% of the textiles analysed so far are made from wool and 26% have been identified as flax. A few

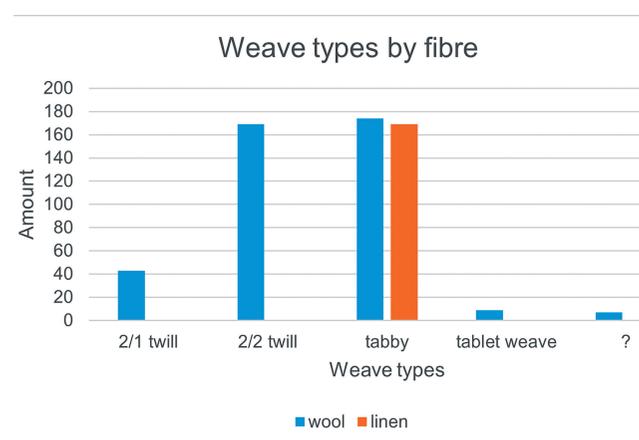


Fig. 1: Weave types by fibres in the textile from the salt mine Dürrnberg



Fig. 2: Textile inventory number 1718, a common brown twill textile with a selvage (Image: Ronja Lau/Keltenmuseum Hallein)

finds even show the use of flax and wool together in a fabric (fig. 3).

Due to the excellent preservation conditions, the colours of the fragments can be described precisely. Natural wool colours such as light brown, medium brown and dark brown make up almost 52% of the total. The other half is dominated by the colour blue, which accounts for approx. 17%. Other colours such

as red or green are less common. The colour yellow is difficult to detect visually and grey and beige are mostly used to describe linen fabrics. The distinctive Dürrnberg dark blue is a special feature of the textile finds. Fig. 4 shows what a strong colour was achieved here. However, detailed photographs under the microscope indicate that the blue was dyed on very light-coloured wool fibres and not on dark brown ones to achieve the dark tone. Further research and analyses are needed to understand the production of Dürrnberg dark blue.

Other colours were also created in the Iron Age by mixing different fibres. The mine offers the unique opportunity of identifying fabrics made of mixed blue and red fibres. An iridescent colour results when red and blue are mixed together and imitate purple. Due to the trade connections of the inhabitants to the Mediterranean region, the use of real murex purple must have been known. Even in pre-Roman times, this dye was immeasurably valuable. By imitating the colour, the Dürrnberg people could also have expressed their wealth. Further investigations into these unique finds are planned.

But other details such as spin directions, patterns, fabric quality and thread diameters also provide a picture that illustrates the textile traditions of the Dürrnberg and distinguishes it from other times and regions. While the variability of textile techniques can still be recognised in the Hallstatt period, a

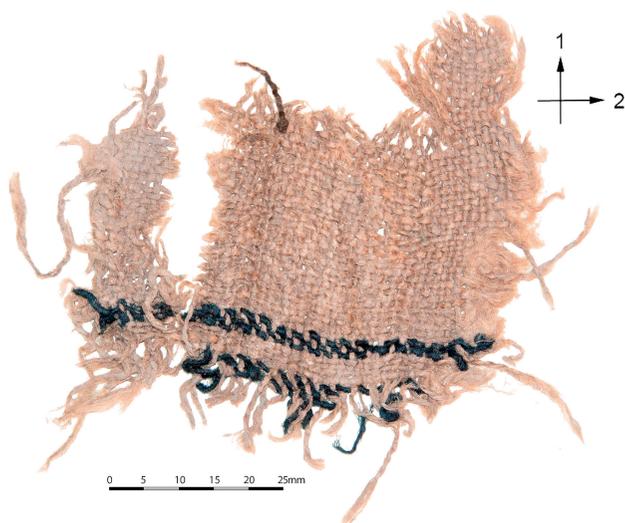


Fig. 3: Textile inventory number 1060, a beige linen textile with dark blue wool threads in a striped pattern (Image: Ronja Lau/Keltenmuseum Hallein)

consolidated textile tradition crystallises in Austria's La Tène period.

The use of different weaves and patterns in combination declines in the Dürrenberg material. Only four pattern categories can be identified in the textiles. Check patterns, striped patterns, spin patterns and colour effects in the fabric determine the design. 57% of the pattern variants are stripe patterns. These are incorporated into the fabrics in a few patterned threads but with a lot of contrast. There are also fine pattern sequences of sometimes one to three pattern threads in different colours (fig. 5). The otherwise concise image of the Celts in the chequered pattern can most probably be revised on the Dürrenberg. There are just 8% chequered patterns compared to the other variants. As with the stripes, the pattern is formed from just a few threads. More popular are the colour effects created by using different threads in the warp and weft. This effect accounts for 29% of the patterns. The final pattern is spin patterning. This is quite common in the Hallstatt period (Lau 2021, 60) but rare in the Dürrenberg textiles. Due to the fact that the salt mine was used from Hallstatt D to the La Tène period, it could be an indicator that the spin pattern textiles are older and date to the Late Hallstatt period. This internal chronology could be investigated in more detail with targeted radiocarbon 14C dating (14C dating).

### Outlook

The mine as a "Dürrenberg laboratory" provides an insight into the textile tradition of a micro-region in a way that is otherwise hardly possible.

An important aspect will be the question of resources in and around the mine. Local textile production requires a wide range of resources to be utilised, including both plant and animal products. Analytical evidence for sheep's wool, linen and/or hemp, horsehair, tree bast or leather can be compared with interdisciplinary co-operations. Wool fineness measurements can furthermore help classify wool quality.

The utilisation of resources, production of textiles and working in the mountains requires close communication within the society on the Dürrenberg. Textile traditions and design concepts can make statements about this differentiated community and possibly reveal social groups. A comparison of the textile finds from the mine with the mineralised textiles from the surrounding graves is aimed for in order to answer these questions. Possible qualitative differences between the mine and the graves can clarify the differentiation of social groups. Questions can also be asked about labour-specific clothing in

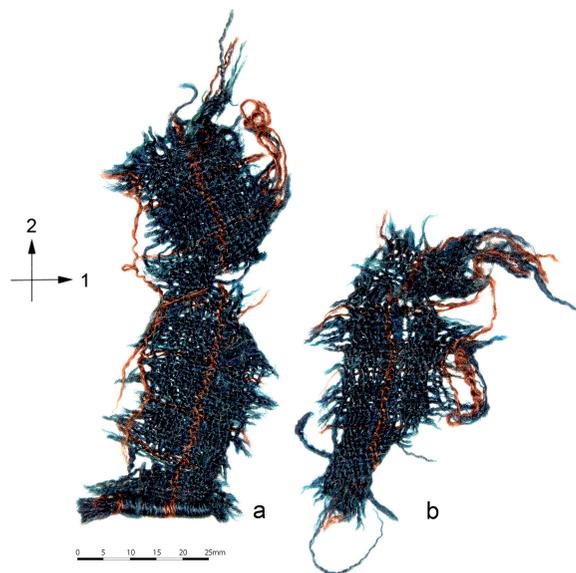


Fig. 4: Textile inventory number 2375, dark blue textile fragments with a red chequered pattern (Image: Ronja Lau/Keltenmuseum Hallein)

the mountain. This can be discussed with the help of different fibre usage or the analysis of technical fabric details.

Archaeological textiles help to develop a picture of numerous prehistoric societies. Clothing was and is a distinctive component of people, their identity and their sense of belonging.

With approximately 600 different textiles the statistical relevance for this research is set and classifies the site as the biggest pre-Roman textile complex in Europe. Both an emerging database and the documented finds

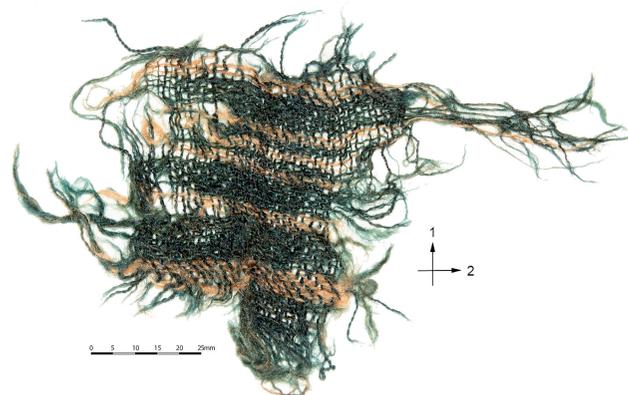


Fig. 5: Textile inventory number 818, a green fabric with light brown stripes (Image: Ronja Lau/Keltenmuseum Hallein)



can serve as a basis for further questions and enrich this work, make it accessible to future researchers.

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## Bibliography

- Banck-Burgess, J. (2012) *Instruments of Power. Celtic Textiles/ Mittel der Macht. Textilien bei den Kelten*. Stuttgart: Theiss.
- Banck-Burgess, J. (1999) *Hochdorf IV. Die Textilfunde aus dem späthallstattzeitlichen Fürstengrab von Eberdingen-Hochdorf*. Forschung und Bericht zur Vor- und Frühgeschichte in Baden-Württemberg 70. Stuttgart: Theiss.
- Frei, K. M., Frei, R., Mannering, U., Gleba, M., Nosch, M. L. and Lyngstrøm H. (2009) Provenance of Ancient Textiles—A Pilot Study Evaluating the Strontium Isotope System in Wool. *Archaeometry* 51(2), 252–276.
- Gleba, M. (2014) Wrapped Up for Safe Keeping: “Wrapping” Customs in Early Iron Age Europe. In L. Douny and S. Harris (eds), *Wrapping and Unwrapping Material Culture*. Walnut creek: Left Coast Press, 135–146.
- Grömer, K. (2012) Austria: Bronze and Iron Ages. In M. Gleba and U. Mannering (eds), *Textiles and Textile Production in Europe from Prehistory to AD 400*. Oxford: Oxbow Books, 27–64.
- Grömer, K. (2014) *Römische Textilien in Noricum und Westpannonien im Kontext der archäologischen Gewebefunde 200 v. Chr.-500 n. Chr. in Österreich*. Graz: Unipress Graz.
- Grömer, K. (2015) bekleiden–verdecken–verhüllen. Kontextualisierung und Theoriebildung zu eisenzeitlichen Grabtextilien. In R. Karl and J. Leskovar (eds), *Interpretierte Eisenzeiten. Fallstudien, Methoden, Theorie. Tagungsbeiträge der 6. Linzer Gespräche zur interpretativen Eisenzeitarchäologie*. Studien zur Kulturgeschichte von Oberösterreich. Linz:

- Oberösterreichisches Landesmuseum Linz, 89–104.
- Grömer, K. (2016) *The Art of Prehistoric Textile Making – The development of craft traditions and clothing in Central Europe*. Wien: Verlag des Naturhistorischen Museums Wien.
- Grömer, K., Kern, A., Reschreiter, H. and Rösel-Mautendorfer, H. (2013) *Textiles from Hallstatt. Weaving Culture in Bronze and Iron Age Salt Mines. Textilien aus Hallstatt. Gewebte Kultur aus dem bronze- und eisenzeitlichen Salzbergwerk*. Budapest: Archaeolingua.
- Hundt, H-J. (1961) *Neunzehn Textilreste aus dem Dürrnberg bei Hallein*. Jahrb. RGZM 8(7). Mainz: Verlag des RGZM.
- von Kurzynski, K. (1996) „... und ihre Hosen nennen sie bracas“, *Textilfunde und Textiltechnologie der Hallstatt- und Latènezeit und ihr Kontext*. Espelkamp: VML.
- Lau, R. (2021) *Mineralisierte Textilreste aus hallstattzeitlichen Gräbern in Slowenien*. Vienna: Verlag des Naturhistorischen Museums Wien.
- Rebay-Salisbury, K. (2016) *The Human Body in Early Iron Age Central Europe. Burial Practices and Images of the Hallstatt World*. London: Routledge.
- Stöllner, T. (2002) *Der prähistorische Salzbergbau am Dürrnberg bei Hallein II Rahden/Westf.*: VML.
- Stöllner, T. (2005) More than old rags: Textiles from the Iron Age Salt-mine at the Dürrnberg. In P. Bichler, K. Grömer, R. Hofmann-de Keijzer, A. Kern and H. Reschreiter (eds), *Hallstatt Textiles*. Oxford: Archaeopress, 161–175.
- Wild, J. P. (1988) *Textiles in Archaeology*. Aylesbury: Shire Publications.

## Internet sources

- Bayrisches Landesamt für Denkmalpflege 2023: <https://www.blfd.bayern.de/information-service/fachanwender/index.html#navtop> (accessed 18 June 2024)
- Natural Colour System 2023: <http://www.ncscolour.com/> (accessed 18 June 2024)
- CinBA undated: <http://cinba.net/> (accessed 18 June 2024)
- CTR 2020: <https://ctr.hum.ku.dk/about/> (accessed 18 June 2024)

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