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Provisioning a Salt Mine

On the Infrastructure of the Bronze Age Salt Mines of Hallstatt

I. Introduction

Any production unit requires certain means of production and subsistence. If these are not available in sufficient amount and quality production stops. Production units tied to a certain place, such as mining facilities, are especially dependent on reliable provisioning lines. Regular shortages can lead to the abandonment of even exceptionally rich deposits, as historical examples illustrate (Westermann 1997). Difficult access and/or remoteness strongly impede provisioning (Westermann 1997: 429).

This applies to the Bronze Age salt mines of Hallstatt. Nonetheless from the 15th century BC onwards, underground salt mining is documented here (Grabner et al. 2006; Barth 1993/94, 1998; Barth – Lobisser 2002: 14; Reschreiter – Barth 2005; Reschreiter – Kowarik 2008a). The considerable size of the mining area, the efficient organization and the highly segmented working process set this structure apart from most of the contemporaneous economic structures mainly limited to producing their own subsistence goods or small surpluses (summarizing: Barth – Lobisser 2002; Reschreiter – Kowarik 2008a).

How were the Bronze Age salt mines provisioned? What mechanisms and structures were at work?

I.1 The Bronze Age salt mining – State of research

The body of theories conceptualizing the mining complex of Hallstatt is highly detailed and complex. Therefore the actual state of knowledge concerning the Bronze Age salt mines and the resulting theoretical framework will be shortly summarized here:

The state of research indicates that three huge shafts (Apoldwerk, Christian-v-Tuschwerk, Grünerwerk) with depths up to 170 m operated in parallel (Barth 1986; Barth – Neubauer 1991; Reschreiter – Kowarik 2008a) (fig. 1). Research activities actually focus on the mining hall in the modern day Christian-v-Tuschwerk where the excavations conducted by the Prehistoric Department of the NHM, Vienna are taking place. Dendrochronological dating of all analyzable wood samples from this mining hall fixes the period of use to 1458-1245 BC (Grabner et al. 2006; Grabner et al. 2007). Shortly after 1245 BC the entire mining area was filled up with material from the surface (Grabner et al. 2006). The hall in question was used over a time span of 213 years. This does not necessarily imply that the time span of the mining activities in this hall corresponds to 213 years as archaeological evidence indicates that above and underneath the discussed halls other mining halls connected by a shaft existed (Reschreiter – Kowarik 2008a).

The enormous amount of archaeological finds and the perfect state of preservation due to the conserving faculties of salt allow for a reconstruction of the working process in the mining halls spanning the breaking of the salt to transporting the salt through the shaft up to the surface (fig. 2)1 (Barth 1993/94: 28; Barth – Lobisser 2002: 18; Reschreiter – Kowarik 2008a: 57).

It is assumed that
• salt mining was organized in an efficient and near industrial manner with strongly optimized working and producing processes (Barth 1993/94, 1998; Barth – Lobisser 2002: 14; Reschreiter – Kowarik 2008a),
• the working process in the mining halls was specifically designed to avoid stops in the production process (Barth 1992)
• division of labour (highly segmented working and production process) (Barth 1992)
• high demands concerning workforce and working materials (accordingly high infrastructural and logistical demands) (Kowarik 2009)

A large body of evidence underpins this theoretical framework:
1, the enormous amount of prehistoric artefacts; 2, the high degree of standardization observ-

1 All organic material left in the prehistoric mines has been conserved undamaged due to the preserving faculties of salt (mine timber, wooden tools, strings of grass and bast, hide, fur, textiles, human excrements etc.). This mine waste – also called heathen rock – was left in the mines and has been compressed to solid rock through mountain pressure.
Fig. 1: The Bronze Age shafts in the modern day Appoldwerk, Grünerwerk and Christian-v.-Tuschwerk. ©Klaus Lücker, NHM Wien

Fig. 2 a: Reconstructed working process (a-d): breaking salt. ©Andreas Rausch, NHM Wien

able on certain groups of tools (i. e. shafts: fig. 3) (Barth 1967; Barth 1973; Reschreiter – Kowarik 2008a); 3, highly functional groups of tools and other work assets (i. e. carrying sack, stair case: figs. 4-5) (Barth 1992; Reschreiter – Barth 2005; Reschreiter – Kowarik 2008a); 4, highly specialized groups of tools and other work assets (i. e. salt collecting tools, carrying sack: figs. 5-6) (Barth 1992; Reschreiter – Barth 2005; Reschreiter – Kowarik 2008a; Reschreiter – Gröner – Totschinig 2009).

Considering the size and complexity of this mining structure as well as the technical requirements of mining salt in such depths (Stöllner 2003:
420) it is assumed that mining wasn't seasonal but took place during the entire year; considering the necessary specialized knowledge, the quality of the working tools and the high degree of organization, it is for the time being assumed that the workers in the mine were “fulltime” miners specialized on their task. Consequently we must suppose that others had at least partly to cater for their needs.

For different reasons we also assume that the mining community lived up in the Salzberg Valley next to the salt mines and was not self-sufficient (discussed in: Reschreiter – Kowarik 2008b: 70-71).

Salt was not the only good „produced“ in the Salzberg Valley. At the current state of research archaeological evidence strongly points to a second „production line“: pickled meat (mainly pork meat) (summarizing: Barth – Lobisser 2002).

Notwithstanding the excellent state of knowledge some data vital to the social and economic analysis of the mining structure is missing:

1. The actual amount of mined salt is unknown. Furthermore the size of the entire prehistoric mining area is unknown as we are only aware of those sites that were discovered haphazardly through medieval or modern mining activities. It is probable that the prehistoric mining area was much bigger than actually known.

2. The size of the mining community is unknown as no cemetery or settlement relating to the salt mines has been discovered up until now.

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2 This assumption is based on the Early Iron Age situation where the anthropological analysis of the musculoskeletal markers of the excavated skeletons indicates a high workload and working patterns fitting for mining activity (Pany 2008). Although a variety of other models is thinkable as historical research shows, see: Mathis 2009: 26.

3 Either people from within the mining community or external groups.

4 By this expression we characterize the group of people engaged in the mining process. Based on the anthropological analysis of the Early Iron Age cemetery (Pany 2008) we assume that this group had a demographic and social structure comparable to a normal village population with men, women, children and old people. Everyone being to a greater or lesser extent engaged in the mining or provisioning process. This model represents a simple analogy and is based on the Early Iron Age situation. Up to now no indications of the demographic and social structure and gender relations of the Bronze Age mines are known. We are fully aware that a multitude of other models might be applied to the Bronze Age situation, either stemming from ethnographic or historical sources (which would again only represent analogies).

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I.2 Production and consumption

Mining structures of the size and kind of the Hallstatt salt mines are part of complex economic networks on regional and superregional level. On the one hand such a structure is a „centre of production“ providing goods that will be subject to short- and long-distance trade. On the other hand a mining complex also represents an important „centre of consumption“ generating high demands concerning workforce, means of production and means of subsistence. Therefore provisioning is of vital importance.

5 Comprehending all material goods necessary to the producing process such as tools, working assets (e.g. staircases in the shaft, protective hand leathers) and raw materials etc.

6 Comprehending all material goods necessary for the living of the workers such as food, clothing, houses etc.

7 All activities necessary to supply the means of produc-
Fig. 2 c: Reconstructed working process (a-d): filling the carrying sack. ©Andreas Rausch, NHM Wien

Fig. 2 d: Reconstructed working process (a-d): emptying the carrying sack. ©Andreas Rausch, NHM Wien
Thomas Stöllner has pointed out that this last point has not been given much attention in the discussion of prehistoric economy (Stöllner 2003: 417). Although this subject touches upon an array of essentially economic questions, e. g.

- Did the Bronze Age salt mines of Hallstatt tend towards self-sufficiency and independence or “outsourcing”?
- Who sustains such a community, providing e. g. food and tools in a sufficient amount and quality?
- And who was to be sustained: only the miners; other people dependent on the salt mining structure? (Mathis 2009: 25-27) 
- How many people had to be sustained?
- What kind of structure can meet the demands in respect to workforce, food and tools over a time span of at least 200 years?
- Can the local resources sustain such a system in means of agrarian surplus production, raw materials for the tools, technological know-how in the manufacture of the mining tools, workforce (miners, farmers, craftsmen, traders, etc.)?

- If not: What kind of trade network is able to provide such performance on a regular and reliable basis?
- What would be the impact on the local structures? How strong would it be? Could such a structure shape an entire region, creating an “economic space” centred on the mines?

Those questions clearly illustrate that quantification is a major issue when addressing the topic of provisioning (Kowarik et al. 2010a-b forthcoming).

1.3 Location and topography

The ancient mining town of Hallstatt (bestowal of market rights 1311) is situated at the northern border of the eastern Alps in the Upper Austrian Salzkammergut (fig. 07). The town lies at the foot of the Dachstein on the shores of the Hallstatt lake (508 m asl; stretching 8.2 km north-south and 2.1 km east-west) and is surrounded by the steep mountain ranges of the Dachstein to the south (the Dachstein plateau reaching up to 2000 m asl) and to the east (Sarstein 1975 m asl), in the west the mountains and subsistence such as the acquisition of raw materials necessary, the production of tools, the production of food, trade etc.

8 Research on historical mining has addressed the question: Westermann 1997; Mathis 2009.
9 Kowarik et al. 2010a-b forthcoming.
10 In this case it must be distinguished between the provisioning with means of production and the provisioning with means of subsistence. In the last case the group of people might have been substantially bigger than the group of people requiring means of production: Mathis 2009: 28. See: Kowarik et al. 2010a-b forthcoming.
poraneous settlement areas located around the Attersee (Erbach 1989: 30-32; 219-221; Gruber 1999: list 5 and map 1-6; Pollak 2008: 14-15) and in the valley of the Enns (Tiefengraber 2007a: 85-91) (fig. 07) 11. Although attention must be drawn to Traunkirchen at the Traunsee (Upper Austria) which seems to take up a special position at the end of the Urnfield period (see note 11).

Provisioning the Hallstatt salt mines must have represented a great challenge due to its remoteness, difficult accessibility and the lack of local resources in respect to arable land.

1.4 Mobility

Traffic and communication in the Hallstatt region is mainly shaped by topography: rivers and alpine passes represent the main communication axes. The most important river system in the region is the Traun with its tributaries (Pollak 2008: 11). The Traun connects Hallstatt with the North, e.g. the Danube basin. The route to the west leads along the course of the Gosau and through the Gschütt pass. Two routes head south:

Either through the Koppen-/Kainischtraun (Pollak 2008; Windholz-Konrad 2008, 2003)12 or across the Dachstein plateau to the Enns valley (Königreich-Alm 2007; Mandl 2006 a-c, 2008). From the Enns valley onwards several routes leading to the south can be taken (Mandl – Mandl-Neumann 2003: 7-17). One route leading to the Mur valley seems to have crossed the Sölk pass where a burnt offering site and several cultural layers have been dated to late Urnfield and early Hallstatt period (Hebert 2003: 57-70).

11 During Middle Bronze Age the closest known cemetery is located next to Gmunden (Upper Austria) (Pollak 2008: 14; Gruber 1999, 87 ff), the next settlements to north are to be found around the Attersee (Pollak 2008: 14-15) and to the south in the Enns valley next to Wörschach (Styria) (MANDL 2006d) or the area around Leoben (Tiefengraber 2007a: 85-91). During Urnfield period Traunkirchen at the Traunsee seems to emerge as a spot of interest in the forefront of Hallstatt: an Urnfield and Hallstatt period cemetery (Blesi – Preinfalk 2008), possible traces of ritual activities (Johanneskogel) (Pollak 2008: 15) and possible traces of settlement activity (Pollak 2008: 15). Other settlements are to be found at the Attersee (Buchberg, Upper Austria) possible traces of settlement activity: at Hallstatt not in the Salzberg Valley but in the area of the modern town on lake level (Stöllner 1996: 134-135; 140-141; 150-151) and in the Styrian Salzkarrekmerg in the vicinity of the Koppen pass (valley of the Koppen) at the Koppentretalm (Modl 2008). For this period there is also indication of ritual activities (burnt offering site) from the Koppentretalm (Modl 2008).

12 The valley of the Koppen-/Kainischtraun gives access to the Enns valley in the Southeast. Until very recent times it represented the most comfortable and shortest route by land (Pollak 2008: 21).
It can be assumed that trade and traffic in the Hallstatt region during Bronze Age were mainly triggered by two aspects: provisioning the salt mining complex and trading salt. The numerous stray finds and depositions in the Koppen-/Kainischtraun (Windholz-Konrad 2008, 2003) and along the western shore of the Hallstatt lake (Pollak 2003: 338 note 54, Pollak 2008: 21-24) dating mainly to the Urnfield period illustrate a high degree of mobility towards and from Hallstatt (Pollak 2008; Windholz-Konrad 2008, 2003; Barth – Unterberger 1983). In addition the Dachstein plateau is evidenced as a zone of mobility/activity from the 18th to the 11th century BC (Königreich-Alm 2007; Mandl 2006 a-c).

It is interesting to note that although Bronze Age mobility is clearly evidenced through a high number of finds only very few objects illustrate superregional contacts (Erbach 1989: especially 206 ff; for the finds from the Koppen-/Kainischtraun see the catalogue in: Windholz-Konrad 2003)13. This stands in stark contrast to the Early Iron Age where superregional and transalpine contacts are strongly evidenced through the Early Iron Age cemetery14 in region (namely the Kalenderberg culture) might be traced back to a middle or even earlier Urnfield period: Dörrer 2002: 70-71. Dörrer draws attention to a bronze vessel from Franzhausen (Lower Austria), certain needle types from the Hallstatt cemetery and a pair of fibulae from Altmünster at the Traunsee (Upper Austria) (Dörrer 2002: 70). The nature of these relations needs to be investigated further as up to now the evidence seems too few in number and too diffuse to be taken as indications of direct trade relations and the integration of “outsiders” into the mining community during Urnfield period, a model Olaf Dörre suggests for the Early Iron Age (Dörrer 2002: 71-72). For further possible exceptions see: Koppen-/Kainischtraun (Windholz-Konrad 2003: S. 39-40 Kat.Nr. 416/2-3 and 78/3; 416/1 and 296/4; S. 44 Kat.Nr. 296/9, 27; S. 55 Kat.Nr. 574/5), the gold depot from the Arickogel (Upper Austria) (Gruber 2008), Dachstein plateau (Tiefengraber 2007)b: 103-104).

13 Still it must be noted that Olaf Dörre has pointed out that connections between Hallstatt and the northeastalpine 14 These objects and the regions they point to have been abundantly discussed in the literature (summarizing: Dörrer 2002). It is evident that these correlations cannot automatically be taken to represent the regions to where the salt was
the Salzberg Valley but stray finds and depositions along tracks are missing.\(^{15}\)

We consider this last point to reflect only partly historical reality and to be mainly due to problematic sources. No cemetery pertaining to the salt mines is known for the Bronze Age which might explain the lack of objects indicating superregional contacts. Although the evident lack of such pieces, traded as numerous trade models and circulation modes are possible. The circulation of the salt must not necessarily have followed the same lines and mechanisms as the goods found in the cemetery.

15 This is mainly due to a change in deposition patterns known throughout Central Europe from Urnfield period to Early Iron Age.

16 Which is at least equal to the Early Iron Age mining district.

17 For the Bronze Age this area is much wider as for the Iron Age when more „salt producers“ emerge, namely the Dürnberg in the direct vicinity of Hallstatt (Kowarik – Reschreiter 2010 forthcoming).

18 Current research activity is focusing on this question: Kowarik et al. 2010 a-b forthcoming.
II.2 Availability of the raw materials

1. Salzburg Valley
   Spruce, fir, beech, grass, lime bast and salt (lightning torches, mine timber, beech shafts, collecting tools, buckets, ropes and cords, withies).

2. Salzburg Valley and adjacent valleys:
   fur, hide/leather, wool (strings, hand leathers, leather caps, woollen sacks)
   This area provides sufficient pastures to sustain animal husbandry of small amplitude. Livestock farming in the Salzburg Valley is indeed evidenced for historical times (in the 19th and early 20th century) (fig. 09). It is possible that during the Bronze Age this area was extended to the Dachstein plateau (Königreich-Alm 2007; Mandl 2006 a-c, Mandl 2008).

3. Locally not available
   Bronze, graphite, oak, big pig herds (bronze picks, graphite ceramic, oak shafts, pickled meat).
   Pork and oak shafts:
   According to F. E. Barth and M. Grabner the closest oak populations big enough to provide sufficient material for the shafts and for the pasture of pig herds are located north of the Traun and Attersee, ca. 40 km from Hallstatt (Barth – Grabner 2003: 89).

II.3 Further Considerations

In the case of locally available resources the local manufacture and/or manufacture through the mining community seems highly probable (mine timber; lightning torches, collecting tools: Klein 2006).

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19 In small amounts at lake level.
20 As well as small scale agricultural production (mainly vegetable gardens).
21 Nearly 50% of the wooden shafts discovered in the Christian v. Tuschwerk are made of oak wood (ca. 150 oak shafts in total number, this number is assumed to represent 5% of the total number of oak shafts used in one mining hall adding up to 3000 shafts in total numbers: Kowarik et al. 2010a forthcoming; Kowarik et al. 2010b forthcoming). Considering the actual state of research such amounts of oak wood meeting the necessary standards for the Hallstatt shafts (Barth 1997, 1973, 1967) was not available in Hallstatt and its direct surroundings (see below and Barth – Grabner 2003).
22 The local manufacture and provisioning of mine timber seems highly probable as short transport distances must be considered the main criterion for this work asset.

However it remains unclear what groups provided the mining community with these goods: the mining community itself (e.g. children not old enough to work in the mine; persons too old to work in the mine, specialized workers) or external groups.

It is a fundamental question whether the mining community was prepared to take on tasks such as provisioning, manufacturing and trading that are not directly connected to salt mining (the production of pickled meat) or not. (This question is relevant for all means of production and subsistence be their raw materials locally available or not.) If they were, it has to be asked how those groups were sustained?

The production of tools types such as shafts, carrying sacks, collecting tools, lightning torches was demanding in respect to technology and/or time (i.e. Klein 2006). The creation and maintenance of a reliable and performant trade network is time consuming as well. But mining as a matter of principle demands a high amount of investment in „non-productive” activities such as maintenance, support and infrastructure and it requires division of labour.

It must be taken into account as well that mining complexes also represent centres of wealth and technological/infrastructural know-how therefore providing a good basis for highly performant provisioning structures.

Considering trade we must assume that the salt mines were part of a complex trading network that was able to operate on different levels: local, regional, superregional/transalpine. Certain goods such as the oak shafts and the pigs had to be brought to Hallstatt. Whether this was organized by the mining
community or external groups is not clear. Few indications exist as to what kind of trade network was in operation. The fact that only few import goods are represented in the Middle Bronze Age and Urnfield record has been discussed as an indication for trade through intermediaries (Erbach 1989: 206-207; see also note 13).

Regardless of the kind of trade network in operation it can be said that in the course of these activities reliable and enduring relations developed that must have gone far beyond simple trade relations (Barth – Grabner 2003: 89).

III. Economic Landscape?

Regarding the Dürrnberg Thomas Stöllner proposed the model of an economic space in which salt production acted as a "primary fuel" for economic development (Stöllner 2002: 86). Meaning that the Dürrnberg developed from a mining structure to a regional and superregional centre of trade attracting and distributing economic activity related or unrelated to the salt production (Stöllner 1999: 12; Stöllner 2002: 84-88).

Could this model be applied to Bronze Age Hallstatt?
- Evidence for economic activities directed towards Hallstatt exists (e. g. pigs and shafts), representing secondary economic structures supplying the salt mines.
- The pickled meat industry could be qualified as a new and independent economic sector (not supplying the salt mines).
- But the geographical position of Hallstatt strongly differs from the Dürrnberg. Considering traffic, mobility and agricultural resources the Dürrnberg is very favourably located in the alpine foreland close to major trade routes. This stands in stark contrast to Hallstatt.

The Salzburg Valley represented an important centre of production and consumption as such, attracting people and economic activity. The salt production did certainly act as primary fuel for the economic development of the entire region comparable to the Dürrnberg.

But regarding the difficult geographic position it is questionable whether the Salzburg Valley can be understood as a centre of trade and economic activity independent of salt mining – a "port of trade" (see also Dörrer 2002: 75).

However at the actual state of knowledge the nature of its relations with its surroundings and its impact on the economic and social structures in the region remain unclear.

Marianne Pollak has pointed out that considering the size of the mining districts a dense network of trading posts, settlements, cemeteries, ritual sites etc. – i.e. a rich archaeological record should be expected in the Salzkammergut (Pollak 2008: 11). But those sites and findings are lacking with the possible exception of Traunkirchen23 and the track systems around Hallstatt (Koppen-/Kainschtraun, Dachstein plateau). Although according to Thomas Stöllner the local impact of mining complexes is considerably shaping economy, settlement, trade and traffic structures and depending at the same time strongly on the local resources and infrastructure (Stöllner 2003: 417).

Thus it is a very interesting question how the Salzberg Valley related to its surroundings? How it was connected to neighbouring groups?

The situation is complicated by several aspects: we are lacking the Bronze Age settlement and cemetery pertaining to the salt mines, the major part of the Bronze Age finds from Hallstatt represent highly specialized mining tools that cannot be related through typology to other contemporaneous materials24.

Finally it will be necessary to enlarge our scope: Hallstatt is located in the Eastern Alps, which represent the richest part of the alpine range in terms of mineral resources. Apart from the salt deposits coming close to the surface in the Salzberg Valley the rich copper ore deposits of the Austrian greywacke zone are of major importance for the wider region. Evidence of copper mining and/or smelting during Bronze Age stems from the Kitzbüheler Alpen (Pichler et al. 2009), the Salzach-Pongau region (e. g. Eibner 1982; Stöllner et al. 2009), the Niedere Tauern (e. g. Eibner – Preßlinger 1996) and the Eisenerzer Ramsau (Klemm 2003). Meaning that from Middle Bronze Age onwards at least two primary production sectors (salt mining, copper mining and smelting25) existed. It is an interesting question how those communities related to each other? Did they sustain trade and marriage relations, exchange information etc.?

Eventually it must be acknowledged that although Hallstatt was situated at the periphery of contemporaneous settlement areas, seen from an economic point of view it was part of a well developed economic landscape thriving on salt and copper mining/smelting thus promoting further economic activities, mobility and trade.

23 Which might be directly connected to the Salt mines as some sort of forepost being more accessible than the Salzberg Valley.
24 See Stöllner 1996 for the few typologically analyzable pieces.
25 Maybe the use of pastures and the production of pickled meat might be added as well.
Zusammenfassung


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