EBBE H. NIELSEN

A LATE BRONZE AGE TIN INGOT FROM SURSEE-GAMMAINSELI (KT. LUZERN)

Located on the shores of the central Swiss Lake Sempachersee a number of Neolithic and Bronze Age settlements, so-called pile dwellings, are known. Most of the sites are threatened by erosion caused by the current and the waves. On behalf of the Kantonsarchäologie Luzern, the archaeological diving team of the city of Zurich thus conducted a preliminary inventory of the locations in 2004 (Nielsen 2005). One of the sites surveyed by the divers was Sursee-Gammainseli, which had been known as an archaeological location for many years (Bill 1995, 81). In the framework of the survey, a small number of posts were sampled for dendrochronological analysis. In addition, a few artefacts found on the lake floor were also collected [1].

FIND SITUATION

The small island »Gammainseli« is located at the northern end of the 7.5 km long, 2.4 km wide and up to 87 m deep Lake Sempachersee. The island is situated close to the Zellmoos peninsula and, at the present lake level, has a size of approx. 1000 m^2. It lies at the highest point of an otherwise submerged moraine, deposited during the last glaciation (Vogel 1993). At deeper lake levels during the Late Bronze Age, the island was considerably larger than it is today. Since parts of the edges of the island have evidently been eroded, its original size cannot be reconstructed. In 1806, the level of Lake Sempachersee was artificially lowered by approx. 1.8 m, and settlement sites from the Neolithic, Bronze and Iron Age as well as a medieval church ruin, subsequently emerged on the lake's shore. In 1861 the island is mentioned for the first time as an archaeological site, but it must have been known to the local population long before.

The archaeological assemblage kept in the collections of the Kantonsarchäologie Luzern, however, remains extremely sparse. From the Neolithic, a few pottery sherds, stone axes and flint tools are registered. A few pieces of pottery could be attributed to the Late Bronze Age (Bill 1993, figs 4. 12). The survey conducted in 2004 revealed a few more sherds dating to the Late Bronze Age as well as a few Neolithic flint artefacts. Exploratory drilling yielded three cultural layers, excavations however, have so far not been undertaken. Vertical stilts, belonging to prehistoric houses, could be observed down to a water depth of 5-6 m, and obliquely standing piles up to 14 m depth. Down to 5 m below the present-day lake level a compact layer of stones can be established around the island. Such pavements are typical of the houses of the Late Bronze Age settlement on the nearby peninsula of Zellmoos (Nielsen 2005, 28; Rigert 2008, 29 ff.).

The dendrochronological analysis of a few piles yielded results at 1090, 1077 and 930 BC. One further dating indicates a settlement phase during the late 9th century BC, and at least three Late Bronze Age settlement phases can thus be anticipated.

Among the finds collected on the lake floor, a piece of metal drew the attention of the divers. Due to its unusual green-greyish patina, it was initially classified as copper or bronze. Only a few small scratches, which probably occurred during the recovery, show the original silvery colour of tin. A recent X-ray fluorescence analysis carried out by F. Sager [2] has revealed that the object consists of almost pure tin. It is thus one of the few finds from Continental Europe of prehistoric tin, which was apparently not formed or used after extraction.

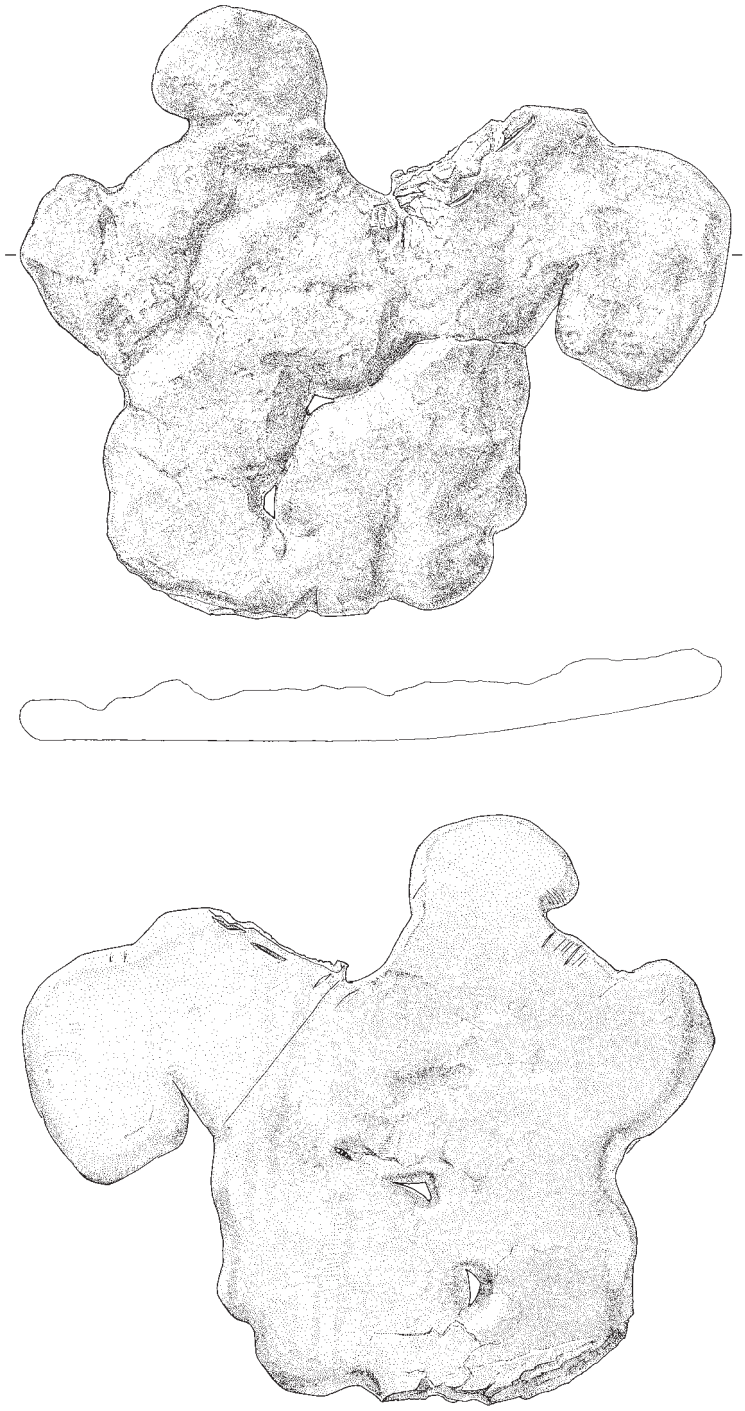

Fig. 1 Late Bronze Age tin ingot from Sursee-Gammainseli (Kt. Luzern). – (Drawing M. Bieri). – Scale 2:3.

THE TIN INGOT

The irregularly shaped tin ingot has a maximum length of 13.7 cm, a maximum width of 11.5 cm, and a maximum thickness of 1.3 cm (**fig. 1**). The present weight is 634.1 g. Two breaks with traces of cutting and chopping indicate that smaller amounts of tin have been deliberately removed for further use (**fig. 2**). Despite the removal of material, the abovementioned measurements probably provide the original maximum size of the ingot. The estimated original weight must have been about 700 g.

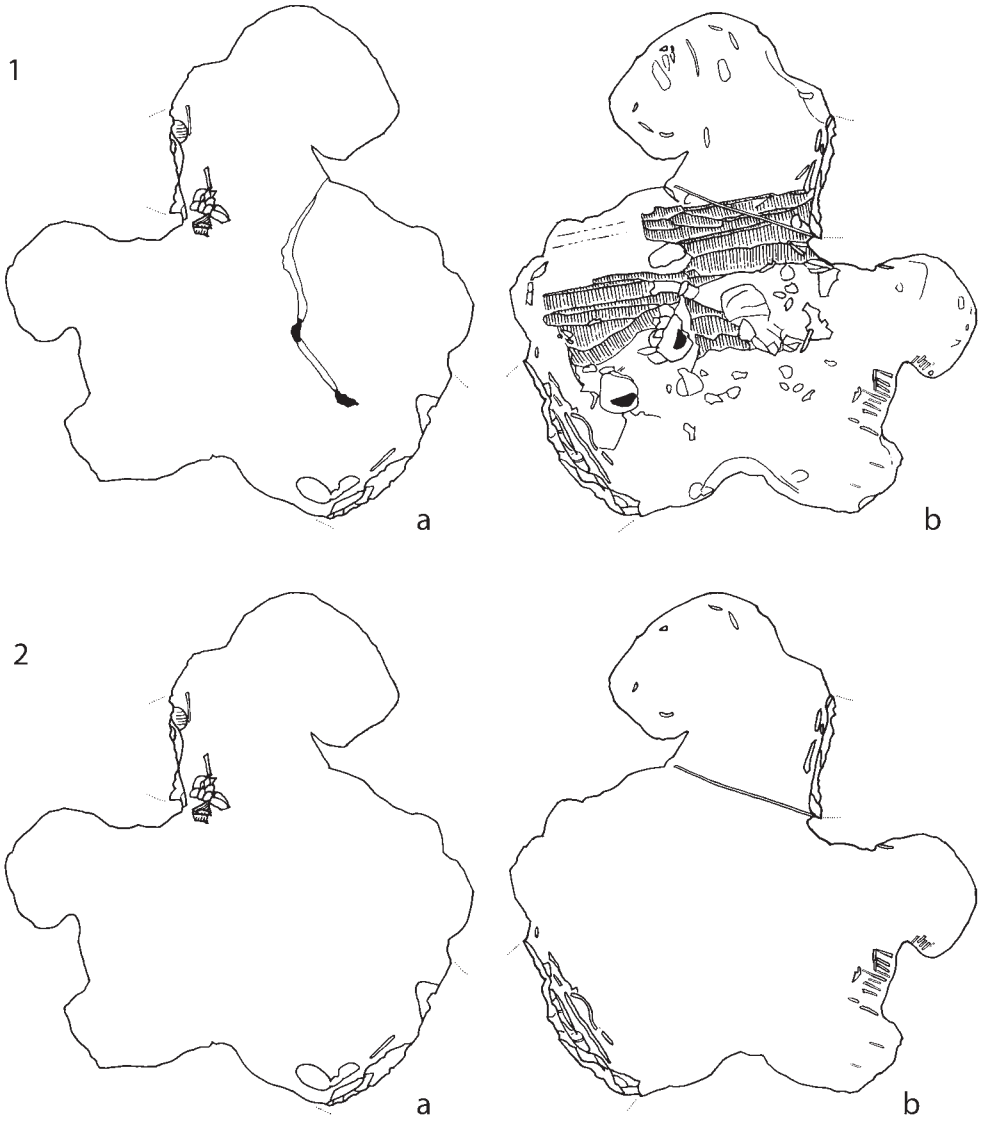

Fig. 2 Sursee-Gammainseli (Kt. Luzern). Working traces and impressions on the tin ingot: **1** impressions: **a** top; **b** bottom. – **2** working traces: **a** top; **b** bottom. – (Drawing E. H. Nielsen). – Scale 1:2.

The irregular outline and the marked convex section indicate that the molten tin was not poured into a proper casting mould. Rather, the metal was filled into a larger, slightly concave vessel or on a plate. The upper side of the ingot is characterised by a distinctly uneven surface, including two holes, which occurred during the cooling process. The slightly convex lower side is smooth, and has only a few weak negatives as well as small dents, which must come from the original underlay. These negatives bear a regular »ladder-like« pattern (**fig. 2, 1b**), a feature which is difficult to interpret. Possibly, they derived from the surface treatment of the vessel or from the plate on to which the melted tin was poured or can be seen as a secondary damage to the ingot. They can almost certainly not be interpreted as deliberately impressed marks, as seen on Mediterranean copper and tin ingots (Lo Schiavo 2005, fig. 9).

As mentioned above, parts of the ingot were broken off on two spots. In the vicinity of these fractures chopping and cut marks can be recognised, explaining the process. A cut mark indicating that the removal of a further section of the ingot was intended but, was not carried out is also of note. All of these work traces

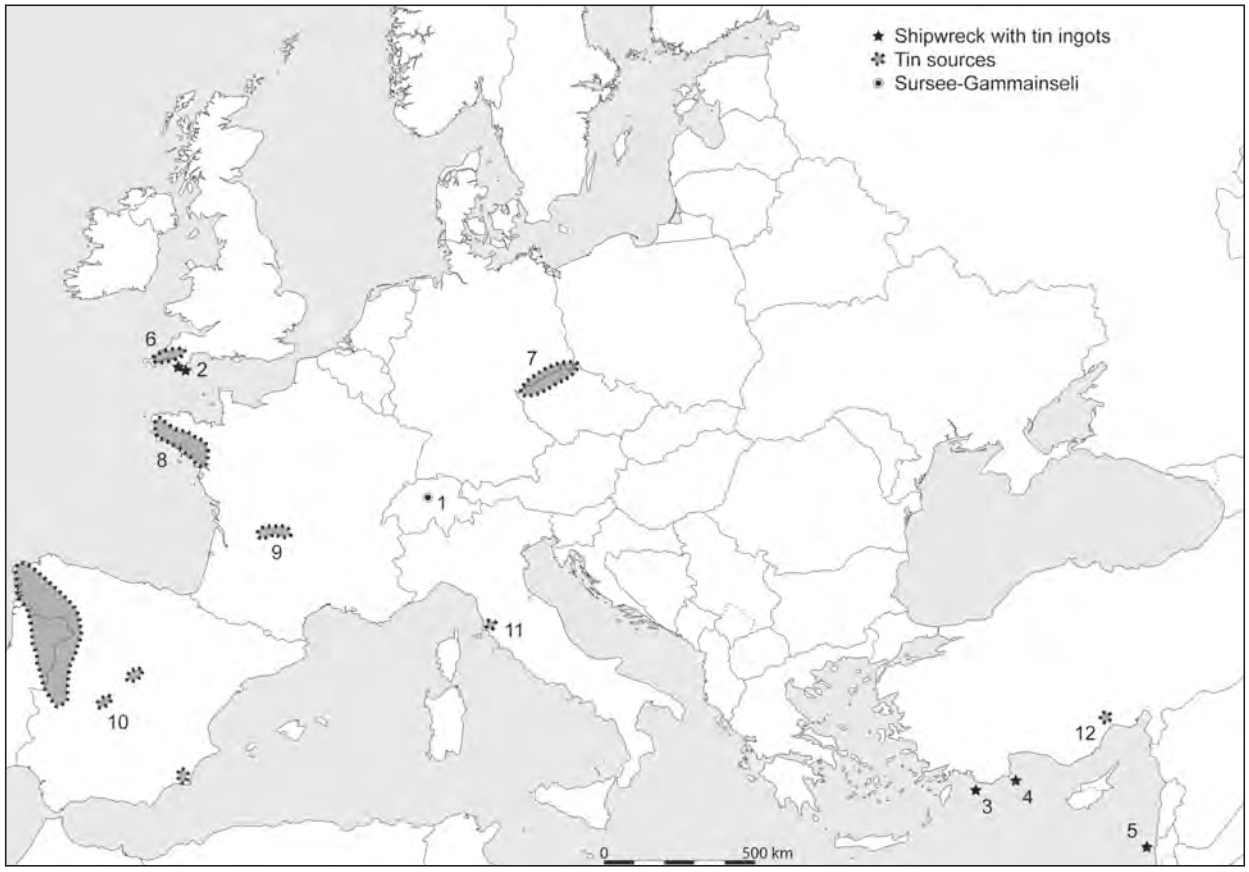

Fig. 3 Bronze Age tin ingot finds and prehistoric tin sources in Europe and the Mediterranean: **1** Sursee-Gammainseli. – **2** Salcombe and Erme Estuary. – **3** Uluburun. – **4** Cape Geledonya. – **5** Haifa. – **6** Cornwall. – **7** Erzgebirge. – **8** Brittany. – **9** central France. – **10** Iberian tin belt. – **11** Tuscany. – **12** Kestel. – (Map C. Jäggi).

suggest that the tin ingot was kept during a longer period of time, and was gradually reduced as required in the production of bronze. Thus it gives the impression that the artefact manufacture was meticulously planned, and the amount of the required metal was defined in advance. In this regard, Late Bronze Age tombs excavated in France yielding weighing equipment together with tools used for the processing of bronze are of major interest. These important finds prove that specialised craftsmen used a fairly advanced system with clearly defined weights (Roscio / Delor / Muller 2011).

TIN DEPOSITS

Tin is in contrast to copper a rarely occurring metal in Europe, and tin mining of this period has not yet been proven in this part of the world. Large tin deposits occur in Cornwall, on the Iberian Peninsula as well as in the Erzgebirge area (fig. 3). Furthermore some smaller outcrops are found in Tuscany, in Brittany and in the French Massif Central (Penhallurick 1986, 64). Bronze Age tin mines have been recorded in Tajikistan, Uzbekistan and Kazakhstan, and probably also for Kestel in the Turkish Taurus Mountains. The latter find has been controversially discussed in literature, though (Stöllner 2005, 458; Cierny / Stöllner / Weisgerber 2005).

In Europe, the lack of evidence of tin mines so far, could possibly be explained by the presence of so-called tin soap deposited in river sediments. Tin soap was washed from rocks and accumulated secondarily in alluvial layers. These deposits can be of considerable size, and were mined up to historical times in the Erzgebirge area as well as in Cornwall (Krause 2003, 207; Penhallurick 1986, 71 ff.). In Britain, Iberia, Brittany and in the Erzgebirge area, pits in layers containing tin soap yielded Bronze Age artefacts thus indicating the extraction of this metal (Bartelheim / Niederschlag 1998, 38 ff.).

PRESERVATION OF TIN

The preservation of tin is more problematic than other non-ferrous metals used in prehistoric times. The corrosion of tin, the so-called tin pest converts the metal into powder at temperatures below approx. 13 °C (Heinrich 1994, 63). This fact must certainly be part of the explanation for the sparse occurrence of tin objects in the European Bronze Age outside Switzerland. Some tin finds have perhaps not yet been recognised as such due to patination. Numerous finds of tin artefacts, as well as remnants of raw pieces from Swiss settlements prove that tin in its pure form – sometimes alloyed with lead – reached the Bronze Age settlements. These findings also indicate that the preservation of tin is possible indeed.

TIN AS RAW MATERIAL

Bronze is an alloy of copper and tin, and tin is thus indispensable for the tool making in the Bronze Age [3]. In the bronze artefacts found in the Swiss »pile dwellings«, an average content of 8 % tin could be established (Fasnacht 1998, 234). Thus, in the light of the large quantities of bronze objects from the younger Early Bronze Age and onwards, the import of tin must have been considerable. A.-M. Rychner-Faraggi has calculated that the approx. 20 kg of bronze found in the Late Bronze Age settlement Hautrive-Champréveyres (Kt. Neuchâtel) correspond to a ratio of roughly 1.5 kg tin. For the production of one bronze axe, with a weight of 600 g, about 42 g of tin were needed (Rychner-Faraggi 1993, 20). Nevertheless, tin has very rarely been found in the settlements. Numerous finds of moulds and fragments of melting ovens show that bronze artefacts were produced locally from the younger Early Bronze Age and onwards.
From the younger Early Bronze Age onwards, copper ingots can be discovered in settlement sites as well as in deposits (Fasnacht 1998, 236 ff.). The thesis that quantities of raw material could have been traded as ready-alloyed bronze thus explaining the scarcity of tin finds, has been discussed by J. P. Northover (2004, 137 f.). Deposits containing broken bronze artefacts – frequently together with copper ingots (Hochuli 1998, 330 f.) – indicate that scrap metal was indeed recycled and probably also traded during the Bronze Age. Large quantities of foreign scrap bronze, which were probably not particularly well suited for long-distance transport, have not been found. It has to be mentioned that copper ingots have rarely been discovered in the settlements. Furthermore, a few finds of ingots containing bronze indicate the trade with alloyed metal (Rychner 1984, fig. 3; 1987, pl. 31, 3; Schmidheiny 2011, pl. 15, 271).
Copper processing was established in the southeastern Alps of Switzerland from the younger part of the Early Bronze Age, and copper mining seems to have been particularly intensely executed during the Late Bronze Age (Fasnacht 1998, 234 ff.; Schaer 2003). Although the copper ores are relatively common, Bronze Age mining has hitherto only been proven in two regions of southeastern Switzerland (Fasnacht 1998, 244 ff.). From where the supply of copper – or bronze – during the Swiss Bronze Age came is thus not yet clear.

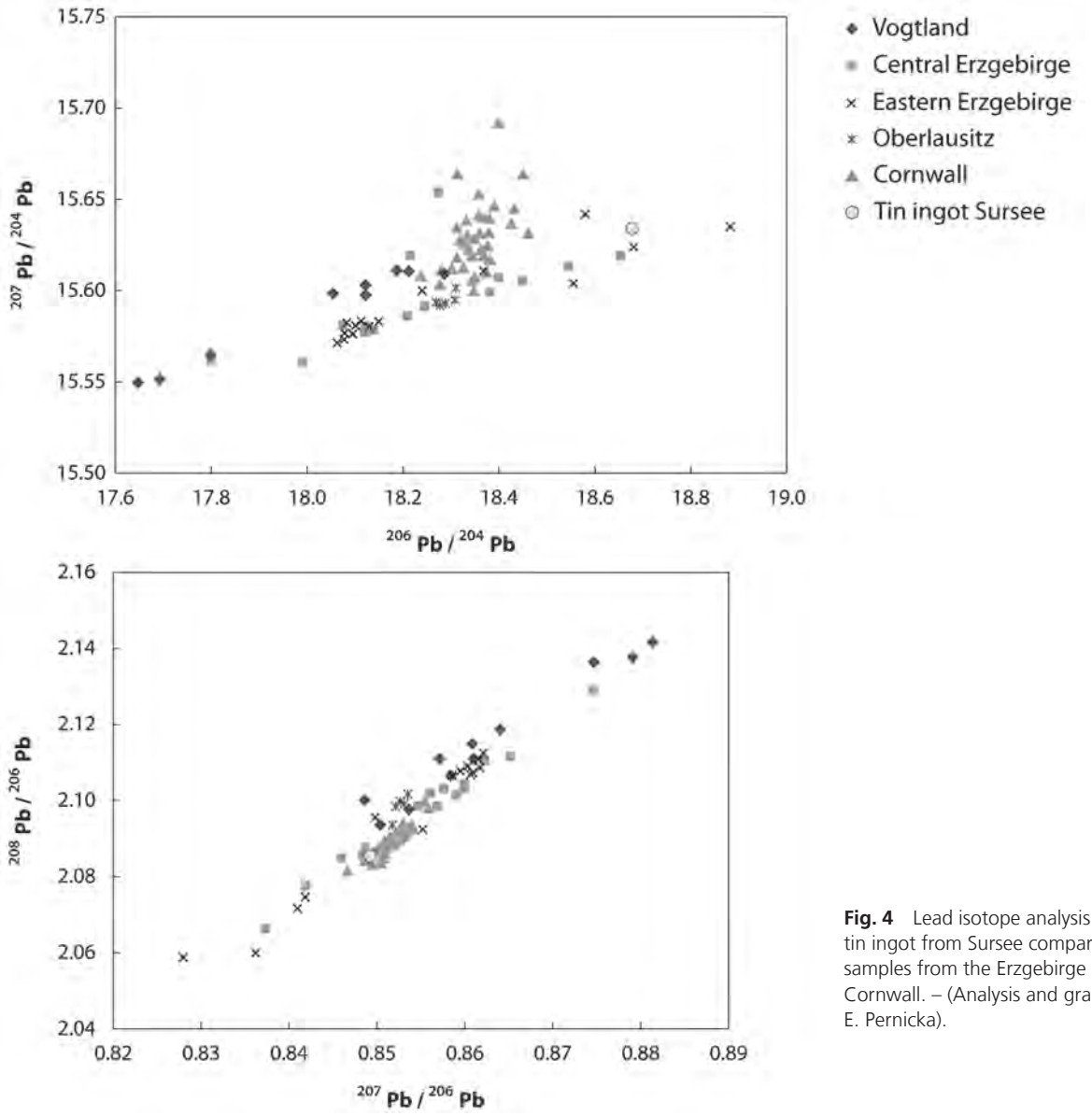

Fig. 4 Lead isotope analysis of the tin ingot from Sursee compared with samples from the Erzgebirge area and Cornwall. – (Analysis and graphics E. Pernicka).

METAL ANALYSIS

Recent research results have promised the possibility of determining the origin of the tin on the basis of lead isotope analysis (Begemann et al. 1999; E. Pernicka, pers. comm.). A sample was therefore extracted from the Sursee ingot by core drilling and passed to the Curt-Engelhorn-Zentrum Archäometrie gGmbH [4] in Mannheim for chemical and isotopic analysis. The result of the isotopic analysis of the Sursee ingot compared with results from the Erzgebirge and from Cornwall is shown in two diagrams illustrating ratios of various lead isotopes produced by E. Pernicka (fig. 4). Regrettably, the diagrams do not give a distinct answer to the question of the origin of the tin. In the lower diagram an origin in the Erzgebirge as well as in Cornwall seems possible. In the upper, the Erzgebirge seems more likely to be the source of the ingot.

The chemical analysis showed that the ingot consists of a very pure tin, as according to E. Pernicka can apparently be expected for prehistoric objects. Tin makes 98.4 %, zinc 0.07 % and lead no less than 1.52 % of the ingot. The high percentage of lead is unusual. This is strikingly unlike the usual proportions in tin ingots with less than 0.1 % (Begemann et al. 1999). It should be noted that the analysed tin ingots came to

light in Israel and Turkey, and therefore they probably originate from other sources and are not necessarily predictive for European finds. J. P. Northover's analysis of two tin items from the central Swiss settlement Zug-Sumpf yielded 1.44 and 1.48 % of lead. In the case of a tin foil decoration, no lead at all could be observed (Northover 2004, 113). A metallurgic analysis of a tin ring from the Tollense valley (Lkr. Mecklenburgische Seenplatte) in northeastern Germany, which has not yet been fully published, yielded a content of approx. 1.4 % of lead (Krüger et al. 2012, 39), and thus a percentage comparable to the result from Sursee.

E. Pernicka assumes that a high lead content might indicate that the tin was obtained either from mining, and the high proportion of lead was thus caused by chance, or that the lead was subsequently applied to the tin. If the tin was exploited by mining and not by streaming, probably only the Erzgebirge or Cornwall, both with large ores, come into question as the provenance of this metal (**fig. 3**). According to E. Pernicka's report the isotopic analysis would in this case more likely indicate a provenance in the Erzgebirge area in the German-Czech border region than a Cornish source.

According to results of J. P. Northover and C. Gillis lead has hardly been found as a natural element in tin from the British Flag Fen (Cambridgeshire) Bronze Age settlement. In these metal analyses, however, a higher content of copper and iron was detected (Northover / Gillis 1999). The authors also point out that the remelting of tin can cause elements, originally included in the metal, to decline or to even vanish. They compare analysed tin objects from Flag Fen with such from the Late Bronze Age site Hauterive-Champréveyres in western Switzerland. In both cases, the tin contained impurities with cobalt, nickel, cadmium, indium, antimony and lead. Zinc is found occasionally. Lead is represented only by traces in the English tin, contrasting the contents in three out of four Swiss samples which yielded 1.3-1.4 % (Northover / Gillis 1999, tab. 1).

So far only scarce evidence of prehistoric tin extraction from the Erzgebirge area has been detected, although this probably must be considered solely as a research gap. If the lead, however, was added secondarily to the tin, the question of origin seems completely open, according to E. Pernicka's report. The origin of the tin and the question how the ingot was produced can ultimately not be determined, and both versions are therefore possible. Artefacts of lead, as well as tin-lead alloys, appear relatively frequently in the Late Bronze Age shore settlements in Switzerland. It is possible that the ingot was remelted in the Sursee settlement or somewhere in the trading chain between the deposit and the site, and that lead was added to the tin during this process. In most cases, the admixture of lead probably took place during the casting process. Addition of lead increases the fusibility of metal. Only towards the end of the Bronze Age (Ha B3) does the percentage of lead in Swiss bronze artefacts reach almost 1.5 %. According to V. Rychner a level is reached which thus can be interpreted as a deliberate alloying of lead with copper and tin (Rychner 1998, 259). Bronze artefacts with a high content of lead are very rarely found in the Swiss Bronze Age (Northover 2004, 144 ff.). In the site of Zug-Sumpf, also situated in central Switzerland (**fig. 5, 3**), only 5 % of the objects contain more than 2 % lead and according to J. P. Northover this metal was thus probably deliberately part of the alloy.

Provided that tin from the Sursee ingot, which contains approx. 1.5 % of lead, was mixed with pure copper, and a proportion of 8 % tin was to be achieved, lead would reach a percentage of 0.12. Compared with the bronze objects from Zug-Sumpf analysed by J. P. Northover, this constitutes a very low percentage. This fact might be explained with a certain percentage of recycled bronze used beneath fresh copper and tin for the production of new artefacts.

It is remarkable that Bronze Age tin finds in northeastern Germany as well as in Switzerland contain approx. 1.4 % of lead. To my opinion this fact might indicate a common origin of the tin, probably the Erzgebirge area. The Sursee find has no typological similarity with Bronze Age tin ingots from southern England

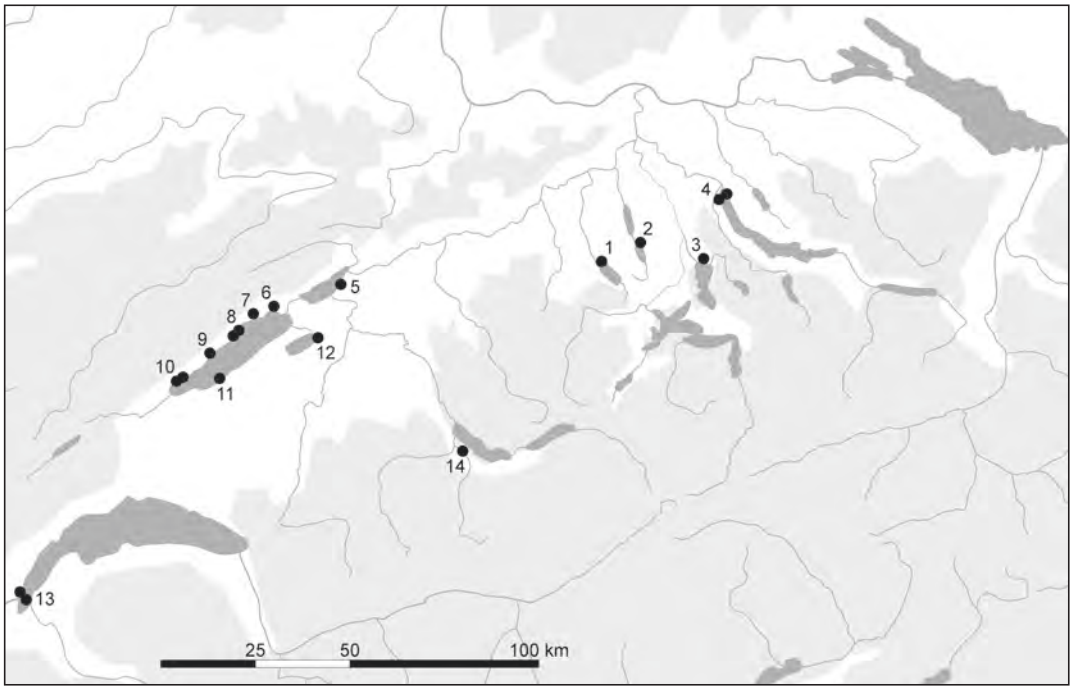

Fig. 5 Swiss Late Bronze Age sites with tin finds: **1** Sursee-Gammainseli. – **2** Hitzkirch-Moos. – **3** Zug-Sumpf. – **4** Zurich-Mozartstrasse, Zurich-Grosser Hafner and Zurich-Wollishofen/Haumesser. – **5** Mörigen. – **6** Hauterive-Champréveyres. – **7** Auvernier-Nord. – **8** Cortaillod-Est and Bevaix. – **9** Concise. – **10** Grandson-Corcelettes and Onnens. – **11** Estavayer-le-Lac. – **12** Muntelier. – **13** Geneva-Eaux-Vives and Geneva-Pâquis. – **14** Aeschi-Bad Heustrich (?). – (Map C. Jäggi).

(Loughton 2012) or from the eastern Mediterranean (Yalçin / Pulak / Slotta 2005). Due to the fact that no tin ingots from the Erzgebirge so far have come to light, there is thus no basis for comparison with this area.

TIN FROM SWISS BRONZE AGE SITES

As mentioned above, pure tin is comparatively rarely found in the European Bronze Age. This fact is now and then referred to as almost mysterious, but one must bear in mind that copper and bronze ingots are very scarce in the settlements as well.

In the following, the Bronze Age tin finds from Switzerland are listed (fig. 5). The ingot from Sursee-Gammainseli is still unique but other kinds of tin raw material as well as artefacts are, in the context of the European Bronze Age, remarkably frequent.

– Hitzkirch-Moos (Kt. Luzern): This Late Bronze Age settlement is situated on the shore of Lake Baldeggersee (fig. 5, 2). Although no excavations have been conducted so far, a large archaeological assemblage has been collected on the lake floor during years of underwater survey. Ceramics and bronze artefacts are primarily dated to Ha A2 and Ha B1, and a few posts sampled during underwater survey could be dated by dendrochronological analysis to the period between 1068 and 1049 BC (Bill 1995, 11. 40 ff.). Of special interest are two ornaments of tin, and one of a tin-lead alloy, containing approx. 30 % lead (fig. 6, 1-3). All three pieces are wheel-shaped, which is typical of ornaments of bronze of this period in Switzerland (Primas 1984, 33 ff.). A connection between wheel-shaped pendants and tin casting has been suggested (Schopper 1993/1994, 45).

– Zug-Sumpf: The Late Bronze Age site located on the shore of Lake Zug (**fig. 5, 3**) has two settlement phases (Seifert et al. 1996; Seifert 1997; Bauer / Ruckstuhl / Speck 2004; Primas 1984). Typologically, the lower layer belongs to Ha B1/Ha B2, and was dated by dendrochronology to the period between 1056 and 940 BC. The upper layer belongs to Ha B3, and was dated dendrochronologically to around 880 BC. In this site tin was occasionally used for decorating. A so-called bomb head pin of bronze was decorated with tin foil and another pin has a globular head made of this metal. Further a wheel-formed pendant was found (**fig. 6, 10. 18. 21**). Moreover a bead-like item (**fig. 7, 59**) was discovered, and a molten piece of tin can be regarded as evidence of a local processing in the Zug-Sumpf settlement (Northover 2004, 138).
– Zurich-Mozartstrasse: The site situated on the shore of Lake Zurich (**fig. 5, 4**) comprises Neolithic as well as Early and Late Bronze Age layers. The Early Bronze Age layer 1 yielded a thin twisted tin bar (**fig. 7, 65**). The layer can be dated to Bz A2, and comprises two phases. According to dendrochronological analysis the lower part must be prior to 1800 BC, the upper part can be dated to the period between 1609 and 1503 BC. A part of layer 1 contains Early Bronze Age as well as Late Bronze Age artefacts. From this section a fragment of an ingot and a drop prove the occurrence of tin as raw material (**fig. 7, 3. 61**; Gross et al. 1992, tab. 292, 6. 19-20; Schmidheiny 2011, 136 figs 8, 82; 15, 270; 23, 457). Dendrochronological dating of Late Bronze Age wood yielded results between 1124 and 953 BC.
– Zurich-Wollishofen/Haumesser: Two wheel-formed pendants (**fig. 6, 4-5**) were found in this Late Bronze Age site situated on the shore of Lake Zurich (**fig. 5, 4**). One of the pendants contains no less than 30 % lead (Primas 1984, 36). Typological as well as dendrochronological analysis dates the settlement to the period between 1050 and 950 BC. This corresponds to Ha B1 and the early phases of Ha B2 (Bolliger 2001).
– Zurich-Grosser Hafner: From this settlement on a former island in Lake Zurich (**fig. 5, 4**) a crescent-formed pendant is known (**fig. 6, 22**; Primas 1984, 36). The site has three settlement phases lasting approx. 100 years, and typologically belonging to Ha B. Dendrochronology yielded results between 1055 and 955 BC. The wood from the uppermost part of the layer could however not be dated (Ruoff 1990, 155 f.; Chronologie 1986, 151).
– Mörigen (Kt. Bern): This Late Bronze Age settlement on the shore of Lake Biel (**fig. 5, 5**) is dated to Ha B3 by typology, and has yielded two trapezoidal plates of tin (**fig. 6, 16-17**; Bernatzky-Goetze 1987, tab. 173, 6-7). Both ornaments have a fir branch decoration, and constitute a hitherto unique shape of decoration. No scientific excavations have been conducted here, most finds thus come from old excavations and surface surveys. Copper ingots do not occur in the site, some bronze bars, however, can be interpreted as a raw material (Bernatzky-Goetze 1987, 173 tabs 14-18).
– Hauterive-Champréveyres (Kt. Neuchâtel): In the Late Bronze Age lake shore settlement, situated on the shore of Lake Neuchâtel (**figs 5, 6; 6, 13-15. 19. 23-24. 28-31; 7, 4-25. 53-55. 60. 63-64**), a number of tin wires were excavated (Rychner-Faraggi 1993, 20). They are, though mostly turned annular, not interpreted as adornments but as raw material prepared for further processing. The tin was partly already alloyed with lead and thus ready for use. There are also two small tin pieces, which are considered as pieces of raw material. The same site yielded ornaments made of tin and of a tin-lead alloy. A pin made of bronze has a globular tin head; a bronze arm ring was decorated with a tin inlay, a D-shaped pendant and four small applications as well as a few other pieces, including two wheel-formed adornments, a globular bead and rings were made of tin. A fishing hook made of tin is to-date unique. A wheel-formed ornament made of a tin-lead alloy should also be mentioned. Three layers can be dated by typology to the phases Ha A2 to Ha B2 and by dendrochronology to between 1050 and 876 BC. J. P. Northover and C. Gillis have conducted metal and isotope analyses on four tin artefacts from this site and compared the results with those from a Bronze Age settlement in the United Kingdom (Northover / Gillis 1999). The differences observed cannot be definitively interpreted concerning origin and production technology.

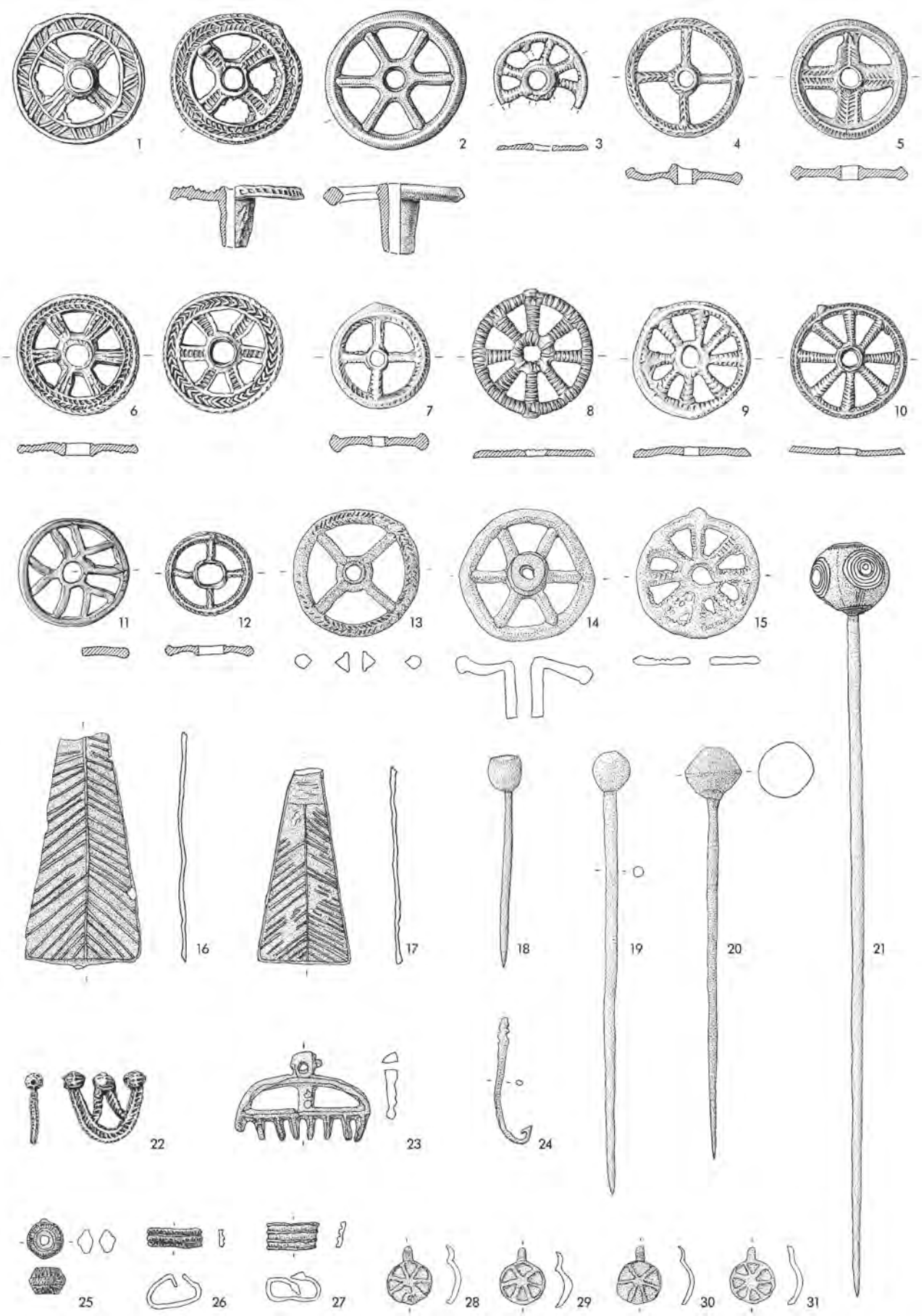

Fig. 6 Swiss finds of Late Bronze Age tools, pendants, beads and pin heads made of tin: **1-3** Hitzkirch-Moos (after Primas 1984). – **4-5** Zurich-Wollishofen/Haumesser (after Primas 1984). – **6-9. 20** Grandson-Corcelettes (after Primas 1984; Bernisches Historisches Museum). – **10. 18. 21** Zug-Sumpf (after Primas 1984; Bauer / Ruckstuhl / Speck 2004). – **11-12** Estavayer-le-Lac (after Primas 1984). – **13-15. 19. 23-24. 28-31** Hauterive-Champréveyres (after Rychner-Farragi 1993). – **16-17** Mörigen (after Bernatzky-Goetze 1987). – **22** Zurich-Grosser Hafner (after Primas 1984). – **25-27** Bevaix-Sud (after Arnold / Langenegger 2012). – Scale 2:3.

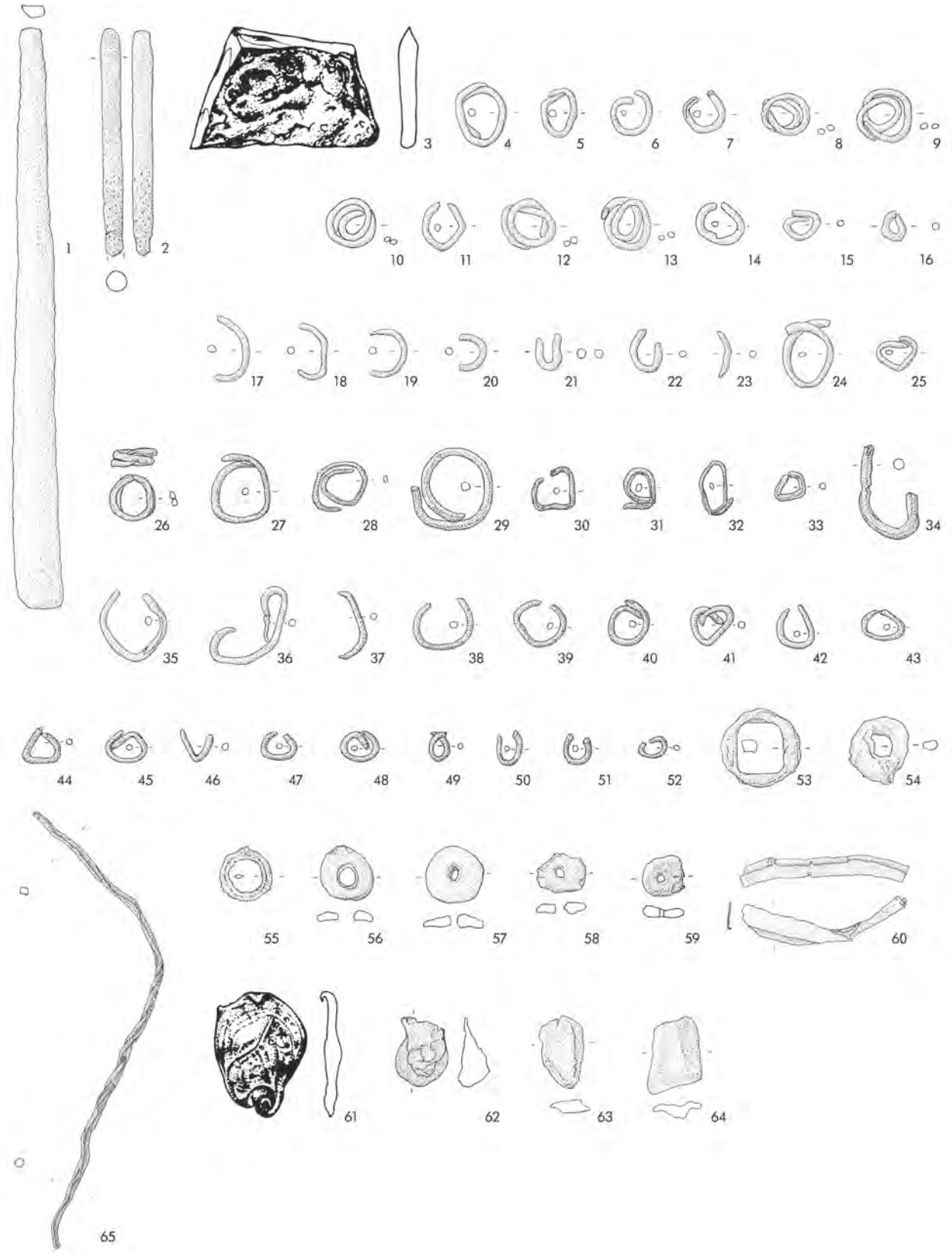

Fig. 7 Swiss finds of Late Bronze Age tin raw material: **1** Auvernier (after Penhallurick 1986). – **2** Grandson-Corcelettes (after Bernisches Historisches Museum). – **3. 61. 65** Zurich-Mozartstrasse (after Schmidheyni 2011). – **4-25. 53-55. 60. 63-64** Hauterive-Champréveyres (22-23 tin-lead alloy; 24-25 lead) (after Rychner-Faraggi 1993). – **26-34. 56-58. 62** Bevaix-Sud (after Arnold / Langenegger 2012). – **35-52** Cortaillod-Est (after Arnold 1986). – **59** Zug-Sumpf (after Bauer / Ruckstuhl / Speck 2004). – Scale 2:3.

– Auvernier (Kt. Neuchâtel): The Late Bronze Age settlement on Lake Neuchâtel (**fig. 5, 7**) is dated by typology to Ha B2 or Ha B3 and by dendrochronological analysis to the period between 878 and 850 BC (Rychner 1979; 1987). R. D. Penhallurick mentioned the old find of a tin bar from Auvernier (Penhallurick 1986, 69), but it is unclear whether it is the same site. The tin bar is approx. 15 cm long and 1 cm thick (**fig. 7, 1**). The piece is apparently undecorated, and it must probably be interpreted as raw material. A mould indicates the local production of wheel-formed pendants during the Late Bronze Age (Schopper 1993/1994, 35).
– Cortaillod-Est (Kt. Neuchâtel): This Late Bronze Age settlement on the shore of Lake Neuchâtel (**figs 5, 8; 7, 35-52**) yielded 18 small annular pieces made of tin wire, similar to those found in nearby Champréveyres (Arnold 1986, 126). No ornaments made of this material were excavated at this site. Typologically the settlement belongs to Ha B2, and it is dated by dendrochronology to the period between 1010 and 955 BC.
– Bevaix-Sud (Kt. Neuchâtel): The Late Bronze Age settlement is situated on the shore of Lake Neuchâtel (**fig. 5, 8**). By typology it can be dated to Ha B2 and by dendrochronology to the period between 1011 and 951 BC (Arnold / Langenegger 2012). In addition to annular pieces of wire, three irregular beads and three adornments of thin sheet were made of tin (**figs 6, 25-27; 7, 26-34. 56-58. 62**).
– Concise (Kt. Vaud): From the Late Bronze Age settlement on the shore of Lake Neuchâtel (**fig. 5, 9**) a crescent-shaped pendant is made of tin (not depicted). Furthermore a piece of tin raw material is mentioned in the catalogue of the Bernisches Historisches Museum [5] – regrettably it was lost in the 1950s, and the character of the find can thus not be defined.
– Grandson-Corcelettes (Kt. Vaud): The Late Bronze Age settlement on the shore of Lake Neuchâtel (**fig. 5, 10**) yielded four wheel-formed pendants (Primas 1984, 36) as well as a double ring, a small bar and a small fragment of tin (**figs 6, 6-9. 20; 7, 2**). In addition a potsherd with tin foil decoration can be mentioned. The length of the tin bar is 59 mm, its thickness 5 mm, its weight 7.9 g. The cross-section is circular, one end is rounded, the other end flattened and broken. The bar is interpreted as a piece of raw material. The finds are from an old collection in the Bernisches Historisches Museum. There are no further details about the dating of the settlement available.
– Onnens (Kt. Vaud): Two tin pendants in the collection of the Bernisches Historisches Museum come from this Late Bronze Age settlement (**fig. 5, 10**) situated on the shore of Lake Neuchâtel (not depicted). Two further pendants as well as a piece of melted tin, probably waste from melting process, are mentioned in the catalogue but were lost in the 1950s. The site has not been excavated and the artefacts mentioned come from old collections.
– Estavayer-le-Lac (Kt. Fribourg): Two wheel-shaped pendants were found in the Late Bronze Age settlement on the shore of Lake Neuchâtel (**figs 5, 11; 6, 11-12**; Primas 1984). The assemblage is otherwise unpublished, and further information concerning the dating is not available.
– Aeschi-Bad Heustrich (Kt. Bern): An old find assemblage from this site in the Bernese Alps (**fig. 5, 14**) of unworked but otherwise undefined pieces of copper and tin is not dated and the finds are today untraceable (Heierli 1901, 235; Tschumi 1953, 176). A Bronze Age dating is possible but not proven.
– Further Swiss Bronze Age sites yielding tin objects: According to M. Primas, tin artefacts were also found in Muntelier (Kt. Fribourg) on Lake Murten (**fig. 5, 12**) as well as in Geneva-Pâquis and Geneva-Eaux-Vives on Lake Geneva (**fig. 5, 13**; Primas 1984, 36). Unfortunately, the type of objects and further details are not known. In addition to the artefacts and pieces of raw material already mentioned, pottery ornamented with tin foil constitutes a very interesting category. Such finds are rather common in the Late Bronze Age settlements in Switzerland, and are also known from other European regions (Fischer 1997, 124 ff. fig. 80).

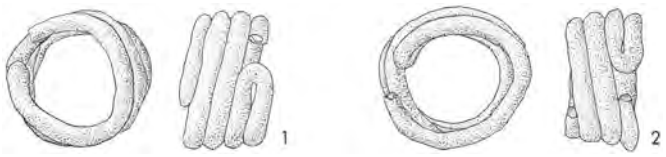

Fig. 8 Late Bronze Age tin rings from Tollensee (Lkr. Mecklenburgische Seenplatte). – (After Krüger et al. 2012). – Scale 2:3.

BRONZE AGE TIN FROM OTHER REGIONS

Pendants, artefacts made of tin as well as pieces of tin raw material are relatively rarely found outside Switzerland [6]. From the Late Bronze Age site Unteruhldingen-Stollenwiesen (Bodenseekreis), on the shore of Lake Constance, a pendant has recently been discovered (Köninger 2005, 68)[7]. M. Primas mentioned two finds of wheel-shaped pendants from northern Italy, similar to those known from Late Bronze Age Switzerland (Primas 1984, 39f.). In southern Germany, in Buxheim (Lkr. Eichstätt) an Early Bronze Age grave yielded 47 tin beads (Möslein / Rieder 1997).

Until the find from Sursee-Gammainseli was made, Bronze Age tin ingots were more or less missing from the Continental Europe, in contrast to copper and bronze ingots. An exception could be the pieces of tin found in the Late Bronze Age settlement on the former island Säckingen (Lkr. Waldshut). The island is situated in the Rhine close to the Swiss border. As so far no illustrations of the finds have been published, it is not possible to discuss these pieces which were referred to as »unshapen ingots« (Gersbach 1969, cat. 109b.87).

In northeastern Germany, in Tollensee two tin rings were recently discovered in a river together with Late Bronze Age artefacts (Krüger et al. 2012). Typologically they belong to the earliest Bronze Age. The rings have diameters of 26-27 and 30-32 mm, and weigh 22.85 and 23.26 g (**fig. 8**). The authors interpret the rings as raw material or even as ingots. These objects might thus be compared to the Swiss finds of prepared tin raw material.

A small number of shipwrecks indicate an extensive and surprisingly well organised trade with tin during the Bronze Age. The famous shipwreck of Uluburun (İl Antalya) on the Turkish Mediterranean coast is based on dendrochronology, ^{14}C and typological analyses, dated to the 14th century BC (Yalçin / Pulak / Slotta 2005). The cargo consisted of merchandise and raw materials from different regions of the Mediterranean and the Middle East, and included numerous copper and tin ingots. The ratio between the 10 t of copper and 1 t of tin on the ship is the mixing ratio for the production of bronze, a fact which is probably not a coincidence (Pulak 2005). Another, but unfortunately scarcely published Bronze Age wreck site is located in Salcombe (Devon) on the south coast of England (Cunliffe 2013, 287)[8]. The wreck itself seems to be totally dispersed, and on the basis of typological analysis of the finds must be dated to around 900 BC. Apart from tools, weapons, ornaments, numerous copper and tin ingots could also be observed. According to Krüger et al., 259 copper ingots weighing 63.87 kg in total, and 27 tin ingots weighing 19.09 kg in total were found (Krüger et al. 2012, 41). Thus, a ratio of 3.3:1 for copper and tin has been established. A possible continental origin of the tin ingots has been discussed, but this assumption must be considered speculative until metallurgical analyses have been conducted.

Another shipwreck from the southwest of England was observed in the Erme Estuary (Devon) and consists exclusively of 44 tin ingots weighing a total of 84.67 kg[9]. It is highly likely that the find is the cargo of a non-preserved shipwreck, and that the metal is of local origin (Loughton 2012). The shipload can probably be related to the rich deposits of copper and tin in southern England. In contrast to the findings in the Mediterranean, the Bronze Age shipwrecks found off the British coast seem primarily to have connection with the metal trading.

TIN IN THE EUROPEAN BRONZE AGE

Tin was indispensable for the production of bronze and during the Bronze Age was evidently often shipped from the sources to the end-users in its raw state. In the settlements tin was not only used for the alloying of bronze, but also for the production of artefacts and for ceramics decors. In contrast to the eastern Mediterranean, where copper and tin were obviously traded specifically for the production of bronze, the situation on the coast of southern England seems less clear. Tin as raw material was portioned, and kept as bars, annular wires, rings as well as beads. Whether the metal was exported in this manner, or if it was portioned after reaching the settlements cannot be decided.

The ingot from Sursee-Gammainseli, as well as the fragment of an ingot from Zurich-Mozartstrasse, indicate that at least in some cases large pieces of tin were imported. The ingots were gradually exploited for the purpose of production of bronze artefacts. The local production of bronze is also shown by tin and copper waste in the settlements of Zurich-Mozartstrasse and Onnens.

To summarise, tin seems to be less scarce in Bronze Age sites than often claimed, especially in the light of the paucity of finds of copper raw material in the settlements of this period. The fact, that tin seems to be more frequent in Swiss lake shore sites, must probably be explained by the impressive number of Bronze Age settlements, the favourable preservation conditions seen here and of course by the numerous excavations.

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Notes

1) The analysis of the tin ingot was conducted in the framework of the Schweizerischer Nationalfonds project 100013-143332.
2) Fritz Sager, Bundesamt für Gesundheit, Bern.
3) In the earliest central European Bronze Age (Br A1) tin was often not added to the bronze. Instead copper containing a high percentage of arsenic and antimony, as well as further elements, were used. It is conceivable that this is a natural »alloy«, and the metal thus a »natural bronze« (Fasnacht 1998, 232 f.). In this connection the well-known axe hoard Sennwald Salez (Kt. St. Gallen) in eastern Switzerland can be mentioned, in which the artefacts content constitutes about 80-90 % of copper and no or only very low contents of tin could be measured (Bill 1997).
4) Chemical analysis by energy dispersive X-ray fluorescence analysis (EDXRF). Determination of lead isotope ratios by multi-collector inductively coupled plasma mass spectrometer ion source. Analysis Report 13-024. Prof Dr Ernst Pernicka. Mannheim 18th April 2013.
5) I would like to thank Prof Dr Felix Müller (Bernisches Historisches Museum) for permission to record a number of tin artefacts.
6) An overview can be found in Krüger et al. 2012.
7) A scientific determination of the raw material was to my knowledge so far not conducted.
8) Most information about the Salcombe site comes from the Internet.
9) Apparently, the wreck was located on the basis of the metal finds. It is thus conceivable that more finds are available in the seabed.

References

Arnold 1986: B. Arnold, Cortaillod-Est, un village du Bronze final. 1: Fouille subaquatique et photographie aérienne. Archéologie neuchâteloise 1 (Saint-Blaise 1986).

Arnold / Langenegger 2012: B. Arnold / F. Langenegger, Bevaix-Sud: plongée dans le passé, fouille subaquatique d'un village du Bronze final. Archéologie neuchâteloise 50 = Plateau de Bevaix 8 (Hauterive 2012).

Bartelheim / Niederschlag 1998: M. Bartelheim / E. Niederschlag, Untersuchungen zur Buntmetallurgie, insbesondere des Kupfers und Zinns, im sächsisch-bömischen Erzgebirge und dessen Umland. Arbeits- und Forschungsberichte zur Sächsischen Bodendenkmalpflege 40, 1998, 8-87.

Bauer / Ruckstuhl / Speck 2004: I. Bauer / B. Ruckstuhl / J. Speck, Die spätbronzezeitlichen Ufersiedlungen von Zug-Sumpf. 3, 1: Die Funde der Grabungen 1923-37 (Zug 2004).

Begemann et al. 1999: F. Begemann / K. Kallas / S. Schmitt-Strecker / E. Pernicka, Tracing ancient tin via isotope analyses. In: The Beginnings of Metallurgy. Proceedings of the International Conference, Bochum 1995. Der Anschnitt Beiheft 9 (Bochum 1999) 277-284.

Bernatzky-Goetze 1987: M. Bernatzky-Goetze, Mörigen. Die spätbronzezeitlichen Funde. Antiqua 16 (Basel 1987).

Bill 1993: J. Bill, Vorgeschichtliche Perioden der menschlichen Besiedlung. Mitteilungen der Naturforschenden Gesellschaft Luzern 33 (Sonderheft Sempachersee), 1993, 167-188.

1995: J. Bill, Goldenes Bronzezeitalter. Die Bronzezeit im Kanton Luzern [exhibition catalogue]. Archäologische Schriften Luzern 6 (Luzern 1995).

1997: J. Bill, Die Bronzebeile von Salez. Das 1883 gefundene Depot aus der Frühbronzezeit. Werdenberger Jahrbuch 10, 1997, 247-263.

Bolliger 2001: S. Bolliger, Zürich Wollishofen-Haumesser: Spätbronzezeitliche Keramik. Tauchsondierungen 1964-1970. Zürcher Archäologie 2 (Zürich, Egg 2001).

Chronologie 1986: Chronologie. Archäologische Daten der Schweiz. Antiqua 15 (Basel 1986).

Cierny / Stöllner / Weisgerber 2005: J. Cierny / Th. Stöllner / G. Weisgerber, Zinn in und aus Mittelasien. In: Yalçin / Pulak / Slotta 2005, 431-448.

Cunliffe 2013: B. Cunliffe, Britain begins (Oxford 2013).

Fasnacht 1998: W. Fasnacht, Metallurgie. In: Hochuli / Niffeler / Rychner 1998, 232-252.

Fischer 1997: C. Fischer, Innovation und Tradition in der Mittel- und Spätbronzezeit. Gräber und Siedlungen in Neftenbach, Fällanden, Dietikon, Pfäffikon und Erlenbach. Monographien der Kantonsarchäologie Zürich 28 (Zürich 1997).

Gersbach 1969: E. Gersbach, Urgeschichte des Hochrheins. Funde und Fundstellen in den Landkreisen Säckingen und Waldshut. Badische Fundberichte Sonderheft 11 (Freiburg i. Br. 1969).

Gross et al. 1992: E. Gross / E. Bleuer / B. Hardmeyer / A. Rast-Eicher / C. Ritzmann / B. Ruckstuhl / U. Ruoff / J. Schibler, Zürich »Mozartstrasse«. Neolithische und bronzezeitliche Ufersiedlungen. 2: Tafeln. Berichte der Zürcher Denkmalpflege: Monographien 17 (Egg, Zürich 1992).

Heierli 1901: J. Heierli, Urgeschichte der Schweiz (Zürich 1901).

Heinrich 1994: P. Heinrich (ed.), Metall-Restaurierung. Beiträge zur Analyse, Konzeption und Technologie (München 1994).

Hochuli 1998: S. Hochuli, Weihe- und Verwahrfunde: Depots und Einzelfunde. In: Hochuli / Niffeler / Rychner 1998, 327-336.

Hochuli / Niffeler / Rychner 1998: S. Hochuli / U. Niffeler / V. Rychner (eds), Die Schweiz vom Paläolithikum bis zum frühen Mittelalter. SPM; vom Neandertaler bis zu Karl dem Grossen. 3: Bronzezeit (Basel 1998).

Köninger 2005: J. Köninger, Unterwasserarchäologie am Überlinger See – Sondagen und Prospektionsarbeiten unter Wasser. Nachrichtenblatt Arbeitskreis Unterwasserarchäologie 11/12, 2005, 63-70.

Krause 2003: R. Krause, Studien zur kupfer- und frühbronzezeitlichen Metallurgie zwischen Karpatenbecken und Ostsee. Vorgeschichtliche Forschungen 24 (Rahden/Westf. 2003).

Krüger et al. 2012: J. Krüger / F. Nagel / S. Nagel / D. Jantzen / R. Lampe / J. Dräger / G. Lidke / O. Mecking / T. Schüler / T. Terberger, Bronze Age tin rings from the Tollense valley in northeastern Germany. Prähistorische Zeitschrift 87/1, 2012, 29-43.

Lo Schiavo 2005: F. Lo Schiavo, Metallhandel im zentralen Mittelmeer. In: Yalçin / Pulak / Slotta 2005, 399-414.

Loughton 2012: E. Loughton, Erme Estuary Ingots (2012). http://swmag.org/index.php/stories/erme-estuary-ingots (1. 4. 2014).

Möslein / Rieder 1997: S. Möslein / K. H. Rieder, Zinnperlen aus einem frühbronzezeitlichen Grabfund von Buxheim, Landkreis Eichstätt, Oberbayern. Das archäologische Jahr in Bayern 1997, 68-70.

Nielsen 2005: E. Nielsen, Unterwasserprospektion im Sempachersee, Kanton Luzern (Schweiz). Nachrichtenblatt Arbeitskreis Unterwasserarchäologie 11/12, 2005, 25-32.

Northover / Gillis 1999: J. P. Northover / C. Gillis, Questions in the Analysis of Ancient Tin. In: Young et al. 1999, 78-85.

Northover 2004: P. Northover, Interdisziplinäre Untersuchungen zu den Metallfunden. In: Bauer / Ruckstuhl / Speck 2004, 102-143.

Penhallurick 1986: R. D. Penhallurick, Tin in Antiquity. Its mining and trade throughout the ancient world with particular reference to Cornwall (London 1986).

Primas 1984: M. Primas, Bronzezeitlicher Schmuck aus Zinn. Helvetia Archaeologica 15 (57/60), 1984, 33-42.

Pulak 2005: C. Pulak, Das Schiffswrack von Uluburun. In: Yalçin / Pulak / Slotta 2005, 55-102.

Rigert 2008: E. Rigert, Sursee – Bronzezeitliche Siedlungen auf der Landzunge Zellmoos. Die Grabung 1991. Archäologische Schriften Luzern 12 (Luzern 2008).

Roscio / Delor / Muller 2011: M. Roscio / J.-P. Delor / F. Muller, Late Bronze Age graves with weighing equipment from eastern France. Archäologisches Korrespondenzblatt 41, 2011, 173-187.

Ruoff 1990: U. Ruoff, Ufersiedlungen am Zürichsee. In: Die ersten Bauern. Pfahlbaufunde Europas. 1: Schweiz [exhibition catalogue] (Zürich 1990) 145-159.

Rychner 1979: V. Rychner, L'âge du Bronze final à Auvernier (Lac de Neuchâtel, Suisse). Typologie et chronologie des anciennes collections conservées en Suisse. Auvernier 1-2 = Cahiers d'archéologie romande 15-16 (Lausanne 1979).

1984: V. Rychner, La matière première des bronziers lacustres. Archäologie der Schweiz 7/2, 1984, 73-78.

1987: V. Rychner, Auvernier 1968-1975: le mobilier métallique du Bronze final. Formes et techniques. Auvernier 6 = Cahiers d'archéologie romande 37 (Lausanne 1987).

1998: V. Rychner, Weitere Metalle. In: Hochuli / Niffeler / Rychner 1998, 253-259.

Rychner-Faraggi 1993: A.-M. Rychner-Faraggi, Hauterive-Champréveyres 9: Métal et parure au Bronze final. Archéologie neuchâteloise 17 (Sainte-Blaise 1993).

Schaer 2003: A. Schaer, Untersuchungen zum prähistorischen Bergbau im Oberhalbstein (Kanton Graubünden). Jahrbuch der Schweizerischen Gesellschaft für Ur- und Frühgeschichte 86, 2003, 7-54.

Schmidheiny 2011: M. Schmidheiny, Zürich »Mozartstrasse«. Neolithische und bronzezeitliche Ufersiedlungen. 4: Die frühbronzezeitliche Besiedlung. Monographien der Kantonsarchäologie Zürich 42 (Zürich, Egg 2011).

Schopper 1993/1994: F. Schopper, Eine urnenfelderzeitliche Gussform aus Mintraching-Moosham, Lkr. Regensburg. Bericht der Bayerischen Bodendenkmalpflege 34/35, 1993/1994 (1995), 30-45.

Seifert 1997: M. Seifert, Die spätbronzezeitlichen Ufersiedlungen von Zug-Sumpf. 2: Die Funde der Grabungen 1952-54 (Zug 1997).

Seifert et al. 1996: M. Seifert / S. Jacomet / S. Karg / J. Schibler / B. Kaufmann, Die spätbronzezeitlichen Ufersiedlungen von Zug-Sumpf. 1: Die Dorfgeschichte (Zug 1996).

Stöllner 2005: Th. Stöllner, Mineralische Rohstoffe in der Bronzezeit – ein Überblick. In: Yalçin / Pulak / Slotta 2005, 451-473.

Tschumi 1953: O. Tschumi, Urgeschichte des Kantons Bern (alter Kantonsteil). Einführung und Fundstatistik bis 1950 (Bern, Stuttgart 1953).

Vogel 1993: A. Vogel, Reuss/Aare-Gletscher als Landschaftsgestalter. Mitteilungen der Naturforschenden Gesellschaft Luzern 33 (Sonderheft Sempachersee), 1993, 33-44.

Yalçin / Pulak / Slotta 2005: Ü. Yalçin / C. Pulak / R. Slotta (eds), Das Schiff von Uluburun – Welthandel vor 3000 Jahren [exhibition catalogue]. Veröffentlichungen aus dem Deutschen Bergbau-Museum Bochum 138 (Bochum 2005).

Young et al. 1999: S. M. M. Young / A. M. Pollard / P. Budd / R. A. Ixer, Metals in Antiquity. BAR International Series 792 (Oxford 1999).

Zusammenfassung / Abstract / Résumé

Ein spätbronzezeitlicher Zinnbarren aus Sursee-Gammainseli (Kt. Luzern)

Die kleine Insel Gammainseli liegt im zentralschweizerischen Sempachersee, unweit des Städtchens Sursee (Kt. Luzern). Die Fundstelle, welche neolithische und spätbronzezeitliche Kulturschichten umfasst, befindet sich teilweise unterhalb des heutigen Seespiegels. Die neolithischen Siedlungsspuren datieren wahrscheinlich in die Cortaillod-Zeit. Anhand von dendrochronologischen Analysen sind drei spätbronzezeitliche Besiedlungsphasen im späten 11., 10. und frühen 9. Jahrhundert v. Chr. nachweisbar. Im Bereich der Fundstelle wurden bisher keine Ausgrabungen durchgeführt. Im Rahmen von unterwasserarchäologischen Prospektionsarbeiten konnte neben einigen wenigen spätbronzezeitlichen Keramikscherben ein Zinnbarren am Seegrund geborgen werden. Der Barren besteht aus einem relativ reinen Zinn, der mit ca. 1,5 % jedoch einen bemerkenswerten hohen Anteil an Blei aufweist. Trotz metallurgischer und Bleiisotopenanalysen war es nicht möglich, die Herkunft des Rohstoffes eindeutig zu bestimmen. Das Zinn stammt aber wahrscheinlich aus dem Erzgebirge im tschechisch-deutschen Grenzgebiet. Inwiefern das Blei als natürlicher Bestandteil des Zinns oder als eine sekundäre Beimengung gewertet werden muss, bleibt ungeklärt. Der Barren wurde für die Bronzeherstellung teilweise abgebaut. Das ursprüngliche Gewicht muss etwa 700 g betragen haben. Bronzezeitliche Zinnartefakte, Keramik mit Verzierungen aus Zinnfolie wie auch unbearbeitete Zinnfragmente konnten in diversen Schweizer Siedlungen dieser Epoche nachgewiesen werden. Ebenso sind Drähte, Stangen und Schmelztropfen aus Zinn von verschiedenen Fundstellen bekannt und werden als Rohmaterial und Abfall der Bronzeherstellung interpretiert. Zinn wurde demzufolge als reines Metall eingeführt und vor Ort weiterverarbeitet. Einige wenige Funde von Kupferbarren lassen ebenfalls auf eine lokale Bronzeproduktion schließen. Depots mit Bruchmetall wie auch Funde von Bronzebarren belegen aber auch den Handel mit fertig legiertem Metall.

A Late Bronze Age tin ingot from Sursee-Gammainseli (Kt. Luzern)
The small island of Gammainseli is situated in the central Swiss Lake Sempachersee near the town Sursee (Kt. Luzern). The multi-phase, partly submerged site includes layers from the Neolithic and the Late Bronze Age. The Neolithic occupation is still undated. Dendrochronological analysis indicates three Bronze Age settlement phases dating to the late 11th, the 10th and the early 9th centuries BC. During submarine surveys in the still unexcavated site, a tin ingot, as well as a few pottery sherds were found on the lake floor. The ingot contains relatively pure tin containing 1.5 % of lead and thus remarkably high content of this metal. Although metallurgical and lead isotope analyses were conducted it was not possible to determine the origin of the metal with certainty. It is most likely that the ingot was imported from the Erzgebirge area on the German-Czech border. Whether the lead is a natural part of the tin or it was added on purpose remains uncertain. Parts of the ingot had been removed for the purpose of bronze production. The original weight must have been approx. 700 g. Artefacts made of tin, ceramics with tin foil ornaments as well as unworked fragments are known from Late Bronze Age sites in Switzerland. Wires, small bars and melted drops of tin are found in a number of Swiss sites, and are interpreted as raw material and as remains of the bronze production. Consequently, tin was used in the settlements, and imported as a pure metal. A few finds of copper ingots also prove the local production of bronze. Hoards containing bronze scrap as well as bronze ingots indicate trade with alloyed metal.

Un lingot d'étain de l'âge de Bronze final de Sursee-Gammainseli (Kt. Luzern)
L'îlot Gammainseli est situé en Suisse centrale, sur le lac de Sempach, à proximité de la ville de Sursee (Kt. Luzern). Le site, qui a livré des niveaux d'habitat du Néolithique et de l'âge du Bronze, est partiellement sous le niveau actuel du lac. Les occupations néolithiques sont probablement attribuables au Cortaillod. Les datations dendrochronologiques permettent de déterminer l'existence de trois phases d'occupation de la fin de l'âge du Bronze correspondant aux dernières décennies du 11e, au 10e et au début du 9e siècle avant notre ère. Jusqu'à présent, aucune fouille n'a pu être réalisée dans l'emprise du site. Une prospection subaquatique a conduit à la découverte, sur le fond du lac, de quelques tessons de la fin de l'âge du Bronze ainsi que d'un lingot. Celui-ci est constitué d'un étain relativement pur même s'il présente une concentration relativement haute de plomb (1,5 %). Malgré les études archéométallurgiques et les analyses isotopiques réalisées, il n'a pas été possible de déterminer avec certitude l'origine de la matière première. Toutefois, l'étain est probablement originaire des Monts Métallifères (Erzgebirge), dans la zone frontière entre la République tchèque et l'Allemagne. Il est actuellement impossible de dire si la concentration de plomb est le résultat d'un ajout volontaire ou si le plomb était associé à l'étain de manière naturelle. Le lingot a été partiellement débité pour produire du bronze. A l'origine, il devait peser environ 700 g. Des objets en étain, des vases décorés d'applications de feuille d'étain ainsi que des fragments d'étain travaillés sont bien attestés en Suisse, sur divers sites de cette période. De même les fils, barres et gouttes d'étain découverts sur différents sites sont interprétés comme étant de la matière première et des déchets de production de bronze. L'étain a donc été importé sous forme de métal pur et transformé sur place. Quelques rares découvertes de lingots de cuivre pourraient indiquer la production locale de bronze. Toutefois, le bronze a également circulé comme en témoignent les dépôts métallurgiques ainsi que des lingots de bronze.
Traduction: S. van Willigen

Schlüsselwörter / Keywords / Mots clés

Schweiz / Kanton Luzern / Spätbronzezeit / Seeufersiedlung / Zinnbarren / Metallanalyse
Switzerland / Canton Lucerne / Late Bronze Age / lakeshore settlement / tin ingot / metal analysis
Suisse / Canton Lucerne / bronze final / palafittes / lingot de étain / analyse de métaux

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