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Petrologic studies of Middle Neolithic stone artefacts from the Salenhof archaeological site near Trillfingen (SW Germany) give evidence for an early diversified long- distance exchange system

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Abstract

The Salenhof (N 48.384071/E 8.822974) archaeological site near Trillfingen contains fragmentary shards of ornamented pottery of the Hinkelstein, Großgartach, Planig-Friedberg and Rössen cultures/groups. In total, 1209 retouched silex artefacts could be recovered at the Middle Neolithic settlement. The high fractions of silex borers (40.9 % of the artefacts) and arrowheads (5.4 %) suggest that jewelry production and hunting activities played a substantial role in addition to ordinary farming activities. Various archaeological objects of imported materials were petrologically studied with standard high resolution research methods. The artefacts consist of material derived from eight remote localities: fine-grained metabasic rocks (amphibolites) from Jistebsko in Northern Bohemia (1), arrowheads and silex artefacts from Lengfeld (2) and Abensberg-Arnhoven (3) in Bavaria, fine-grained eclogites from Monviso (4) in the Western Alps, semi-transparent arrowheads of Cretaceous flint from Rijckholt near Maastricht in the Netherlands (5) and from the Paris Basin (6), siliceous red iron ores from the Lahn-Dill region (7), and a large arrowhead of silex material from Auggen/Schliengen in the Markgräflerland in SW Germany (8). All these artefacts are evidence of far-reaching contacts and the transfer of goods within a Middle Neolithic population at Salenhof. The climax of an early, diversified long-distance exchange system in Central Europe may have occurred during the period of the Rössen Culture ca. 6700 years ago.

Introduction

The small village of Trillfingen near Haigerloch in the Zollernalb district at the southeastern corner of the *Oberes Gäu* is located in a fertile landscape between the Black Forest and the Swabian Alb (Geyer et al. 2011, 16). Trillfingen is located ~7.5 km south of the Neckar River and is situated on top of the Muschelkalk (Middle Triassic) plane. The regional flat landscape lies between the rivers Eyach and Starzel, which form two deeply gorched tributary valleys. The several meters thick soils covered by loamy loess provided favorable places for the cultivation of grain by the Neolithic farmers who had imigrated from Eastern Europe. They began settling in Central Europe approximately 7500 years ago. Shards with *Spiralmäander* ornaments from the earliest Linear Pottery Culture (LBK, phase I) have been found at Rottenburg-Hailfingen at the locality *Unter dem Tübinger Weg* (Albert/Schröter 1971, 65; Lüning et al. 1989, 369). On the basis of the

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publication by Stoll (1933) on local prehistoric monuments, Bofinger (2005) described the whole range of Neolithic settlements inside the area *Oberes Gäu* and the northeastern region up to the present-day city of Tübingen. He also presented detailed data of Neolithic ceramic and stone tool find.

The studied Neolithic archaeological site west of the Salenhof farm (ca. 400 m x 100 m in dimension) lies on a loamy ridge and descends down to a water-rich sink towards the south (Stoll 1933, 86). The unusual abundance of prehistoric artefacts at that place (see Albert 1975, 55, Tables 158–161) provoked our engagement to save these Neolithic objects. In the period of 1971–1975, V. Stähle and G. Unrath recovered more than 1000 lithic artefacts at the Salenhof site. At that time, it did not seem to be reasonable to excavate anywhere on the site, as deep agricultural plowing had intensely scattered quite all the shallowly buried artefacts.

The first step in this study aims to classify the archaeological period from the Salenhof site. This is mainly based on classifying the secured ornamented Neolithic ceramic shards. Our main focus, however, lies in the raw material of the lithic artefacts, not only on the quality of the rocks, but primarily on the original geological location of these materials. Such information yields valuable clues to early exchange networks and the directions of communication that once took place at a single Neolithic site. Beyond that, our ultimate intention is to retain Salenhofs' archaeological artefacts as part of the cultural heritage at SW Germany.

Analytical methods

A hand lens was used for checking some of the pottery shards and retouched silex artefacts. Intensive microscopical studies were performed on polished thin-sections from crystalline rocks in transmitted and reflected light. Back-scattered electron (BSE) images from various archaeological objects were obtained with a LEO 440 scanning electron microscope (SEM) equipped with an Oxford semiconductor detector. Electron probe microanalyses (EPMA) from single silicate grains were obtained using a CAMECA SX51 equipped with five wave-length dispersive spectrometers. Both instruments belong to the Institute of Earth Sciences at the University of Heidelberg.

Results on Ceramics

All Neolithic shards found on Salenhofs' cultivated land are strongly fragmented with linear dimensions of <6 cm. Therefore, the original shape of the Neolithic pottery can only be suspected. About 170 shards were picked up. Most of them are brownish and black and only some show reddish colors. The shards are smooth when they are covered with a thin layer of black or brownish fine clayey cover. Some shards are slightly weathered with porous surfaces. The unornamented coarse ceramics (~60 pieces) are represented by thicker fragments and among them are handles and lugs. Coarse shards often have angular quartz grains (<1 mm) which were then a main tempering component. One shard additionally contains some tiny red particles which could be snippets of red ochre. On the other hand, the smooth and ornamented fine ceramics show variable scratch and stitch motives. The decorated shards yet published are mostly belonging to the Rössen Culture (Albert 1975, Table 160). After careful examination of the variably ornamented potsherds from Salenhof they could be attributed to the Middle Neolithic cultures/groups

Hinkelstein (HST), Großgartach (GG), Planig-Friedberg (P-F) and Rössen (RÖ) (Figs. 1 and 2). A single gray specimen with linear striped decoration belongs to the LBK Culture. A similar observation was made by Albert (1975, 55).

The early Middle Neolithic HST phase is characterized by hatched rhombs or triangles (Bofinger 1996, 45 Abb. 17.7). Two small fragments with sections of scratched lines are certainly remnants of triangles from HST pottery (Fig. 1a). The HST shards are smooth and blackish. They typically contain small glimmering particles. Weathered pieces show fine silica fragments as tempering admixtures. Such a slightly weathered shard with parallel lines is seen in figure 1b. Metopes with parallel scratches at the upper boundary of bowls are typical features of HST ceramics (Meier-Arendt 1975, Catalogue,

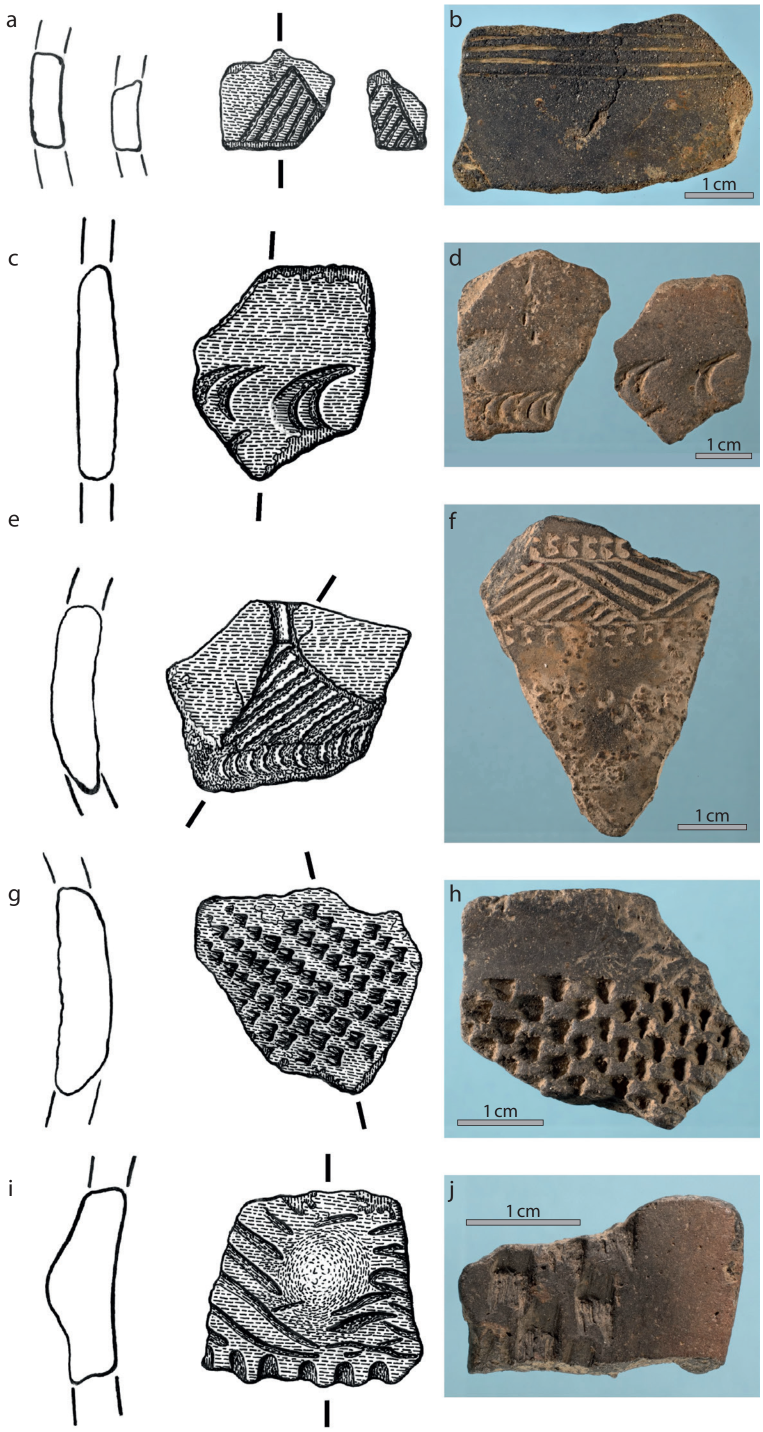


Fig. 1. Twelve selected ceramic fragments presented as hand drawings (left) or photographs (right). From top to bottom the classification of ornamented shards to diverse Neolithic cultures is as follows: (a) and (b) Hinkelstein; (c) and (d) Hinkelstein/Großgartach; (e) and (f) Großgartach; (g) and (h) Planig-Friedberg; (i) and (j) Rössen.

Table 109, 11; Heide 2003, Catalogue, 181). The blackish ceramics with glimmering lamellae among the Neolithic finds from the *Oberes Gäu* have generally been asingned to the Stroke Ornamented Pottery Culture (SBK *Strichbandkeramik*). However, shards from the HST pottery can also contain mica (Bofinger 2005, 187, Table 75, B). On the basis of the scratched ornaments, the early Middle Neolithic shards found at the Salenhof belong to the HST phase II (see Strien 2000, 54, Table 2.3).

Waning moon or sickle-like grooves in shards may be part of both HST and GG groups. However, small pieces with no other decorative features cannot be assigned to either group without doubt. The small shards shown in figure 1c and 1d belong to the early Middle Neolithic era (HST, GG).

The shards in figure 1e and 1f are typical examples with ornaments used by the GG group. Figure 1e exhibits a line of sickle stamps which is overlayed by an open triangle with oblique haching (Bofinger 2005, 174, Abb. 110.9). The second GG sample (Fig. 1f) shows a band of alternating hachings which is framed with rows of double imprints (Bofinger, 2005, 174, Abb. 110. 3). A similar GG shard with white encrustations was documented by Schliz (1901, Table VIII, 30) who named this impressive design "Wolfzahnband" (wolf's teeth band).

Shards with fields of deep double punctures recall knotted carpets (Figs. 1g and 1h). The pricked ornaments on broken fragments belong to the P-F ceramic phase (Stroh 1939, Table 11, 6.7). This phase forms an intermediate link between GG and RÖ (Spatz 2000, 60). However, such shards may also occur in GG as well as in RÖ, while small shards do not allow an exact determination of Middle Neolithic ceramic phases.

The RÖ Culture represents the last Middle Neolithic ceramic phase. A lug encircled by deep engravings and a small rim shard of a bowl with some deep punctures belong to the RÖ Culture (Figs. 1i and 1j). The last example with deep punctures in the clay was once filled with white encrustations (Raetzel-Fabian 2000, 84).

The ornamented ceramic shards found at the Salenhof range from HST to RÖ (Fig. 1). Based on current models for the Neolithic (Lüning 1996; Eisenhauer 1999, 233; Eisenhauer 2002, Fig. 3.3; Gleser 2012, 42) the settlement at Salenhof lasted for about 350 years. The comparatively short period of farming activities in the Middle Neolithic is shown in figure 2.

Neolithic retouched silex artefacts

Masses of rude siliceous debris and more than 1200 modified silex tools have been picked up at the Salenhof Neolithic site. The siliceous raw material comes predominantly from the Swabian Alb that are located at a distance of ~20–30 km. Kimmeridge layers (Malm δ and ε) of the Upper Jurassic limestones (Geyer et al. 2011, 285) contain roundish chert nodules with sizes in the range of 4–10 cm. Likewise, the unstratified bioherms in Malm δ and ε display many chert concretions (Geyer et al. 2011, 285, Fig. 97). These fossiliferous mud stones contain masses of algae and sponge colonisations. After extinction, the opal skeletons of sponges provided free silica to form early diagenetic chert concretions.

Many of the worked silica nuclei found at the Salenhof site (Figs. 3a and 3b) indicate an adequate supply of lithic raw material. The siliceous material used can be classified into the common grayish chert (Fig. 3a) and yellow-brown or red colored bean ore chert or jasper (Fig. 3b). The last material often is homogeneous and is derived from secondary deposits in Karst cavities of the Swabian Alb.

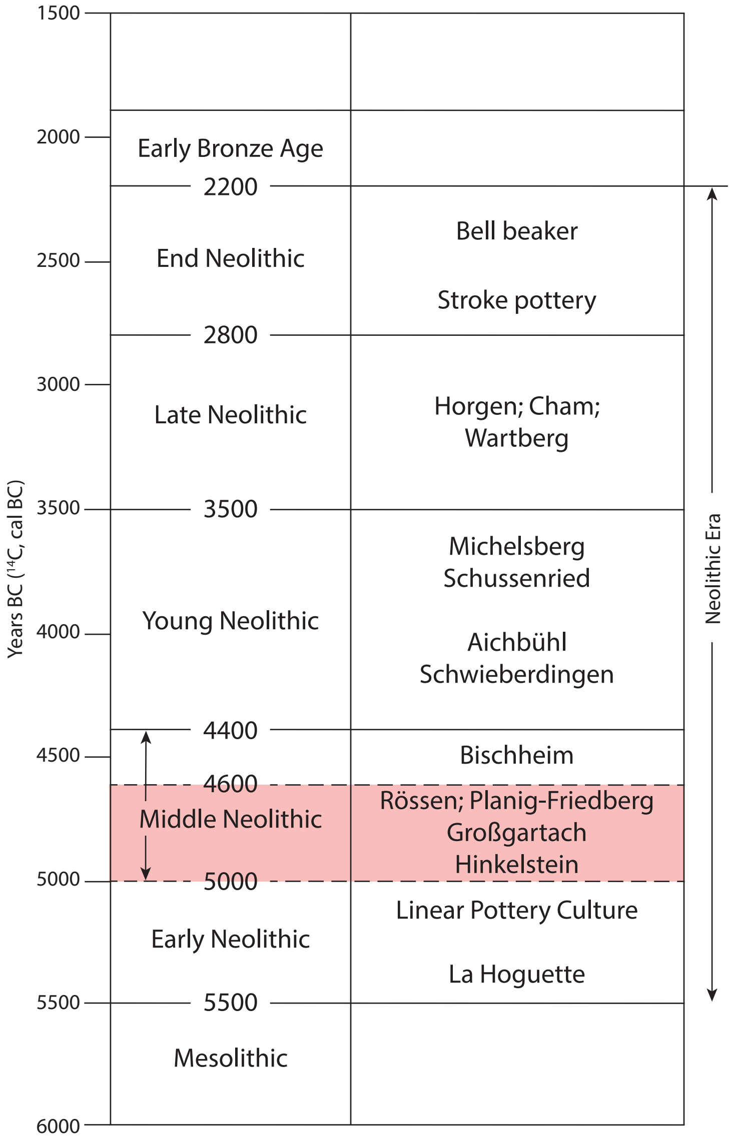


Fig. 2. Time table of the Neolithic era with cultures after Lüning (1996) and Gleser (2012). The Middle Neolithic phases found at Salenhof (red colored) are short relative to the whole Neolithic period of more than 3000 years.

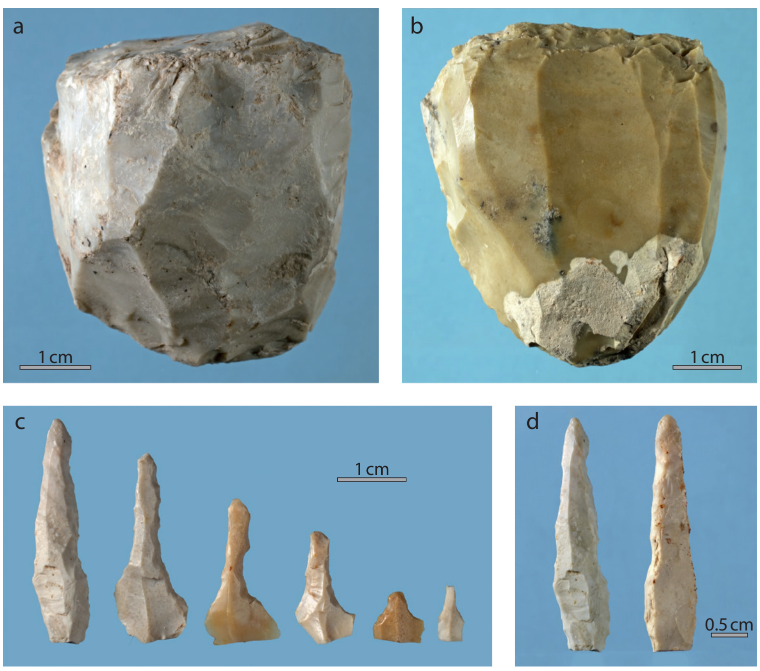


Fig. 3. (a) and (b) The photographs show a gray and yellowbrown silica nucleus which remained after detachment of numerous blades. At the beginning of the operations an upper striking platform was installed which is clearly visible on both nuclei. The materials used originated from the neighboring Swabian Alb. (c) and (d) Typical *Dickenbännli* tips are displayed in figure 3c. Their lengths range from 32.8 to 7.6 mm. During handling the ventral edges of the drills were destroyed with detachment of tiny flakes (Fig. 3d). Rounded tips mark boring of hard substances like teeth or stones.

Excavated from Kimmeridgian limestones and washed into hollows, the nodules often occur in conjunction with roundish iron-rich bean ore (*Bohnerz*) pebbles that are also an excellent material for blade production.

With regard to their colors and luster, the retouched chert artefacts can be classified into 11 different groups. However, most Neolithic tools are white to gray colored or ocker-hued in accordance with a detailed color-based categorization of Middle Neolithic silex material excavated at Rottenburg *Lindele* (Bofinger 1996, 56).

Number and typology of the silex tools allow us to draw some conclusions about the Neolithic farmers' way of life. For supra-regional comparability, the siliceous inventory was classified into an hierarchic system given by Gehlen (2012). The retouched stony equipment (1209 single pieces) of the Salenhof farmers consisted of variable proportions of arrowheads, silex borers, artefacts with lustre, pointed blades with laterally retouch on both sides (*beidseitig retuschierte Spitzklinge*), truncated pieces, scrapers, laterally retouched pieces, splintered pieces, silex hammerstones and miscellaneous modifications (Fig. 4). A conspicuous fact of the silex inventory is the existence of masses of filigrane silex borers (Fig. 3c) with the huge portion of about 40 %. Most of the drills belong to the 'Dickenbännli' type (Fig. 3c) (D'Aujourd'hui 1975, 1981; Hoffstadt 2012, 894). Likewise, numerous arrowheads (5.4 %) that frequently consist of imported silex material are a striking feature and deserve closer attention.

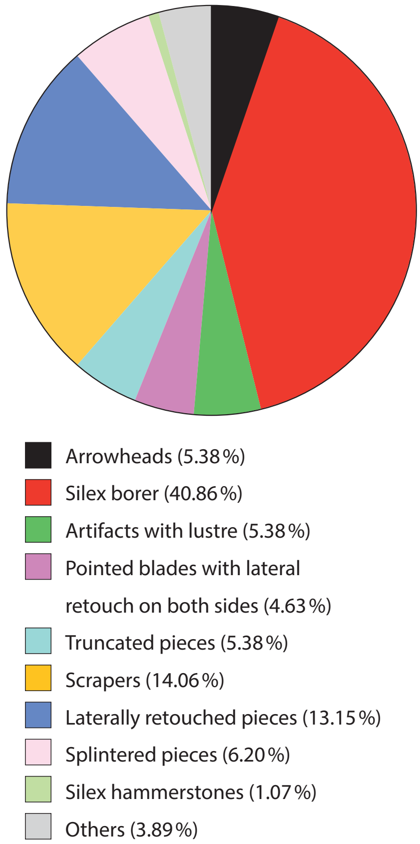


Fig. 4. Pie chart showing the proportions of classified retouched silex artefacts (1209 in total). It is remarkable that nearly half of the siliceous objects consist of silex borers and arrowheads.

Silex borers

The large borer assemblage from the Salenhof comprises 494 pieces whereof only 308 are more or less completely preserved. Many drills are perfectly modelled and look aesthetic (Fig. 3c). The filigrane tools exhibit steeply retouched spikes which merge into variably shaped shoulders. Wedged specimen without shoulders also occur (Fig. 3d). The proportion of shoulder to wedged types is ~9:1. Eight double drills form a subordinate group. Most borers are of the *Dickenbännli* type with large retouched cusps and short shoulders, but a few borers with different shapes are also present.

The unbroken Salenhof drills range in length from 7.6 to 32.8 mm. Their length distribution shows a maximum at ~16.3 mm whereas their average length is ~18.8 mm (Fig. 5). This is in accordance with studied Young Neolithic *Dickenbännli* cusps which have average lengths of 15–18 mm (Hoffstadt 2012, 893). The length distribution of the drills is unimodal and harmonic, whereas a slight shift to larger tools is apparent. Furthermore, a small second amplitude at ~31.3 mm length is obvious (Fig. 5).

Nearly 90 % of the tools contain fossil inclusions. The residues of former organisms consist of skeletal needles of sponges, perforated rags of porifera, rounded lumps of tuberoliths and other enclosures. These compounds are typical entrapments of local cherts from Kimmeridgian to Tithonian limestones of the Swabian Alb.

All sampled Neolithic silex borer show traces of an intense use. The edges of the spikes are heavily notched and in some cases the outermost tips are rounded (Fig. 3d). Roughly one third of the borer are broken, representing either proximal end pieces or, more rarely, median fragments. Small borer were produced from broken blades whereas larger specimen are flakes that show platform remnants at their proximal end and contain small-sized peripheral bulbs.

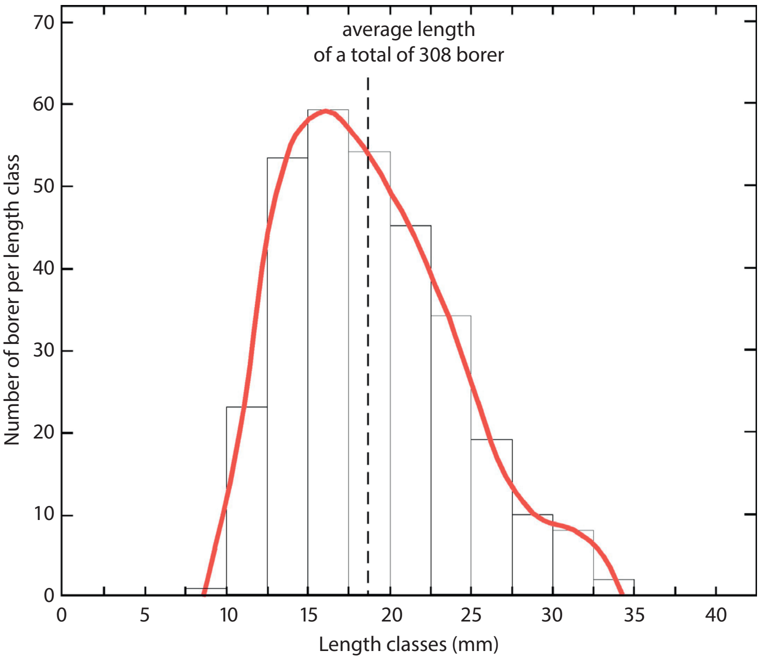


Fig. 5. Borer inventory at Salenhof with longitudes in the range of 7.6–32.8 mm, grouped into eleven length classes. The frequency is harmonic with a second small amplitude at the length of 30.0–32.5 mm.

Arrowheads made of silex

The arrowheads at the multi-cultural Salenhof site show great diversity. The bulk of 65 projectiles on site is remarkable since their rarity within early Neolithic settlements is a well-known feature (Gehlen 2012, 722). About one half of the arrowheads are damaged mostly at their extreme points. Their shapes, the silex material and the manner of processing allow in many cases their specification to regional or cultural derivation. Trapezes, symmetric triangles and a single bifacially retouched tanged arrowhead are the existing varieties.

All arrowheads are made from blades and facial retouch is either restricted to the edges or covers the complete surfaces on both sides of the projectiles. The bases of the arrowheads may be straight, concave and, more rarely, convex, but this attribute does not indicate any cultural affiliation.

Three trapezoidal projectiles which belong to the HST Culture are shown in figure 6a. The slightly banded artefacts appear different in comparison to local silex raw materials. The transverse arrowheads have a flat cross section and are broader on cutting edge than at their base. Two similar microliths from Salenhof have been published previously (Albert 1975, Table 158). Both examples were classified as Neolithic and appear unrelated to similar looking Mesolithic microliths (Taute 1973/1974, 78). The silex material of the three transverse arrowheads consist of slightly banded Jurassic chert with larger variabilities in color (Fig. 6a). It is known that at the period of HST about 50 % of the silex raw material came from Lengfeld out of the Regensburg region (Zimmermann 1995, 16). The imported material from Lengfeld has visibly stronger staining (Fig. 6a) and resembles original material from Lengfeld which varies from gray to yellowish shades (Elburg/van der Croft 2008).

The most frequent Neolithic projectiles at Salenhof are arrowheads with symmetric triangular shapes with straight or concave base. Typical specimen are variably sized objects with laterial retouch at their edges and basis (Fig. 6b). These randomly bifacially retouched arrowheads belong to the GG Group (Goller 1972, 236, Table 46, 4–6). They are reminiscent of LBK points and are made from local silex of the Suebian Alb.

Fig. 6. Various arrowheads from the Salenhof material and examples of imported artefacts from Abensberg-Arnhofen. (a) This picture shows three trapezoidal arrowheads with front and back sides. Both branch lines are characterized by steep retouche. A slight layering indicates the materials' foreign source. The projectiles belong to HST. (b) Three triangular symmetric arrowheads of different dimensions are shown with their front and back sides. The flat retouche is confined to the edges and bases. All arrowheads consist of local silex. They belong to the GG Culture. (c) These triangular arrowheads are bifacially retouched. The silex material reveals in many cases foreign parentage. This type of projectile was firstly used by the RÖ Culture. (d) Four bifacially retouched arrowheads with their front and back sides are presented. These objects are semi-transparent and produced from Cretaceous flint. The retouche indicates a derivation from the RÖ Culture. (e) Two bifacially retouched arrowheads consisting of similar silex material. The smaller one is derived from RÖ. The large one with basal spike (*Stielpfeilspitze*) contains concentric *Liesegang* rings (arrows). (f) This image contains three artefacts of fine-grained banded material from Abensberg-Arnhofen. The tabular chert shows the typical fine cortex strip at one side of the artefacts. Two blades and a broken tip of a silex borer are illustrated.

Another type of projectile is bifacially retouched and has triangular outlines with sizes of ~20 mm (Fig. 6c). These arrowheads have a convex, straight or concave base. A total of eleven pieces were found at Salenhof. These arrowheads with straight or concave bases belong to the RÖ Culture (Goller 1972, 241, Table 48, 2–6). Similar pieces were detected under secure archaeological conditions and are found in Neolithic graves (Goller 1972, 241; Dehn 1985, Abb. 2).

Two bifacially retouched arrowheads are presented in figure 6e. The smaller one is a typical triangular RÖ apex, whereas the larger one is unique with a tang at the base (*Stielpfeilspitze*). With a length of 45.8 mm it clearly differs from all the other collected Neolithic projectiles which were collected. In addition, the large, carefully retouched arrowhead shows another anomalous feature. Some reddish, concentric rings are fixed within the chert material (Fig. 6e). Such phenomena resemble so-called *Liesegang* rings which may have been produced by infiltrating ferrous aqueous solutions under changing environmental conditions. Chert nodules with rhythmic *Liesegang* rings occur in secondary bean ore deposits at Auggen/Schliengen in the region of the *Markgräflerland* (Gayck 2000, 304; Geyer et al. 2011, 350). This extraordinary material was already used in the Palaeolithic (Floss/Siegeris 2012, 23).

Arrowheads made up of Cretaceous flint

Four peculiar, bifacially retouched arrowheads from the Salenhof are slightly translucent (Fig. 6d). Their triangular shapes with concave bases and facial retouch classify them as derivatives of the

RÖ Culture. Unlike local silex, this translucent material must originate from remote Cretaceous formations. The arrowheads in the upper row of figure 6d come from Rijckholt near Maastricht (Weisgerber 1980, 559; Zimmermann 2017 pers. comm.). Most probably, these yellow and dark brown projectiles were produced from flint of the Parisian basin (Strien 2017, pers. comm.). Some Neolithic tools made from Cretaceous material have already been registered in the area of the *Oberes Gäu* (Albert/Schröter 1977, 95; Bofinger 2005, 185). Dumped materials at a P-F waste pit located to the north in the *Filder* region show up to five Cretaceous flint varieties (Strien 2000, 35).

Tabular chert from Abensberg-Arnhofen

A considerable portion of chert material at the Salenhof comes from Abensberg-Arnhofen in Lower Bavaria. This banded material can easily be identified and forms a considerable portion of 4.8% of the silex inventory (Fig. 4). This is not unusual for Middle Neolithic settlements along the Neckar river in SW Germany where 5–20% of Jurassic banded chert is regularly enclosed in find assemblages at archaeologic sites (Bofinger 2005, 185). The imported banded material indicates close contacts to the Abensberg flint mine in Lower Bavaria (Binsteiner 1990). Two blades and a broken drill from this external, fine-grained chert material are shown in figure 6f.

Polished amphibolitic adze blades

Neolithic farmers used a variety of adz blades for different kinds of woodworking. Felling of trees and building of farm houses continuously produced a high demand for stone adzes. The used raw materials were mostly amphibolites, basaltic and sedimentary rocks, as well as lydites (Ramminger 2017, 84). With regard to the grain size of the archaeological implements two types of amphibolites occur. In most cases both types can be distinguished macroscopically from each other. Contrary to common coarse-grained amphibolites, a special fine-grained amphibolitic stone was the dominant rock type within the find spectra of most Early to Middle Neolithic settlements everywhere in Central Europe. However, the source of this particular fine-grained rock remained unknown for a long time. One of the last proposals referred to the Balkan or Carpathian region (Schwarz-Mackensen/Schneider 1986, 2012). Recently, Jistebsko in the Izera Mountains of Northern Bohemia was identified as an archaeological site where there are outcrops of such fine-grained metabasic rocks. Petrographical, geochemical and isotope studies of these basic, contact-metamorphic rocks resulted in a vast accordance with the bulk of the recovered archaeological tools (Šreinová *et al. 2003*, Klominsky et al. 2004; Christensen et al. 2006, Šída/Kachlík 2009). One calibrated radiocarbon date of 5150–4920 B.P. for charcoal from the base of a Neolithic quarry was published by Postředník et al. (2005). It is most likely that the majority of the fine-grained material in early Neolithic times originated from Jistebsko within the thermal contact-metamorphic aureole of the Tanvald granite. For this highly appreciated, fine-grained metabasic rock material the name actinolithe-hornblende schist has been established (*AHS schist*) (Schwarz-Mackensen/Schneider 1983, 307).

Most stone implements at the Salenhof are fine-grained AHS schists. A shoe-last adz, two fragments of polished implements with bore holes and a drill-core from a Neolithic shoe-last adz or hammer-stone are shown in figure 7a–d. The fine-grained rock material appears dark greenish-gray and the outer surfaces are carefully polished. The arrangement of the rocks' foliation parallel to the longitudinal axis of the adz blade ensured greatest hardness and stability for the Neolithic implement (Fig. 7a).

Ideas about the provenance of the fine-grained stone tools may be checked by microscopical and electron microprobe studies of the rocks. Eight polished thin sections from fragmented tools or unshaped production debris from the Salenhof locality were prepared (Fig. 8), but the original pieces of axes remained untouched (Fig. 7).

Fig. 7. Some specimen of fine-grained metabasitic implements from the Salenhof are presented. (a) The discovered shoe-last adz is shown from above, from the side and from below. The original foliation in longitudinal direction is well seen. (b) A conical drill core is derived from a fine-grained metabasic hammer-axe (c) The fragment of a bored adz is broken at the drilled weak point. (d) The fragment represents the neck of a shoe-last adze.

Furthermore, one sample (J1) of a metabasic rock from an outcrop near Jistebsko was used for a substantial comparison with the Salenhof material. This fine-grained, dark-colored rock comes from the large Neolithic mining area (Jistebsko I–IV), described by Postředník et al. (2005, Fig. 3) and Šída (2009, Fig. 1, Table 1). The metabasites in this area occur as numerous small bodies (<2 m in diameter) within schists (Šída/Kachlík 2009; Šída 2009, Fig. 1, Table 1).

Indigeneous material from Jistebsko (J1) and five thin sections from metabasic material found at Salenhof are presented in figure 8. Mineralogical compositions of the metabasites are listed in Table 1. All samples are fine-grained, but their fabrics are largely different and display an older regional metamorphism with rock deformation and a younger static contact metamorphism. While only one sample (T37) still contains relict minerals formed during regional metamorphism, all the other samples consist of mineral grains that can be attributed to the second metamorphic phase. Main minerals are

Fig. 8. Thin-sections from fine-grained metabasic material from Jistebsko (J1) and from Salenhof (T33, T18, T37, T35, T34). The fabrics of the rock material are fairly variable but the abundance of black-colored ilmente grains in all samples is remarkable.

Table 1. Petrographical composition of fine-grained metabasites from Salenhof and Jistebsko (Northern Bohemia).

Sample	**J1**	**T33**	**T41**	**T38**	**T37**	**T34**	**T18**	**T36**	**T35**
Locality	**Jistebsko**	**Salenhof**	**Salenhof**	**Salenhof**	**Salenhof**	**Salenhof**	**Salenhof**	**Salenhof**	**Salenhof**
Neolithic fragment	Rock fragment	polished	shapeless	shapeless	polished	polished	shapeless	shapeless	drill core
Fabric	foliated	foliated	foliated	weakly foliated	homo-geneous, nearly isotropic	weakly foliated hetero-geneous	homo-genous, foliated	foliated	hetero-geneous, foliated
Primary plagioclase	An76	An84	An72	An84	An89	An69	An50	An91	An90
	bytown-ite	bytown-ite	bytown-ite	bytown-ite	bytown-ite	labrador-ite	andesine/ labrad.	anorthite	anorthite
Ilmenite									
MnO (wt %)	0.75	0.88	0.77	0.95	1.29	1.30	1.47	3.28	3.73
max. grain size (µm)	105	145	225	380	250	430	115	310	520
Amphibole									
Cummingtonite/ grunerite	+	+	+		+				+
Actinolite	+	+	+	+	+	+		+	+
Ferroactinolite			+	+		+			
Magnesio-Horn-blende	+	+		+		+	+	+	
Ferrotschermakite*					+				
Quartz	+	+	+		+	+	+	+	+
Apatite		+	+	+	+	+	+	+	+
Pyrite	+	+			+	+	+	+	
Chlorite		+	+	+	+	+		+	+
Clinozoisite + Albite			+		+			+	

* Relict regional metamorphic amphibole

plagioclase and amphibole of diverse compositions (Fig. 9). It is clear, that minor differences in bulk-rock composition of the metabasites, e.g. their ratio Mg/(Mg+Fe^{2+}) and the degree of contact-metamorphic overprint will determine the composition of the calcic amphiboles (Fig. 9). With increasing distance from the intrusive contact, the second metamorphism reached lower temperatures producing amphiboles with higher Si contents. In samples that were nearer to the contact magnesio-hornblende was produced (T18), but in samples that were further away from the contact, maximum temperatures were lower and actinolitic amphiboles were produced. There may be samples such as T37 that still contain relictic amphibole from regional metamorphism (ferro-tschermakite), while magnesio-hornblende and actinolite were produced during later contact metamorphism. Mg-Fe-Mn amphibole (Fig. 10a and 10b) in coexistence with calcic amphibole are only present in some of the amphibolites (J1, T33, T35,T37, T41). It has to be noted that the coexistence of these amphiboles represents a rare case in nature. Note, that sample T37 also contains some grains of relict ferrotschermakite from the first (regional) metamorphism.

Plagioclase grains normally show intermediate compositions around $Na_{0.5}Ca_{0.5}Al_{1.5}Si_{2.5}O_8$ (Table 1). Some grains however, are more Ca-rich with compositions around $Na_{0.1}Ca_{0.9}Al_{1.9}Si_{2.1}O_8$. Most probably, these grains are relics from regional metamorphism. Some samples show aggregates of clinozoisite and albite that were formed during a late-stage retrograde recrystallization (Table 1; Fig. 10e).

Minor or accessory minerals in the fine-grained metabasites are ilmenite, apatite, pyrite, chlorite and quartz (Table 1). A distinguishing feature of the polymetamorphic amphibolites are high concentrations of ilmenite (Figs. 8 and 10c, d, f). MnO contents of these ilmenite

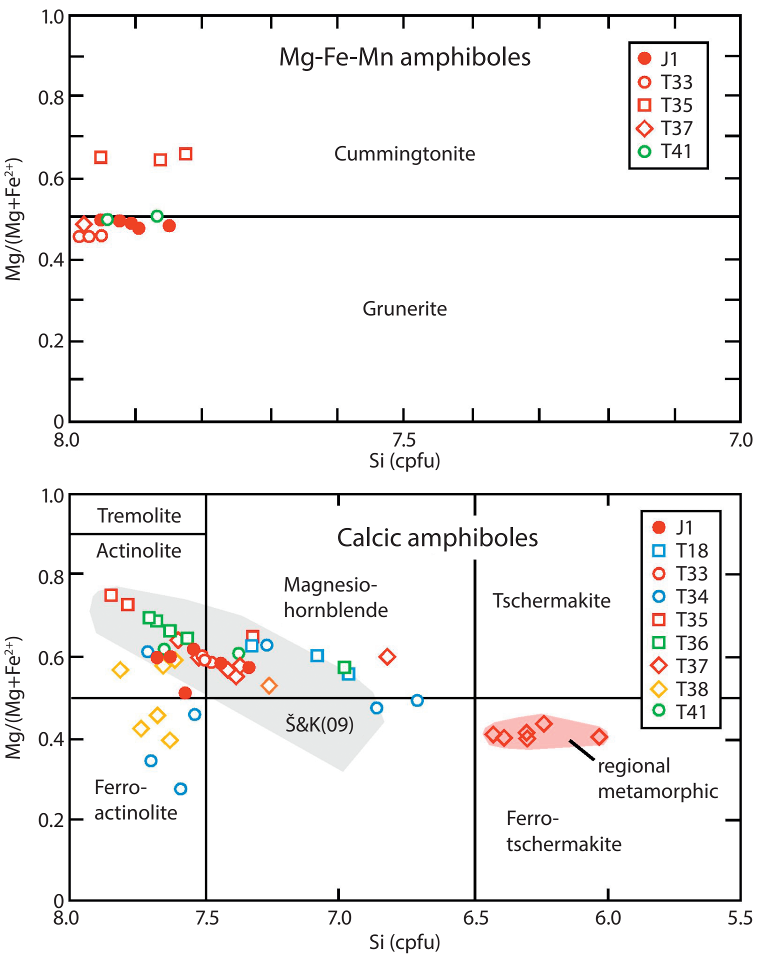
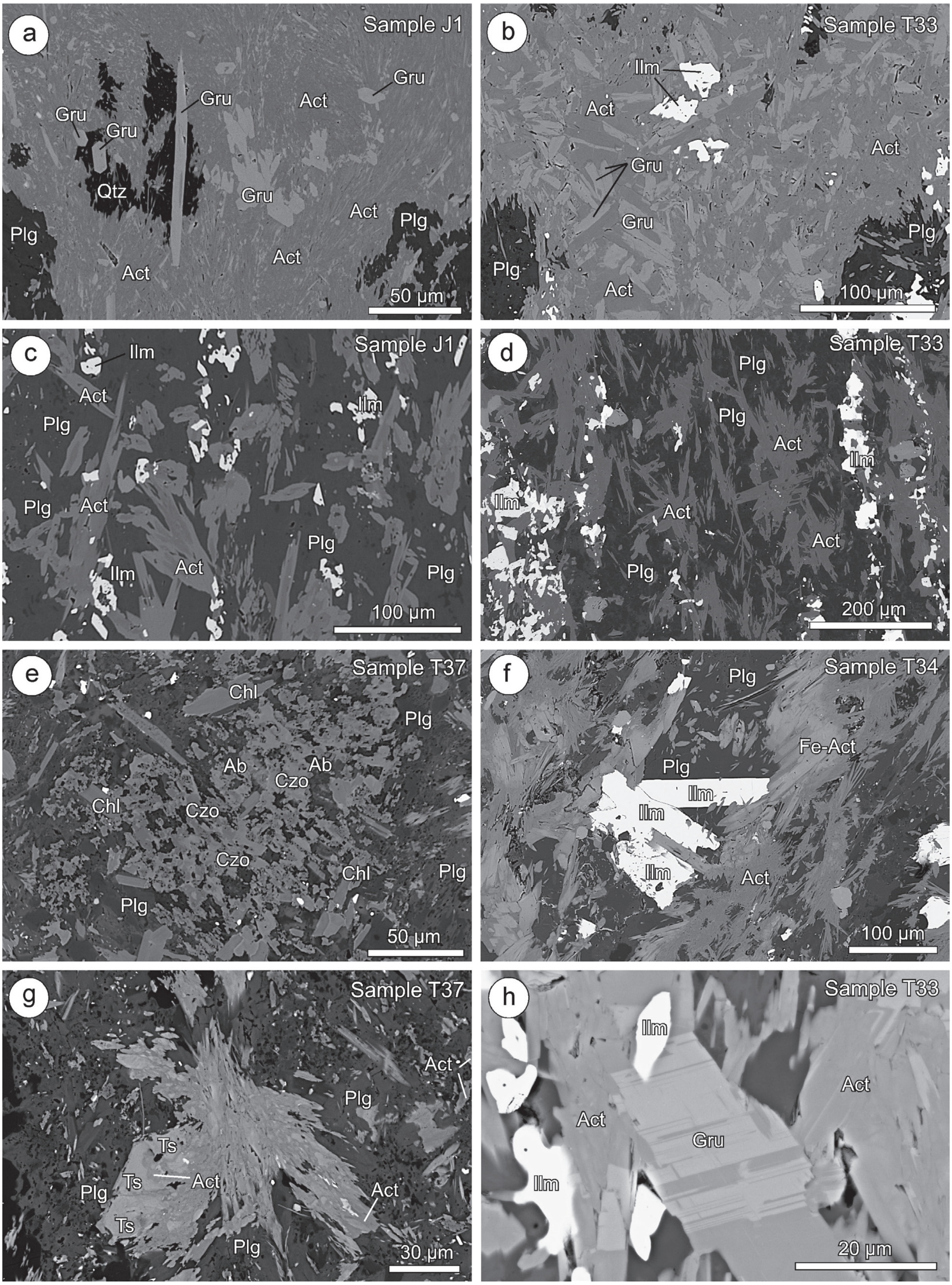


Fig. 9. Chemical compositions of different amphiboles in the investigated metabasites. Nomenclature of amphiboles is based on Leake et al. (1997). The gray field labeled Š&K(09) represents amphibole analyses given by Šída/Kachlík 2009.



grains are highly variable and can be used as a discriminatory characteristic (Table 1). It is the accidental orientation of the needle-like contact-metamorphic actinolites that accounts primarily for the toughness and endurance of the these metabasic rocks (Figs. 10c and 10d)

Fig. 10. BSE-images of some metabasic rocks. The samples from Jistebsko (J1) and Salenhof (T33, T34, T37) show details of the rock-forming minerals. Abbreviations used are those from Whitney/Evans (2010).

Fragments of fine-grained eclogitic rocks

Four peculiar rock fragments were found at Salenhof. The rare fragments have distinct blue-green colors and show single grains or patches of small reddish garnets (Fig. 11). Thin-sections from two smaller chips (T32, T39; Fig. 12) confirmed that the rocks are fine-grained eclogites. One side of the largest fragment is polished (Fig. 11a, left hand side) indicating that it is part of a broken Neolithic tool.

Main minerals of the fine-grained *eclogite T32* (Fig. 12) are small (<100 µm) euhedral garnet grains (~40 vol. %) and omphacite (~50 vol. %), accompanied by minor or accessory minerals such as zircon (Fig. 13a–b), rutile, apatite, allanite (Fig. 13c) and large poikiloblastic pyrite (~700 µm). A cathodoluminescene image of a zircon crystal shows a weak oscillation pattern (Fig. 13b). A careful inspection reveals that this grain is chemically zoned. The dark colored material at smaller sections of the rim represents a new zircon generation (Fig. 13b). *Eclogite T39* is rich in omphacite (~75 vol. %) but poor

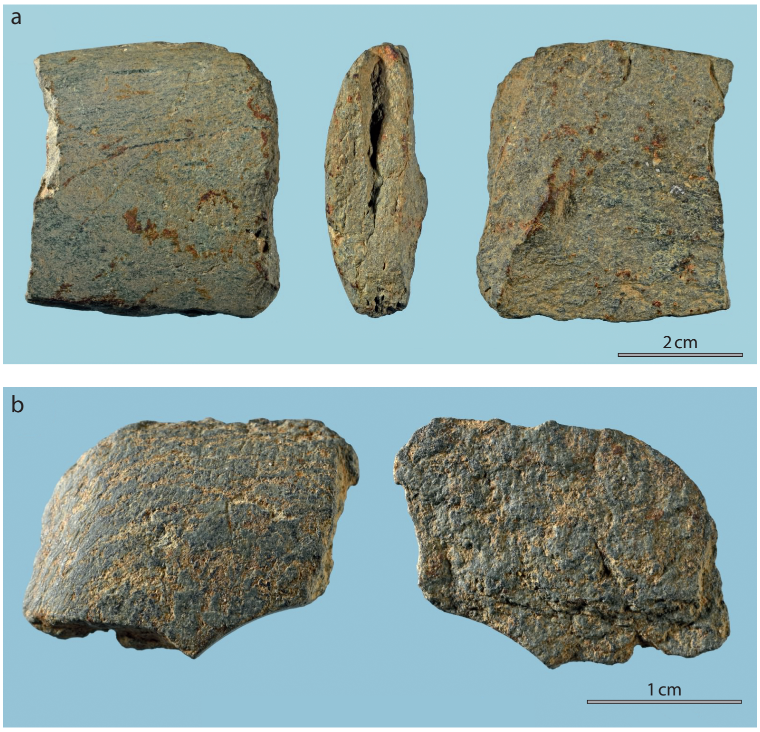


Fig. 11. Color-photographs from two fragments (a and b) of blue-green colored, fine-grained eclogites. The polished surfaces (left sides) document their derivation from glossed Neolithic stone implements.

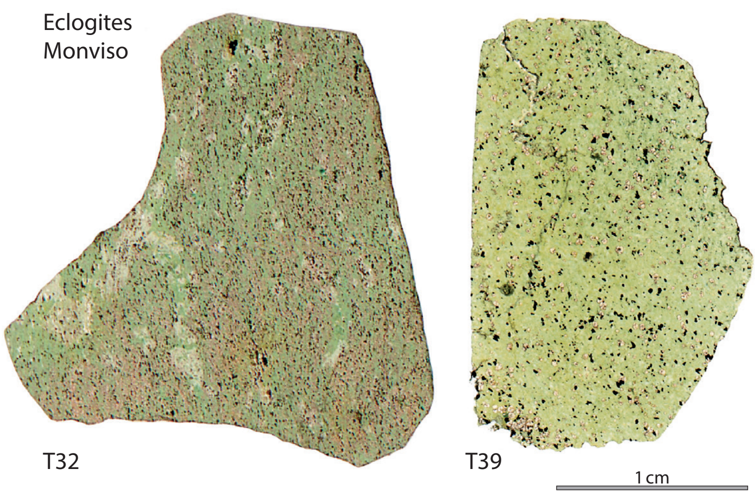


Fig. 12. Thin-sections of two fine-grained eclogites from Monviso. Garnets in sample T32 are agglomerated whereas those in T39 occur as isolated single grains.

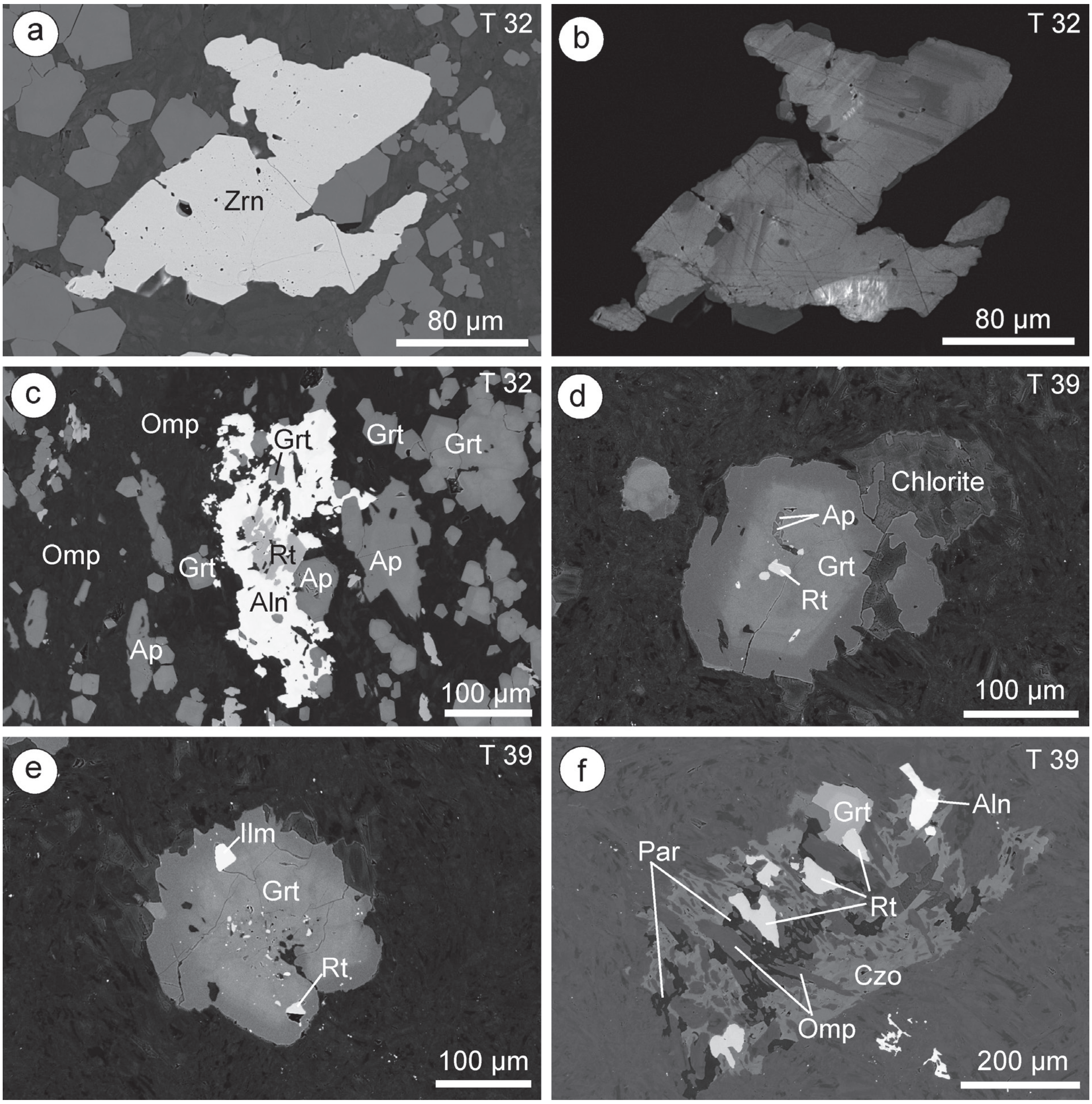


Fig. 13. BSE and CI images showing details of the eclogites T32 and T39. (a) Large zircon grain (T32) surrounded by a matrix of omphacite (dark) and garnet (gray). (b) CI image of the same zircon grain showing zoned interior (~160 Ma old) surrounded by a discontinuous uniformly dark rim (~50 Ma). (c) Large crystal of allanite (Aln) intergrown with garnet (Grt) and rutile (Rt) surrounded by a matrix of omphacite (black) and garnet (gray). Some apatite (Ap) grains can be seen. (d) and (e) Two garnet grains (T39) containing inclusions of Ap, Rt and ilmenite (Ilm) in their central portions (lighter gray). The rims of both garnet grains (darker gray) are more or less free of inclusions. (f) Pseudomorph after lawsonite consisting of paragonite (Par) and clinozoisite (Czo). Grt, Aln and Rt may be inclusions within the original lawsonite.

in garnet (~20 vol. %). Garnet grains (<400 µm) are homogenously scattered and may be marginally replaced by dark-green chlorite (Fig. 13d). Rutile grains (<200 µm) are evenly distributed within the rock. Further accessory phases are apatite and ilmenite. Many garnet grains contain inclusions of rutile, apatite and ilmenite (Fig. 13 d–e). A single pseudomorphic grain (probably after lawsonite) consists of clinozoisite and paragonite (Fig. 13f). Additional small crystals of omphacite, rutile, garnet and allanite most probably represent former inclusions.

Garnet grains of both eclogites show complex chemical zonations (Fig. 14a–d). Those from *sample T32* show core compositions of about $Ca_{0.64}Mg_{0.32}Fe^{2+}_{1.94}Mn_{0.10}Al_2Si_3O_{12}$ (Fig. 14c). Towards the rims, Ca decreases in an unregular manner, while Mg, Fe and Mn increase moderately until the approximate composition $Ca_{0.21}Mg_{0.45}Fe^{2+}_{2.12}Mn_{0.22}Al_2Si_3O_{12}$ (lowest Ca content) is reached. These points are marked in figure 14a with small greenish arrows and correspond to the black vertical lines at profile distances of about 23 and 53 µm (Fig. 14c). From these points towards the rims, Fe contents are approximately constant, while Ca contents increase significantly, and those of Mg and Mn decrease towards the black vertical lines at distances of about 13 and 53 µm in figure 14c (pink arrows in figure 14a). At these points, garnet compositions are very similar to those of the core. These points correspond to a drastic change in colour of the garnet rim in figure 14a. Towards the rim, Fe and Ca decrease, while Mn and Mg increase.

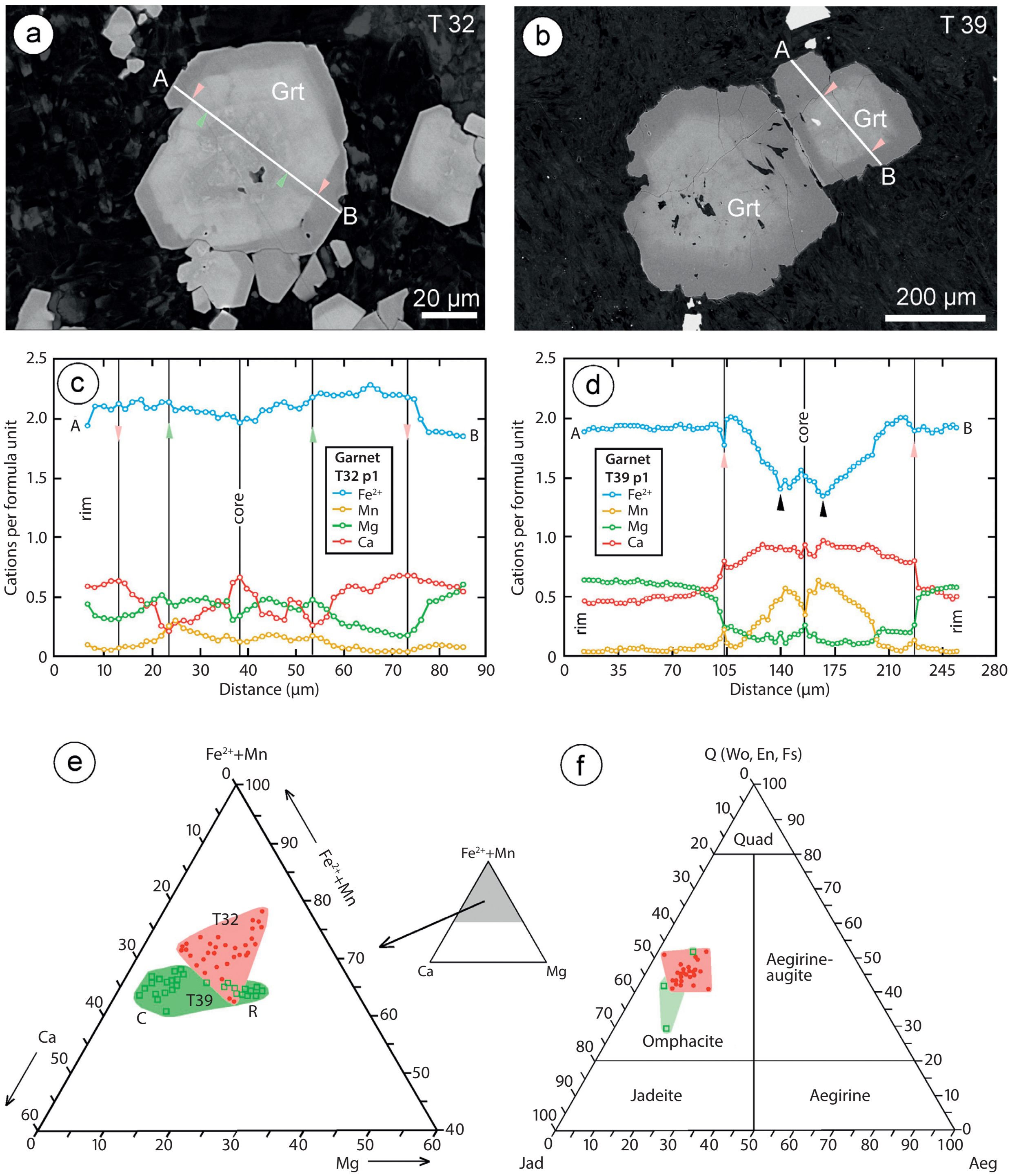


Fig. 14. Chemical compositions of garnet and omphacite grains in eclogites T32 and T39. (a) and (b) Position of chemical profiles across zoned garnet grains of samples T32 and T39, respectively. (c) and (d) Chemical compositions of garnet grains along profiles A–B. Concentrations of Fe^{2+}, Mg, Mn and Ca are given in cations per formula unit based on 12 oxygen ions. (e) Chemical compositions of garnet grains T32 and T39 in the cation triangle (Fe^{2+}+Mn)–Mg–Ca. (f) Compositions of omphacite grains from eclogite samples T32 (red) and T39 (green) in the clinopyroxene triangle with the chemical components Wo = $Ca_2Si_2O_6$, En = $Mg_2Si_2O_6$, Fs = $Fe_2Si_2O_6$, Jad = $NaAlSi_2O_6$ and Aeg = $NaFe^{3+}Si_2O_6$ (Morimoto et al. 1988, 1129, Fig. 6)

The zonation pattern of garnet from *sample T39* is somewhat different from that of garnet T32 (Figs. 14d and 14b, respectively). The cores are very rich in Mn and show the composition $Ca_{0.95}Mg_{0.14}Fe_{2+1.35}Mn_{0.56}Al_2Si_3O_{12}$. Towards the rims, there is a narrow zone in which Fe and Mg decrease, while Mn increases and Ca stays constant. Then there is a turning point (black arrows in Fig. 14d) where Fe and Mg start to increase, while Ca and Mn decrease. The outer rim, characterized by a change from light to dark in the BSE picture (pink arrows in Figs. 14b and 14d) shows more or less constant compositions. This zonation pattern corresponds more or less to a prograde zonation, i.e. a zonation that is due to garnet growth under rising temperature.

Garnet compositions of samples T32 and T39 are compared in Fig. 14e that shows the relative amounts of (Fe^{2+}+Mn), Mg, and Ca. Garnet grains of T39 show cores (C) that are richer in Ca than their rims (R). Garnets of T32 are somewhat richer in (Fe^{2+}+Mn). These differences are due to different chemical compositions of the eclogites and/or slightly different metamorphic evolutions. The omphacite grains in the eclogites T32 and T39 are chemically nearly identical (Fig. 14f). According to the nomenclature diagram for clinopyroxenes (Morimoto et al. 1988), omphacites of both samples are nearly similar. The zircon crystal in T32 (Fig. 13a-b) shows a weak oscillatory zoning in the anhedral core and a discontinuous rim zone with dark CL brightness (Fig. 13b). Such a zonation suggests that the zircon crystal grew during two periods.

All petrographic characteristics of the eclogitic material from Salenhof suggest a derivation of these rocks from the Western Alps. We will discuss this assumption later.

Chunks of intergrown hematite and quartz

The Middle Neolithic farmers used single chunks of hematite ore for creation of red pigmented powder. Pulverized pigments in the Neolithic are raw materials for body painting, leather clothes, sun protection (L. Owen, pers. comm.) or served as grave goods (Spatz 1999, 165). Nineteen variably sized pieces with bright, steel-gray colors or dull, reddish staining (Fig. 15a–b) have been secured at the Salenhof site. The mass of single lumps ranges from 2 to 45 g. Most pieces show roughly broken planes and contain some polished abrasion planes (Fig. 15a). One single piece with a nearly faceted surface represents an exception (Fig. 15b). Larger milky quartz inclusions in few fragments are clearly visible with naked eyes (Fig. 15a) and reveal that the used iron ores at Salenhof are predominantly chunks of intergrown hematite and quartz. Fifteen specimens (~80 %) of the hematite-quartz boulders belong to this type of siliceous iron ore. Two thin-sections from these materials are shown in figure 16.

Inspection at higher magnification (BSE images) reveals that the chromophoric component consists of small laminated hematite crystals with sizes up to 50 µm (Fig. 17a–b). Massive hematite spheres in a matrix of silica are composed of small flaky intergrowths with sizes of ~10 µm (Fig. 17b). In places, spherical shells of precipitated hematite or silica occur (Fig. 17c–d). These roundish structures are typical for the red iron ores and are caused by early gel formations. Similar fabrics are well-known from volcano-sedimentary iron ore deposits of the Lahn-Dill type (Lippert 1952, 267; Ramdohr 1960, 890; Bottke 1963, 439; Quade 1976). Rare mineral inclusions of Fe-chlorite (Fig. 17e–f) could be identified in sample T 17 of the siliceous iron ores. Similarly, the formation of chamosite was described from Fe-rich deposits of Middle Devonian volcanics of the Lahn-Dill region (Harder 1954, 59).

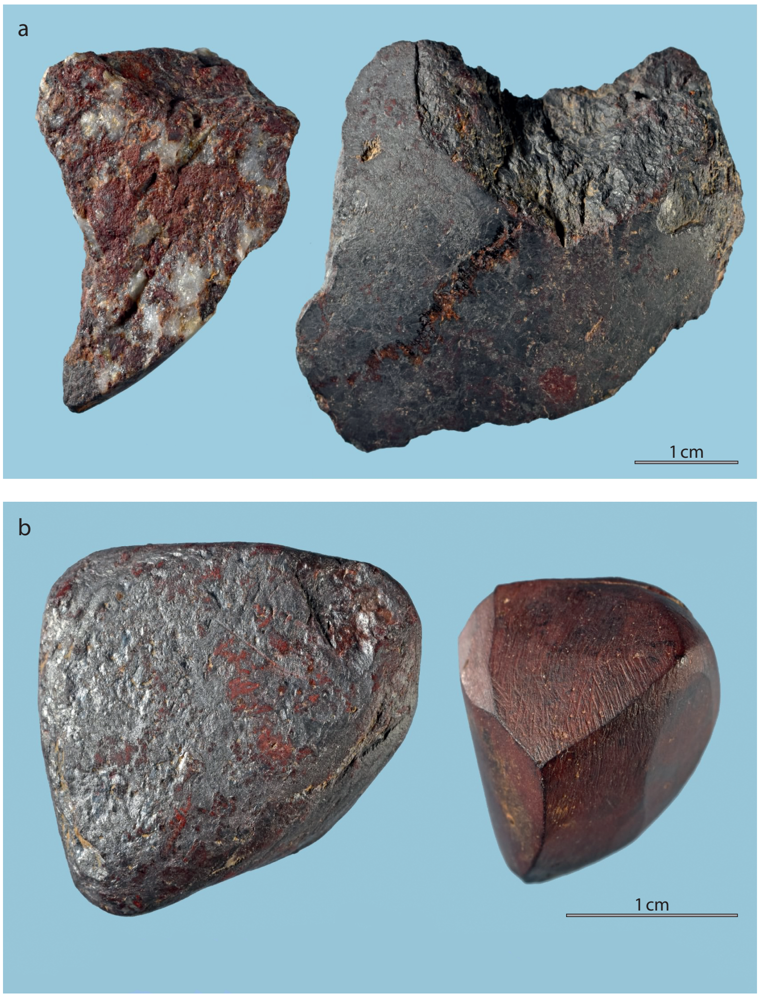


Fig. 15. (a) and (b) Photographs of abraded red hematite chunks with bright steel-gray to red brown colors. The pieces are mostly smashed and iregular breaked. The silica component is highly variable. A completely faceted piece is shown in b.

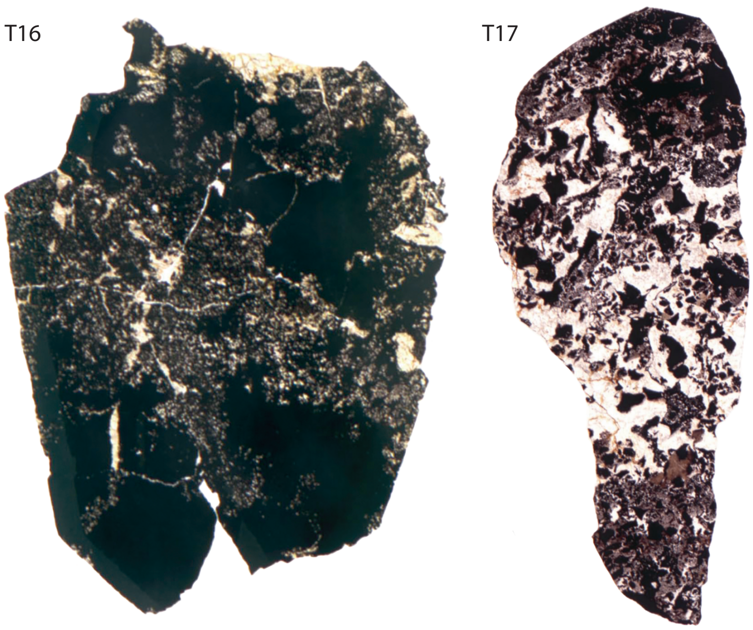


Fig. 16. Two thin-sections of siliceous red iron ores (T16, T17).

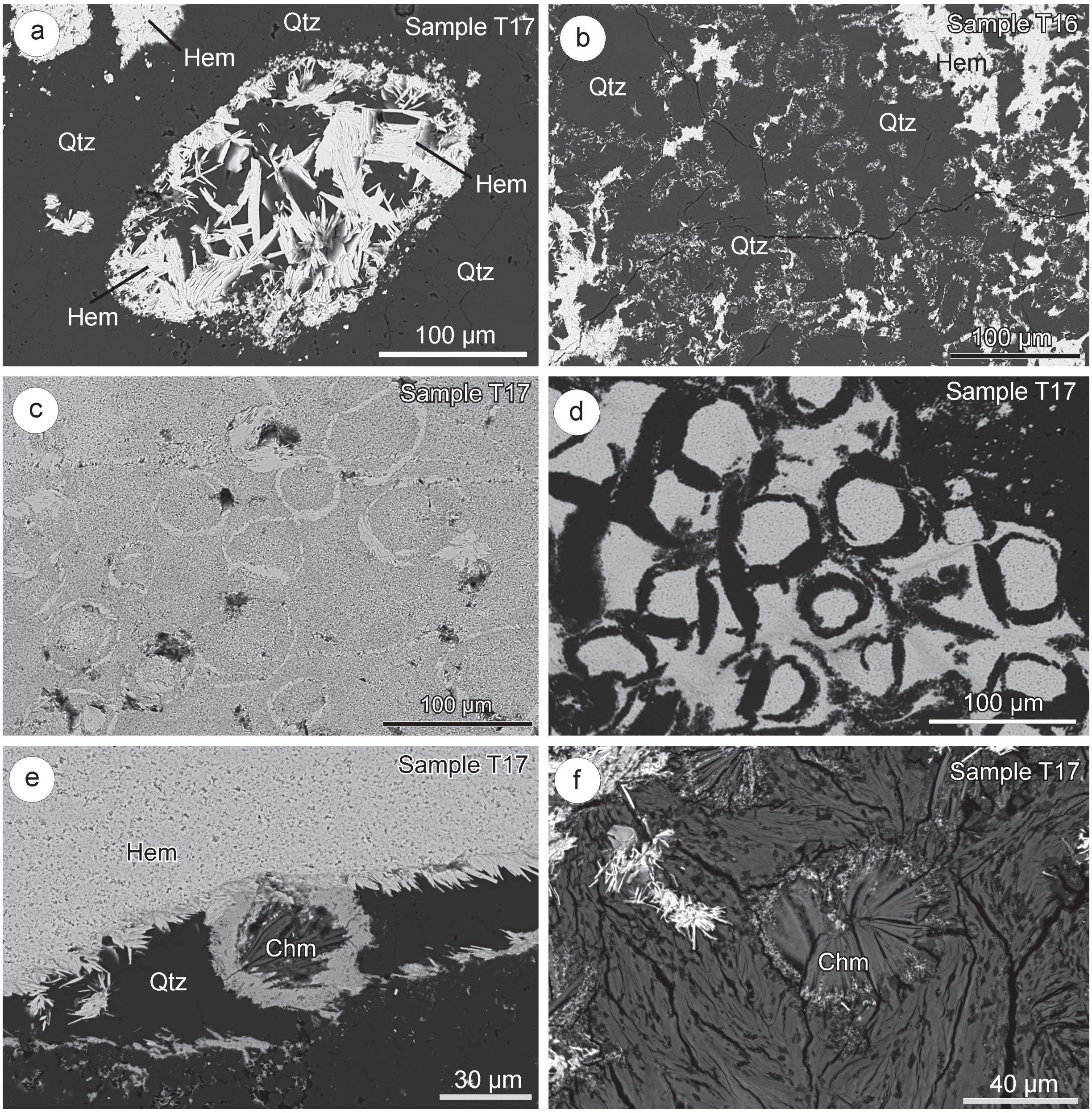


Fig. 17. (a) and (b) BSE images of siliceous red iron ores. Bright hematite crystals with dark colored SiO_2 material in between characterize the reddish coloured stones. (c) and (d) Former gel structures produced rocks with roundish textures of hematite (light) and SiO_2 (dark). Crystallization sequence is different. (e) and (f) Aggregates of flaky crystals of chamosite (Chm) (= Fe-chlorite) are relatively abundant.

Discussion

The transition from the Early to Middle Neolithic was accompanied by profound changes in rural economics, pottery decoration, burial ceremonies, exchange and raw material supplies (Meier-Arendt 1975; Zimmermann 1995; Eisenhauer 1999; Spatz 2003; Zeeb-Lanz 2009; Scharl 2010). The postulated crisis at that time was probably mainly caused by climate fluctuations and/or changes in religious and burial traditions (Spatz 2003, 582; Gronenborn 2010, 70).

The Salenhof settlement contains fragmentary pottery of the whole chronological sequence Hinkelstein (HST), Großgartach (GG), Rössen (RÖ) (Spatz 1994, 11). The Middle Neolithic at Salenhof begins with HST II, which is identical with contemporaneous settlements at the northern Filder province (Strien 2000, 54, Tab. 2.3) and ends with the Early to Middle Rössen Culture.

In the Neolithic, the acquisition of goods from distant areas indicate some kind of trade or an exchange system (Willms 1985, 331; Zimmermann 1995, 89; Eisenhauer 1999, 21; Strien 2000, 36; Scharl 2015, 382; Rind 2018). However, the exact time at which provable trade was organized by traveling tradespeople in the past is an old and open question (Jahn 1956, 33ff). The provenance of foreign materials gives some clues about human relations and directions of communication. So, petrogaphical fingerprints from imported crystalline rock or silex materials can help to identify the remote places of their origin.

The change from Early to Middle Neolithic was accompanied by the transition of imported Rijckholt flint to silex material from Abensberg-Arnhofen (Zimmermann 1995, 130; Eisenhauer 1999, 216; Scharl 2015, 379). Artefacts of tabular chert from Arnhofen (Fig. 6f) have a high fraction of 4.3% in the siliceous find spectrum at Salenhof (Fig. 4). In contrast to the early LBK phase, the high proportion of arrowheads (5.4%) and silex borers (40.9%) at Salenhof (Fig. 4) is typical for the Middle Neolithic of SW Germany. It can be deduced that farming activities were changed to enhanced hunting activities and additional stock farming (Sielmann 1971, 66).

Half of the arrowheads at Salenhof are broken which indicates intense usage or later damage by plowing. The projectiles are extremely variable in shape, size, mode of retouch and derivation of material. Similarly to ornamented pottery, the polymorphic arrowheads at Salenhof can be used for temporal or cultural classifications. The severe change of the projectile types can be explained with short-lived cultural conversions during the Middle Neolithic. This may be underlined with the idea that during the Neolithic arrowheads form media for personel identity and communication (Zeeb-Lanz 2003, 250) .

A significant part of the described projectiles consist of imports. Three transverse arrowheads (*Querschneider*) occur in the Salenhof silex inventory (Fig. 6a). These rare arrowheads in the Middle Neolithic are limited to the HST phase and came from Lengfeld in the Kehlheim region near Regensburg (Zimmermann 1995, 16, Spatz 2002, 296). The exclusive usage of this form at that time attests close relations to populations of the Stroke Ornamented Pottery Culture (SBK) in Bavaria (Meier-Arendt 1975, 158; Spatz 2003, 582).

Rössen is the first Central European Neolithic Culture that uses bifacially retouched arrowheads (Sangmeister 1960, 203) and this kind of retouch was totally new (Meier-Arendt 1974, 12). The geographical distribution of arrowheads suggests a derivation from western Europe and can be traced back to North African traditions (Sangmeister 1960, 203; Sangmeister 1979, 45). From this situation a more westerly orientation during the RÖ Culture at the late stage of the Middle Neolithic period may be assumed. Four semi-transparent, bifacially retouched arrowheads (Fig. 6d) made of Cretaceous flint from the Maastricht region and/or the Paris Basin (A. Zimmermann/H.-Ch. Strien 2017, pers. comm.) underline this view. It is very likely that the yellow arrowhead in figure 6d consists of material from Le Grand-Pressigny.

It was generally thought that tanged arrowheads (*Stielpfeilspitzen*) first occur at Young Neolithic times (Schön 2012, 812) preferentially at Late or Endneolithic (Raetzel-Fabian 1988, 41, Fig. 60; Pfeifer 2011, 339; Strien 2000, 8). However, there are strong arguments that the large, ~5 cm long projectile from Salenhof (Fig. 6e) is contemporaneous: (i) The material of both arrowheads in Fig. 6e is identical; (ii) It is known that many larger tanged arrowheads were found at places in SW Germany where RÖ remains are ascertained (e.g. Fundberichte aus Baden-Würrttemberg, vol. 2); (iii) In the middle of the past century, it was mentioned that the RÖ Culture in southwest Germany used such tanged arrowheads (Paret 1961, 79). Furthermore, the large tanged arrowhead is characterized by *Liesegang* rings (Fig. 6e). Such material is known from siliceous pebbles within bean ore deposits at Auggen/Schliengen (*Markgräflerland*). It is supposed that the unusual circular structure in siliceous nodules at Auggen was produced by Fe-rich fluctuating thermal waters during the late evolution of the Rhine Graben.

The production of jewelry had become a significant economic factor in the Middle Neolithic. Although no beads were found in the lime-free loess at the surface on the Salenhof site, large quantities of *Dickenbännli* borers (at least 30–35 % of the silex tools) give strong evidence for local pearls' production, first of all from bone and limestone. Limestone beads are well-known for their favourable preservation conditions at the Hegau countryside (Dieckmann 1987b, 28; Dieckmann et al. 1998, 45) and from grave goods (Dehn 1975, 27; Spatz 1999, 142). The conspicuous preference for individual decoration with limestone disks or tube beads at that time lasted for about 1000 years in SW Germany, from HST to the Hornstaad group at Lake Constance (Dieckmann 1987a, 27; Hoffstadt 2005, 104–110; Hoffstadt 2012, 897; Schlichtherle 1990, 107–119). Furthermore, jewelry with perforated animal teeth, snails, shells and deer canines (*Hirschgrandel*) is also known from HST and GG graves (Spatz 1996, 11; Heumüller 2009, 207–214) for which the application of silex borers is necessary.

The stone material of most of the fine-grained polished adze blades and hammer-axes at Salenhof came from amphibolites close to Jistebsko in northern Bohemia. The extraordinary hardness and rigidity of these mafic metamorphic rocks depends first of all on the post-deformational growth of amphibole needles across the rock's schistosity. This recrystallisation of the earlier regional metamorphic rock was due to a later contact metamorphism by the intrusion of the Tanvald granite (e.g. Klomínský et al. 2004; Šída & Kachlik 2009). The fine-grained amphibolitic rocks are the dominant rock-type in find assemblages of polished adzes in the Early to Middle Neolithic era in Central Europe (Schwarz-Mackensen/Schneider 2012, 880). However, the source of the so-called AHS schists remained unidentified for a long time. The reason for this may be that such fine-grained metabasic rocks with their special double metamorphism are extrememly rare in the European metamorphic belts.

We investigated eight fragments from Salenhof and all of them turned out to be polymetamorphic amphibolites whereby the first dynamic metamorphism produced a rock foliation that was later overprinted by the growth of amphibole in all directions (contact metamorphism). Mineralogically all these rocks are nearly similar to an original sample from Jistebsko (J1).

From eight fragments of the fine-grained metabasic rocks (Table 1, Fig. 8) one piece (T33) is nearly identical with an original sample from Jistebsko (J1). The rock fabric, coexistence of grunerite and tschermakite, the Ca-rich plagioclase ($Na_{0.5}Ca_{0.5}Al_{1.5}Si_{2.5}O_8$–$Na_{0.3}Ca_{0.7}Al_{1.7}Si_{2.3}O_8$) and MnO contents of ilmenite are almost identical (Table 1). However, the other samples differ more or less in fabric and chemical composition of rock-forming minerals compared to J1 (Table 1). This may be explained by different distances of the finding places from the contact of the Tanvald granite. Since the temperature values reached during contact metamorphism depend on the distance to the inrusive contact, amphibolites within the contact aureole may look fairly different, even when produced from the same protolith. Indeed, there exist further excavation sites along the contact metamorpic belt of the Tanvald granite (Šída/Kachlík 2009, 271; Ramminger/Šída 2012, 168) and it is well possible that there is some variation in the rocks' mineralogical and chemical compositions. It appears probable that semi-finished pieces of AHS schists were transported from Northern Bohemia along the Flint route (Binsteiner 2000) and along the upper Danube to reach the Salenhof on this way.

The rare, fine-grained garnet-omphacite-rutile-bearing rock fragments T32 and T39 at the Salenhof site are Alpine eclogitic rocks. Four peculiar bluish-green colored rock fragments at the Salenhof site come from the region of Monviso in the Western Alps. The largest fragment (~60 g) documenting the piece of a broken adze/ax is polished at one side (Fig. 11a). With a polarizing petrographic microscope the texture of the fine-grained garnet and omphacite-rich rocks can be studied efficiently. Moreover, their mineral parageneses and the chemical zonation patterns of their garnets reveal their provenance. The existence of accessory apatite, allanite, zircon and pyrite in sample T32 and rare pseudomorphs after lawsonite in T39 are diagnostic minerals that were described from eclogites from the Monviso region of the Western Alps (Angiboust et al. 2014, 889). Moreover, the zonation pattern of garnet in sample T39 (Fig. 14b and 14d) is nearly identical with that of a garnet profile from a mylonitic eclogite (sample ISZ-17) in the Monviso area (Angiboust et al. 2014, 897). The zonation of the zircon crystal in T32 (Fig. 13a–b) is similar to zoned zircon crystals from Monviso. Based on previous results from zircon dating of eclogitic metagabbroic rocks from Monviso we have concluded that the inclusion-free zircon core (Fig. 13a) is a magmatic relic from the Jurassic oceanic protolith (163 ± 2 Ma) whereas the dark colored exterior Cl rims (Fig. 13b) are newly metasomatic formations grown at the peak of Alpine subduction around 45 Ma ago (Rubatto/Hermann 2003, Rubatto et al. 2015).

Many eclogitic implements in the Early to Middle Neolithic in northern Italy come from HP-metaophiolites of the Western Alps. They are often composed of eclogites with zoned and inclusion-rich garnets, fine-grained omphacites and sporadic zircon or apatite (D'Amico et al. 1995, 33, D'Amico et al. 2003, 22). The Neolithic polished axes at northern Italy are substantially identical with the garnetiferous material at Salenhof. The provenance of most fine-grained eclogitic implements from the Monviso in the Western Alps and the more southern Beigua region is generally accepted. Artifically exploited boulders at the south-eastern foot of the Monte Viso were discovered in 2003 and the peak of the ^{14}C dated Montviso quarries is around 5000 BC (Petrequin et al. 2006, 19; Forno et al. 2015).

The imported eclogitic material from Monviso is present at Salenhof since RÖ times. It was used as a functional tool for wood processing. However, in younger Neolithic times the West-Alpine high-pressure metamorphic material (eclogite, jadeitite) was principally used for the creation of jadeite-rich large dimensioned ceremonial axes ('Prunkbeile') that were occasionally found in central parts of Germany (Jacobs/Löhr 2003, 157).

Chunks of metallic sparkling hematite ores (Fig. 15a–b) were imported to Salenhof from Devonian marine volcanic-sedimentary deposits of the Lahn-Dill region. Roundish gel particles composed of hematite or quartz (Fig. 17c–d) and sometimes also flakes of Fe-chlorite (chamosite) (Fig. 17e–f) are evidence for their provenance from iron ore deposits of the Lahn-Dill type. Reddish pigment from this material was used in Early Neolithic settlements (e.g. Langweiler 8) on the Aldenhofer plate (Horsch/Keesmann 1982). In male graves of the GG Group at Trebur, abraded hematite nodules are characteristic grave goods underlining humans' polarity (Spatz 1996, 10).

The imported lithic material found at Salenhof came from eight different places scattered all over Central Europe (Fig. 18). The distances of these remote places of origin to the Salenhof archaeological site amount up to 550 km. Due to their hardness and stabilitiy, stone adzes of fine-grained foreign materials formed highly desired goods. However, chert material from Abensberg, for instance, was generally appreciated although enough local material of high quality existed. An economic or symbolic meaning therefore can be suspected (Scharl 2015). Beyond that, actual goods for an exchange in former times like jewelry, skins or agricultural products remain unexplained.

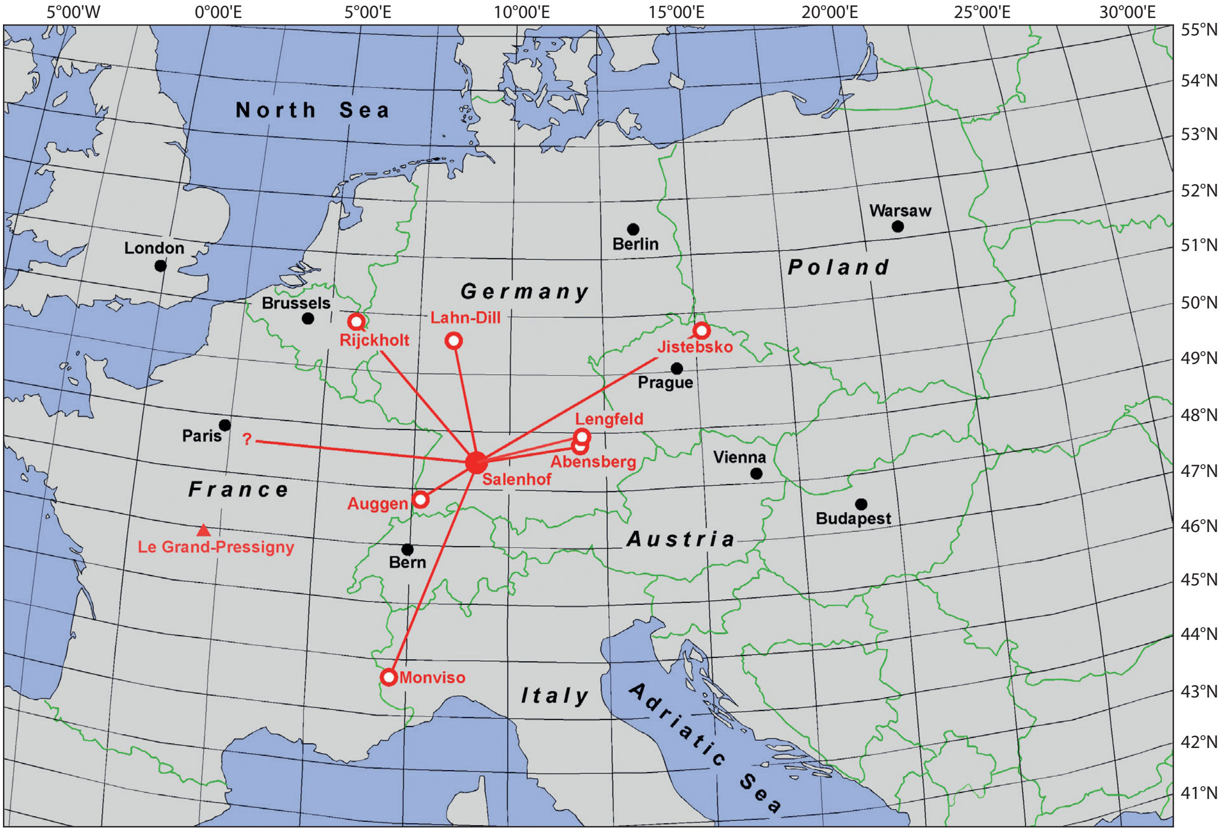


Fig. 18. Map of Central Europe with sources of lithic artefacts found at the Middle Neolithic Salenhof settlement. Exchanged goods came from various remote places in Central Europe. The yellow colored arrowhead prepared of Cretaceous flint material (Fig. 6d) originated possibly in the region of Le Grand-Pressigny.

Conclusions

The Middle Neolithic Salenhof site near Trillfingen is a multi-cultural settlement on top of the water-poor Gäu Plateau like similar settlements at Eckenweiler (*Konlesäcker*) and Nellingsheim (*Sechzig Morgen*) (Bofinger 2005, 180). However, at Salenhof a lot of lithic artefacts may be hidden to date in waste pits underneath the plow horizon.

The most striking feature of the siliceous residue at Salenhof is the abundance of silex borers (40.9 %) and arrowheads (5.4 %). Finely prepared *Dickenbännli* borers indicate an extensive preparation of jewelry which is a characteristic phenomenon during the Middle Neolithic and the beginning of the Younger Neolithic. The HST graves at Trebur, for example, show an individual preference for jewelry at that time (Spatz 1999, 142). Typical *Dickenbännli* borers were described earlier from the GG artefacts of the neighboring Middle Neolithic site of Nellingsheim (Reinerth 1926, 207; Hoffstadt 2005, 107).

The arrowheads from Salenhof can be assigned in many cases to HST, GG and RÖ. Four semi-transparent triangular projectiles are prepared from Cretaceous flint and came from Rijckjolt (Maastricht) and the Paris basin. A similar observation was made by Strien (2000, 35) who ascertained five different types of Cretaceous flint at a Planig-Friedberg settlement in the northern Filder region. A single larger projectile in form of a tanged arrowhead (*Stielpfeilspitze*) indicates an early usage of this type of large arrowhead already at the end of the Middle Neolithic in SW Germany. According to its mineral data one fine-grained AHS schist (T33) at the Salenhof is virtually identical to a metabasite (J1) from Jistebsko (Northern Bohemia). Some polished eclogitic fragments from the Western Alps document early transalpine connections at the Middle Neolithic, probably at RÖ times.

The imported "exotic" artefacts at the multiphase Salenhof settlement show that from the beginning, during the HST phase, substantial exchange and communication was primarily adjusted to members of the Stroke-Ornamented Pottery Culture (SBK) in the East. It was at the beginning of the RÖ period when the exchange of goods arrived at Salenhof from western and southern directions. An increase of imported lithic material during the Middle Neoltihic starting at around 4900 B.C. (Gronenborn 2014, 43) has been observed (Zimmermann 1995, 21; Eisenhauer 1999, 216; Strien 2000, 35; Bofinger 2005, 232). The beginning of an extensive exchange system during the Middle Neolithic period into all directions of Central Europe is reminiscence of the modern European flow of goods. Although the desired objects in Early Neolithic or earlier times came from remote regions (e.g. Spondylus from the Aegean Sea), a broadly fanned, long-distance exchange system in the past did not exist before Rössen, about 6700 years before today.

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