PROVENANCE STUDIES ON TROJAN LATE BRONZE AGE FINE WARES FROM TROY AND ITS NEIGHBOURHOOD USING NEUTRON ACTIVATION ANALYSIS (INAA)

Schubert, C. – Pernicka, E.

Curt – Engelhorn – Zentrum für Archäometrie gGmbH Mannheim (CEZA), An-Institut der Univeristät Tübingen
cornelia.schubert@cez-archaeometrie.de, Ernst.Pernicka@cez-archaeometrie.de

Abstract: *Anatolian Grey Ware (AGW) and Tan Ware (TW) are the characteristic fine wares of LBA Troy (**Fig. 1**). But they are common not only at Troy itself but also on several sites in the Troad (Aslan & Bieg 2003) and in the case of AGW also in the Eastern Mediterranean (Allen 1991, Mommsen & Pavúk 2007). In this work the spotlight lies on samples from Troy and from several sites in the Troad collected in surveys (**Fig. 4**). Likewise the question of the imported pottery from Troy VI (Early and Middle) is also investigated. Some of the wares turn out to be indeed imports, originating both from Samothrace, some other unidentified littoral island and the coastal stripe of the Troad (**Fig. 2**). More than 200 samples were analysed so far by means of NAA and the results allow for a preliminary report represented here.*

Keywords: *pottery analysis, Troy, NAA, Anatolian Grey Ware (AGW), Tan Ware (TW)*

INTRODUCTION

At Troy the AGW appears first at the end of the MBA, at the beginning of Troy VI Early (ca. 1750 - 1600 BC) with new shapes that possess strong similarities to Aegean shapes of the stage of the Middle Helladic III on the Greek mainland (a chronological table is given in **Fig. 3**). At this time the quantity of the Grey Ware in the spectrum of Trojan fine ceramics amounts to only 10%, it is, however, very important for chronological classification. In the course of TroyVI Early these Aegean shapes disappear slowly and Anatolian characteristics in the pottery increase (*Pavúk 2007*). In this early phase the surface of the AGW contains a lot of mica, which gives it a shining coat, so that a comparison to metal containers forces itself upon the researcher. Due to the mica it is called "micaceous Anatolian Grey Ware" or "early Anatolian Grey Ware" (AGW I). In TroyVI Middle (ca. 1600 - 1420 BC) a new, light-brown, beige pottery called Tan Ware appears for the first time and nearly simultaneously pottery painted in Mycenaean style also appear (*Mountjoy 2006*). Later on in Troy VI Late (ca. 1420 – 1300 BC), imitations of Mycenaean shapes also appear in local fine wares (in AGW II = "classic" Anatolian Grey Ware and TW). In Troy VIIa (ca. 1300 - 1180 BC) Tan Ware reaches its climax together with the newly introduced "brown burnished Ware" (W721). The latter has the same characteristics as Tan Ware but is additionally covered with a thin brown slip. For a long time Tan Ware was regarded as the counterpart to Anatolian Grey Ware just fired in oxidizing conditions (*Pavúk & Rigter 2006*).

This was confirmed in 2006 by the analysis of 45 samples of AGW I, AGW II, TW and W721 from Troy. These samples constituted the basis for further investigation. Further samples both from Troy and other surrounding sites in the Troad were taken in the summer of 2006.

In addition samples of pottery, presumably imported from the littoral islands close to Troy, were also taken. Especially the latter samples should contribute to a better understanding of the contacts between Troy and the nearby islands. First results are shown in **Fig. 5**.

The results of the analysis were compared with some previously published analyses run on Trojan pottery by *Knacke Loy (1994)* and by *Mommsen et al. (2001 and 2006)* (**Fig. 6**). The data was compared using multivariate statistics and is represented in a dendrogramm and by a discriminant plot.

METHOD

After cleaning of the surface of a given sample, a subsample was taken and powdered by an agate mortar.

Fig. 1 Late Bronze Age Anatolian Grey Ware and Tan Ware from Troy © Troia Projekt

Table 1 Averages M in ppm, if not indicated otherwise, spreads σ in percent of M. Due to forthcoming analysis, a change within the groups is possible (State: September 2007).

	Group1A (54 samples)		Group 1B (71 samples)		Group 1C (14 samples)		Group 2 (6 samples)		Group 3 (3 samples)	
	M	σ %	M	σ %	M	σ %	M	σ %	M	σ %
As	31.77	38.87	29.86	87.33	17.54	63.99	24.99	69.12	24.08	34.00
Ba	642.71	53.57	573.21	53.10	521.78	36.72	985.59	103.56	755.00	29.92
Ce	106.18	58.63	79.60	54.78	59.55	12.21	68.12	61.11	102.97	43.20
Co	25.39	10.77	21.05	22.80	25.55	9.60	26.96	44.37	27.61	24.63
Cr	220.43	16.95	209.74	32.69	239.80	9.11	388.80	50.74	237.49	19.93
Cs	11.57	19.84	8.76	29.49	10.43	30.13	7.82	39.07	13.82	41.53
Eu	1.58	6.18	1.27	7.91	1.36	5.69	1.06	16.30	1.57	16.25
Fe%	4.65	6.84	4.15	9.76	5.27	8.04	3.75	17.23	5.22	12.43
Hf	5.32	9.52	4.29	13.94	4.14	9.47	3.95	3.58	5.31	11.42
K%	2.65	15.31	2.62	20.20	2.45	11.55	2.41	33.96	2.70	14.49
La	41.39	7.88	31.34	9.96	30.68	5.79	25.87	1.86	40.59	19.14
Lu	0.40	12.86	0.35	12.98	0.38	8.01	0.29	8.79	0.58	9.44
Na%	1.09	20.98	0.94	24.18	1.10	20.63	1.14	51.15	1.18	10.83
Nd	39.13	26.03	33.04	32.52	30.15	15.30	28.07	37.96	41.33	34.81
Ni	116.44	51.73	86.67	47.44	161.79	41.31	154.70	56.24	110.72	46.75
Rb	114.76	11.05	106.46	14.01	118.13	12.65	84.63	39.14	121.05	20.11
Sb	2.29	31.59	1.26	28.71	0.82	24.86	1.02	10.84	1.34	62.92
Sc	18.25	8.34	16.85	8.84	22.53	8.38	15.15	7.25	22.56	11.36
Sm	6.92	8.10	5.48	7.69	5.81	5.42	4.50	9.76	7.57	17.30
Ta	1.29	14.45	1.03	9.73	1.04	8.82	0.93	8.07	1.19	9.19
Tb	0.95	7.94	0.71	13.45	0.70	15.23	0.57	8.95	1.58	78.43
Th	19.65	14.39	13.20	13.08	11.37	6.07	9.70	12.60	16.87	20.31
U	4.24	18.91	3.29	16.51	2.69	9.41	2.52	15.95	5.99	77.21
Yb	2.81	8.85	2.34	8.95	2.75	6.14	1.98	10.55	3.20	14.98
Zn	91.98	10.44	82.54	12.22	106.31	12.23	68.36	18.76	89.80	1.64
Zr	289.93	100.91	270.07	113.13	183.86	94.28	202.78	100.96	139.00	18.24

The powdered samples were packed first into PET cups (~ 150 mg) and then packed together with a standard (TONY HD4)[1] in a PET tube for four rows with two samples and one standard in a row. The irradiation has been made at the TRIGA reactor at the Institute for nuclear Chemistry at the Gutenberg University of Mainz. The samples are irradiated by a neutron flux of $1*10^{12}$ n/cm^2*s for 12 hours.

After the irradiation the samples and standards were counted twice. The first count took place after a cooling period of six days for the radionuclides of Na, K, As, Sb, Ba, La, Sm, Yb, Lu and U. The second count was done after another cooling period of about 28 – 30 days for the radionuclides of Sc, Cr, Fe, Co, Ni, Zn, Rb, Zr, Sb, Cs, Ba, Ce, Nd, Tb, Hf, Ta and Th (*Kuleff 1996, Schifer 2003*). The measurement of the samples and standards was done by one of three ORTEC HPGe – Gamma – detectors at the CEZA in Mannheim.

For the examination of the obtained results multivariate statistics were used. The statistical treatment happened with the STATGRAPHICS XV.I software.

RESULTS

The chemical groups, which were formed using the cluster analysis (average linkage, squared euclidean distance), were checked also by discriminant analysis, as shown in **Figure 5**. The 202 analysed samples form eight chemical groups and four singles. These four singles could not be assigned to any of the groups.

Group 1 is divided by the dendrogramm into three subgroups (1A – C). The group 1A comprises most of the AGW I samples, group 1B almost all of the Late Bronze Age fine-ware samples of AGW II, Tan Ware and W721 collected from Troy, and in group 1C are particularly samples from vessels, which are thought to be imported

Table 2 Averages M in ppm, if not indicated otherwise, spreads σ in percent of M. Due to forthcoming analysis, a change within the groups is possible (State: September 2007).

	Group 4 (16 samples)		Group 5 (16 samples)		Group 6 (14 samples)		Group 7 (2 samples)		Group 8 (2 samples)	
	M	σ %	M	σ %	M	σ %	M	σ %	M	σ %
As	43.78	74.84	24.42	90.99	35.23	72.29	22.84	9.04	25.91	28.96
Ba	911.32	41.69	789.88	60.29	1164.65	59.87	654.02	36.95	1371.00	43.53
Ce	104.80	9.99	148.29	28.42	119.05	31.19	58.66	16.72	188.05	6.35
Co	29.18	21.14	20.83	10.22	19.16	22.89	39.41	49.81	17.90	0.00
Cr	272.81	33.43	237.49	36.55	164.49	57.55	907.03	10.02	136.70	69.00
Cs	44.19	17.75	19.81	16.97	20.68	37.71	8.78	2.42	26.50	55.50
Eu	1.93	9.82	2.10	6.68	1.83	12.72	1.22	9.27	2.37	4.48
Fe%	4.97	11.78	4.69	7.62	4.09	9.40	4.83	16.40	4.34	5.54
Hf	6.26	8.65	6.89	7.73	6.94	15.45	4.49	8.04	8.37	4.31
K%	3.40	18.12	3.09	8.90	3.20	11.30	2.05	57.26	3.37	1.47
La	54.82	11.19	69.47	6.19	58.90	13.99	28.87	16.58	96.45	6.67
Lu	0.43	11.53	0.45	17.05	0.33	21.69	0.31	22.81	0.48	8.84
Na%	1.00	39.62	1.23	30.04	1.32	24.21	0.90	47.14	1.74	5.30
Nd	45.50	18.30	48.48	19.19	50.70	24.47	44.66	21.11	67.50	7.54
Ni	142.41	36.80	123.28	50.05	78.62	46.19	160.76	65.15	65.95	48.14
Rb	179.41	8.66	160.77	7.82	151.43	8.40	85.38	22.43	194.50	23.85
Sb	3.88	24.62	2.06	18.62	2.43	55.65	1.64	33.30	1.68	7.58
Sc	19.16	12.01	18.10	10.07	15.80	12.31	17.70	16.98	15.75	14.82
Sm	8.40	8.52	9.62	9.05	8.42	12.26	5.20	15.38	12.38	3.66
Ta	1.48	7.93	1.53	9.69	1.77	73.69	1.03	17.85	1.65	14.19
Tb	1.10	10.18	1.51	10.75	1.16	21.38	0.69	26.64	1.92	1.11
Th	25.62	17.45	41.62	12.76	31.49	15.14	12.65	44.12	57.33	5.61
U	5.69	14.66	7.32	11.79	6.05	17.13	2.34	52.58	9.18	13.64
Yb	2.81	9.77	3.05	12.30	2.42	9.57	2.20	14.50	2.89	6.13
Zn	87.21	11.23	87.00	12.22	81.01	14.81	90.59	0.77	82.30	8.76
Zr	227.21	84.11	341.90	102.06	398.21	139.96	127.97	12.78	171.50	0.41

from the littoral islands, especially from Samothrace. Indeed, group 1C shows strong similarities to the analysed samples from Samothrace, but because of the similarities to group 1B, which definitively has a local Trojan provenance, the results should be treated with caution and further work needs to be done. As for the previous analyses the group 1A matches very well with Knacke Loy's group Troia B and the group 1B matches very well with Knacke Loy's group Troia C. Both of his groups (Troia B and Troia C) have a good match with analysed sediments of the Karamenderes River near Troy (*Knacke Loy 1994*). There is also quite a good match to Mommsen's group B–Troy which is postulated as one of the main local clay pastes at Troy (*Mommsen et al. 2001, 2006*) (**Fig. 6**).

As a comparison Group 2 shows very similar chemical patterns to Knacke Loy's Troia A and Troia D groups, which he related to the sediments of the river Dümrek, the second river near Troy (*Knacke Loy 1994*) (**Fig. 6**).

Groups 3 and 7 may also be of Trojan origin, but further analysis is necessary (**Fig. 5**).

Groups 4, 5 and 6 are for sure of non-local origin (**Fig. 5**). Because particularly the Tan Ware samples from Larisa – Liman Tepe as well as some AGW II samples from that site are in group 4, it is very likely that around Larisa – Liman Tepe there is another production centre of AGW II and Tan Ware, but further work needs to be done (**Fig. 4**).

Group 5 contains seven samples of the so called "Rote Ware" (Red Ware) which is also thought to be an import at Troy, along with two other imports and six samples of AGW II from different survey sites. There is only one Tan Ware sample found at Troy in this group.

Fig. 2 White painted plain burnished pottery (I8.168.1) found at Troy (after Pavúk 2007a, Fig. 1, 475)

It is hard to say at the moment what is the origin of this group. There are some matches to members of group 6, which also consists of some more samples from Larisa – Liman Tepe (5) but also AGW II samples from Hanay Tepe (Calvert's Farm), Hanay Tepe (Bozköy), Beşık Tepe – Kolonai, Asarlık Tepe, Kilisetepe (Eceabat), as well as two imports from Troy and one Tan Ware sample also from Troy.

This group also shows a good match to Mommsen's group E-Troy, which consists of three members of AGW II, one AGW I and one Early Bronze Age ware sample (**Fig. 6**). One of the AGW II samples comes from Hanay Tepe (Calvert's Farm).

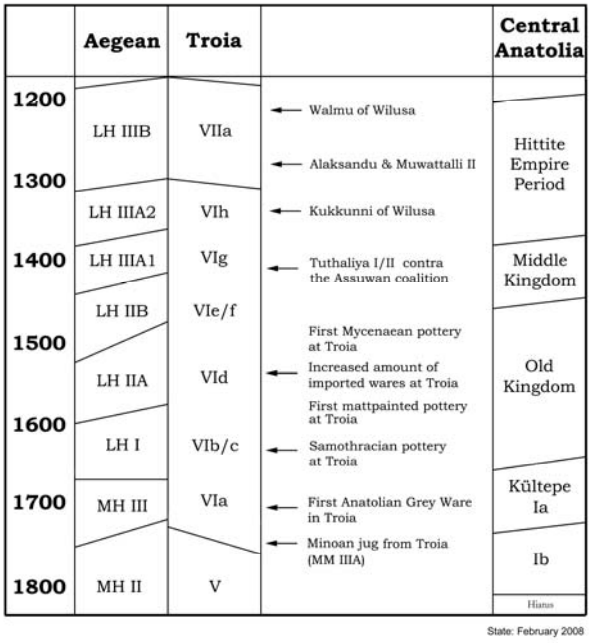

Fig. 3 Timetable of the phases on the Citadell at Troy (after Pavúk 2007b, Fig.1)

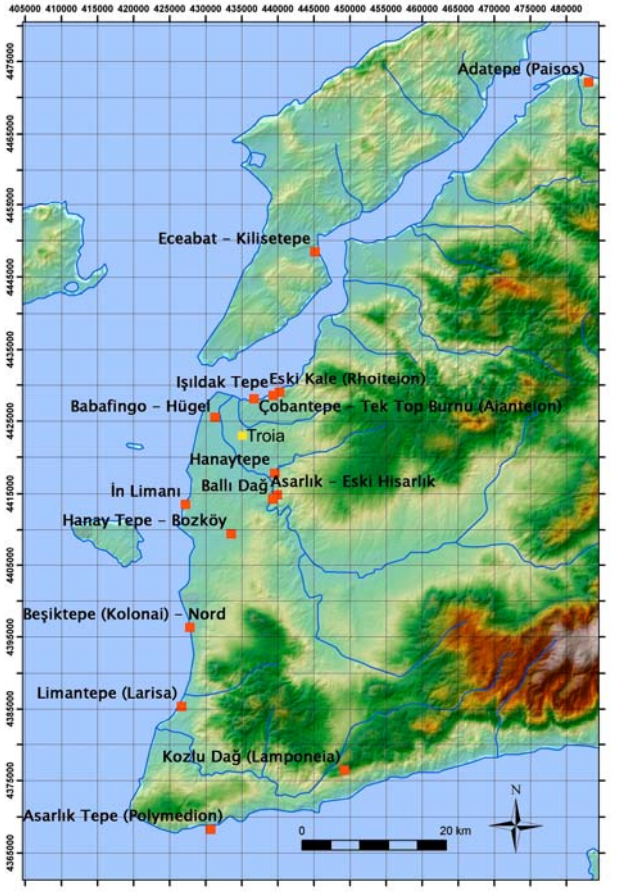

Fig. 4 Sites in the Troad where samples were taken © Troia Projekt

Mommsen et al. postulated the clay paste of this group as local Trojan which was in use from Troy II – VI but with the advice, that further samples are necessary (*Mommsen et al. 2001*). Because the two members of group 8 are from two distant sites and because of the high chemical difference between each other, they should be treated as singles, too. Mean values of the 8 groups are given in **Tables 1** and **2**.

CONCLUSION AND A VIEW TO THE FUTURE

The presented results show, that AGW as well as Tan Ware were produced in more than one place in the Troad. A likely candidate for a workshop is for example Larisa – Liman Tepe as all but one sample from that site are in group 4, 5 and 6 with a focus on group 4 followed by group 6.

But Troy still remains the main production centre in the Troad, as more than half of the analysed survey samples of AGW and Tan Ware are in group 1A and group 1B.

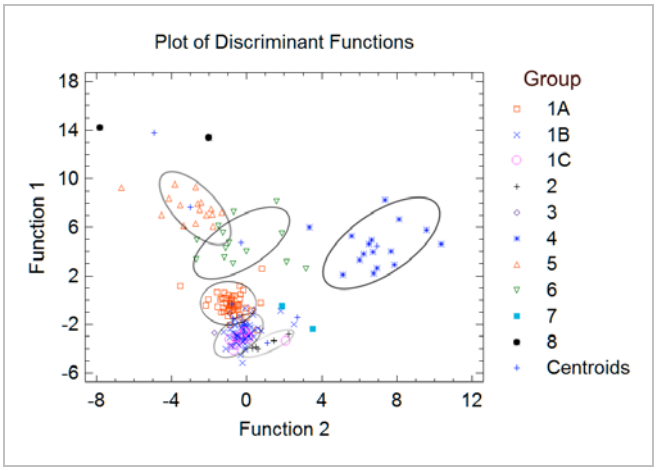

Fig. 5 obtained groups from cluster analysis shown as discriminant plot; all elements used except for As, Ba, K, Na

As for the somewhat problematic group 1C, further analyses are necessary especially Sm and Nd isotopes could be helpful. The next step will be a comparison to the results of another work at the CEZA on the sediments of the Troad, which is done by our colleague Carlos Morales Merino.

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NOTES

[1] The TONY HD4 is callibrated with the Perlman-Asaro-Standard, with four rockstandards (BCR-1, GSP-1, G-2, AGV-1) and the standard SRM 278 (Obsidian Rock, National Institute of Standards, Washington DC).

REFERENCES

ALLEN, S. H. (1991): Northwest Anatolian Grey Wares in the Late Bronze Age: Analysis and Distribution in the Eastern Mediterranean, Unpublished PhD. Dissertation, Brown University. UMI 9101726. Ann Arbor.

ASLAN, R. & BIEG, G. (2003): Die Mittel- und Spätbronzezeitliche Besiedlung (Troia VI und VIIa) der Troas und der Gelibolu - Halbinsel - ein Überblick, in: Studia Troica 13, 165 – 214.

KNACKE LOY, O. (1994): Isotopengeochemische, chemische und petrographische Untersuchungen zur Herkunftsbestimmung der bronzezeitlichenKeramik von Troia, Heidelberger Geowissenschaftliche Abhandlungen 77. Heidelberg.

KULEFF, I. (1996): Provenance study of pottery: choice of elements to be determined, in: Revue d'Archèométrie 20, 57– 67.

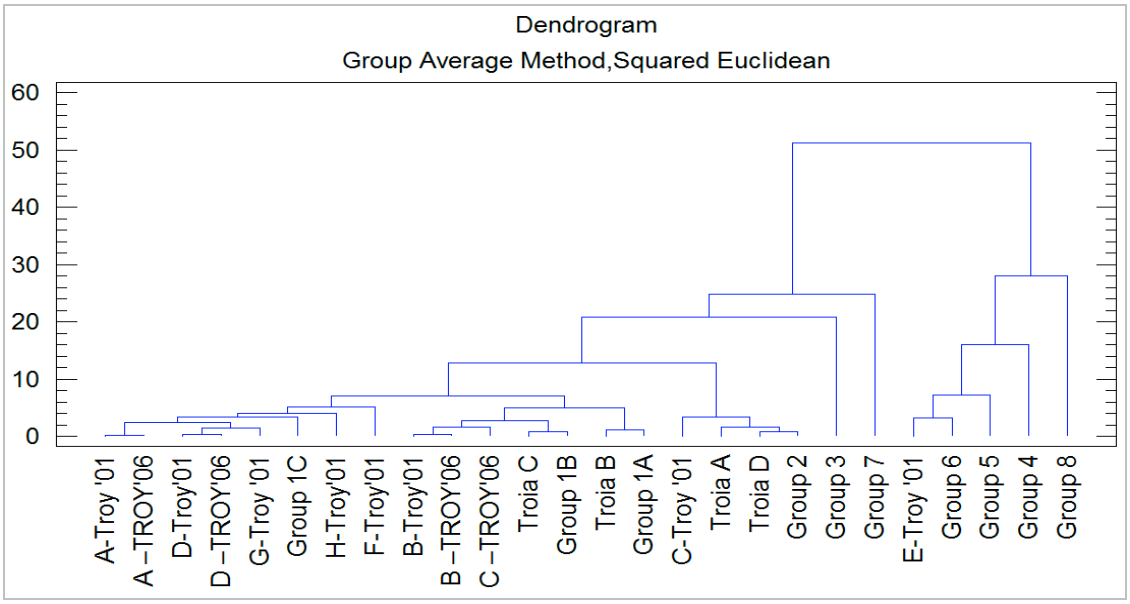

Fig. 6 Comparison between the mean values of already published pottery analysis from Troy as well as the actual groups 1 to 8 used elements: Ce, Cr, Cs, Eu, Hf, La, Lu, Rb, Sc, Sm, Th, U (Troia A – C: Knacke Loy 1994; A-Troy'01 – H-Troy'01: Mommsen et al. 2001; A-Troy'06 – C-Troy'06: Mommsen et al. 2006).

MOMMSEN, H., HERTEL, D and MOUNTJOY, P. A. (2001): Neutron Activation Analysis of the pottery from Troy in the Berlin Schliemann Collection, Archäologischer Anzeiger 2001, 169 – 211.

MOMMSEN, H. & MOUNTJOY, P. A. (2006): Neutron Activation Analysis of Mycenean pottery from Troia - 1988-2003 Excavations, in: Studia Troica 16, 97 – 124.

MOMMSEN, H. & PAVÚK, P. (2007): Provenance of the Grey and Tan Wares from Troia, Cyprus and the Levant, in: Studia Troica 17, 25 – 41.

MOUNTJOY, P. A. (2006): Mykenische Keramik in Troia – Ein Überblick; in: Korfmann, M. (Ed.): Troia Archäologie eines Siedlungshügels und seiner Landschaft, Zabern, 241 – 252.

PAVÚK, P. & RIGTER, W. (2006): Goblets, Schüsseln und Krater – Die Keramik der Perioden Troia VI und VIIa; in: Korfmann, M.O. (Ed.): Troia Archäologie eines Siedlungshügels und seiner Landschaft, Zabern, 231–240.

PAVÚK, P. (2007a): New perspectives on Troia VI chronology; in: Bietak, M. and Czerny, E. (Eds.): The Synchronisation of civilisations in the Eastern Mediterranean in the second millennium B.C. III, Proceedings of the SCIEM 2000 – 2nd EuroConference Vienna, 28th of May – 1st of June 2003.

PAVÚK, P. (2007b): What can Troia tell us about the Middle Helladic Period in the Southern Aegean? in: Felten, F., Gauss, W. and Smetana, R. (Eds.): Middle Helladic pottery and synchronisms, Proceedings of the International Workshop held at Salzburg October 31st – November 2nd, 2004, 295 – 308.

SCHIFER, TH. (2003): Archäometrische Untersuchungen an Waldenburger Steinzeug, PhD., https://fridolin.tu-freiberg.de/archiv/pdf/GeowissenschaftenSchiferThorsten916276.pdf (December 2007)