



Fig. 15 Pots with cooked beans; water is not leaking through the walls. ■ Nádoby s uvařenými fazolemi, voda neprosakuje. ■ Gefäße mit gekochten Bohnen; das Wasser sickert nicht mehr durch die Wände. ■

Experiments Related to Early Medieval Ceramics

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1. Research Questions

The experiments presented here are part of a complex archaeological and scientific analysis of Avar-period ceramic found on the site of Zillingtal (Burgenland, East-Austria, 7-8th century AD).⁽¹⁾

At Zillingtal there have been excavations of a cemetery (797 graves) and parts of a settlement dating to the Avar-period.⁽²⁾ The main goals of the archaeological interpretation of the ceramic finds from Zillingtal were as follows: Constructing a chronology and typology of the ceramic vessels while comparing the ceramics types found at the cemetery with those from the settlement. While processing the finds, the question of provenance and function of the ceramic vessels emerged. In order to answer these questions with a greater degree of security, the following experiments have been carried out, in addition to archaeological and scientific investigations.

⁽¹⁾ The publication of this analysis is in preparation (Herold in preparation). A version of the present article has been published in the special issue of the *Archäologie Österreichs* on experimental archaeology (Herold 2001).

⁽²⁾ Preliminary report about the excavation: Daim – Distelberger 1996.

Tab. 1 Colour and consistency of the clay samples			* - after Munsell
No. of sample	Colour*	Name of colour*	Consistency
Sample 1	HUE 10YR 3/1	brownish black	medium hard
	HUE 10YR 2/1	black	
Sample 2	HUE 10YR 3/2	brownish black	medium hard
	HUE 10YR 2/2	brownish black	
Sample 3	HUE 10YR 2/1	black	very hard
	HUE 10YR 2/2	brownish black	
Sample 4	HUE 2.5Y 3/1	brownish black	soft
	HUE 2.5Y 3/2	brownish black	
Sample 5	HUE 2.5Y 3/1	brownish black	medium hard
	HUE 2.5Y 2/1	black	
Sample 6	HUE 10R 2/1	reddish black	soft
	HUE 10R 1.7/1	reddish black	
Sample 7	HUE 7.5YR 2/1	black	soft
	HUE 7.5YR 1.7/1	black	
Sample 8	HUE 2.5YR 2/1	reddish black	medium soft
	HUE 2.5YR 1.7/1	reddish black	
Sample 9	HUE 7.5R 2/1	reddish black	very soft
	HUE 7.5R 1.7/1	reddish black	

Tab. 1 Barva a konzistence vzorků hlíny. ■

Tab. 3 The weight of the produced vessels									
No.	A	B	C	D	E	F	G	H	I
1	707	540	23,62	421	p.miss.	not. int.			
2	443	343	22,57	267	p.miss.	not. int.			
3	352	275	21,88	227	p.miss.	not. int.			
4	501	394	21,36	304	p.miss.	not. int.			
5	309	250	19,09	219	intact	29,13	12,40	225	2,74
6	484	372	23,14	200	broken	not. int.			
7	407	322	20,88	283	intact	30,47	12,11	291	2,83
8	409	313	23,47	215	p.miss.	not. int.			
9	389	297	23,65	164	broken	not. int.			

A Weight after building up (g), **B** Weight after one week of drying (g), **C** Weight lost during drying (%), **D** Weight after firing (g), **E** State after firing, **F** Weight lost from after building up to after firing (%), **G** Weight lost in firing (%), **H** Weight after cooking (g), **I** Additional weight from cooking (%), **p. miss.** - parts missing, **not. int.** - vessel not intact.

Tab. 3 Hmotnost nádob. ■

2. Experiment 1:

Producing pottery from clays local to the site

2.1. Archaeological background

On the basis scientific analyses (X-ray diffraction analysis, thin-section analysis) it has been concluded that the Avar-period ceramics of Zillingtal had been produced from clays ⁽³⁾ local to the site. This applies to both technological groups of the ceramics: coil-built pottery and pottery made on a slow wheel (turntable, “hand-wheel”). On the basis of the thin section analysis it was surmised that the hand made ceramics were made without additional tempering material, whereas the slow-wheel turned ceramics were relatively highly tempered (quartz, muscovite, carbonates). In order to eliminate the insecurity caused by the tempering materials (source, exact amount, sphericity), the following experiments applied only to the coil-built ceramics.

2.2. The experiment

For the experiment 9 clay samples were taken from the surface at the site of Zillingtal. The samples were taken 150-200 m away from each other, in a quadratic raster (**Fig. 1**). With the help of the regular distances between the samples it was intended to test the homogeneity/heterogeneity of the local sediments.

From each clay-sample a pot was produced. The samples were not sieved; larger particles (stones, plant remains) were removed manually. Each sample was then mixed with water and the vessels were built using the coil-technique, without the use of a potter's wheel (**Fig. 2-6**). Although the clay was identical no attempt was made to replicate a particular pot but a generic form based on the Zillingtal vessels was adopted. The production of one pot (including the preparation of the clay) took between 1.5 and 3 hours, of which preparation of the clay took more than half. Once ready the pots were dried for a week, but without using sunlight or heating.

The firing of the vessels took place in the middle of August 2001 at the Museum für Urgeschichte, in Asparn/Zaya (Lower-Austria). First a fire was made in a pit (1-1.2 m in diameter, 50 cm deep). The pots were preheated beside the fire for one hour (**Fig. 7**) before the firing which took 1.5 hours (pots in the firing pit: **Fig. 8**). Most breakages took place in the first 15 minutes. 30 minutes after reaching the red heat the vessels were taken out from the fire with the help of a spanner. 2 pots remained intact, 5 pots had lost parts and 2 pots were broken completely (all ready vessels: **Fig. 9**).

⁽³⁾The word “clay” is used in this article simply in the sense of raw material for ceramics; it does not refer to the geological meaning of “clay”.

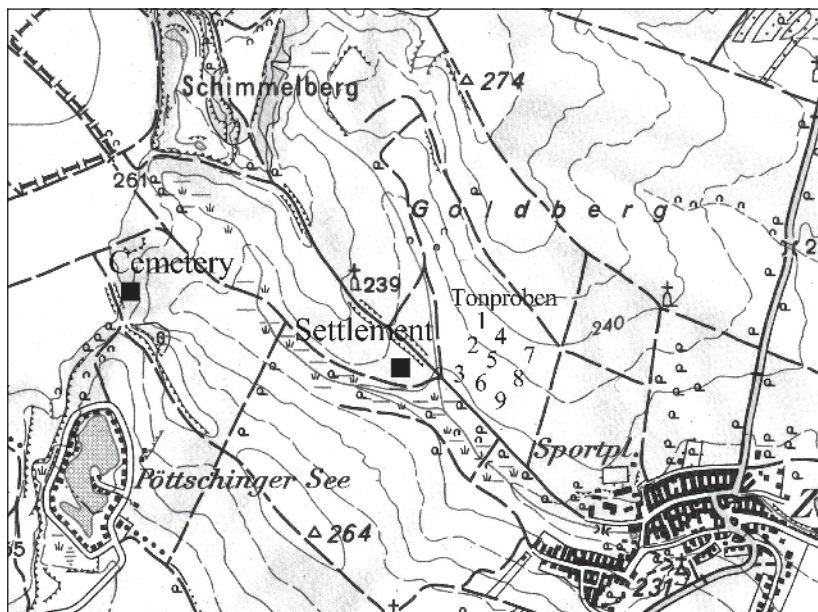


Fig. 1 Plan with places marked where the clay samples were obtained from. ■ Plán míst, ze kterých byla získána hlína. ■ Karte mit Lokalisierung der Tonmuster. ■

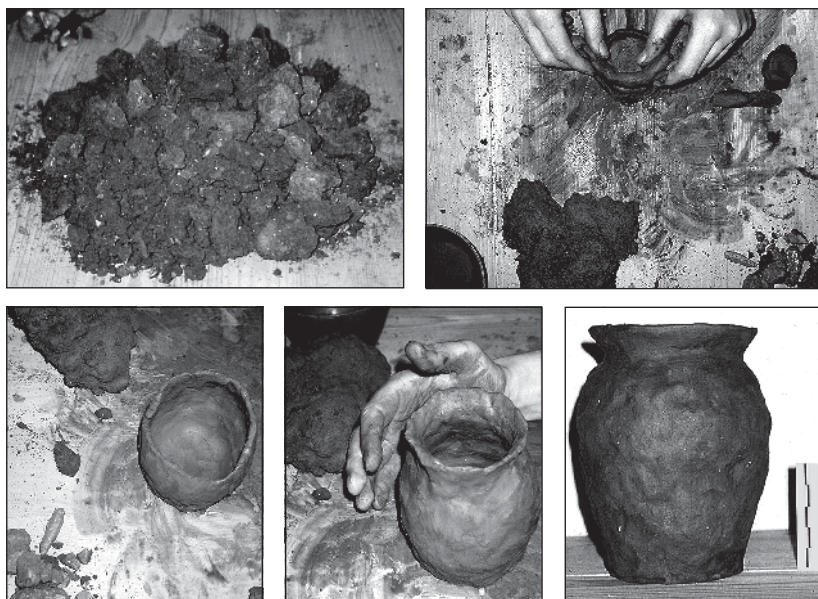


Fig. 2-6 Making a vessel (No. 4). ■ Výroba nádoby (č. 4). ■ Ein Gefäß entsteht (Gefäß 4). ■

2.3. Results, Conclusions

The main result of this experiment is that it has proved possible to produce ceramic vessels from clay local to the site of Zillingtal. This experiment alone is no evidence that the Avars had also done so, but it is, together with the results of scientific analysis, a strong indication in this direction.

Besides proving the possibility of local pottery production, there were also been some observations made during the experiment which are described in the following paragraphs.

2.4. Colour of clay samples and vessels

After forming the vessels their colour was recorded with the help of the Munsell Soil Colour Chart (**Tab. 2**). Two characteristic colour-intervals could be observed: Vessels 1, 2, 4, 5, 7 were brown, the vessels 3, 6, 8, 9 were black. Although it was possible to produce a pot from each sample, it was easier to work with the brown samples as they were easier to form and broke less often than the black samples.

Interestingly, the above colours did not show any relation to the original colours of the clay samples (**Tab. 1**). The reason for this is that the colour of the clay is probably strongly related to the water content which was due to differences in position and vegetation. In order to produce the vessels, the water content in the samples had to be brought to a similar level. Through this other colour-defining properties of the samples came to the foreground. It became obvious that among the samples there are two types of clays. These two types are not only differ in colour, but as mentioned above, also in plasticity.



Fig. 9 Vessels after firing. ■ Nádobý po vypálení. ■ Gefäße nach dem Ausbrennen. ■



Fig. 8 Pots in the firing pit. ■ Nádobý v jámě. ■ Gefässe in der Ausbrennungsgrube. ■



Fig. 11 Pots with beans beside the fire. ■ Nádobý s fazolemi vedle ohně. ■ Gefässe mit Bohnen am Feuer. ■



Fig. 12-13 Vessels with boiling water in the fire. ■ Nádobý s vařící se vodou na ohni. ■ Gefässe mit kochendem Wasser im Feuer. ■

Tab. 2 Colour of the produced vessels¹⁾

No. of sample - vessel - colour²⁾ - name o colour^{2,3)}						
before firing			after firing		after cooking	
1	HUE 2.5YR 4/1	YE gray	HUE 10R 5/6	red		
	HUE 2.5YR 3/1	BW black	HUE 10R 5/8	red		
	HUE 2.5YR 3/2	BW black	HUE 10R 4/6	red		
			HUE 10R 4/8	red		
			HUE 10R 3/1	DAR gray		
			HUE 10R 4/1	DAR gray		
2	HUE 2.5YR 4/1	YE gray	HUE 2.5YR 6/6	orange		
	HUE 2.5YR 3/1	BW black	HUE 2.5YR 6/8	orange		
	HUE 2.5YR 3/2	BW black	HUE 2.5YR 5/6	BRR brown		
			HUE 2.5YR 5/8	BRR brown		
			HUE 2.5YR 5/1	RE gray		
			HUE 2.5YR 4/1	RE gray		
3	HUE 10YR 4/1	BW gray	HUE 7.5YR 6/1	BW gray		
	HUE 10YR 3/1	BW black	HUE 7.5YR 5/1	BW gray		
			HUE 7.5YR 2/1	black		
			HUE 7.5YR 1.7/1	black		
			HUE 7.5YR 6/6	orange		
			HUE 7.5YR 6/8	orange		
			HUE 7.5YR 4/3	brown		
			HUE 7.5YR 4/4	brown		
4	HUE 2.5YR 4/1	YE gray	HUE 7.5YR 6/1	BW gray		
	HUE 2.5YR 3/1	BW black	HUE 7.5YR 5/1	BW gray		
	HUE 2.5YR 3/2	BW black	HUE 7.5YR 6/6	orange		
			HUE 7.5YR 6/8	orange		
			HUE 7.5YR 2/1	black		
			HUE 7.5YR 1.7/1	black		
			HUE 7.5YR 5/3	D brown		
			HUE 7.5YR 5/4	D brown		
5	HUE 2.5YR 4/1	YE gray	HUE 7.5YR 6/1	BW gray	HUE 10R 3/1	DAR gray
	HUE 2.5YR 3/1	BW black	HUE 7.5YR 6/2	GR brown	HUE 10R 3/2	DAR brown
	HUE 2.5YR 3/2	BW black	HUE 7.5YR 4/1	BW gray	HUE 10R 3/3	DAR brown
			HUE 7.5YR 3/1	BW black	HUE 10R 4/1	DAR gray
			HUE 7.5YR 6/6	orange	HUE 10R 2/1	RE black
	HUE 7.5YR 6/8	orange	HUE 10R 1.7/1	RE black		

No. of sample - vessel - colour ⁽²⁾ - name o colour ⁽²⁾⁽³⁾						
before firing			after firing		after cooking	
6	HUE 10YR 4/1	BW gray	HUE 5YR 5/1	BW gray		
	HUE 10YR 3/1	BW black	HUE 5YR 4/1	BW gray		
			HUE 5YR 5/4	DUR brown		
			HUE 5YR 5/6	BRR brown		
			HUE 5YR 5/8	BRR brown		
7	HUE 2.5YR 4/1	YE gray	HUE 7.5YR 6/2	GR brown	HUE 10R 3/1	DAR gray
	HUE 2.5YR 3/1	BW black	HUE 7.5YR 6/3	D brown	HUE 10R 3/2	DAR brown
	HUE 2.5YR 3/2	BW black	HUE 7.5YR 6/4	D orange	HUE 10R 3/3	DAR brown
			HUE 7.5YR 6/6	orange	HUE 10R 4/1	DAR gray
			HUE 7.5YR 6/8	orange	HUE 10R 2/1	RE black
			HUE 7.5YR 5/1	BW gray	HUE 10R 1.7/1	RE black
			HUE 7.5YR 5/2	GR brown	HUE 10R 4/4	RE brown
					HUE 10R 4/6	red
					HUE 10R 4/8	red
8	HUE 10YR 4/1	BW gray	HUE 2.5YR 5/6	BRR brown		
	HUE 10YR 3/1	BW black	HUE 2.5YR 5/8	BRR brown		
			HUE 2.5YR 6/6	orange		
			HUE 2.5YR 6/8	orange		
			HUE 2.5YR 5/1	RE gray		
			HUE 2.5YR 4/1	RE gray		
9	HUE 10YR 4/1	BW gray	HUE 2.5YR 5/1	RE gray		
	HUE 10YR 3/1	BW black	HUE 2.5YR 4/1	RE gray		
			HUE 2.5YR 5/6	BRR brown		
			HUE 2.5YR 5/8	BRR brown		

⁽¹⁾ the order of the colours reflects their frequency on the surface of the vessels; ⁽²⁾ after Munsell; ⁽³⁾ colours: **YE** yellowish, **BW** brownish, **GR** grayish, **RE** reddish, **BRR** bright reddish, **DAR** dark reddish, **DUR** dull reddish, **D** dull.

Tab. 2 Barva vyráběných nádob (pořadí barev dle četnosti jejich výskytu na povrchu nádob) ■

The pots from the (black) samples 6 and 9 produced cracks during the drying phase. These two pots broke completely on firing. Pots 1, 2, 3, 4, 8 lost parts in firing which could probably have been avoided with more experience. Vessels 5 and 7 (both from the brown clay) remained intact.

Vessels 1 and 2 produced strong red-orange colours in firing, the other pots became a more reddish-brown or greyish-brown (**Tab. 2**).

It was thus possible to see differences between clay-samples on the relatively small area from which the samples were taken (a square with sides of 300-400 m). The samples from the north-western part of this square differed from the south-eastern ones not only optically, but also had a better plasticity and were easier to fire.

2.5. Weight of vessels

The weight of each vessel was measured three times during the production process: once after building the pot, after one week of drying and after firing (**Tab. 3**). The vessels have lost an average of 20-23 weight% of water during the drying phase. It is necessary to point out that the two pots that remained intact in firing (No. 5 and 7) had lost the least amount of water (19.09% and 20.88%). These two vessels lost a further 10% of their original weight (about 12% of the weight after drying) during firing. From building to after firing these pots lost about 30% of their water content. In the case of the pots that did not remain intact this value can of course not be calculated.

3. Experiment 2: Testing the produced vessels as cooking ware

3.1. Archaeological background

When analysing pottery from the Early Middle Ages it is often discussed if the main function of the pots was cooking. Usually it is doubted that these vessels of relatively bad quality were capable of being heated directly. In the following experiment the two intact pots of the previous experiment were tested as cooking ware. The test food was beans.

3.2. The experiment

The beans were initially soaked overnight (about 10 hours). When the beans were put into the pots to be tested as cooking ware, the water started to leak through the wall of the pots (**Fig. 10**), but the amount was not too great, i.e. the sinking of the water level was not visible in the pot. The two vessels were placed beside the fire for 20 minutes (**Fig. 11**) and were put into the fire afterwards. After about 15 minutes the water started to boil (**Fig. 12-13**). On boiling the water evaporated steadily, but it was possible to add cold water into the pots (without the vessels getting ruined from the temperature change). The beans were cooked after three hours (as a comparison: on an electric oven it took two hours to cook them). With more experience this time could be reduced. After having cooked the beans the pots were removed from the fire with the help of a Y-shaped tree branch (**Fig. 14**). The cooked beans were edible.



Fig. 7 Ready dried vessels being preheated before firing. ■ Hotové a vysušené nádoby jsou předeřhřívány před vypalováním. ■ Ausfertigte und trockene Gefäße werden erwärmt vor dem Ausbrennen. ■



Fig. 14 Removing a pot from the fire with the help of a Y-shaped tree branch. ■ Vytahování nádoby z ohně s pomocí rozvětvené větve. ■ Ein Gefäß wird aus dem Feuer mit Hilfe eines Y-förmigen Astes herausgenommen. ■

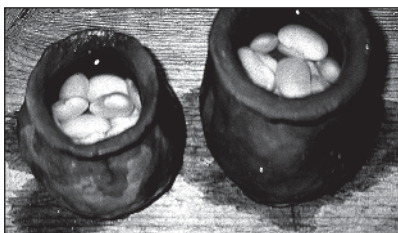


Fig. 10 Pots with beans before cooking; water is leaking through the walls. ■ Nádoby s fazolemi před vařením, voda prosakuje stěnami. ■ Gefäße mit Bohnen vor dem Kochen; das Wasser sickert durch die Wände. ■

3.3. Results, Conclusions

With this simple experiment it is shown that it is possible to use hand-modelled pottery made of clays local to the site of Zillington as cooking ware.

The two vessels used for cooking did not produce new cracks during cooking, but did produced changes in the pots. After cooking water did not leak through the walls of the vessels anymore (**Fig. 15**), i.e. the pores and cracks have been filled during cooking. The weight of both vessels has risen slightly (2.7-2.8 weight%). The surface of the pots became smoother and acquired a kind of glaze. The colour of the vessels also changed: the original distribution of the stains from firing stayed, but tunes altered (**Tab. 2**).

On the basis of the changes in the colour and surface of the vessels and of the filling of the pores it seems in principle possible to ascertain if a pot from an archaeological context was used for cooking.

3.4. Considerations for future experiments

The experiments presented here are among the first documented experiments on the ceramics of the Avar-period, so many questions have yet to be answered. In the future these experiments have to be repeated in order to gain experience in the applied techniques and to standardise the results. So as to draw well-founded conclusions, scientific investigations of the experimental vessels are going to be included in the overall analysis of the presented experiments.

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Summary

Experimenty s ranně středověkou keramikou

Článek představuje dva experimenty: výrobu keramiky za použití lokálních materiálů a testování možností vaření ve vyrobené keramice. Experimenty byly spojeny se zpracováním keramických nálezů z pohřebiště a sídliště Avarského období v Zillingtal (Burgenland, východní Rakousko, 7.-8.st. n. l.) Na základě vědeckých analýz (rentgenová difrakční analýza a analýza výbrusů keramiky) kombinovaných s laboratorními výpalyvými experimenty lze předpokládat, že keramika Avarského období v Zillingtal byla vyrobena z hlíny vyskytující se v okolí naleziště. Z 9 vzorků hlíny odebraných v Zillingtal byly vyrobeny nádoby bez použití hrnčířského kruhu. Keramika byla vypálena v zahloubeném ohništi. Neporušené nádoby byly úspěšně testovány pro vaření na otevřeném ohni. Na základě výsledků experimentů můžeme předpokládat na raně středověkých sídlištích zemědělského charakteru místní výrobu keramiky. Experimenty rovněž ověřily otázku pravděpodobné funkce nádob.

Experimente mit der frühmittelalterlichen Keramik

Der Beitrag stellt zwei Experimente vor: die mit Ausnutzung der Lokalmaterialien durchgeführte Keramikherstellung und die Überprüfung der Kochenmöglichkeiten mittels der hergestellten Keramik. Die Experimente wurden mit der Verarbeitung der keramischen Funde aus einer Grabstätte und einer Wohnsiedlung aus der Avarzeit im Zillingtal (Burgenland, Ostösterreich, 7.-8.Jht. u. Z.) verbunden. Auf Grund wissenschaftlicher Analysen (Röntgendiffraktionsanalyse und Keramikschliffanalyse), kombiniert mit Laborexperimenten übers Ausbrennen, kann man vorhaben, dass die Keramik der Avarzeit im Zillingtal aus dem rund die Fundstelle existierendem Ton hergestellt worden ist. Aus neun im Zillingtal abgenommenen Tonmustern wurden Gefäße hergestellt, ohne die Töpferscheibe zu benutzen. Die Keramik wurde in einer vertieften Feuerstelle ausgeglüht. Unversehrte Gefäße wurden erfolgreich testiert fürs Kochen auf offenem Feuer. Auf Grund verwirklichter Experimente kann man vorhaben, dass eine lokale Keramikproduktion auf den frühmittelalterlichen Wohnsiedlungen mit dem Agrarcharakter existierte. Gleichzeitig beantwortete man die Frage nach der möglichen Hauptfunktion der hergestellten Gefäße.

Expérimentation de céramiques du haut moyen-âge

L' article présente 2 expérimentations: confections de céramiques a partir d' argile locale et utilisation de ces céramiques dans un contexte culinaire. Les reconstitutions de ces vaiselles médiévales étaient liées a une étude du matériel céramique provenant du site de Zillingtal (Burgenland, Autriche Orientale), daté de la période Avar 7-8eme siecle après J.C. Des travaux scientifiques (analyses au rayon-X de la structure minérale des pâtes) combinés avec des cuissons expérimentales en laboratoire, ont permis de supposer que la céramique du site de Zillingtal correspondant a l' occupation Avar était réalisée avec une argile extraite dans les environs du site. 9 échantillons de terre collectés a Zillingtal ont servi a la réalisation de céramiques sans utilisation de tour de potier, puis elles ont été cuites dans un four en fosse. Avec succès les pieces ont ensuite étaient testées sur un feu de bois pour apprécier leurs propriétés culinaires. A la lumiere de ces reconstitutions il a été possible de démontrer qu' une production céramique a un niveau local, dans un contexte de société agricole du haut moyen-âge était possible. De plus, des éléments de réponses ont été apportés aux fonctions des differents types de vaiselles produites.