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THE ARCHAEOMETRIC ANALYSIS OF GRAVE CERAMICS I

Raetian beakers and lead-glazed set from the eastern cemetery of the *Aquincum* civil town

Rescue excavations between 2005 and 2010 conducted east of the *Aquincum* Civil Town on the site of the former Gas Factory brought to light some 1300 Roman-period graves (**fig. 1**).[1] The processing of this large group of finds is being carried out as part of a Hungarian Scientific Research Fund project (OTKA no. 10095 – Study of the archaeological material from the eastern cemetery of the Civil Town of *Aquincum*, led by Dr Gábor Lassányi). The funding of the project allowed the mineralogical and chemical analysis of a limited number of ceramic finds with archaeometric methods.[2] The phase composition analysis was carried out by X-ray diffraction measurements, while the major and trace elements were analysed by X-ray fluorescence. The aim of the analyses, beyond answering the most important archaeological questions concerning the ceramic finds, was to expand the analytical database of the *Aquincum* finds for future comparative studies.

Although the archaeometric analysis phase of the project has not yet been concluded and the evaluation of the results is still in progress, for particular topics, such as the Raetian ware and glazed ceramics the preliminary results already provide interesting data, which we would like to present in this publication.

Concerning the ceramic types under investigation, the most common problem is to distinguish locally-made vessels from imported ones. This, based only on macroscopic characteristics, can often be difficult. This is especially true for glazed vessels, but also for Raetian ware as well. With the latter, the shape, decoration, and material of the vessels do provide some help in distinguishing local products from imported vessels, but no definitive method has been established to date.[3] In the future, wider material testing might, perhaps, indirectly be of help in this as well.

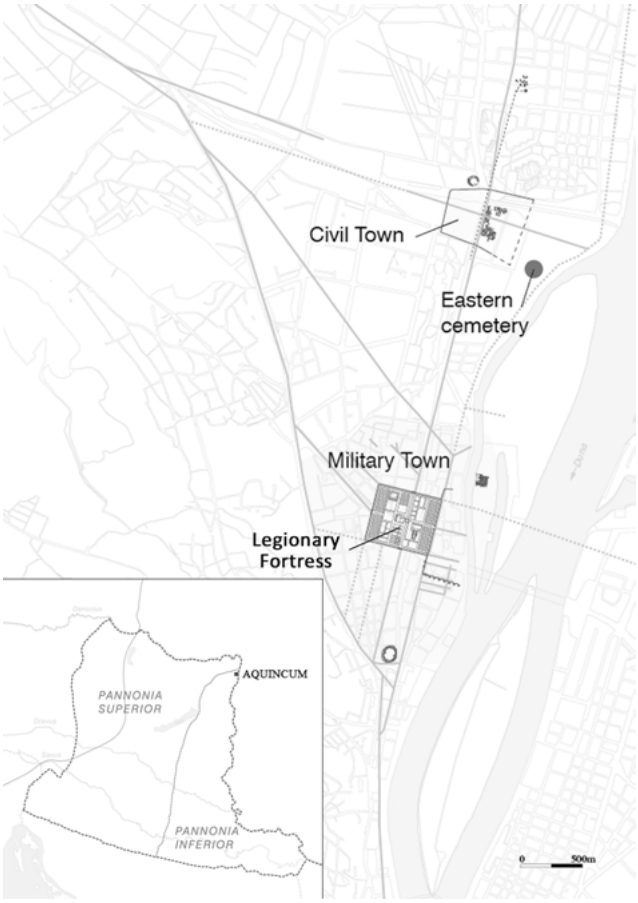

Fig. 1. Location of *Aquincum* and the eastern cemetery of the civil town.

Raetian beakers

During the excavations of 2006 and 2007 two beakers were discovered from different graves of the cemetery (**fig. 2,1–2**[4]),[5] which, based on their form and decoration, are very similar to Raetian ware.[6] The vessels differ slightly in quality, but not even the best object matches the quality of the products of western workshops. Hence we assumed that at least one of the beakers (with a brownish-red slip and

[1] We would like to thank the leader of the excavations and the project, Gábor Lassányi for allowing us to use the finds for this publication.

[2] The analysis was carried out under the supervision of Mária Tóth by the Archaeometric Research Group of the Institute for Geological and Geochemical Research (Hungarian Academy of Sciences).

[3] Fényes 2003, 12–13; for finds from Savaria see Varga 2009, 211.

[4] The drawings are by Gábor Varga.

[5] Lassányi 2007, 102–116; id., Előzetes jelentés az aquincumi polgárváros keleti (gázgyári) temetőjében, 2007-ben végzett feltárásokról/ Preliminary report on the excavations conducted in the eastern (Gas Factory) cemetery of the Aquincum Civil Town in 2007. Aquincumi Füzetek 14, 2008, 64–70.

[6] ORL B 66c Faimingen (1911). – For more on this vessel type and on the finds from *Aquincum* see the article of N. Varga in this volume.

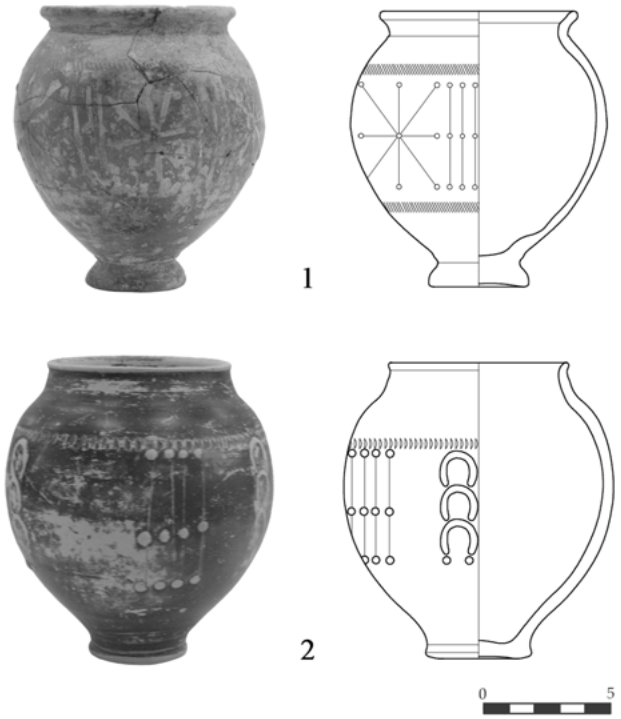

Fig. 2. Raetian-type beakers from the eastern cemetery of the civil town. – Scale 1:3.

thicker walls, more worn and of a lower quality), or perhaps both were locally produced, i.e. they were made from the so-called "Kiscell clay" used also by the potters of *Aquincum*.

Fig. 2,1.
Beaker: light brown claybody, surface covered with worn brownish-red slip, secondarily burnt.

Decoration: clay trails articulated with clay dots standing either vertically parallel or forming a star between two bands of chattering (Drexel I); Rim diameter: 7.8 cm; Base diameter: 4 cm; Height: 11 cm, Inv. no.: 2007.3.35.

Fig. 2,2.
Beaker: yellowish-brown clay body, surface covered with slightly worn dark-brown–brownish-red slip.
Decoration: Columns of linked horseshoes between incised, parallel, vertical clay trails with clay dots under a chattered line. (Drexel I); Rim diameter: 7.2 cm; Base diameter: 4 cm; Height: 11.7 cm, Inv. no.: 2006.5.5162.

In *Pannonia*, local workshops too began the production of Raetian ware in the second half of the 2nd century – presumably because of the increase of customs dues following the reorganisation of customs barriers[7] – to meet the demands of the market.[8] To date, there is clear evidence for their production in *Pannonia* from *Poetovio*,[9] *Savaria*,[10] and *Vindobona*.[11] But production is also suspected in other find-spots as well, such as *Gorsium*,[12] and *Carnuntum*.[13]

"Raetian-like" vessels were presumably also produced in *Aquincum*, but until now clear evidence for this has not been found.[14] Hence, we sought to establish, with the help of archaeometric analysis, whether or not the beakers could be considered truly the products of local pottery production.

Below we will briefly outline the methodology and results of the analysis.

Methodology

We paired the beakers prepared for analysis (samples B1–B2) with "reference material" from the *Aquincum Museum*.[15] In this group (samples R1–R5) we only included import-quality "Raetian fragments". Furthermore, we also created a control group (samples K1–K5), in which we included "Raetian samples" also from *Pannonia*, but not from *Aquincum* (**table 1**). In this group it was also important to select finds from sites where the potters did not use Kiscell clay. Thus two sherds from *Savaria*, one from *Carnuntum*, one from Sárvár, and another from Ács-Vaspuszta were included in this group.[16]

For the mineralogical and chemical analysis we prepared the following highly important questions:
– Were samples B1 and B2 made from Kiscell clay?
– How do the samples from the reference group (R1–R5) relate to B1 and B2?
– How do the samples from the control group (K1–K5) relate to the samples from *Aquincum* (B1–B2, R1–R5, and other locally produced ceramics previously analysed)?

7 Varga 2009, 209; D. Gabler, Differences between imported pottery in the Western and Danubian Provinces of the Roman Empire. Acta Arch. Acad. Scien. Hungaricae 38, 1986, 100–102; id., A belső vámok szerepe a rajnai és a dunai provinciák importált kerámiasprektumában. Diss. Arch. Ser. 3/2, 2014, 55–56.

8 For a summary of fragments identified as local products see Varga 2009, 213.

9 I. Curk/M. Gulič/I. Tušek, Zur Sigillataproduktion von Poetovio. RCRF Acta 24, 1984, 61–68.

10 Szőnyi 1973, 87–108; Varga 2009, 209–260.

11 P. Donat, Feinkeramik aus Vindobona – Hinweise auf eine lokale Produktion? Fundort Wien 2, 1999, 32–46.

12 Szőnyi 1973, 102.

13 Fényes 2003, 13.

14 According to K. Póczy the Schütz workshop of *Aquincum* produced such "pearly" slipped vessels with rouletted decoration, which were Raetian ware imitations (K. Póczy, Die Töpferwerkstätten von Aquincum. Acta Arch. Acad. Scien. Hungaricae 7, 1956, 115). She did not, however, publish the vessels, and we do not even know their find-context. Later, citing Póczy, Bónis published "so-called Raetian vessels" (É. Bónis, Töpferei an der Südmauer der Aquincumer Zivilstadt neben dem „Schütz-Gasthof". Budapest Régiségei 30, 1993, 229, 233 Fig. 11–12), but these are, in fact, imitations of Trier black-slipped ware (E. Harsányi, Die Imitationen der Trierer schwarz engobierten Keramik in Pannonien. In: S. Biró [ed.], EX OFFICINA… Studia in honorem Dénes Gabler [Győr 2009] 189–204). Hence for now, we must treat the data concerning the Schütz workshop with reservations. The Raetian beaker known from the Gázgyár workshop publication was considered to be imported (Kuzsinszky 1932, 354–355 Fig. 364,2), while, according to Szőnyi, it might be a local product (Szőnyi 1973, 92). We must, however, note that Kuzsinszky – as he himself admits – also included in the publication vessels found in graves or the Danube, which are thus not, or not directly, connected to the pottery workshop.

15 The finds in the "reference group" were discovered during P. Vámos's excavation in the north-eastern zone of the *Aquincum canabae* (5 Miklós Square). P. Vámos, Feltárás az aquincumi canabae északkeleti régiójában/Excavations in the north-eastern region of the Aquincum canabae. Aquincumi Füzetek 13, 2007, 78–87.

16 We would like to express our thanks to our colleague, Nikoletta Varga, for allowing us to use her samples for the control analysis. We would also like to thank Dénes Gabler, Izida Berger-Pavić, Marcella Nagy and Péter Kiss for providing us samples from Sárvár, Ács-Vaspuszta, *Carnuntum*, and *Savaria* respectively.

Lead-glazed set

The issue of glazed-vessel production and the possible workshops in *Pannonia* has long been a problem in the scholarship on the province.[17] This is perhaps because distinguishing imported vessels from local products based on macroscopic observation is considerably more difficult in the case of glazed vessels. It is, however, certain that apart from the products imported from Italian or provincial (e.g. Gallic or Moesian) workshops, vessels made in local workshops too can be found, which in some cases were made with a design similar to the imported glazed vessels. It is suspected that during the 2nd century *Aquincum* too may have produced such glazed vessels,[18] which can be found among the deposits in the cemeteries.[19] Nevertheless, so far, there is no direct evidence for local production.[20] Among the fragments of lead-glazed finds, glazed casserole handles are characteristic; they have for a long time been discovered from various find-spots in *Aquincum*,[21] for instance from the site of "Gas Factory - Graphisoft". Due to the large number of such finds, one of their production centres is suspected to have been in *Aquincum*.[22] It is further suspected that during the middle and second half of the 2nd century, such early glazed vessels may have been produced in the so-called "Gas Factory" pottery workshop to the east of the Civil Town. Indeed, A. Bugán, considers the lower-quality casserole handles (with thin, "grass green" glaze) found in the "Gas Factory" can be waste products.[23]

In 2006, from one of the graves in the "Gas Factory cemetery" (present-day Graphisoft) three, almost intact, green-glazed vessels were found,[24] which are exceptional among vessel deposits. This special group imitating metal vessels consists of a single-handled jug with applied decoration, a double-handled dish, and a casserole with a relief-decorated handle (**fig. 3,1–3**[25]).[26] The vessels clearly form a set: they are of the same quality, and were probably made in the same workshop. Hence, with the archaeometric analysis we hoped first of all to determine whether or not this workshop – bearing in mind the above factors – was in *Aquincum.* In other words, can it be proved that the three vessels were made from the already-mentioned, local Kiscell clay?

Fig. 3. Vessels of the lead-glazed set from the cemetery.

Fig. 3,1.
Single-handled jug: grey fired clay body (reddish under the glaze), coated with yellowish-green glaze on the surface, on the side an applied decoration of a head. Rim diameter: 7.5 cm; Base diameter: 6.3 cm; Height: 26.6 cm, Inv. no. 2006.5.8.

Fig. 3,2.
Double-handled dish: grey fired clay body (reddish under the glaze), coated with yellowish-green glaze on the surface, Rim diameter: 19.2 cm; Base diameter: 8.2 cm; Inv. no. 2006.5.7.

Fig. 3,3.
Casserole: grey fired clay body (reddish under the glaze), coated with yellowish-green glaze on the surface. Decoration: the handle ends in a semicircle and features the relief of a naked, winged boy under a female head; (the edge of the handle is framed with rosettes and series of arched foliage). Rim diameter: 14.3 cm; Base diameter: 8.2 cm; Height: 11.7 cm; Length: 23 cm. Inv. no. 2006.5.6.

Methodology

We paired the glazed vessels (samples GS1–GS3) with a reference group of further – mostly unpublished – casserole handles (GP1–GP3) from the *Aquincum Museum*'s collections (**table 2**), which have a relief decoration matching that of the casserole from the set (GS3, **fig. 4**[27]). These fragments, however, with respect to quality (i.e. quality of the glaze, its

17 For a summary see Bónis 1990, 24–38; on early Roman glazed vessels see Barkóczi 1992, 7–35.

18 Bónis 1990, 26; Topál 1993, 246; id. 1995, 102–103; Bugán 2002, 98.

19 Bónis 1990, 26. The number of glazed vessels in grave deposits is, however, low. And this was not changed by the excavations in the eastern cemetery of the Civil Town (Gázgyár - Graphisoft) between 2005 and 2010. Of the approximately 1400 excavated graves, only a few contained glazed vessels, even though as far as we know the cemetery was used most intensively precisely during the 2nd and 3rd century.

20 The so-called mixing bowls found earlier in the territory of the *Aquincum* Civil Town are no longer considered to have been used for the production of glazed vessels. See T. Nagy, Perióduskutatások az aquincumi polgárváros területén/Erforschung der Periode im Zentral-Gebiete der Zivilstadt von Aquincum. Budapest Régiségei 21, 1964, 50, 53; Bugán 2002, 98.

21 For the latest summary see Bugán 2002, 93–113.

22 Their centres of production may have been in the urban centres of *Pannonia*, since their fragments too appear in the largest numbers from these sites. Popović 2009, 132.

23 Bugán 2002, 103; 105.

24 Lassányi 2007, 108 Fig. 5–6.

25 The photos were taken by Péter Komjáthy.

26 Concerning the vessels, their sacral roles, and the grave context a paper will be published in the near future by G. Lassányi.

27 The drawing is by Fiorella Tortoriello.

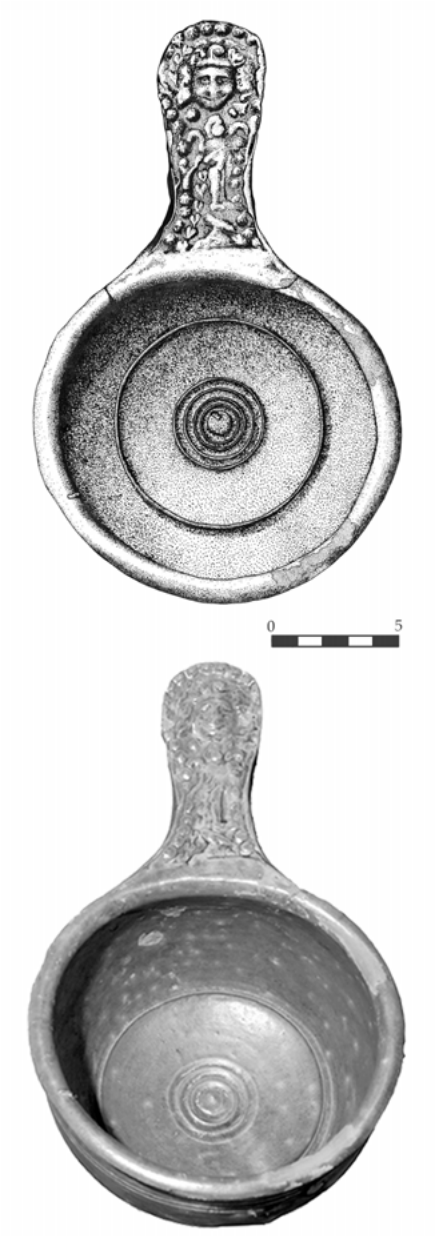

Fig. 4. Casserole with relief decorated handle of the glazed set. – Scale 1:3.

colour, and the sharpness of the relief's contours, etc.) are not uniform,[28] and come from different find-spots in *Aquincum*.[29]

Concerning the samples, we were primarily interested in finding answers for the following questions:

1. The vessels of the set (samples GS1–GS3)
– do they present a uniform picture in terms of raw material as well?
– can their raw material be identified as the local Kiscell clay?
2. The samples of the reference group (samples GP1–GP3)
– do they present a uniform picture in terms of their raw material?
– are they made from Kiscell clay?
– can they be connected to the vessels of the set (samples GS1–GS3) based on their raw material?

Analysis methodology and results

X-ray powder diffraction analysis (XRPD) was carried out with a Philips PW1710 diffractometer (CuKα radiation, graphite monochromator, 45 kV, 35 mA, 1° divergence and detector slit). Chemical composition analysis was performed using X-ray fluorescence with a NITON XL3t 900 (Thermo Scientific), energy dispersive spectrometer (EDXRF Spectrometer) in a He atmosphere.

Raetian ceramics

The raw material in Aquincum is mostly Kiscell clay, characterised by calcareous (calcite, dolomite), and illitic-sericitic-chloritic clay minerals, and its quartz and feldspar content varies between 45 % and 70 %. The iron content is not outstandingly high. The characteristic phases of the mineralogical composition of the ceramic samples (**figs. 5–6**) as determined by X-ray powder diffraction are as follows: quartz, 10Å–phyllosilicate (illite), feldspars (plagioclase, K-feldspar), diopside, gehlenite, spinel, calcite, dolomite, hematite. Based on the proportion of crystalline phases, and the presence and absence of individual phases, a typical picture emerged of the group examined (**figs. 5–6**).

The chemical composition of the ceramic samples is shown by the major elements in **table 3**. The following are typical of the sample group: more than 50 % SiO_2, more than 10 % Al_2O_3, relatively high Fe_2O_3 (4–9 %), and a rather varied count for CaO (0.86–18.71 %). The trace elements (**table 4**), as geochemical fingerprints, form an important part of provenance research. Of the trace elements, the quantity of Zr, Ba, Sr, and Zn reach a value around the limit of detection. Of these, Zr, as an immobile element, proved to be definitive for evaluating the similarities and differences between the samples. In the Zr vs. CaO diagram of a large number of Aquincum ceramics and bricks (**fig. 7**), the group of ceramics made from Kiscell clay can be clearly distinguished (black triangle). The data show a positive match with the findings by G. Schneider et al. in 2007 (Zr ~ 100–250 [ppm]; CaO ~ 6–23 [%]).[30] Taking into account the variability of the poten-

[28] **GP1**: yellowish-brown to yellowish-green, matt, thin, glazed, grey clay body (reddish under the glaze). – **GP2**: yellowish-brown to yellowish-green, matt, thin, glazed, grey clay body (reddish under the glaze). – **GP3**: olive-green, glossy, dark-grey clay body, with a thicker glaze. Samples GP1 and GP2 are of roughly the same quality; the contours of the reliefs are the sharpest on these two. Their glaze is thinner and matt. Their clay body is reddish-grey under the glaze. It seems that their reliefs match each other in the details as well. Hence, we may suspect that the two objects were probably the products of the same workshop. Sample GP3 differs more from the previous objects. The fired clay, the colour of the glaze and its quality are all different. The contours of the relief are more worn, and the surrounding row of rosettes show small differences from the other samples. And thus, this begs the question whether the analysis of the raw material and origin will support these differences and similarities.

[29] As mentioned in the table, one of them was found right at the site of "Gas Factory - Graphisoft".

[30] G. Schneider/M. Daszkiewicz/P. Zsidi/Zs. Ujlaki Pongrácz, Analyses of Roman pottery and lamps from Aquincum and Intercisa. In: K. T. Biró et al (eds.), Vessels: inside and outside. Proceedings of the conference EMAC '07. 9th European Meeting on Ancient Ceramics, 24–27 October 2007, Hungarian National Museum, Budapest, Hungary (Budapest 2010) 123–131 Fig. 1.

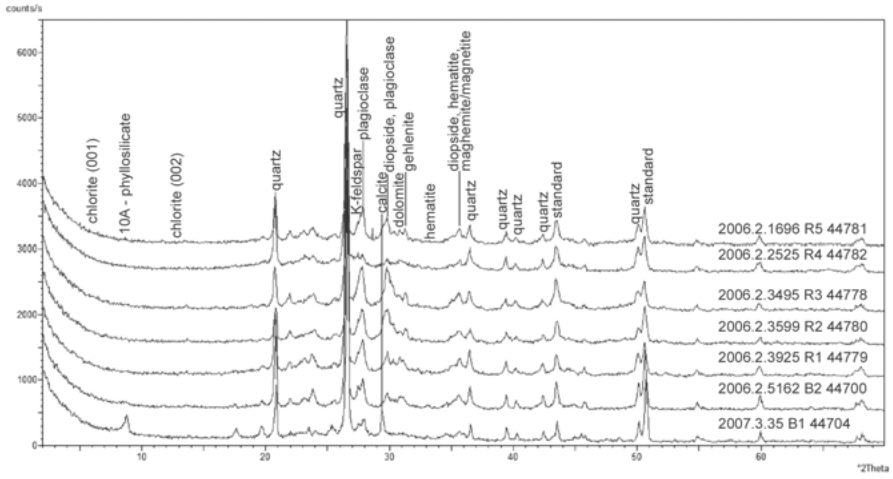

Fig. 5. The X-ray diffractograms of ceramic groups B and R.

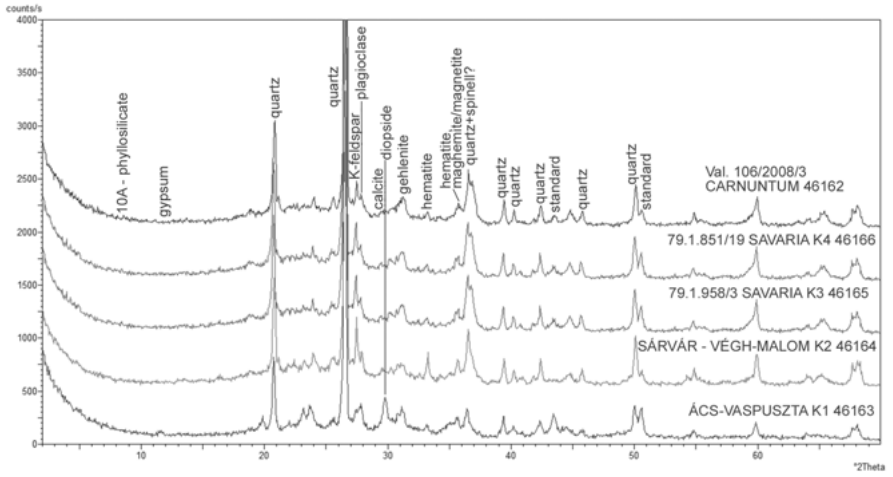

Fig. 6. The X-ray diffractograms of ceramic group K.

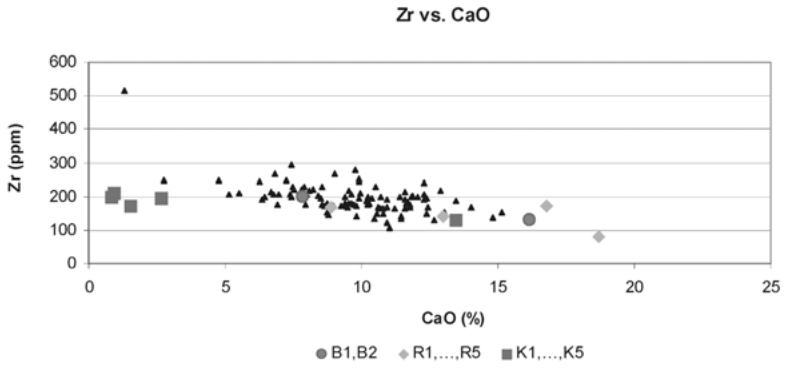

Fig. 7. The Zr/CaO diagram of *Aquincum* bricks and ceramics (black triangle) with the data from examined ceramic sample groups.

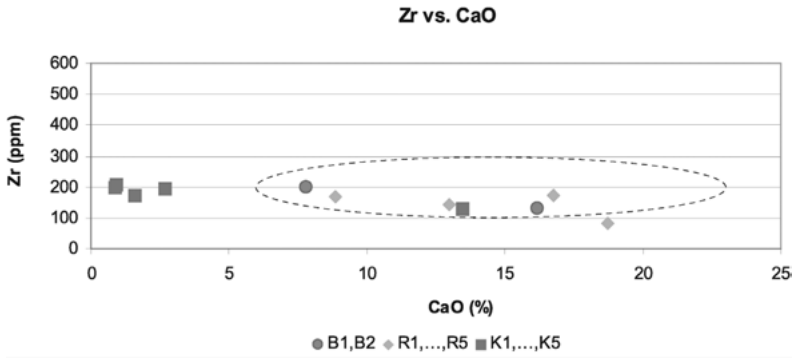

Fig. 8. The Zr/CaO diagram of examined samples. The values of bricks and other ceramics fired from Kiscell-type raw material fall within the area surrounded by the dashed line.

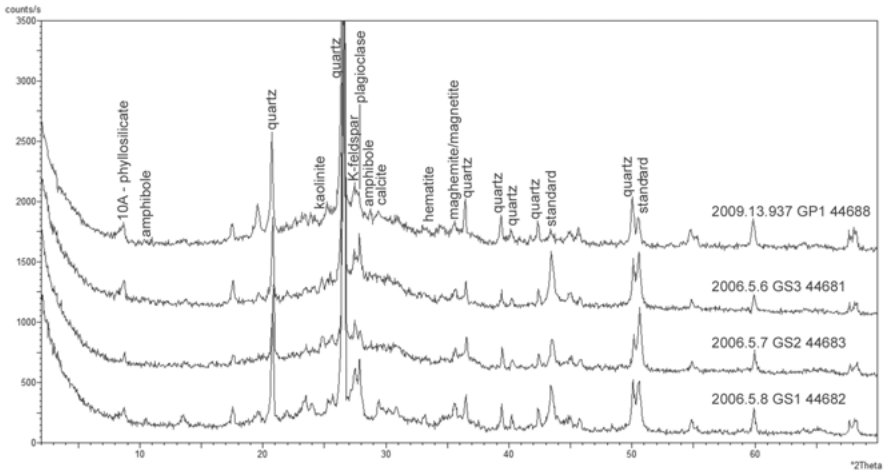

Fig. 9. X-ray diffractograms of glazed ceramics.

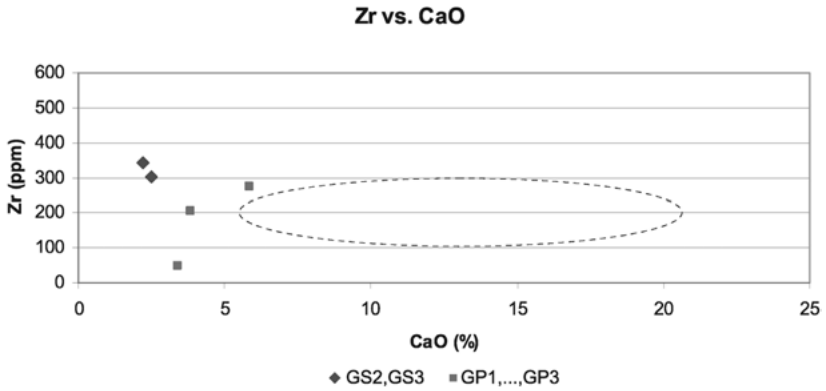

Fig. 10. The Zr/CaO diagram of glazed ceramics.

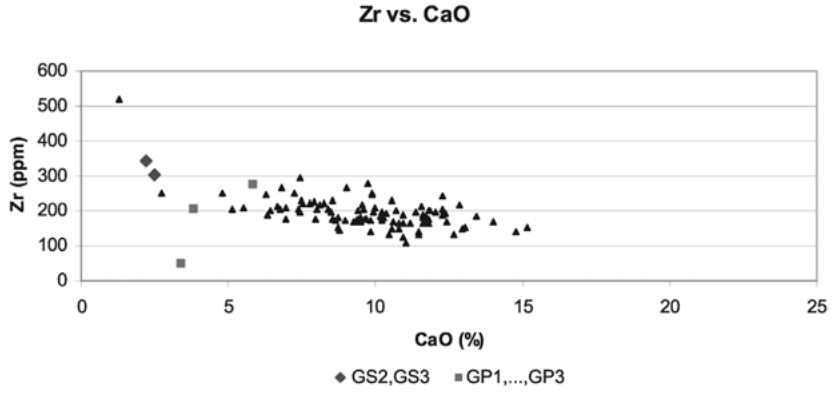

Fig. 11. The Zr vs. CaO diagram of *Aquincum* bricks and ceramics (black triangle) with the data from glazed ceramic samples.

B1	44704	beaker	whole vessel	2007.3.35.	*Aquincum*, Graphisoft
B2	44700	beaker	whole vessel	2006.5.5162.	*Aquincum*, Graphisoft
R1	44779	beaker	base fragment	2006.2.3925.	*Aquincum*, 5 Miklós Square
R2	44780	beaker	rim and wall fragment	2006.2.3599.	*Aquincum*, 5 Miklós Square
R3	44778	beaker	rim and wall fragment	2006.2.3495.	*Aquincum*, 5 Miklós Square
R4	44782	beaker	wall fragment	2006.2.2525.	*Aquincum*, 5 Miklós Square
R5	44781	beaker	rim and wall fragment	2006.2.1656.	*Aquincum*, 5 Miklós Square
K1	46163	?	wall fragment	without number	Ács-Vaspuszta
K2	46164	?	wall fragment	without number	Sárvár-Végh-Malom
K3	46166	cup	wall fragment	79.1.958/3	*Savaria,* JPIR
K4	46165	cup	wall fragment	79.1.752/5, 13...	*Savaria,* JPIR
K5	46162	beaker	wall fragment	Val. 106/2008/3	*Carnuntum*, Valetudinarium

Table 1. Raetian-type ceramic samples from *Aquincum* and from the control group.

GS1	44682	jug	whole vessel	2006.5.8.	*Aquincum*, Graphisoft
GS2	44683	dish	whole vessel	2006.5.7.	*Aquincum*, Graphisoft
GS3	44681	casserole	whole vessel	2006.5.6.	*Aquincum*, Graphisoft
GP1	44688	casserole	handle fragment	2009.19.937.	*Aquincum*, Graphisoft-Dél*
GP2	x0001	casserole	handle fragment	2005.40.634.	*Aquincum*, Keled Street**
GP3	x0002	casserole	handle fragment	89.1.44.	*Aquincum*, Kórház Street***

Table 2. Samples of the glazed set with other casserole handles with similar relief decorations from *Aqiuncum*.
* G. LASSÁNYI, Feltárások az egykori Óbudai Gázgyár területén/Excavation in the area of the former Óbuda Gas Factory. Aquincumi Füzetek 16, 2010, 25–38. – * LASSÁNYI 2007, 73–78. – *** K. SZIRMAI, Barrack-Blocks in the Praetentura of the Legionary Fortress in Aquincum (1987–1988). In: V. A. Maxfield/M. J. Dobson (eds.), Roman Frontier Studies 1989. Proceedings of the XVth International Congress of Roman Frontier Studies (Exeter 1991) 259–262; BARKÓCZI 1992, 7–35; TOPÁL 1993, 245–252 Fig. 8; ID. 1995, 101–113 Fig. 6.8; BUGÁN 2002, 93–113 Fig. 1,2; 2,2.

		SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	K_2O	P_2O_5
B1	44704	51,75	0,91	17,01	7,49	0,04	1,15	16,18	2,88	2,62
B2	44700	58,16	0,94	14,88	7,1	0,05	2,61	7,83	1,88	1,37
R1	44779	62,43	0,33	11,43	4,24	< LOD	3,29	8,87	6,35	< LOD
R2	44780	57,76	0,99	11,1	4,75	0,06	3,3	18,71	2,94	0,38
R3	44778	58,93	1,09	11,07	5,6	0,09	2,81	16,77	3,29	0,34
R4	44782	–	–	–	–	–	–	–	–	–
R5	44781	62,2	1,36	11,45	5,27	#TR	3,5	13	2,96	0,26
K1	46163	58,4	0,81	14,34	5,21	0,05	2,83	13,46	2,85	1,7
K2	46164	64,56	0,83	16,27	7,77	0,12	1,42	2,67	3,29	2,42
K3	46166	64,08	1,08	18,53	9,05	0,12	1,07	1,56	3,49	0,37
K4	46165	58,57	0,97	22,92	8,98	0,14	2,11	0,86	5,26	0,19
K5	46162	66,47	0,83	18,58	7,72	0,18	1,96	0,93	4,41	0,3
GS2	44683	59,01	1,51	17,78	10,3	0,05	2,22	2,19	4,57	0,42
GS3	44681	58,52	1,24	16,88	11,57	0,06	1,54	2,51	4,63	0,56
GP1	44688	61,24	1,51	17,68	10,69	0,09	1,69	3,83	3,28	< LOD
GP2	x0001	64,36	1,25	16,85	9,39	#TR	1,58	3,41	3,25	< LOD
GP3	x0002	62,37	1,39	15,83	9,17	0,07	1,8	5,85	3,53	< LOD

Table 3. The major element composition of the examined Raetian-type and glazed ceramics (wt. %).

		Ba	Co	Cr	Ni	Rb	Sr	Zn	Zr	Nb	Pb
B1	44704	< LOD	< LOD	< LOD	< LOD	14	34	10	129	< LOD	20,19
B2	44700	< LOD	< LOD	280	< LOD	48	181	90	199	18	26
R1	44779	< LOD	< LOD	< LOD	< LOD	26	34	20	168	< LOD	15
R2	44780	64,56	< LOD	< LOD	< LOD	28	142	37	80	< LOD	18
R3	44778	72,44	< LOD	< LOD	< LOD	31	128	30	171	< LOD	54
R4	44782	–	–	–	–	–	–	–	–	–	–
R5	44781	< LOD	< LOD	< LOD	< LOD	23,64	77	36	141	< LOD	9
K1	46163	270	< LOD	91	37	< LOD	147	94	131	< LOD	23
K2	46164	482	< LOD	124	81	< LOD	94	125	194	< LOD	< LOD
K3	46166	330	< LOD	224	< LOD	84	88	89	171	17	53
K4	46165	487	< LOD	95	72	< LOD	85	82	197	< LOD	< LOD
K5	46162	539	< LOD	114	72	< LOD	91	126	209	< LOD	< LOD
GS2	44683	465	< LOD	147	< LOD	83	87	129,6	342	21	9906
GS3	44681	380	< LOD	86	< LOD	64	79	150,33	304	20	13776
GP1	44688	594	< LOD	308	75	89	90	127	207	22	545
GP2	x0001	< LOD	< LOD	162	< LOD	19	28	39	49	< LOD	4719
GP3	x0002	612	< LOD	263	< LOD	72	114	113	274	22	230

Table 4. The trace element composition of the examined Raetian-type and glazed ceramics (ppm).

tial raw material, it can be seen that the difference between samples in groups B and R is not larger than the difference between ceramics and bricks made from local clay (see the part surrounded by the dashed line on **fig. 8**); samples of group K – with the exception of K2 – are, however, clearly distinct. Samples in groups B and R are very likely made from local Kiscell-type raw material. Based on both their phase composition and chemical composition, these vessels do not appear to be imported products.

Glazed ceramics

In the phase composition of glazed ceramics, the dominant component is quartz. In smaller quantities they also contain plagioclase, K-feldspar, and 10Å–phyllosilicate phases. In subordinate quantities we found amphibole, hematite, gypsum, kaolinite, and traces of calcite. Among the fired ceramics, the gehlenite and diopside phases, expected at this firing temperature, are absent (**fig. 9**). Kaolinite found in samples GS2 and GS3 is also not found in the Kiscell raw material. The proportion of plagioclase to K-feldspar is varied: in samples GS3 and GS1 the amount of plagioclase is greater than that of the K-feldspar. Sample GS2 shows similarities in this regard with sample GP1. The 10Å–phyllosilicate has an illitic character.

A large degree of similarity is characteristic of the major elements in the chemical composition of the samples (**table 3**). The low CaO content (< 5 %) implies a non-calcareous, or low-calcareous raw material. The quantity of SiO_2 is slightly higher in samples GS2 and GS3 compared to samples in group GP. In the samples of the glazed group we have measured a slightly higher content of Fe_2O_3 compared to the local unglazed ceramics. Larger differences can be seen among the trace elements (**table 4**). The quantity of Ba is exceptionally high – excluding sample GP2. In the case of samples in group GP, the lower content of K_2O and the quantity of P_2O_5 below the limit of detection is conspicuous. Sample GP2 differs from the other samples based on its Zr content as well (**figs. 10–11**). Due to the higher value of Zr and low value of CaO, the ceramics examined cannot be considered as fired from Kiscell clay. Sample GP3 comes closest to the Kiscell range. The GS samples form a separate group: in effect they can be considered as made from a non-calcareous raw material. Yet, are the higher values of SiO_2 and Fe_2O_3 due to tempering or the mixing of raw materials (a material containing Fe_2O_3)? This is a highly important question in researching the provenance of terra sigillata quality ceramics in *Aquincum*[31], but further analyses are required. If we assume that there was no tempering, then, based on the results of phase and trace element analysis, we suspect that the raw material was not the Kiscell clay, and thus the vessels were probably made elsewhere.

Conclusions

The already large amount of data from earlier analyses of Kiscell clay and the Roman-period vessels made from it served as the basis for comparison with the new mineralogical (XRD) and chemical (XRF) analyses. In the case of both Raetian beakers (B1 and B2) the analysis has shown that they are imitations made from local (Kiscell) clay. It was, however, surprising that the samples from the reference group, too, for the most part belonged to the so-called "*Aquincum* range";[32] based on both their phase composition and chemical composition, they can very likely be considered local products. As we have mentioned above, in the reference group we only included high-quality vessels with metallic slip, which were of significantly higher quality than the beakers B1 and B2.[33] The results of the analyses – which we sought to support with control analyses – therefore support the hypothesis that, as in *Poetovio*, *Vindobona*, and *Savaria*, there was at least one workshop (or perhaps more) in

[31] P. Vámos, Some remarks on military pottery in Aquincum. Acta Arch. Acad. Scien. Hungaricae 63, 2012, 395–406.

[32] Sample R4, with a lower quantity of Zr, fell slightly out of the *Aquincum* range, but based on the analysis, this difference may be ascribed to the potential variations within the same raw material. In the case of sample R5, the chemical analysis was unsuccessful due to measurement errors; unfortunately it could not be repeated.

[33] The sharp difference in quality between samples B1–B2 and R1–R5 might be explained on the one hand with a price difference (cheaper and more expensive products), or, on the other, with a difference in the technical skill of the particular workshops.

Aquincum – albeit its location is unknown – which produced imitations of imported Raetian ware. The quality of the products, as it seems, could reach a rather high level, which also reminds us, just how careful we must be, when identifying Raetian-type vessels as imported products.

The study, however, is not complete. First of all, we could only examine a limited number of finds, and second, in the reference group we were able to analyse the ceramic finds of only a single site in the *Aquincum canabae*. In the future, therefore, a wider examination of the finds from *Aquincum* will be necessary, which employs a larger quantity of samples from multiple sites.This will be a great help in establishing the types and chronology of *Aquincum* products, and perhaps it may bring us closer to the identification of the workshop or workshops.

In the case of both the glazed set (GS1–GS3), and the casserole handles of the reference group (GP1–GP3), however, the analyses did not indicate a local origin. Although the vessels of the set certainly come from the same workshop, based on the findings of the analyses, their place of production has to be located elsewhere. The reference samples with reliefs matching that of the casserole of the set are probably also not local in origin, even though in *Pannonia* it is in *Aquincum* that the largest number of similar objects have currently been found.[34]

The results for the vessels of the set seem more straightforward: since they are made of an, in effect, non-calcareous material, they are more clearly distinct from the parameters of the local raw material. The picture is, however, not as clear in the case of the reference group. The chemical composition of these samples showed a greater variety compared to the so-called *Aquincum* range. It is interesting that of the reference samples precisely the apparently highest-quality fragment (GP3) fell closest to the "*Aquincum* zone" in the graph. On the other hand, samples GP1 and GP2, which more closely matched the visual quality of the Gas Factory objects – considered to be waste products by A. Bugán –, differed more from the Zr vs. CaO values characteristic of local ceramics. Nevertheless, the negative results for local production do not, of course, preclude the possibility that glazed casseroles and other glazed vessels different from those discussed here could have been produced in *Aquincum* as well, and indeed the results published here need to be supplemented. In order to answer the still open questions we must publish the vessels and their context, and we must certainly expand the examined group of glazed samples and, in the light of the present results, expand the provenance research as well.

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[34] Previously we only knew of one such relief-decorated fragment from *Aquincum* (GP3), but thanks to the excavations in recent years our collection increased with three further pieces (samples GS3, GP1, GP2). Thus, in *Pannonia*, as far as we know, there are four glazed objects from *Aquincum*, and there is another unglazed object coated with the traces of whitish engobe from *Sirmium*. See POPOVIĆ 2009, 121 Fig. 2.

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