GERWULF SCHNEIDER, MALGORZATA DASZKIEWICZ

IMPORTED AND LOCAL FIRMALAMPEN IN AQUILEIA: CHEMICAL ANALYSES BY WD-XRF

Some 1800 Firmalampen from Aquileia are published in the catalogue by Ezio Buchi [1]. The attribution of these lamps by archaeological methods to their places of production is limited, even in the case of Firmalampen bearing lampmakers' marks. Most of the potters' names on these stamps are known from many finds at Roman sites. A large part of them is believed to originate from the Modena region, as indicated on some stamps giving Mutina as their place of production. The same names of these North-Italian potters also, however, occur on lamps which were certainly local products, made at various sites, including Aquileia. The name stamps on some other lamps, because of their limited number and the fact that they appear only in Aquileia, suggest that these lamps were produced in Aquileia. The typology of the Firmalampen is very simple. Loeschcke (1919) distinguishes type IX and the later type X. Buchi (1975) makes a further classification into seven forms: IXa, IXb, IXc, Xa, Xb, Xc and X short.

Chemical analysis is a powerful means of determining the provenance of pottery. It has also been used to identify the production centres of Firmalampen [2]. Therefore, together with Franca Maselli Scotti, we concluded that a series of chemical analyses by wavelength-dispersive X-ray fluorescence (WD-XRF) would help to identify the locally produced lamps and the imports, and to establish a reference group for lamps produced in Aquileia. Ninety-five samples were selected for analysis [3]. These included three moulds, two of Cresces, and 74 Firmalampen featuring makers' stamps (tabs. 1 and 2).

Most samples were taken by drilling with tungsten carbide drills of one to two millimetres diameter, the resultant powders subsequently being prepared for analysis [4]. The results were classified taking into account all significant elements and using multivariate cluster analysis. Initially, two major groups were distinguished: imports from Modena (tab. 3) and other products (tab. 4).

Imports from Modena

Firmalampen of Loeschcke's technique A and B were produced in the region of Modena. This is clear both from archaeological evidence and from chemical data. Our database now includes 421 analyses of Firmalampen chemically attributed to Modena. The stamps on these lamps are of the well known North-Italian lampmakers, and cover a period from about the mid-1st to the 3rd century AD. Finds have been analysed from the region of Modena, as well as from other sites in Italy and the northern Roman provinces [5].

The lamps ascribed to techniques A and B are characterized by their predominantly high quality and orange to brick-red colours caused by iron contents of between 5 and 9% Fe_2O_3 and by low calcium contents, mostly below 2% CaO. Higher calcium contents were very probably caused by absorption of calcite during the course of deposition. Lamps from Modena never have an applied slip and very rarely have a handle which, when present, is always a strap handle [6] that differs significantly from the handles of lamps representing Loeschcke's technique D, produced and widespread in the provinces of Germania and Belgica, but not noted at Aquileia.

In the dendrogram (fig. 1) obtained from multivariate cluster analysis, nearly all lamps from Modena are confined to one compact group. The two separated samples with enriched calcium contents (tab. 3: E451, E468) have high ignition losses (l.o.i.) indicating that these samples are strongly weathered, which would have caused the high phosphorus content in E468. The small compositional diffe-

Lab.-No.	Inv.-No.	Buchi-Cat.No.	Stamp	Type
E447	7105	69	ATIMETI	-
E446	7106	70	ATIMETI	-
E448	6500	77	ATIME	-
E445	7137	106	CASSI	-
E444	9366	127	CERIAL[IS]	-
E455	560	133	COMES	Xa
E458	6391	139	[COM]MVNIS	IXb
E457	6392	163	COMMVNIS	IXc
E456	73409	176	COMVNI	-
E434	73353	237	CRESCE/S	Xa
E451	6415	241	CRESCE/S	Xa
E430	6420	244	CRESCE/S	Xa
E450	7229	256	CRESCE/S	Xa
E433	49151	257	CRESCE/S	Xa
E431	73338	289	CRESCE/S	Xb
E405	6211	415	FORTIS	IXb
E469	6709	435	FORTIS	IXb
E470	6782	436	FORTIS	IXb
E415	6372	455	FORTIS	IXc
E414	6210	474	FORTIS	Xa
E413	6330	477	FORTIS	Xa
E406	6805	539	FORTIS	Xa
E411	6814	542	FORTIS	Xa
E409	6751	598	FORTIS	Xa
E407	73364	656	FORTIS	Xb
E441	6755	673	FORTIS	-
E439	7164/41	685	FORTIS	-
E402	7164/63	705	FORTIS	-
E440	7219	711	FORTIS	-
E412	73401	714	FORTIS	-
E420	9359	730	[FRO]NTO	
E468	73343	791	QGC	-
E417	73340	812	IANVAR	Xb
E419	7164/15	828	IEGIDI	X short form
E423	6507	835	L.L.C	Xa
E435	7164/30	842	L.L.C	-
E418	6518	852	LITOGENE	-
E462	6237	890	NERI	Xa
E463	7164/18	897	NER[I]	Xa
E477	6406	909	OCTAVI	Xa
E476	6644	910	OCTAV[I]	Xa
E461	6513	947	PHOETASPI	IXb
E465	7177	1000	STROBILI	IXb
E466	73333	1003	STROBILI	IXb
E464	6495	1013	STROBILI	-
E443	7164/25	1034	VERECVN	-
E720	without inv.no.	-	-	-
E722	without inv.no.	-	-	-
E723	without inv.no.	-	-	-
E726	without inv.no.	-	-	-
E727	without inv.no.	-	-	-
E728	without inv.no.	-	-	-
E731	without inv.no.	-	-	-
E734	without inv.no.	-	-	-
E735	without inv.no.	-	-	-

Tab. 1. *List of analysed samples classified after analysis as imports.*

Lab.-No.	Inv.-No.	Buchi-Cat.No.	Group	Stamp	Type
B221	7541	1583	A1	CRESCE/S	mould
E401	6846	641	A1	FORTIS/o	Xa
E416	7544	1584	A1	CRESCE/S	mould frgt
E422	73371	381	A1	FELICI	-
E429	6740	651	A1	FORTIS	Xb
E442	7692	1207	A1	VIBI[ANI]	-
E449	6359	719	A1	FORTIS/o	-
E452	6993	280	A1	CRESCE/S	Xb
E459	7164/20	1227	A1	PAR/T	Xb
E732	without inv.no.		A1	--	
E733	without inv.no.		A1	--	
L506	Mün. 3174	(page 21)	A1	CIIPII/RII/IVS	Xb
E471	6936	1105	A2	VIBIANI	Xa
E472	73355	1165	A2	VIBIANI	Xb
E473	7164/28	1205	A2	VIBIANI	-
E721	without inv.no.		A2	--	
E410	6813	605	A3	FORTIS/o	Xa
E404	73359	572	A4	FORTIS/o	Xa
E725	without inv.no.		A5		
B220	7543	1586	C1	--	mould Xc
E403	6743	517	C1	FORTIS/o	Xa
E425	73446	386	C1	FELIX	-
E432	6994	297	C1	CRESCE/S	Xc
E436	7164/10	311	C1	CRESCE/S	Xc
E437	7091	125	C1	CERIALIS	X short
E438	without inv.no.		C1	--	
E453	7228	285	C1	CRE[SCE]/S	Xb
E467	6486	770	C1	QGC	Xc
E474	6223	1195	C1	[VIB]IANI	-
E475	52839	1178	C1	VIBIANI	Xc
E478	73393	1446	C1	--	Xc
E730	without inv.no.		C1		
E421	6533	377	C2	FELICIO	Xc
E424	7164/31	843	C2	L.L.C.	-
E454	7509-114	1413	C2	--	Xc
E460	7136	1226	C2	PAR/T	Xb
E724	without inv.no.		C2	--	
E729	without inv.no.		C2	--	
E718	without inv.no.		C3	--	
E408	6726	426	C4	FORTIS	IXb
E719	without inv.no.		C5	--	
Import from Poetovio					
E428	6824	638	Poet	FORTIS	Xa (Xc?)
Wasters found in Aquileia					
F565			C1	--	lamps
F942	without inv.no.		C2	--	handle
E426			C1	--	pareti sottili
Find in Aquincum					
E676	Aqc. 32140 (D22)		A1	CRESCE/S	
Finds in Poetovio					
E574	LMJ 4690		C2	ASPE	Xa/b
E578	LMJ 8244		A1	FORTIS	Xb

Tab. 2. *List of analysed samples classified after analysis as local products.*

Lab.-No.	Major elements in percent oxide										Trace elements in ppm													l.o.i.	Total
	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	V	CR	NI	(CU)	ZN	RB	SR	(Y)	ZR	(NB)	BA	(CE)	(PB)	%	%
E 402	64.58	1.130	20.61	8.01	0.077	1.17	1.96	1.11	1.18	0.17	72	146	85	40	74	86	82	30	304	19	338	89	51	6.19	98.27
E 405	64.55	1.004	21.17	8.17	0.101	1.53	1.13	0.88	1.38	0.08	101	157	82	24	79	87	72	36	261	18	396	107	51	0.01	98.29
E 406	66.60	0.948	19.42	7.50	0.049	1.57	1.26	0.93	1.67	0.05	145	152	75	26	73	104	87	40	239	21	425	117	83	1.18	98.70
E 407	65.62	0.988	20.90	7.44	0.034	1.25	1.17	0.93	1.56	0.12	105	154	56	34	67	97	81	29	272	18	383	79	81	2.23	98.42
E 409	66.03	0.969	19.66	7.32	0.033	1.46	1.61	1.32	1.53	0.07	137	155	82	43	68	106	91	38	267	21	397	110	55	1.18	99.65
E 411	67.49	1.065	19.88	7.10	0.038	1.29	0.73	0.92	1.39	0.09	97	136	58	23	70	86	71	34	317	16	387	50	59	2.28	99.16
E 412	70.17	0.863	16.54	6.90	0.053	1.29	1.11	1.25	1.72	0.10	126	160	60	35	66	98	83	38	285	16	373	106	84	1.12	100.50
E 413	68.44	0.909	18.87	6.30	0.059	1.46	1.00	1.25	1.66	0.06	111	116	51	46	74	98	92	33	284	17	422	83	143	1.74	99.08
E 414	67.97	0.942	18.41	6.87	0.053	1.17	1.90	1.04	1.58	0.08	114	140	62	35	65	100	84	35	276	21	406	71	79	2.17	98.00
E 415	65.40	1.045	20.20	8.03	0.036	1.63	1.44	0.88	1.25	0.09	124	160	77	23	68	82	85	39	278	20	344	98	57	2.26	98.34
E 417	65.42	0.987	20.56	7.64	0.044	1.35	1.42	0.84	1.67	0.06	118	144	60	55	67	129	88	24	244	23	432	45	69	1.45	97.12
E 418	66.48	0.956	19.62	7.66	0.028	1.21	1.44	0.91	1.64	0.06	127	153	64	43	69	103	80	32	262	18	411	89	70	1.42	99.59
E 419	66.17	0.990	19.65	6.96	0.046	1.45	2.19	0.84	1.63	0.08	115	143	71	73	81	95	84	36	275	22	419	53	62	3.26	99.15
E 420	67.11	0.943	19.61	7.41	0.035	1.44	1.07	0.97	1.33	0.09	133	153	54	21	73	87	75	32	253	19	325	65	64	1.92	97.32
E 423	67.02	0.987	19.61	7.15	0.030	1.28	1.01	0.91	1.94	0.06	83	141	62	23	70	104	78	20	271	16	434	75	67	1.84	96.84
E 430	67.51	0.947	19.50	7.21	0.065	1.28	0.94	0.67	1.80	0.08	135	129	61	30	63	88	77	42	244	19	415	76	54	2.58	101.15
E 431	64.95	0.986	19.47	9.39	0.091	1.24	1.49	0.83	1.44	0.12	147	164	58	39	64	113	78	29	273	19	342	75	79	1.84	96.18
E 433	64.97	0.973	20.40	7.24	0.029	1.32	2.63	0.92	1.44	0.09	138	149	48	31	67	99	86	31	270	21	385	67	68	2.87	97.31
E 434	65.34	0.978	20.95	7.33	0.028	1.36	1.59	0.90	1.46	0.07	133	134	59	22	65	103	82	30	268	21	412	102	72	2.29	100.79
E 435	66.20	0.983	20.53	7.29	0.039	1.38	0.87	0.90	1.74	0.07	126	156	64	27	74	111	82	30	249	13	432	79	79	1.40	99.80
E 439	67.35	1.016	19.31	7.39	0.028	1.38	1.00	1.01	1.44	0.08	132	161	68	41	71	103	89	39	290	21	411	88	75	1.28	100.26
E 440	66.77	0.915	19.40	7.07	0.046	1.62	0.93	1.27	1.92	0.06	127	146	55	20	71	106	96	33	266	10	450	35	60	0.64	101.28
E 441	66.04	0.950	19.96	7.85	0.086	1.53	0.99	1.00	1.52	0.08	120	162	85	61	76	105	79	37	252	17	430	68	89	1.38	99.90
E 443	65.20	0.927	20.18	7.56	0.051	1.97	1.30	0.99	1.58	0.24	147	167	104	44	84	102	93	30	217	15	406	77	57	2.22	100.10
E 444	67.44	0.966	19.34	6.78	0.029	1.30	1.28	1.09	1.74	0.04	115	142	61	51	69	116	92	29	288	17	424	59	104	1.52	100.71
E 445	66.23	0.989	20.51	6.70	0.034	1.38	1.25	1.06	1.73	0.13	130	149	64	36	73	120	95	27	229	19	481	47	65	1.85	100.27
E 446	65.11	1.034	21.05	8.13	0.032	1.40	0.95	0.92	1.25	0.14	136	163	73	35	76	86	77	33	272	23	350	66	87	2.01	100.36
E 447	68.35	0.751	17.15	6.20	0.048	1.81	2.58	1.27	1.70	0.14	123	138	67	65	70	106	114	24	234	18	390	84	130	2.34	101.10
E 448	67.39	0.948	19.63	7.16	0.065	1.30	0.94	0.70	1.80	0.08	136	137	65	36	62	108	81	33	265	18	452	76	69	0.61	101.06
E 450	65.48	0.973	20.17	7.75	0.035	1.30	1.71	0.89	1.64	0.07	140	153	64	41	75	108	86	28	270	24	401	81	58	2.35	99.15
E 455	65.21	0.995	20.28	7.26	0.035	1.28	2.09	0.90	1.71	0.24	127	144	60	54	83	106	90	31	273	22	426	69	82	4.70	96.40
E 456	64.17	0.889	20.00	7.62	0.040	1.92	2.15	1.06	2.06	0.10	129	180	72	59	85	122	106	34	230	17	476	51	81	2.65	98.86
E 457	68.92	0.834	17.25	6.60	0.106	1.66	0.93	1.75	1.87	0.09	122	157	83	51	75	111	104	36	223	16	437	88	67	4.02	99.37
E 458	64.28	0.928	20.70	8.08	0.035	1.73	1.33	0.99	1.85	0.08	120	160	64	42	78	110	90	30	255	17	448	76	66	2.20	98.80
E 461	66.35	0.918	19.40	7.37	0.051	1.94	1.29	0.98	1.64	0.06	113	160	83	31	83	105	94	37	218	18	440	60	41	1.97	99.80
E 462	65.50	0.921	19.41	7.34	0.056	1.58	2.27	0.91	1.92	0.10	127	145	72	41	74	116	103	34	235	17	416	82	73	1.43	96.71
E 463	67.41	0.950	19.21	6.65	0.041	1.10	1.82	0.90	1.81	0.12	108	126	71	57	72	109	103	29	262	23	509	92	473	4.48	99.60
E 464	65.12	0.942	20.59	7.72	0.029	1.67	1.47	0.99	1.31	0.17	108	155	67	23	76	81	79	34	235	19	292	100	54	3.86	98.40
E 465	67.34	0.993	19.60	7.43	0.049	1.34	0.90	0.74	1.40	0.21	127	144	68	31	75	90	76	33	262	21	385	71	63	1.35	98.60
E 466	66.70	0.857	19.84	7.69	0.036	1.42	0.99	1.03	1.23	0.22	117	140	64	38	69	80	76	33	235	18	313	84	73	2.43	98.12
E 469	65.37	0.916	18.83	7.96	0.039	1.48	1.80	1.03	1.91	0.68	115	149	82	41	76	101	114	36	214	16	500	87	91	6.25	99.45
E 470	65.58	0.903	18.82	7.27	0.066	2.00	2.30	0.97	1.87	0.23	127	145	79	37	79	115	102	38	213	20	412	71	76	4.67	99.19
E 476	66.55	1.024	20.09	7.21	0.043	1.32	0.91	0.92	1.85	0.08	116	127	58	36	72	101	77	28	268	16	479	27	65	2.33	97.40
E 477	66.37	0.929	19.46	7.78	0.039	1.64	1.12	1.01	1.56	0.09	135	154	70	44	77	105	91	35	233	22	393	79	52	2.49	99.69
E 720	66.02	0.908	20.19	7.37	0.033	1.63	1.22	0.83	1.73	0.06	136	145	93	48	108	126	86	35	206	20	432	95	40	1.17	100.02
E 722	64.90	0.952	20.47	7.91	0.048	1.86	1.00	0.96	1.84	0.07	105	168	86	44	93	107	85	29	230	20	361	76	57	2.27	100.64
E 723	67.58	0.945	19.12	7.11	0.035	1.16	1.19	1.05	1.76	0.04	125	135	69	37	64	119	83	31	270	21	410	99	84	0.82	100.28
E 726	67.08	0.898	18.56	6.78	0.035	1.81	1.70	1.13	1.94	0.07	122	150	77	42	76	129	102	31	215	22	417	73	23	1.21	100.24
E 727	65.30	0.857	20.03	8.37	0.093	1.24	1.54	0.97	1.55	0.05	136	146	81	39	66	111	78	30	213	19	444	93	39	1.12	100.60
E 728	68.90	0.988	18.18	6.36	0.075	1.61	0.93	1.00	1.88	0.08	112	137	72	30	87	122	91	26	245	24	424	82	50	0.85	100.75
E 731	66.63	1.006	19.85	7.96	0.038	1.40	0.85	0.89	1.30	0.07	140	147	88	39	63	99	79	37	276	22	353	95	45	1.80	100.66
E 734	66.51	1.016	20.25	7.46	0.040	1.26	0.73	0.86	1.80	0.08	114	135	75	43	86	109	75	31	279	22	384	67	69	1.60	100.98
E 735	68.24	1.031	19.54	6.80	0.025	1.11	0.77	0.86	1.59	0.04	116	134	61	31	68	107	74	27	302	21	374	76	45	0.91	100.46
mean	66.40	0.956	19.66	7.39	0.047	1.46	1.36	0.98	1.63	0.11	122	148	70	39	74	104	87	32	256	19	408	78	76	2.15	
std ±	1.31	0.062	0.94	0.57	0.020	0.23	0.49	0.17	0.22	0.09	15	12	11	12	8	12	10	4	26	3	45	19	59	1.29	
cv %	2.0	6.5	4.8	7.7	41.9	15.9	35.9	17.5	13.3	86.8	12.1	8.1	16.5	30.2	11.3	11.6	12.0	13.6	10.2	14.7	11.0	24.0	77.9	59.8	
E 451	61.49	1.055	22.85	8.05	0.035	0.93	3.16	0.97	1.34	0.13	95	162	72	30	72	98	111	29	265	15	474	67	81	11.36	97.08
E 468	63.22	0.933	19.05	9.29	0.077	0.83	2.38	0.86	1.54	1.81	101	140	64	65	81	87	140	23	262	13	516	54	133	9.42	100.43
Modena: mean and standard deviation of 421 analyses:																									
mean	66.44	0.971	19.71	7.35	0.038	1.41	1.24	1.00	1.68	0.17	122	153	68	43	77	116	95	32	287	20	439	83	73	1.83	
std ±	1.53	0.070	1.07	0.63	0.031	0.24	0.58	0.16	0.23	0.29	18	15	20	27	11	22	26	5	45	7	73	20	102	1.53	

Tab. 3. *Results of chemical analysis by WD-XRF (ignited samples with l.o.i. = ignition loss at 900°C): imported lamps from Modena.*

rences are, however, big enough to exclude these two analyses from the main group. Four samples (E472, E721, E471, E473, E410) denoted as group A2 in the dendrogram, are included in the large Modena group. These samples will be discussed in the next chapter.

The mean and standard deviations (std) of the group of Modena lamps from Aquileia almost corresponds with those calculated from the 421 analysed Modena lamps (tab. 3). The coefficients of variation (cv) show that there are very large variations in manganese (MnO), calcium (CaO), phosphorus (P_2O_5), copper (Cu) and lead (Pb) – elements which may have been affected by their post-deposition conditions.

The 46 stamps on the 55 imported lamps from Modena do not reveal anything unexpected. With the sole exception of Comes, all stamps have already been confirmed by previous analyses to represent the names of lampmakers in Modena. The presence of 15 lamps of Fortis within the analysed series from Aquileia reflects the fact that, as at other sites, a large number of lamps produced by this most prolific potter were found at Aquileia and, also, that our

Lab.-No.	Major elements in percent oxide										Trace elements in ppm													l.o.i.	Total
	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	V	CR	NI	(CU)	ZN	RB	SR	(Y)	ZR	(NB)	BA	(CE)	(PB)	%	%
Non-calcareous group A1																									
B 221*	69.78	0.818	13.82	5.76	0.185	1.77	3.63	1.58	2.26	0.19	142	270	116	23	77	115	115	41	215	9	300	88	133	2.82	99.96
E 401	61.24	0.929	21.06	7.33	0.052	2.00	4.19	0.86	2.23	0.12	145	153	67	49	87	132	161	32	175	18	516	81	54	2.88	100.27
E 416*	70.16	0.894	15.24	6.54	0.141	1.77	1.44	1.21	2.41	0.21	138	198	101	32	79	104	97	38	199	18	348	108	44	1.55	99.74
E 422	64.52	0.949	20.06	8.18	0.087	1.55	1.84	0.40	2.21	0.20	183	225	101	62	104	113	80	53	172	26	362	126	93	2.62	99.36
E 429	63.72	1.039	18.65	7.02	0.074	2.67	2.25	1.44	2.93	0.22	125	125	73	63	99	120	140	44	255	21	558	80	103	1.81	98.33
E 442	66.37	0.942	16.70	8.05	0.301	1.96	2.13	1.02	2.20	0.31	164	260	172	62	93	128	93	31	188	11	455	64	74	2.24	100.58
E 449	61.91	1.079	20.25	8.99	0.133	1.85	3.57	0.70	1.39	0.16	171	273	128	79	116	84	66	39	299	18	259	61	69	4.52	99.90
E 452	67.23	0.927	16.30	7.97	0.176	1.97	2.16	0.96	2.21	0.11	157	246	137	55	90	129	92	33	188	21	410	33	90	2.78	97.86
E 459	60.39	1.001	19.60	7.80	0.117	2.71	4.70	0.91	2.37	0.40	178	192	102	51	106	140	114	42	241	18	390	114	72	2.89	98.62
E 732	63.58	0.948	19.09	7.53	0.126	2.77	2.00	0.89	2.71	0.36	113	197	110	54	104	126	81	37	193	18	326	81	32	3.14	100.46
E 733	64.87	0.903	16.60	6.42	0.091	3.09	3.18	1.66	3.05	0.15	114	166	81	55	87	143	101	32	196	19	306	85	44	1.93	100.59
mean	64.89	0.948	17.94	7.42	0.135	2.19	2.82	1.06	2.36	0.22	148	210	108	53	95	121	104	38	211	18	385	84	73	2.65	
std ±	3.09	0.068	2.23	0.89	0.065	0.49	1.02	0.36	0.42	0.09	23	47	29	14	12	16	26	6	37	4	89	25	28	0.77	
cv %	4.8	7.2	12.4	11.9	48.5	22.4	36.2	34.3	17.9	41.8	15.8	22.6	26.7	27.2	12.1	13.3	25.5	16.3	17.6	24.6	23.2	29.8	38.8	29.0	
Non-calcareous group A2																									
E 471	64.37	0.980	20.57	8.93	0.027	1.42	1.11	0.34	2.14	0.12	138	179	55	47	56	107	86	29	170	14	307	61	71	2.17	98.32
E 472	68.39	0.992	17.63	8.03	0.068	1.17	1.47	0.27	1.90	0.09	135	182	78	53	77	108	84	32	188	16	317	64	74	2.63	97.64
E 473	66.21	0.964	18.10	7.84	0.019	1.35	3.15	0.27	1.98	0.11	160	170	54	57	54	101	88	25	183	13	256	63	95	3.42	99.46
E 721	67.25	0.990	18.14	8.05	0.022	1.12	2.05	0.27	2.01	0.10	131	170	57	61	48	109	88	23	197	20	217	78	34	2.13	99.98
mean	66.55	0.982	18.61	8.21	0.034	1.26	1.95	0.29	2.01	0.11	141	175	61	55	59	106	87	27	185	16	274	67	69	2.59	
std ±	1.71	0.013	1.33	0.49	0.023	0.14	0.89	0.04	0.10	0.01	13	6	11	6	13	4	2	4	11	3	47	8	25	0.60	
cv %	2.6	1.3	7.1	5.9	67.1	11.3	46.0	12.4	5.0	11.9	9.2	3.5	18.7	11.0	21.5	3.4	2.2	14.8	6.1	19.7	17.0	11.7	37.0	23.2	
Not matching the major non-calcareous groups																									
E 404	74.07	0.852	14.02	5.35	0.028	1.49	0.39	1.41	2.35	0.06	109	184	53	57	68	95	75	26	278	14	232	80	54	1.41	99.76
E 410	67.31	1.170	19.89	5.36	0.037	0.91	2.46	0.29	2.43	0.15	117	114	41	22	73	117	77	36	290	18	451	88	80	3.03	99.50
E 725	57.93	0.907	22.81	7.68	0.121	2.30	2.66	0.74	4.68	0.17	130	92	56	43	138	226	124	38	192	24	705	121	113	2.63	100.64
Calcareous group C1																									
B 220*	57.06	0.783	14.14	6.03	0.078	5.50	12.30	1.23	1.96	0.93	131	196	95	118	119	104	194	33	165	13	230	71	25	8.90	100.30
E 403	49.28	0.662	13.02	5.61	0.178	5.24	22.34	1.02	2.14	0.51	87	129	73	64	77	139	186	24	136	7	285	50	64	13.63	99.58
E 425	56.57	0.817	14.77	6.74	0.148	5.26	12.64	0.49	1.96	0.61	111	184	101	76	123	83	161	36	149	12	385	91	214	3.61	101.75
E 432	55.25	0.825	15.94	7.10	0.162	3.68	13.04	0.69	2.65	0.67	122	178	110	63	97	121	179	32	129	16	395	76	86	9.49	101.16
E 436	57.54	0.744	14.50	5.77	0.099	4.64	13.30	0.92	2.13	0.36	109	152	92	98	90	94	146	36	148	15	283	67	218	17.35	99.82
E 437	53.77	0.791	15.24	6.59	0.113	4.18	15.41	0.74	2.32	0.85	120	164	107	96	119	108	179	33	126	11	405	62	82	11.08	99.09
E 438	59.90	0.815	13.69	5.98	0.115	5.55	10.71	0.98	1.93	0.34	95	212	80	48	86	123	130	27	170	13	229	48	190	2.76	99.69
E 453	54.35	0.931	17.50	7.11	0.132	4.56	11.48	0.79	2.62	0.53	136	162	111	81	107	121	160	41	130	14	373	47	190	4.42	98.07
E 467	56.32	0.738	14.50	5.68	0.121	3.35	15.24	1.00	2.51	0.55	93	165	86	68	91	117	172	33	153	13	361	37	120	12.71	98.87
E 474	51.75	0.896	16.96	7.45	0.120	5.49	14.39	0.79	1.29	0.86	120	183	113	459	88	60	175	40	137	10	288	48	683	4.81	99.05
E 475	54.76	0.689	13.61	4.77	0.113	5.38	17.55	0.95	1.63	0.55	79	139	54	80	93	95	176	34	145	14	319	66	365	7.84	99.89
E 478	57.61	0.780	13.89	6.24	0.205	5.50	12.57	0.79	2.03	0.40	116	176	102	61	81	90	152	30	139	14	318	37	88	12.00	100.03
E 730	57.15	0.859	14.11	6.90	0.317	3.77	12.70	0.89	1.97	1.32	106	189	128	251	210	91	143	28	157	17	337	73	207	12.92	99.55
mean	55.56	0.796	14.76	6.34	0.146	4.81	14.02	0.84	2.08	0.65	110	172	97	120	106	102	165	33	145	13	328	59	195	8.94	
std ±	2.69	0.074	1.28	0.74	0.059	0.78	2.97	0.20	0.37	0.27	17	23	19	114	35	22	19	5	13	3	59	16	172	4.78	
cv %	4.8	9.3	8.7	11.7	40.4	16.2	21.2	24.3	17.8	41.0	15.6	13.3	19.5	94.8	32.6	21.5	11.3	14.8	9.2	20.1	18.0	27.4	88.4	53.5	
Calcareous group C2																									
E 421	58.87	0.813	15.83	7.07	0.081	3.47	9.24	0.96	2.94	0.74	132	170	99	85	109	130	118	28	150	17	332	49	48	10.18	98.07
E 424	60.24	0.870	16.81	6.82	0.063	2.39	9.74	0.68	1.85	0.54	141	206	106	90	94	110	122	31	202	18	332	85	124	13.82	99.01
E 454	60.62	0.834	16.32	6.29	0.069	4.20	6.80	1.45	3.02	0.41	117	184	89	207	101	159	125	38	154	12	388	66	101	3.28	100.26
E 460	58.17	0.953	18.87	7.71	0.123	2.55	8.18	0.79	2.37	0.30	177	192	96	45	85	132	116	37	218	15	349	107	76	5.69	98.26
E 724	58.60	0.950	17.09	7.31	0.158	4.40	7.22	0.90	1.46	1.92	87	211	120	103	145	33	137	35	198	17	325	69	164	7.19	99.98
E 729	59.92	0.926	17.40	7.15	0.079	3.41	6.56	0.98	2.15	1.43	86	201	110	77	128	88	108	35	196	20	328	76	87	7.06	100.04
mean	59.40	0.891	17.05	7.06	0.095	3.40	7.95	0.96	2.30	0.89	123	194	103	101	110	109	121	34	186	17	342	75	100	7.87	
std ±	0.99	0.061	1.05	0.48	0.037	0.82	1.32	0.26	0.61	0.64	35	15	11	55	22	44	10	4	28	3	24	20	40	3.68	
cv %	1.7	6.8	6.1	6.8	39.2	24.2	16.6	27.5	26.4	72.5	28.1	7.9	10.7	54.7	20.3	40.5	8.1	11.2	14.9	16.6	7.0	26.0	40.3	46.7	
Not matching the major calcareous groups																									
E 408	46.99	0.992	25.13	9.59	0.126	6.19	5.89	0.71	3.28	1.12	117	136	76	87	161	114	129	48	165	22	753	129	86	8.04	99.39
E 718	59.04	0.734	16.15	5.98	0.070	2.67	10.80	1.28	3.04	0.23	123	128	77	36	62	151	363	24	143	18	327	58	88	3.20	99.07
E 719	58.55	0.743	18.79	6.37	0.085	3.35	6.80	1.22	3.80	0.30	84	87	46	58	118	181	120	33	181	18	638	98	129	2.83	100.01
Import from Poetovio																									
E 428	65.35	1.317	23.58	4.42	0.035	1.46	0.83	0.79	2.07	0.13	129	127	55	24	89	91	89	36	295	21	531	122	82	3.90	95.95
Firmalampe from Aquileia found in Bad Reichenhall																									
L 506	60.48	1.023	21.25	8.60	0.057	1.62	4.51	0.58	1.71	0.18	223	228	121	133	123	119	79	34	269	23	701	90	94	12.92	99.60
Firmalampe from Aquileia found in Aquincum																									
E 676	63.11	0.952	18.36	7.32	0.116	1.77	5.21	0.91	2.04	0.20	172	221	86	27	86	102	137	45	247	11	421	111	81	3.25	99.72
Firmalampen from Aquileia found in Poetovio																									
E 574	57.48	0.934	18.02	7.66	0.093	2.74	8.46	1.47	2.38	0.77	138	150	84	66	73	113	238	26	202	18	515	117	52	2.66	100.78
E 578	58.75	0.993	21.04	9.19	0.143	3.07	3.05	0.79	2.34	0.65	237	215	120	34	89	128	89	44	214	19	421	128	58	0.23	99.74
Ceramic wasters in Aquileia																									
F 565	52.58	0.780	15.61	6.74	0.124	5.12	15.58	0.76	2.54	0.15	103	165	87	16	81	136	260	41	113	6	329	82	15	0.20	100.84
F 942	58.88	0.857	15.33	6.50	0.110	4.85	9.34	1.04	2.79	0.30	115	190	87	70	126	149	128	32	175	11	270	69	44	0.00	99.53
E 426	55.07	0.784	16.83	6.94	0.133	3.87	11.85	1.15	3.11	0.27	136	204	141	40	95	143	285	26	133	19	382	67	71	0.18	100.89

Tab. 4. *Results of chemical analysis by WD-XRF (ignited samples, l.o.i. = ignition loss at 900°C): locally produced lamps and others.*

focus was on this potter. Two stamps of Fortis with irregular letters (samples E469, E470) without question belong to the main group. This is also true for two lamps with strap handles, one of Fortis and one of Ianuarius, which do not differ in chemical composition. The types represented within the Modena group are mainly IXb and Xa, with fewer examples of IXc and Xb and none of the late and poor quality Xc. The colours are always more or less red and never yellow or pale [7]. All this new information regarding lamps from Aquileia confirms previous results obtained from Modena lamps.

Other imports and locally produced lamps

A high titanium content of 1.3% TiO_2 separates one lamp (E428) from all other analysed lamps from Aquileia, as can be seen in Tables 3 and 4. When we compared this analysis with our large database of Firmalampen it was clear that this lamp of Fortis represents an import from Poetovio [8]. Its colour is yellowish and it has a slip. Because of its clear attribution it was not included in the dendrogram, where it would be an outlier.

The samples outside the Modena group in the dendrogram (fig. 1) form several groups of about the same level of similarity. The groups are named A1-A2 and C1-C2. The six samples which are not encompassed within these groups are numbered A3-A5 and C3-C5 to show their similarity to groups A and C. Group A2 and sample E410 in the dendrogram are less clearly distinguished from the Modena group, but they all have significantly lower contents of sodium – below 0.34% Na_2O, compared to the Modena lamps, where sodium in 421 samples is always higher than 0.7% Na_2O. Depending on which elements are taken into consideration, the attribution of some samples by multivariate statistics changes. Two groups, however, are significant: a calcareous group C with no similarities to the Modena imports, and a non-calcareous group A, including some samples with similar composition to Modena imports. This similarity can also be seen in the colours of the lamps. In the non-calcareous group A (calcium below 5% CaO) they are reddish, as in the Modena group. However, the calcareous lamps with calcium contents exceeding about 6% CaO (group C) are characterized by yellowish colours [9] and by applied, more or less visible slips. Other differences with the Modena group include significantly higher potassium (K_2O) and/or chromium (Cr) values in groups A and C from Aquileia (Fig. 2). The reference group of 421 analyses of Modena lamps only features twelve samples which have over 2.1% K_2O and only six which have more than 200 ppm Cr. This distinguishes most of the Aquileia lamps clearly from the Modena group (Fig. 2). Means, standard deviations and coefficients of variation were calculated for the four groups in spite of large variations and some overlapping. Manganese, calcium, sodium and phosphorus, which were not used to calculate the dendrogram, exhibit the largest variation.

Nearly all lamps of the A- or C-groups are of type X (tab. 2). Type Xc lamps are only found in group C and not in groups A1 or A2. The moulds are in groups A1 and in C1, as is the case with lamps featuring the stamps of Cresces, Fortis, and Vibianus, and with lamps bearing the stamp PAR/T, which very probably represent a local potter. This may be an indication that the internal grouping into groups A and C does not distinguish workshops, and that different local, or regional, raw materials may have been used at different periods. Some of the Fortis lamps have stamps with a dot (FORTIS o in Table 2) which was not noted for the Fortis lamps from Modena (tab. 1). This is probably a distinguishing feature which should be checked with a larger series.

Previous analyses of lamps from other sites had left some lamps without attributions. These data were now compared to the Aquileia groups, resulting in the attribution of four lamps to Aquileia. One of them is an analysed lamp found in Bad Reichenhall in Noricum (L506) with an extraordinary stamp: CIIPIIRIIIVS (Cepereius) that seems to be known only from Aquileia [10]. The chemical data attribute this lamp without doubt to group A1, thus providing further evidence that this group represents local products from Aquileia. The other previously unattributed lamps comprise one lamp of Cresces found in Aquincum and two lamps found in Poetovio: one of Fortis and the second bearing the stamp ASPE. A question mark hangs over this last lamp because, amongst the many lamps found in Aquileia, no lamp with this stamp has ever been noted.

Evidence of whether all the lamps which are not from Modena were locally produced in or around Aquileia is still to be found. Here, comparison with a reference group representing the local pottery in Aquileia is needed. A secure reference group, however, is still not available, even after the analysis of over 100 pottery samples from Aquileia and its region. If we assume that the three moulds found in Aquileia were made locally, then groups A1 and C1 must represent local products. Another indication of the composition of local ceramics may be provided by ceramic wasters, even if it cannot be excluded that they were simply destroyed by a fire which broke out in a merchant's depot. Wasters of Loeschcke type Ia/b lamps were found near Monastero, one kilometer east of Aquileia, and a small sample was analysed (F565). Other analysed wasters include an overfired handle from Aquileia, probably belonging to a lamp (F942), and a stack of thin-walled pottery which had fused together (E426) [11]. All three samples are made from calcareous clay and in composition they are very similar to groups C1 (E426, F565) or C2 (F942). Three analysed painted sherds from Monastero also more or less correspond to group C1. Even if wasters of Loeschcke type Ia/b lamps may be no probable indication of a workshop producing Firmalampen, the analyses confirm that the calcareous groups C1 and C2 represent at least regional goods. That calcareous clays are available everywhere around Aquileia is shown by the analysis of clay samples and samples of bricks and pottery from Aquileia and from various locations within the region. The analysed samples of

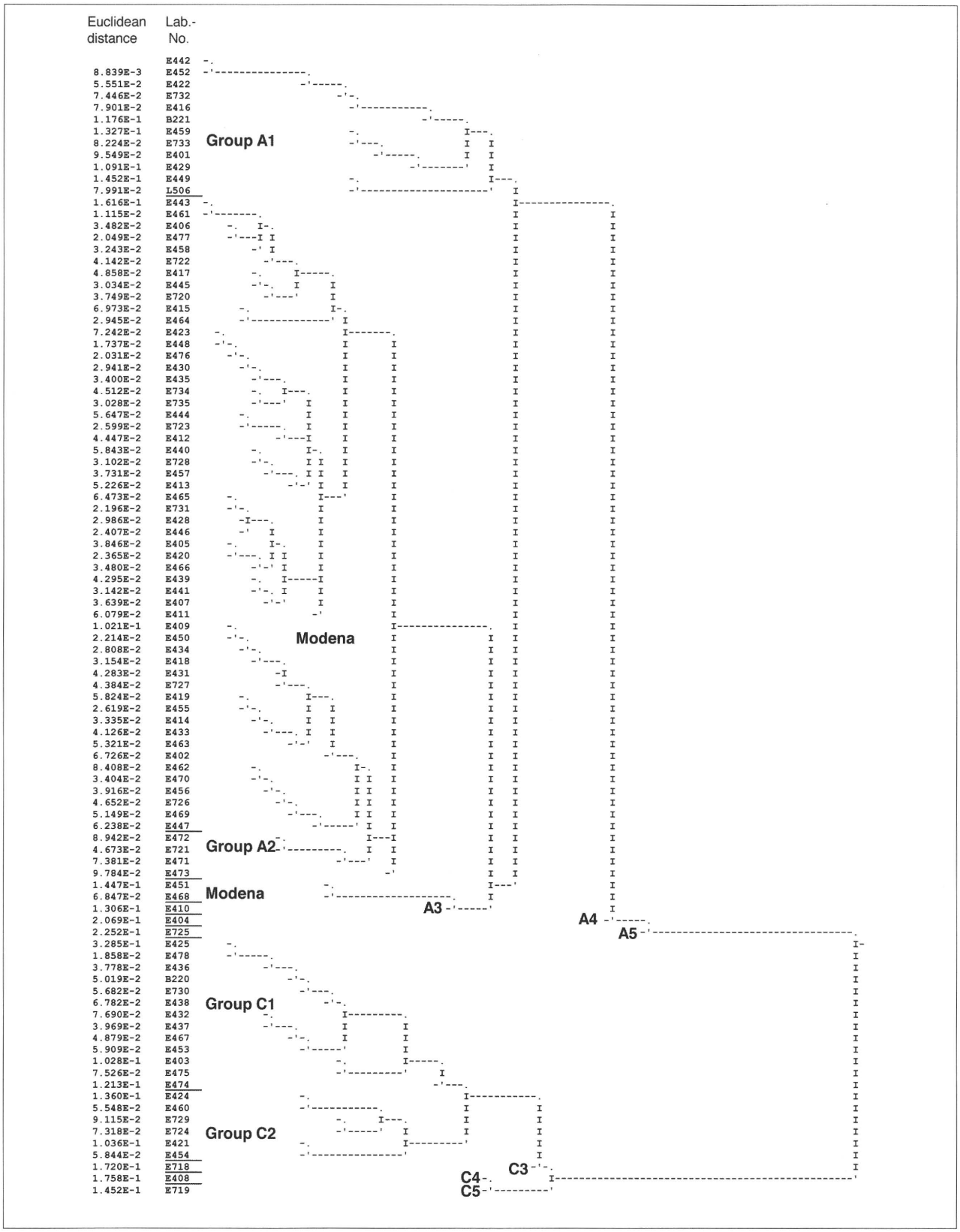

Fig. 1. *Dendrogram of multivariate cluster analysis using Euclidean distances of logarithms of concentrations of SiO_2, TiO_2, Al_2O_3, Fe_2O_3, MgO, CaO, K_2O, Cr, Rb, Sr, Zr (hierarchical clustering using average linkage).*

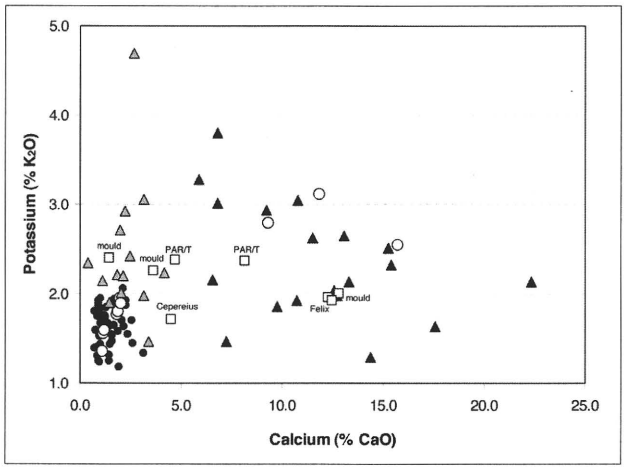

Fig. 2. *Diagram showing the variation of calcium and potassium concentrations in the analysed lamps from Aquileia: black circles = provenance Modena, white circles = reference samples (lamps from Modena and wasters from Aquileia), triangles = groups A (grey) and C (black) from Aquileia, squares = moulds, lamp of Cepereius and Felix and lamp with stamp PAR/T (the two points for two analyses of Felix may demonstrate the precision of the analyses).*

raw clay (fired at 900°C) include four samples from different contexts at the excavations in Aquileia and three from geological drillings [12]. With over 23% CaO, all clay samples are more calcareous than the lamps; however, together with analysis of pottery from an Iron Age kiln and analysis of bricks found in Aquileia, they confirm the local geochemistry, featuring higher potassium and chromium contents than in the Modena lamps. The composition of the local materials never exactly matches the chemical groups of the Firmalampen from Aquileia but, because of the large variation within the groups, a common provenance for all of the ceramics from the area is plausible.

Only one sample of non-calcareous clay was found north of Aquileia. It was taken from some loam which was found where it had been dropped on a country road, but we do not know where it came from. It is chemically very similar to group A1. Because this weathering loam certainly comes from the region, maybe from near the limestone rocks at the eastern rim of the plain, it is at least an indication for the local provenance of the non-calcareous groups.

A larger series of analyses was carried out for pottery from Carlino [13]. The analyses show that calcareous as well as non-calcareous clays were used at this site. The glazed pottery of Carlino is mainly non-calcareous with a calcium content below 5% CaO, but bricks, some pottery sherds and workshop finds were made from calcareous clay with up to 20% CaO. The composition of pottery from Carlino, even with a comparable calcium content, differs somewhat from that of the lamps from Aquileia. This is especially true of the non-calcareous samples from Carlino which do not match groups A1 and A2. Therefore, Carlino probably was not the place where the majority of the Firmalampen were made.

Conclusions

Firmalampen in Aquileia, with very few exceptions, originate from only two regions. The lamps were either made within the region or they were imported from the lampmakers' centre at Modena. This is the same picture as we found at other sites from which we studied Firmalampen. Besides local lamps, all imports were from Modena, as was the case at Rome, Cosa, Poetovio and, north of the Alps, at Castra Regina/Regensburg in Raetia [14]. Only in the 1st century AD at Vindonissa nearly all lamps were imports originating from three production centres: Modena, Lyon and Trier. In the more northern Roman provinces, where, with few exceptions, nearly all lamps had handles (Loeschcke technique D), a similar picture exists, though all imported lamps were from Trier rather than Modena.

The potters' names on the lamps from Modena are known as the North-Italian lampmakers. The early stamps include Strobilus, Fortis, Atimetus, and Communis, the later ones – Cresces and others. Firmalampen, as an innovation in Modena in the mid-1st century, were made of red firing non-calcareous clay, therefore making a red slip superfluous when a red appearance was wanted. Other types of lamps and part of the local Firmalampen at Aquileia were made from calcareous clay and a slip was applied.

The secure attribution of 55 chemically analysed lamps to the Modena group is based on a large number of analyses, including lamps and workshop finds from the vicinity of Modena. The only lamp securely identified as an import from another region is represented by an analysed sample of a Fortis lamp attributed to Poetovio, where pottery and lamp production is well-known and confirmed by chemical analysis. It is less surprising that two lamps made in Aquileia have also been detected among the analysed lamps from Poetovio, one made by Fortis and one featuring the stamp ASPE – a name which had hitherto not been represented in Aquileia. Another lamp of Fortis made in Aquileia was among the analysed lamps from Aquincum. Of very special interest is a lamp found in Bad Reichenhall bearing the singular stamp CIIPIIRIIIVS, noted elsewhere only on two finds discovered in Aquileia. It can securely

be attributed to group A1 from Aquileia. This small number of Aquileia lamps found far from Aquileia are, however, certainly not an indication of the wide-scale export of lamps from Aquileia, and the hypothesis remains that lamps which were traded over long distances came from very few exporting centres, of which, between Rome and Cologne thus far only Modena, Lyon and Trier have been reliably identified [15].

The remaining 37 lamps analysed from Aquileia form a much less homogeneous group than the lamps from Modena. This is mainly, but not only, because of a large variation in calcium content. Four groups may be distinguished also taking into account large variations of other elements. These groups cannot be correlated with potters' names. The potters' names Fortis, Cresces, Vibianus and the undoubtedly local potter who used the stamp PAR/T are found on lamps of different groups. This means that the groups do not represent individual workshops of potters but rather different raw materials within the region. These may have been used in different parts of the region or/and at different points in time. We even cannot exclude the possibility that the moulds or lamps e.g. of Cresces are not products of a branch workshop of this well known north-Italian lampmaker but just copies made at several local workshops of unknown potters.

The combined groups A1 to A4 and C1 to C4, taking into consideration individual elements as well as multivariate hierarchical clustering, form a framework which accommodates most of the ceramics and geological clay samples that have been analysed as comparative local materials. This large, somewhat inhomogeneous, group includes wasters, bricks and material from kiln sites including Spessa-Capriva, Locavaz, Monastero, Aquileia and Carlino. Compositional similarities between some of these analyses with one or another lamp, however, are not interpreted as evidence of the location of a lamp-making workshop. From the experience of clay sampling in the region, it seems that identifying the location of individual workshops requires a much more sophisticated study of a larger number of samples from possible kiln sites, as well as the use of complementary techniques of pottery classification, such as thin-section studies and MGR-analysis [16]. This possibility is limited, however, because of the very small samples which, for the most part, can only be taken by drilling, and also because of a lack of excavated kiln sites or workshop areas. As a result, we have to accept that the Firmalampen in Aquileia which do not represent evident imports were very probably made within a large region around Aquileia using calcareous as well as non-calcareous clay at the same time or at different times.

NOTES

[1] BUCHI 1975.

[2] SCHNEIDER 1978; SCHNEIDER, WIRZ 1992a; SCHNEIDER, WIRZ 1992b; DASZKIEWICZ, SCHNEIDER 1999; ISTENIC *et alii* 2003; SCHNEIDER *et alii* 2007; SCHNEIDER, HENSEN 2009.

[3] We are much obliged to Dr. Maselli Scotti and the Soprintendenza Archeologica e per i Beni Ambientali Architettonici Artistici e Storici del Friuli Venezia Giulia – Trieste for their kind permission to take samples for analysis.

[4] The dry powders, weighing a minimum of 100 mg, were ignited at 900 C, then melted with a lithium-borate mixture (Merck Spectromelt) and cast into small discs for measurement with a Philips PW1400 X-ray spectrometer. Samples E718–E735 represented small fragments with no stamp or information regarding type. For each of these latter samples one gram was available for analysis, which would yield more precise data for trace elements. Small pieces of the samples were powdered in an agate mill after first having had any impurities and surface layers removed and having been washed with distilled water in an ultrasonic device. All data are valid for ignited samples but, with the losses on ignition (l.o.i.) given, may be recalculated to a dry basis. Major elements are calculated as weight percent oxides and normalised to a constant sum of 100% for easier comparison. The original totals are given. The precision for major elements is better than 1%, for trace elements it rises up to 20% depending on the concentrations. Trace elements indicated in brackets are determined with less precision. Accuracy was tested by analysing international reference samples and through exchange of samples with other laboratories. For major elements and the most important trace elements the coefficients of variation are between 5 and 10%.

[5] The sites include Rome, Cosa, Vindonissa, Emona, Castra Regina/Regensburg (and various other sites in Raetia), Carnuntum, Aquincum, Poetovio. A general discussion is given by SCHNEIDER 2003.

[6] *Bandhenkel* (*ansa a nastro*).

[7] For the analysed lamps the colours given by Buchi vary between *giallo-rosso* and *rosso mattone* with more or less grey or brownish tints.

[8] DASZKIEWICZ, SCHNEIDER 1999.

[9] For these lamps Buchi registered colours from *bianco-giallastro* to *giallo-rosso* (one exception is E460, the lamp of PAR/T, which is *rosso-marrone*).

[10] This lamp is mentioned in BUCHI 1975, p. 21-22.
[11] A photo of this waster of *pareti sottili* was published by MASELLI SCOTTI 1988, p. 275.
[12] From Essiccatoio Nord.
[13] SCHNEIDER, DASZKIEWICZ 2010.
[14] SCHNEIDER, WIRZ 1992b.
[15] However, we do not know anything about the distribution of Poetovio lamps in Moesia and Dacia.
[16] DASZKIEWICZ, SCHNEIDER 2001.

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RIASSUNTO

Sono stati analizzati per mezzo di WD-XRF gli elementi maggiori e dodici in traccia di "Firmalampen" da Aquileia (BUCHI 1975) per individuare il loro luogo di fabbricazione. Cinquantacinque delle lucerne analizzate sono importazioni dalle principali officine di Modena rappresentate da 421 analisi effettuate in proprio. Solo una delle lucerne selezionate per l'analisi è un'importazione da *Poetovio*. Questo conferma i risultati precedenti, ad esempio a Roma, Cosa, *Poetovio*, i quali indicano che le lucerne di importazione venivano quasi esclusivamente da Modena. Trentasette delle lucerne analizzate sono molto probabilmente prodotti locali. La grande variabilità della composizione delle lucerne locali si riflette nella composizione degli stampi, scarti e campioni di argilla della regione. "Firmalampen" e stampi anche con lo stesso nome del vasaio furono realizzati con diverse materie prime, ad esempio, argilla non calcarea e calcarea, evidenziando in tal modo che le differenti officine operavano in diverse parti della regione nello stesso o in diversi periodi. Singoli locali rinvenimenti di lucerne da Aquileia sono stati rilevati mediante analisi a Bad Reichenhall, *Aquincum* e *Poetovio*.

Parole chiave: Aquileia; "Firmalampen"; analisi fluorescenza X; luoghi di produzione.

ABSTRACT

Firmalampen from Aquileia (BUCHI 1975) have been analysed by WD-XRF for major and twelve trace elements to find their places of manufacture. Fifty-five of the analysed lamps were imports from the major lampmaking workshops at Modena represented by 421 own analyses. Only one of the lamps selected for analysis is an import from Poetovio. This confirms previous findings indicating that imported lamps are almost exclusively from Modena, e.g. at Rome, Cosa, Poetovio. Thirty-seven of the analysed lamps are very probably local products. The large compositional variability of the local lamps is reflected in the composition of moulds, wasters and clay samples from the region. Firmalampen and moulds even with the same potter's name were made from different raw material, e.g. non-calcareous and calcareous clay, thus evidencing that several workshops were operating in different parts of the region at the same or at different periods. Single finds of local lamps from Aquileia were detected by analysis at Bad Reichenhall, Aquincum and Poetovio.

Keywords: Aquileia; Firmalampen; X-ray fluorescence analysis; workshops.

Gerwulf Schneider
Malgorzata Daszkiewicz
Freie Universität Berlin, Exzellenzcluster 264 -Topoi
Hittorfstr. 18, D-14195 Berlin
Tel. +49 30 838 52417
schnarch@zedat.fu-berlin.de
www.archaeometry.pl