AML SITE FILE; 2499

Ancient Monuments Laboratory
Report 5/89

ANALYSIS OF BARBAROUS RADIATE COINS
FROM COLCHESTER, ESSEX.

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Summary

A large group of barbarous radiate coins dating to the late third century AD found at the Angel Yard site were analysed, together with a comparative group of similar coins from the Culver Street site. Qualitative analysis using X-ray fluorescence showed a range of compositions for the coins, but the compositions did not seem to be related to numismatic groups and it is likely that the barbarous radiates were made from remelting any suitable metal that was available.

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ANALYSIS OF BARBAROUS RADIATE COINS FROM COLCHESTER, ESSEX

Introduction

Barbarous radiates are irregular antoniniani which are dated to the 270s and 280s AD and are copies of the regular radiates of this period (Davies 1987). A large group of 128 such coins were found during excavations at the Angel Yard site in Colchester and these were analysed, together with a comparative group of 44 similar coins from the Culver Street site in Colchester.

Analytical Method

All the coins were analysed qualitatively by energy-dispersive X-ray fluorescence (EDXRF) using a Link Systems Meca 10-42 machine. The primary radiation source was an X-ray tube with a rhodium target run at 35 kv and the fluorescent X-rays were detected by a Si(Li) detector. The elements recorded were copper (Cu), zinc (Zn), lead (Pb), silver (Ag) and tin (Sn).

The method of analysis used only looks at the surface of the coin and as no surface preparation was carried out on the objects the results will have been affected by surface contamination, corrosion and the depletion of elements from the surface this can produce, as well as any variations in surface topography. However the area analysed is an average across the whole coin surface and should give a reasonable indication of the alloys used in the production of the objects.

A number of the coins from Angel Yard were analysed on both sides to assess the variations in results, however no major compositional differences were noted between the two sides of any single coin and it was assumed that the analysis of a single side of each coin could be taken as representative of the surface of the coin as a whole.

It is particularly difficult with this type of analysis to identify surface platings unless they are obvious visually. The plating of coins is undertaken using noble metals such as gold or silver in order to enhance the value of the coin. The majority of coins from Colchester had no visible surface platings. Only one coin (SF No. 1344) was obviously plated and this was confirmed by analysis. It is possible that other techniques such as pickling were carried out on these coins which would have altered the composition of the coin surfaces but there is no definite evidence of this from the analyses.

There were a number of methods of surface treatments which could have been applied to the coins, though it is often difficult to be certain whether any analytically distinct surface was originally intended or whether it is the result of "selective chemical corrosive and surface enrichment processes" which have taken place since the object was buried (Cope 1972, 261). The coin surface treaments known to have been used in the Roman period include plating where a copper alloy core was surrounded with sheet-metal silver, silver washing where, after striking, the coins were covered with a thin applied wash of silver, and blanching where low-purity silver coins were boiled in a citrus fruit acid or vinegar which caused the leaching of copper from the alloy on the surface giving a whiter (more silvery) appearance (Cope 1972).

Three of the coins from Colchester (SF Nos. 1188, 1344 & 1372) were analysed, after cleaning the edge of the coin down to bright metal, using a Link Systems AN10000 energy dispersive X-ray analyser attached to a scanning electron microscope (this work was carried out by Dr J.G.McDonnell in the Ancient Monuments Laboratory). It was hoped that this would show any differences in composition between the coin surface and core which might indicate the presence of surface platings or other surface treatments.

Results

A number of different groups could be identified within the coin compositions, however there was no compositional distinction between the coins from the two sites within Colchester, with both sites producing coins which fitted in each of the identified compositional groups. Some of the coins from the Angel Yard site were part of a dispersed hoard but again there was a wide variety of compositions within these coins which meant they could not be distinguished compositionally from the other coins from the site.

A significant proportion of the coins could be linked with a specific Emperor associated either with the Central Empire or the breakaway Gallic Empire. The majority of the identifiable coins were copied from the Gallic Empire types, particularly those of the Tetrici.

Number of coins analysed divided by Empire and Emperor

Gallic Empire Coins		Central Empire Coins		Unidentified Coins	
Probus	1	Claudius II	4		
Tetricus I	54	Divo Claudio	17		
Tetricus I/II	2	Gallienus	7		
Tetricus II	17				
Victorinus	19				
Total	93	Total	28	Total	51

There seem to be some differences in composition between the coins of the two Empires, though there is not a distinct pattern. The coins from the Central Empire in general contain higher levels of lead and tin, the two elements being highly correlated which would suggest that they were added to the metal melt together. However there is a great deal of variation in the composition of coins in each Empire group (and also within each Emperor group) which makes any more patterns in the data hard to detect.

Average element ratios for each Empire group for the two sites (see Table 1 for definition of element ratios)

	Zn	Pb	Ag	Sn
Angel Yard coins				
Central Empire	16	115	4	13
Gallic Empire	18	48	2	6
Culver Street coins				
Central Empire	6	91	4	10
Gallic Empire	21	43	1	4

There is also a group of coins which has a much higher zinc content, and these coins rarely have a detectable level of silver, however they are not distinguishable by Empire or Emperor type. These compositions may be due to the use of *dupondii* coins dating from the 1st - 2nd centuries which were usually made of brass (a copper-zinc alloy) and which could have been remelted and used in the production of barbarous radiates (Davies pers comm).

Some of the coins had significant levels of silver detectable and three of these coins were examined by the X-ray analyser attached to the scanning electron microscope in an attempt to identify whether the silver was a surface plating or whether it was contained in the bulk metal of the coin. In the case of two coins (SF Nos. 1188 and 1372) there was definite evidence that the silver was contained in the bulk metal and there was no evidence of any surface plating. The other coin (SF No. 1344) was more problematic in that the analysis showed a lead/tin rich surface layer but no silver in the surface layer or in the core. It is possible that the silver was very localised and therefore not included in the small area analysed by the SEM, this would be likely in cases where a coin was worn and a surface layer of silver would only remain in depressions in the coin surface and not necessarily on the edges. There appeared to be no pattern of the coins containing significant silver levels relating to specific Empires or Emperors.

Very few comparable analyses of barbarous radiates are known and it is obvious that a greater number of analyses from a wider group of sites will be needed before any clear patterns are likely to emerge, though the large number of coins analysed here may indicate that there is no clear pattern to find. An attempt to link the analysis of the coins with the coin weight was also unsuccessful.

Conclusions

The lack of any clear pattern relating coin composition to specific groups of coins belonging to individual Empire or Emperor groups suggests that barbarous radiates were manufactured from melting down any available metal which was suitable and that no identifiable distinct compositional groups exist for this type of coin.

References

Cope, L.H., 1972 "Surface-silvered Ancient Coins", in Methods of Chemical and Metallurgical Investigation of Ancient Coinage, E.T.Hall & D.M.Metcalf (eds), Royal Numismatic Society Special Publication No.8, pp.261-278.

Davies, J.A., 1987 "The Barbarous Radiates", in The coins from excavations in Colchester 1971-9, Colchester Archaeological Report 4, N.Crummy (Ed), pp.44-49.

TABLE 1

Analytical Results for Colchester Barbarous Radiates

The results of the X-ray fluorescence analysis of the barbarous radiates from Colchester are given in the following table. XRF peak heights were recorded for the following lines in the spectrum: Cu K_a, Cu K_B, Zn K_a, Pb L_a, Ag K_a and Sn K_a. It was assumed that the copper contents of the coins were approximately constant and the figures given in the table are therefore ratios to copper which were calculated as follows:

zinc = (Zn K_a/Cu K_B) x 100

lead = (Pb L_a/Cu K_B) x 100

silver = (Ag K_a/Cu K_a) x 1000

tin = (Sn K_a/Cu K_a) x 1000

The peak heights for each element cannot be directly compared between elements as the height bears little relation to the proportion of that element present. Different elements are excited with varying efficiencies by the primary X-rays, eg tin is excited far less than zinc so the peak height will be a lot lower even when the amounts involved are similar. The use of ratios is an attempt to make the data more meaningfully comparable so that it is possible to roughly compare the proportion of each element present. This is achieved by using copper, which is assumed to be present at about the same level in each analysis, as an internal standard and using a different multiplication factor for the lower energy elements (zinc and lead) to that for the higher energy elements (silver and tin).

Coin weights were also recorded, measured in grammes.

ANGEL YARD SITE, COLCHESTER

Emperor	SF No		Zn	Pb	Ag	Sn	Weight
Central Empire							
Gallienus	645		5	33	8	8	2.14g
Gallienus	1045		49	65	6	11	2.07g
Gallienus	1165		5	12	-	-	0.42g
Gallienus	1188		4	8	29	4	3.63g
Gallienus	1225		4	83	2	11	2.65g
Gallienus	1264		6	56	6	11	2.64g
Claudius II	1052		5	139	5	9	2.39g
Claudius II	1224	obverse	6	94	6	20	2.03g
Claudius II	1224	reverse	5	94	4	16	2.03g
Claudius II	1239		103	97	-	12	1.71g
Divo Claudio	1109		18	271	-	21	2.15g
Divo Claudio	1137		8	83	-	17	1.34g
Divo Claudio	1141	a	20	7	4	12	0.37g
Divo Claudio	1141	b	7	3	-	2	0.37g
Divo Claudio	1189		39	366	2	32	2.72g
Divo Claudio	1191		16	158	-	20	1.74g
Divo Claudio	1211		12	135	-	10	1.85g
Divo Claudio	1243		3	97	11	8	2.53g
Divo Claudio	1246		49	53	-	8	2.11g
Divo Claudio	1254		30	101	-	16	1.30g
Divo Claudio	1279		3	124	-	14	2.65g
Divo Claudio	1330		5	88	-	13	1.89g
Divo Claudio	1416	a	6	355	-	23	2.22g
Divo Claudio	1416	b	9	315	5	25	2.22g
Divo Claudio	1420		4	114	-	15	2.39g
Divo Claudio	1425		5	29	8	7	1.78g
Gallic Empire							
Tetricus I	35		8	41	2	6	0.93g
Tetricus I	522		4	4	6	-	1.02g
Tetricus I	669		5	21	3	-	1.60g
Tetricus I	771		103	34	-	6	2.32g
Tetricus I	797	obverse	4	37	-	2	2.38g
Tetricus I	797	reverse	3	46	-	2	2.38g
Tetricus I	852		15	529	2	43	0.26g
Tetricus I	874		3	30	2	-	2.50g
Tetricus I	905		29	38	-	3	1.58g
Tetricus I	1018		4	18	-	-	2.15g
Tetricus I	1024		52	34	-	3	1.59g
Tetricus I	1030		4	26	-	-	1.47g
Tetricus I	1046		13	92	-	13	1.52g
Tetricus I	1144		13	10	-	-	1.41g
Tetricus I	1171		32	88	-	20	1.25g
Tetricus I	1214	obverse	6	47	-	9	2.67g
Tetricus I	1214	reverse	5	75	-	9	2.67g
Tetricus I	1215	obverse	31	22	-	4	1.85g
Tetricus I	1215	reverse	27	22	-	4	1.85g
Tetricus I	1219	obverse	5	14	-	7	1.97g
Tetricus I	1219	reverse	3	14	-	6	1.97g
Tetricus I	1221		5	77	-	11	2.72g

Emperor	SF No		Zn	Pb	Ag	Sn	Weight
Tetricus I	1232		4	12	3	–	2.10g
Tetricus I	1234		4	56	4	–	2.59g
Tetricus I	1244		4	7	2	–	3.18g
Tetricus I	1247	obverse	89	60	–	16	1.79g
Tetricus I	1247	reverse	93	63	–	15	1.79g
Tetricus I	1253		4	6	2	–	2.81g
Tetricus I	1262		3	4	–	–	0.91g
Tetricus I	1272		8	142	4	6	2.24g
Tetricus I	1345		5	–	–	6	0.69g
Tetricus I	1364	obverse	12	40	–	7	2.27g
Tetricus I	1364	reverse	13	38	–	8	2.27g
Tetricus I	1383		4	5	–	–	2.68g
Tetricus I	1407		9	23	–	3	2.43g
Tetricus I	1428		37	150	–	27	1.21g
Tetricus I	1434		4	4	2	–	1.83g
Tetricus I	1435		63	–	–	–	1.48g
Tetricus I	1438		4	8	4	2	0.64g
Tetricus I	1454		48	312	14	25	1.50g
Tetricus I	1500		27	12	–	3	1.58g
Tetricus I	1513		3	6	3	2	2.35g
Tetricus I	1621	obverse	4	24	–	9	2.25g
Tetricus I	1621	reverse	3	17	–	9	2.25g
Tetricus I/II	729		4	7	2	–	1.94g
Tetricus I/II	1204		3	12	4	–	0.45g
Victorinus	667		7	34	8	4	0.69g
Victorinus	672		3	4	3	–	1.54g
Victorinus	843	obverse	7	12	6	4	2.39g
Victorinus	843	reverse	8	15	7	6	2.39g
Victorinus	920	obverse	7	124	–	5	2.42g
Victorinus	920	reverse	7	192	–	8	2.42g
Victorinus	1021	obverse	4	13	4	–	2.45g
Victorinus	1021	reverse	4	16	7	–	2.45g
Victorinus	1187		11	22	4	6	3.62g
Victorinus	1210		48	28	–	14	1.09g
Victorinus	1212		79	339	2	45	1.69g
Victorinus	1340	obverse	65	81	–	13	2.00g
Victorinus	1340	reverse	71	84	–	15	2.00g
Victorinus	1342	obverse	4	25	5	–	2.48g
Victorinus	1342	reverse	3	27	5	–	2.48g
Victorinus	1372		3	7	10	–	0.57g
Victorinus	1380		4	43	2	3	2.48g
Victorinus	1432		3	3	–	–	1.70g
Victorinus	1443	a	6	26	2	5	0.51g
Victorinus	1443	b	6	23	–	6	0.51g
Victorinus	1468	obverse	3	2	–	–	1.49g
Victorinus	1468	reverse	3	2	–	–	1.49g
Tetricus II	175		4	5	2	–	2.60g
Tetricus II	665		4	8	2	–	1.68g
Tetricus II	1025		27	191	9	9	0.43g
Tetricus II	1048		70	5	–	–	0.71g
Tetricus II	1128		3	18	–	–	1.41g
Tetricus II	1129		4	29	–	–	2.44g
Tetricus II	1145		6	3	–	4	1.92g
Tetricus II	1148		5	22	–	14	1.82g
Tetricus II	1151		93	5	–	–	0.97g
Tetricus II	1213	obverse	23	4	–	–	2.32g

Emperor	SF No		Zn	Pb	Ag	Sn	Weight
Tetricus II	1213	reverse	27	5	-	-	2.32g
Tetricus II	1223		21	50	-	14	3.02g
Tetricus II	1317		5	26	3	-	1.79g
Tetricus II	1411		3	18	2	-	1.84g
Tetricus II	1418		16	115	5	8	2.83g

Empire/Emperor unidentified

-	169		4	68	-	5	1.69g
-	228		46	116	5	15	0.58g
-	370		4	-	-	20	2.52g
-	575	a	32	22	-	22	0.63g
-	575	b	40	21	-	21	0.63g
-	748		5	7	-	11	1.59g
-	767		8	114	-	15	1.02g
-	795		37	4	-	-	1.11g
-	798	a	37	-	-	8	1.21g
-	798	b	30	3	-	17	1.21g
-	840	a	57	163	2	28	0.57g
-	840	b	71	163	-	33	0.57g
-	925		21	48	-	7	0.97g
-	926		59	-	-	-	1.54g
-	929		4	7	-	-	0.43g
-	1005		5	146	-	34	0.65g
-	1009		23	15	-	2	2.50g
-	1019		4	-	-	-	1.85g
-	1034		9	202	-	55	0.72g
-	1113		7	496	4	38	1.19g
-	1114	obverse	9	64	4	2	1.06g
-	1114	reverse	11	74	5	4	1.06g
-	1115	a	4	33	4	-	0.58g
-	1115	b	4	27	4	-	0.58g
-	1125	a	9	3	-	13	0.63g
-	1125	b	10	3	-	10	0.63g
-	1126	a	30	91	10	13	0.29g
-	1126	b	39	114	8	14	0.29g
-	1152		3	28	3	-	1.75g
-	1174	a	5	5	3	-	0.52g
-	1174	b	4	4	6	-	0.52g
-	1195		14	11	-	-	0.23g
-	1199		6	4	12	2	0.40g
-	1222		4	16	-	9	0.71g
-	1281		6	13	-	-	0.57g
-	1299		10	44	-	17	1.01g
-	1332	a	4	3	11	-	0.65g
-	1332	b	4	11	21	-	0.65g
-	1341	obverse	7	112	-	12	1.75g
-	1341	reverse	5	110	-	2	1.75g
-	1344		5	18	10	5	1.02g
-	1358		9	234	3	11	0.54g
-	1386		19	241	-	39	1.34g
-	1440		10	15	-	12	0.55g
-	1442	a	4	-	15	4	0.49g
-	1442	b	4	-	23	4	0.49g
-	1444	a	16	49	5	9	0.39g
-	1444	b	13	36	2	4	0.39g
-	1502		72	-	-	-	1.16g

CULVER STREET SITE, COLCHESTER

Emperor	SF No	Zn	Pb	Ag	Sn	Weight
Central Empire						
Gallienus	3021	3	3	17	5	1.91g
Claudius II	2746	4	14	–	6	2.23g
Divo Claudio	3029	4	8	–	4	1.97g
Divo Claudio	3079	13	299	4	19	0.49g
Divo Claudio	4140	5	129	–	15	2.77g
Gallic Empire						
Probus	3014	4	8	2	–	0.67g
Tetricus I	2734	5	3	–	–	1.37g
Tetricus I	2747	4	6	3	–	0.98g
Tetricus I	2751	5	139	–	6	2.62g
Tetricus I	2816	3	13	3	–	2.24g
Tetricus I	2867	9	25	–	2	1.78g
Tetricus I	2926	26	11	–	2	2.43g
Tetricus I	2968	36	57	–	6	1.55g
Tetricus I	3002	19	13	–	3	2.17g
Tetricus I	3022	3	13	–	–	2.28g
Tetricus I	3048	27	2	–	7	1.00g
Tetricus I	3059	3	9	2	–	1.62g
Tetricus I	3104	4	10	2	–	1.57g
Tetricus I	3106	12	19	–	4	1.04g
Tetricus I	3129	107	12	–	5	1.50g
Tetricus I	3142	4	36	–	5	1.47g
Tetricus I	3206	4	287	–	9	2.36g
Tetricus I	3270	8	13	–	6	3.59g
Victorinus	2738	6	36	3	2	0.53g
Victorinus	3214	60	113	–	7	2.81g
Victorinus	3605	42	33	–	4	1.31g
Victorinus	3751	82	151	3	16	2.66g
Tetricus II	2880	37	48	–	3	0.97g
Tetricus II	3278	18	8	–	6	1.67g
Tetricus II	3279	5	13	4	–	2.05g
Empire/Emperor unidentified						
–	2754	4	4	–	2	2.35g
–	2755	4	64	10	6	0.65g
–	2760	4	3	2	–	1.41g
–	2856	4	20	–	14	0.85g
–	2874	5	62	–	11	2.04g
–	2965	4	–	18	–	0.73g
–	2984	15	37	–	4	0.51g
–	3030	11	32	–	5	1.76g
–	3126	9	15	–	6	1.22g
–	3156	4	2	–	14	1.71g
–	3191	12	8	–	2	2.13g
–	3213	33	33	–	7	2.29g
–	4143	4	17	–	8	0.53g
–	4308	40	3	–	–	0.56g