Chemical Characterisation of Clay Tobacco Pipes from Cambridge

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Eighteen samples of clay tobacco pipe and one wig curler from sites in Cambridge were submitted for analysis of the pipeclay using Inductively-Coupled Plasma Spectroscopy.

The samples were chosen to span the total period of use of clay tobacco pipes in the city, ranging from the late 16th/early 17th century to the 19th century (Table 1).

TSNO	Sitecode	Context	REFNO	cluster	Description
V4913	GAD05	30809	9045	gp 1	1600-40.
V4914	GAD05	31498	9062	gp 2	A Cleever 1858-64
V4915	GAD05	32506	9084	gp 6	1680-1710.
V4916	GAD05	30052	9012	gp 6	1660-80
V4917	GAD05	31574	9069	gp 2	TM mark 1830-39
V4918	GAD05	30790	9043	gp 6	1640-60.
V4919	GAD05	32704	9092	gp 5	S mark 1580-1600.
V4920	BDC06	1009	1040	gp 6	WB mark wig curler – 17th century
V4921	GAD05	32448	9083	gp 6	IK mark 1713-50.
V4922	GAD05	30408	9035	gp 5	1580-1610.
V4923	GAD05	32901	9095	gp 5	James Pawson1786-1813.
V4924	GAD05	32022	9077	gp 5	Wilkinson 1762-87.
V4925	SJT07	4115	1960	gp 6	C on base, TD and * on side of heel. 1730-40.
V4926	SJT07	4115	1960	gp 6	C on base, TD and * on side of heel. 1730-40.
V4976	GAD05	32901	9095	gp 4	PAWSON IN CIRCLE ON STEM
V4977	GAD05	32901	9096	gp 4	PAWSON WYER STYLE
V4978	GAD06	50003	862	gp 4	STAMPED STEM "WIL./KINSO./CAMB"
V4979	GAD05	30254	9028	gp 3	STEM STAMPED "BALLS/CAMB"
V4980	GAD05	31498	9062	gp 2	SPURRED BOWL;MOULDED CIRCLE ON ONE SIDE OF SPUR;OTHER SIDE PROBABLY BLANK

For each sample, an offcut was made, wherever possible using a section of unmarked stem, and the lining of the borehole and the exterior surfaces were mechanically removed, leaving a lump of uncontaminated pipeclay. This was then ground to a fine powder and submitted to Dr J N Walsh, Royal Holloway College, London, where it was analysed using inductively-coupled plasma spectroscopy. A range of major elements was measured and expressed as percent oxides (App 1). A range of minor and trace elements was measured and expressed in parts per million (App 2).

Three elements which are extremely mobile were measured bur omitted from analysis. These are calcium, phosphorus and strontium. All are present in calcium phosphate concretions found as post-burial infill in pores and laminae. In these pipeclay samples, however, it is unlikely that post-burial contamination of this type is significant.

Silica is not measured in the RHCL configuration and an estimate of silica content was made by subtracting the total measured oxide values from 100%. Estimated silica ranged from 58% to 73% (mean 66.06% +/- 4.20%). There is a possible correlation between silica content and date since the nine latest samples (late 18th and 19th century) have a mean estimated silica content of 62% (mean: 62.69% +/- 3.28%) compared with 69% for remainder (mean: 69.02% +/- 2.13%).

The difference in silica content could be due to levigation of the clay. The main effect of differences in silica content is to dilute the frequencies of those elements which are present in the clay fraction and for this reason the measured frequencies were normalised to aluminium. The normalised data were then analysed using the WinSTAT for Excel add-in (2002). The main technique used was Factor Analysis. In this method, the data is transformed to replace the original variables (normalised element frequencies) with a smaller number of Factors. The degree to which these factors can account for the variability in the dataset is shown by the eigenvalue and normally only factors with an eigenvalue of 1 or high are considered.

Factor analysis of the Cambridge pipeclay data found four factors with eigenvalues over 1. A plot of the first against the second factor scores indicated that one of the samples could be separated by its much higher F2 score with the remaining samples having similar F2 values and an overlapping range of F1 scores. A plot of the F3 against F4 scores, however, separated the samples into discrete clusters and these clusters were assigned codes, Group 1 to Group 6.

Group 1 consists of one sample, V4913, an unmarked early 17th-century pipe. It has high normalised iron, manganese, chromium, copper, nickel, yttrium, cerium, europium, dysprosium and cobalt values and low sodium, potassium, strontium values.

Group 2 consists of three samples, V4914, V4917, V4980, all 19th-century pipes. The three samples all have high lithium values.

Group 3 consists of one sample, V4979, a 19th-century pipe. This has a high zircon, lanthanum, neodymium and ytterbium values and low zinc, magnesium and nickel values.

Group 4 consists of three samples, V4976, V4977 and V4978, all late 18th century pipes. The group has low barium values.

Group 5 consists of four samples, V4919, V4922, V4923 and V4924. Two of these are late 16th/early 17th-century pipes and the other two are late 18th century. The early pipes have higher iron, magnesium, calcium, potassium, manganese, barium, nickel, vanadium and yttrium than the later ones but none of the four have extreme values of any elements.

Group 6 consists of seven samples, V4915, V4916, V4918, V4920, V4921, V4925 and V4926.They include the wig curler and pipes dating between the early to mid 17th and the early to mid 18th centuries. The samples have high potassium, titanium, barium, scandium, strontium, vanadium, samarium and zinc values and low calcium and phosphorus values.

Fig 1 shows the F1 scores plotted against the F2 scores. There is clearly some patterning in the F1 and F2 scores for groups 2 to 6, but it is masked by the high F2 score for the group 1 sample.

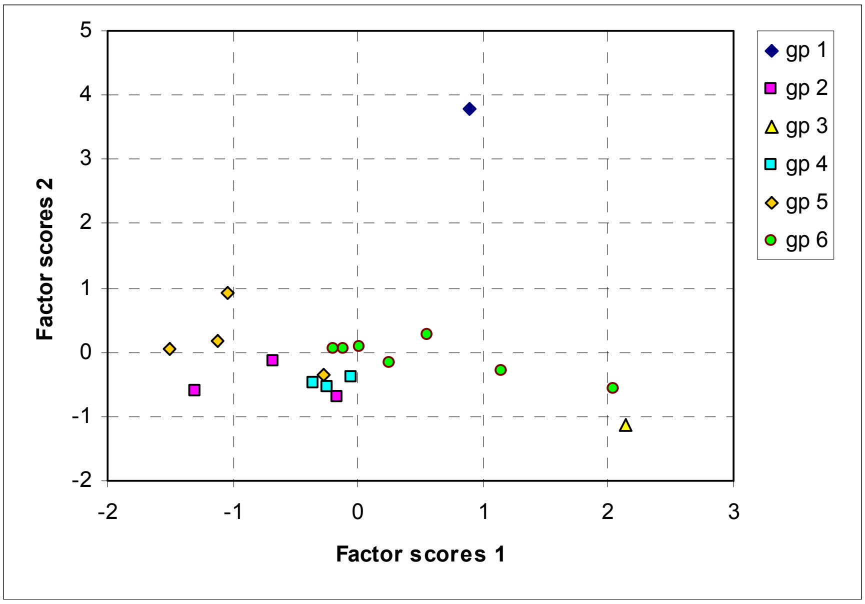

Figure 1

Fig 2 shows the F3 scores plotted against the F4 scores. Groups 1 to 4 have high F4 scores which distinguish them from groups 5 and 6. The F3 scores separate groups 5 and 6 and group 2 from groups 1, 3 and 4.

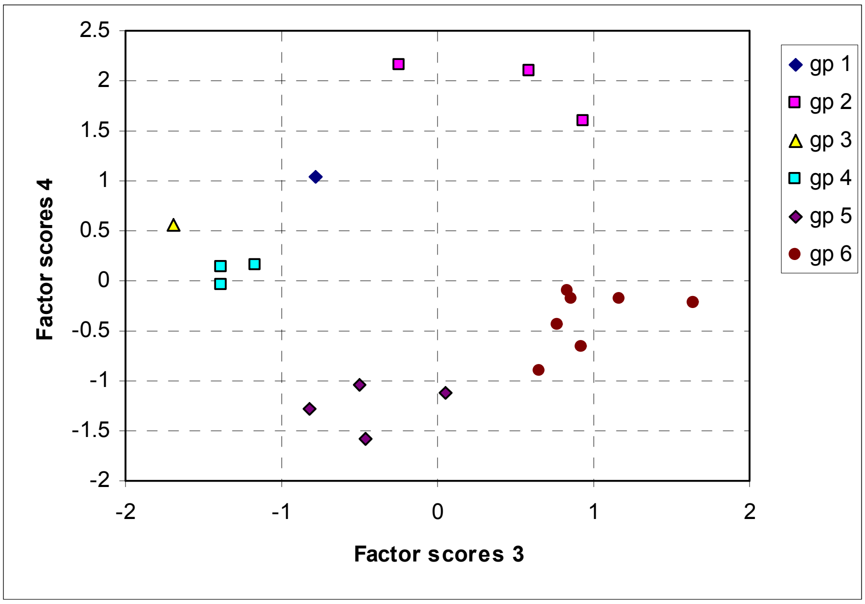

Figure 2

Discussion

There are two potential sources for the pipeclay used for the majority of the Cambridge pipes (i.e. those for which a Cambridge source is indicated). The first is the Dorset/Isle of Wight Tertiary ball clay. This clay was used by the London pipemakers and in the early 17th century they had a monopoly on its use, despite which, it seems to have been widely traded both along the east and south coasts. The other potential source is the white-firing middle Jurassic clays of Lincolnshire and Northamptonshire. The pipeclay from Northampton Field, for example, was said in the early 18th century to be the finest in the land (1712). Unfortunately, no good comparative data for either source exists, although most of the Cambridge data is similar to that from pipes made in the south west of England, which clearly utilised a source of Tertiary ball clay (such as those at Peter's Marland or Bovey Tracey in Devon, Chitterne in Wiltshire, Poole or the Isle of Wight) and is less similar to that of whiteware pottery produced at Stamford, which was produced from similar estuarine clays to those cropping out at Northampton. The exception is the Group 1 sample, which is very similar in composition to that of Developed Stamford ware samples from a variety of sites (Fig 3). Given the likely East Midlands origin for the pipeclay used for this pipe it is clearly a local, i.e. East Midlands product whereas the other early unmarked pipes, on the evidence of the composition of the pipeclay, might be products made locally or elsewhere (probably London). Groups 2, 3 and 4 consist entirely of marked pipes of local origin and both groups 5 and 6 contain a mixture of marked and unmarked pipes, indicating that probably all of these pipes were locally made. However, this conclusion needs to be confirmed through comparison with definite London products.

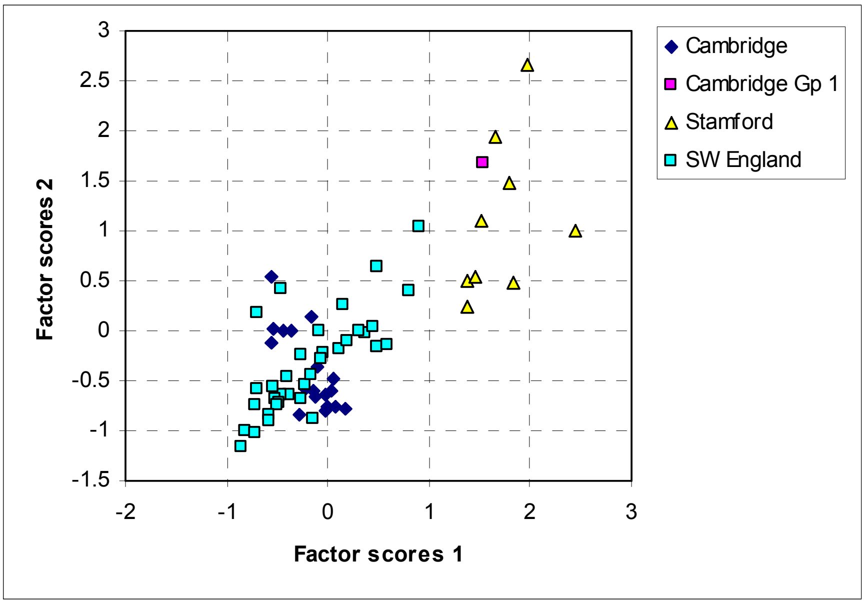

Figure 3

The other potential use of the chemical composition data is to examine the relationships between different Cambridge makers. The data clearly shows that the Pawson and Wilkinson pipes occur in the same two composition groups, Groups 4 and 5. Group 5 also includes two very early pipes although, as noted above, there are differences in composition between these two and the later, locally-made, pipes. Since Pawson succeeded Wilkinson it seems that both pipeclay groups were in use together and we cannot therefore use composition to help to date pipes made by these two makers.

Appendix 1

TSNO	Al2O3	Fe2O3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO
V4913	26.53	2.67	0.50	0.58	0.18	1.12	1.22	0.21	0.078
V4914	30.84	1.20	0.38	0.35	0.48	3.50	1.17	0.06	0.005
V4915	21.70	0.92	0.30	0.28	0.25	2.22	1.87	0.04	0.003
V4916	24.66	1.08	0.34	0.24	0.28	2.54	1.80	0.06	0.003
V4917	27.04	1.25	0.40	0.48	0.38	3.18	1.12	0.35	0.006
V4918	25.86	1.19	0.40	0.26	0.34	2.99	1.48	0.09	0.003
V4919	21.60	1.81	0.61	0.49	0.17	1.62	0.86	0.14	0.012
V4920	22.64	1.34	0.47	0.31	0.35	2.83	1.19	0.05	0.005
V4921	25.77	1.55	0.48	0.26	0.31	2.85	1.24	0.09	0.005
V4922	25.21	1.59	0.47	0.83	0.34	2.19	1.31	0.09	0.007
V4923	26.39	0.94	0.22	0.42	0.27	1.33	1.29	0.22	0.003
V4924	29.98	1.09	0.27	0.52	0.30	1.66	1.12	0.21	0.005
V4925	25.88	1.29	0.47	0.31	0.30	2.81	1.21	0.11	0.004
V4926	24.64	1.37	0.45	0.31	0.34	2.84	1.19	0.19	0.005
V4976	35.68	1.38	0.30	0.51	0.37	1.61	1.39	0.27	0.009

V4977	33.84	1.31	0.28	0.39	0.33	1.74	1.42	0.18	0.006
V4978	32.46	1.29	0.26	0.58	0.28	1.48	1.28	0.31	0.006
V4979	33.33	1.22	0.26	0.40	0.37	1.72	2.15	0.08	0.008
V4980	31.67	1.48	0.39	0.31	0.40	3.28	1.19	0.07	0.006

Appendix 2

TSNO	Ba	Cr	Cu	Li	Ni	Sc	Sr	V	Y	Zr*	La	Ce	Nd	Sm	Eu	Dy	Yb	Pb	Zn	Co
V4913	298	185	117	111	96	21	74	134	37	83	75	217	77	13	3	7	4	35	44	46
V4914	623	97	22	197	33	19	149	103	11	82	40	88	40	8	1	2	2	185	43	14
V4915	411	85	24	45	26	16	126	87	16	70	76	157	74	13	2	3	2	35	58	24
V4916	483	86	28	67	34	19	135	120	16	72	70	161	69	11	2	3	2	35	92	26
V4917	568	129	31	189	29	19	157	118	11	72	53	112	52	9	2	2	2	43	60	12
V4918	535	97	29	74	37	21	129	150	12	71	65	134	63	10	2	2	2	50	61	21
V4919	262	98	22	50	21	13	105	83	14	77	49	89	48	6	1	2	2	27	37	17
V4920	518	114	37	58	38	19	119	111	12	61	62	134	60	10	2	2	2	49	101	18
V4921	546	118	27	67	25	22	158	139	15	91	64	130	63	9	2	3	2	42	40	15
V4922	383	98	40	33	25	14	106	112	12	77	47	85	46	6	1	2	2	37	44	17
V4923	296	127	33	74	20	14	123	73	12	94	69	141	67	9	1	2	2	41	43	18
V4924	333	146	42	92	28	18	124	107	9	80	49	106	47	8	1	1	1	43	55	17
V4925	522	117	29	58	25	21	152	136	13	78	60	121	59	10	1	3	2	34	51	17
V4926	492	111	36	52	26	20	132	106	16	70	57	121	56	9	1	2	2	39	57	17
V4976	331	125	53	112	29	20	154	74	29	191	80	136	79	11	2	4	4	55	87	14
V4977	352	119	54	91	29	21	142	112	29	170	77	140	76	11	2	4	4	48	55	15
V4978	334	111	34	91	26	19	138	85	27	156	71	124	70	9	2	4	3	67	48	13
V4979	347	115	46	76	23	20	193	85	40	279	120	206	118	16	3	6	5	114	31	19
V4980	579	92	25	167	31	20	155	92	25	143	65	115	65	11	2	4	3	148	33	11

Bibliography

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