The Limehouse Porcelain Factory

ITS OUTPUT, ANTECEDENTS & THE INFLUENCE OF THE ROYAL SOCIETY OF LONDON ON THE EVOLUTION OF ENGLISH PORCELAIN BASED ON COMPOSITION AND TECHNOLOGY

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ABSTRACT

Three porcelain compositions attributed to the Limehouse porcelain manufactory are recognised and both body and glaze compositions of each are presented. Two of these compositions have been identified for the last 20 years, namely the silica-aluminium (Si-Al) and the silica-aluminium-calcium (Si-Al-Ca) bodies, whilst a third composition of the magnesium-phosphorus (Mg-P) type is newly documented and is tentatively attributed to Limehouse. Criteria to distinguish visually these three ceramic types are provided and a compositional stratigraphy for the Limehouse output is erected extending from late 1745 - early 1748. Preliminary results are presented which allow the compositional differentiation of Limehouse porcelains from Lund's Bristol and a discussion on technology pathways linking Bow to Limehouse and thence to Lund's Bristol and Worcester is given. Limehouse, far from being innovative, was in fact highly derivative at several levels both from Bow and earlier experimental firings, commissioned by members of the Royal Society of London dating back to the beginning of the 18th Century, if not earlier. We recognise that porcelain development in England was much more indigenous, diverse, and complicated than may have been realised to date in that the presence of high-fired Si-Al-Ca and Si-Al bodies coupled with the inferred use of china clay predate Meissen by some 30 years.

This *grand tradition* in porcelain development based on rational English experimental science and technology has remained largely opaque to previous ceramic studies over the last 150 years predicated on the notion of the *primacy of the artistic pursuit*. In fact, as at least three recipe types used by English porcelain makers are unique, one wonders how any foreign technology could have influenced this development

In addition to discussing the new scientific work and its impact on the chronological development of early English porcelains, documentary evidence surrounding the establishment of the Limehouse Factory is reviewed in an attempt to determine the extent of its operating period and its place within the associated technology. Evidence discovered in parish registers, land tax assessments, insurances, letters, and newspaper advertisements recorded by earlier researchers and one or two recent discoveries not yet in the ceramic literature are co-ordinated, presented in chronological order, and evaluated.

With information dating from before the change of the calendar from Julian to Gregorian in 1752; that is dates falling between 25th December and 25th March (Christmas Day to Lady Day - the latter being the start of the New Year under the Julian system) are shown in both styles. Hence 15th March 1744 in the old Julian style becomes on converting to the modern convention (Gregorian style) 15th March 1745 and is written as 15th March 1744/45.

PREFACE

The senior author is the recipient of generous research grants from the American Ceramic Circle and the Southern Institute of Technology to investigate the use of steatite in early English porcelains and this paper on the Limehouse porcelain manufactory is the second in the series. The first appeared on the range of ceramic compositions recognised for Lund's Bristol (Fig. 1) (Ramsay et al., 2011a). Combining both historical accounts (Camden Society, 1888) and modern analytical techniques, Ramsay and co-authors were able to demonstrate that Benjamin Lund produced at least three ceramic types, namely a high-clay porcellaneous stoneware (inferred crushed silica, ball clay +/- saltpetre), a magnesian-plumbian (Mg-Pb) porcelain (inferred soapstone, crushed silica, and a lead-bearing frit) and a magnesian-phosphatic-plumbian (Mg-P-Pb) porcelain (inferred soapstone, bone ash, crushed silica, and a lead-bearing frit). The glaze composition employed on both the soft-paste porcelain bodies was broadly similar with moderate PbO, high Al_2O_3, distinct levels of MgO, and $K_2O \geq CaO$. From this research the authors proposed a compositional stratigraphy for Lund's Bristol with the Mg-P-Pb body being produced up till late 1750 and the Mg-Pb body occurring from that date until the Worcester takeover in early 1752. Based on composition these authors have suggested that a technology pathway can be traced extending back in time from Worcester, through Lund's Bristol, to Limehouse, to Bow, and thence back to John Woodward (Secretary to the Royal Society of London) and his experimental porcelain firings of the 1720s (Woodward, 1728). From these observations Ramsay et al., (2011a) have argued that such compositional or technological pathways are likely to transcend linkages inferred from stylistic and decorative features.

A key raw material in this account is steatite, or soapstone, a generic name for a soft, easily carved talcose rock (Moffat and Buttler, 1986) dominated by a hydrous magnesian silicate, typically talc (Jones et al., 2007). Bates and Jackson (1987) describe steatite as a compact, massive, fine grained, fairly homogeneous rock consisting chiefly of talc; an impure talc-rich rock. Soapstone is essentially synonymous with steatite being a metamorphic rock with a massive, schistose, or interlaced fibrous or flaky texture with an unctuous feel composed essentially of talc. The most notable steatite locality in the United Kingdom is the Lizard Peninsula, Cornwall (Fig. 1), where several localities have been mined (Hobbs, 1995; Hillis, 2011). Other localities include Anglesey, mainland Scotland, the island of Harris, and the Shetland Islands (Bray, 1994).

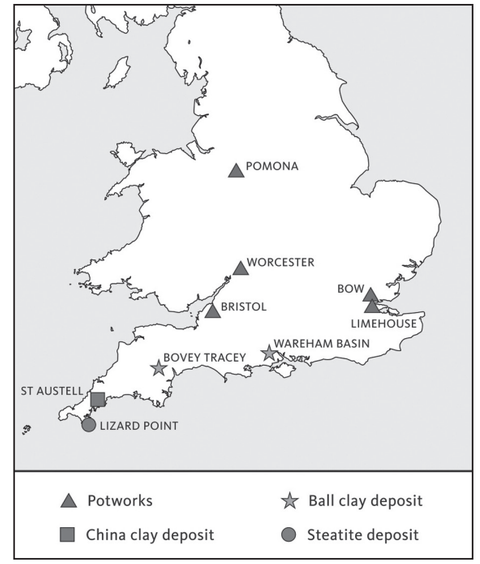


Fig. 1. Locality map showing location of various English porcelain manufactories: Bow, Limehouse, Pomona (Newcastle-under-Lyme), Lund's Bristol, and Worcester. Also shown are the localities for various potential raw materials used in porcelain production during the early - mid 18th Century; ball clay from Poole (Wareham Basin), steatite from Lizard Point (Kynance Cove and Gew Graze). Not shown is quartz sand from the Isle of Wight and King's Lynne, and chert/flint from the London Basin. China clay was initially imported from the Carolinas and possibly very small quantities from the East. Such clay was probably not 'discovered' in Cornwall (Tregonning Hill and St Austell) till the 1750s or early 1760s.

BACKGROUND TO THE LIMEHOUSE POTWORKS

It was with the publication of letters by the Camden Society in 1888 of letters by Dr. Richard Pococke FRS, Bishop of Meath, that ceramic historians first became aware of a forgotten potworks named Limehouse. Subsequently Dr. H. Bellamy Gardner (1928), in conjunction with A. J. B. Kiddell, discovered a number of advertisements for 'new-invented blue and white Limehouse ware' in the *Daily Advertiser* of 1747 and 1748. Aubrey Toppin (1931) wrote *A note on the Limehouse China Factory* and came to the conclusion

that Limehouse must have been located in Fore Street near Dick or Duke Shore in Limehouse. Mrs MacAlister (1933) announced the discovery of an early letter dated 28th December, 1745 from Mr. James Middleton of Shelton to, *William Tams at the Potworks in Four-Street, nigh Duke-shore in Limehouse, London*. For the next 60 years speculation continued as to the type of wares produced by this east of London concern. Watney (1963, 1973) summarised the then existing knowledge, reporting that the Limehouse manufactory was believed to have been sited on the north side of the river Thames in that part of Narrow Street, then called Fore Street, close to Duke Shore, only a few miles south from the Bow manufactory, alluding to the New Canton site at Stratford in Essex adjacent to the river Lea (Fig. 1). However, the present authors point out that they suspect that initially an earlier Bow site was established on the Middlesex side of the Lea, at a still unknown location. Further advertisements were discovered by Nancy Valpy (1983).

From the Registers of St. Anne's, Limehouse baptisms A.J.V. Toppin discovered a John Wilson, potter, of Queen Street, Ratcliffe. Ratcliffe Stairs was at the western end of Narrow Street. This potter appears to be related to Joseph Wilson (the potter previously from Limehouse whom Pococke apparently saw at a pottery in Newcastle-under-Lyme in 1750), as John is recorded in Fore Street near the factory site in the 1740's and in the Rope Walk in 1752. J. P. M. Latham (1988, p. 148) records that both John Wilson and David Wilson were taxpayers at Blakes Rents prior to 1744, (an address very close to the Fore Street site), and in Fore Street by 15th March, 1744/5,which corresponds with the opening of the Factory. Toppin also searched through the Bankruptcy Order Books at the Public Record Office in an endeavour to find persons who may have become bankrupt due to the forced closure of the factory. For further comment on this refer to Appendix 1.

In the same Registers for 8th March, 1747-48, Toppin found the baptism of *Elizabeth, daughter of William Ball, Potter, Fore Street and Mary….* Elizabeth Adams found William Ball in the Bow registers in December 1746 when his first daughter Susannah was born and in the Land Tax Assessments of St. Mary, Bow in 1745 and 1746; also the earliest record of the potter with payments of Land Tax in the parish of St. Leonard's, Bromley-by-Bow in 1744, '45, and '46 (Adams, 1969). So William Ball paid Land Tax of £1.12.0 annually in Bow in 1745 and 1746 before paying Land Tax at Limehouse in 1747. Latham (1987, 1988) recorded the dates when Joseph Wilson & Co. paid Rent and Land Tax and from Insurance Records, Frank Britten (1991), was able to pin-point the exact location of the site as 20 Fore Street, Limehouse and to speculate on the period the Factory was operating. It is known that Joseph Wilson arrived at 20 Fore Street by March 1744/45 and left after 23rd February, 1747/48 (Latham, 1987) or between June 1747 and August 1748 (Watney, 1993). The last advertisement from the Limehouse proprietors to all creditors is dated 3rd June, 1748 (Gardner, 1928) and consequently it has been assumed that the concern was in existence between 15th March, 1744/45 when Joseph Wilson and Company first paid Land Tax on the property at 20 Fore Street (Latham, 1987) to early - mid 1748, thus giving a possible operating period of up to two years or a little more (Appendix 1).

The real hero of Limehouse might appear to be John Potter, who in July 1985 learnt of a planning application for the demolition of 102-106 Narrow Street. He wrote to the London Docklands Development Corporation requesting that archaeological expertise be employed during any excavation work. In 1987, when the plans for the Limehouse Link Road connecting Canary Wharf with the Highway and Rotherhithe Tunnel were approved, Potter again wrote to the Corporation sending copies of his letter to ceramic societies and museums. Finally at the 11th hour in late 1989 the Museum of London (MoLAS) called a meeting of interested parties and was able to persuade the contractors to allow a six week delay for a professional excavation to be made on the Limehouse site. This excavation took place in the Spring of 1990. John Potter was on site in May 1990 when Lawrence Pontin, the senior archaeologist in charge, recovered a muddy waster, which on cleaning proved to be part of a lion mask and paw from a type of sauceboat formerly attributed to William Reid of Liverpool.

Accounts of the archaeological excavation and the range of ceramic sherds and wasters recovered from the Limehouse site are to be found in Drakard (1993), Potter (1998), and Tyler et al. (2000).

PREVIOUSLY PUBLISHED LIMEHOUSE CERAMIC RECIPES

Two compositional studies of wasters recovered from the Limehouse site have been published (Freestone, 1993; Owen, 2000). In the first publication Ian Freestone recognises two distinct compositional groups with one assemblage referred to as 'Limehouse early' or 'experimental ware' and the second as 'Limehouse porcellaneous ware'. The former is described by Freestone as showing evidence of vitrification, yet the body is still very porous of an earthenware type. Compositionally the body is that of a silica - high Al_2O_3 (assumed secondary clay type, ball clay) with a small addition of K_2O. Silica is ~78 wt%, Al_2O_3 ~16 wt%, and K_2O ~1.5 wt% (Table 1) classified by Owen (2007) as the Si-Al type. Freestone demonstrates that the glaze associated with this group contains minimal lead oxide, with low K_2O, Na_2O, and MgO, and with CaO in the vicinity of 10 wt% (Table 2).
This glaze can be explained by a mixture of 2 parts lime-alkali bottle glass and 1 part 'experimental' ceramic body. Freestone also notes that this glaze composition mirrors that recorded on Bow first patent porcelains, thus demonstrating a technology pathway from Bow to Limehouse as discussed below.

The second ceramic group recognised by Freestone (1993) shows lower SiO_2 levels (~73 wt%) and lower Al_2O_3 (~11 wt%) assumed to reflect lesser amounts of introduced secondary clay into the ceramic body. CaO varies from 5-7 wt%, Na_2O from 2-3 wt%, and K_2O around 3 wt% (Table 1; Figs. 2a, b, c, d). Based on the classification provided by Owen (2007) this body is of the Si-Al-Ca type. The glaze used contrasts with that found on the experimental Si-Al wares in that it is a moderate lead-bearing glaze with PbO ~30 wt%, SiO_2 ~48 wt%, Al_2O_3 ~6 wt%, with low K_2O, Na_2O, CaO, MgO and SnO_2 (Table 2).
Subsequent work by Owen (2000) broadly confirms the earlier work by Freestone and again recognises two distinct ceramic bodies from wasters and sherds recovered from the Limehouse excavation. One of the bodies identified by Owen conforms to the experimental Limehouse body and is referred to by Owen as 'proto-porcelain' of the Si-Al type. The associated glaze is of the lime-alkali type with moderately high MgO (~2.3 wt%). The second body of the Si-Al-Ca type is described by Owen as the 'calcic type' and it equates with Freestone's second group, 'Limehouse porcellaneous ware'. Owen (2000) records that from his analyses this group comprises lower Al_2O_3 ~10.7 wt%, with CaO ~6.7 wt%. Of particular note, Owen reports that the PbO levels in the porcelain body are low (<1.2 wt%). The associated glaze is lead-bearing, ranging from a high PbO variant (41 wt%) to a lower PbO type (25 wt%).

In summary, Owen (2000) confirms the presence of two types of Limehouse porcelain. What is assumed to be the earliest ware is of the Si-Al type with low CaO (~0.5 wt%) and with a lime-alkali glaze. The second group is of the Si-Al-Ca type with a lead glaze. Both Freestone and Owen agree that in each case the clay used at Limehouse was a secondary clay and not a primary china clay. Freestone (1993) comments that based on analyses of sherds from Limehouse there is no evidence for the use of soapstone, although unpublished XRD analyses of porcelains attributed to Limehouse from private collections have indicated the presence of steatite or soapstone. Freestone concludes that the absence of such magnesian wares from analysed sherds may reflect the vagaries of archaeological sampling. Watney (1993, p. 29) likewise asserts that analyses of 'Limehouse' pieces from collections show the presence of significant amounts of MgO. Unfortunately, unpublished analytical work lacking information as to the objects analysed, the name of the analyst, methods used, where analysed, and precision levels, constantly 'bedevils' English ceramic studies to the detriment of progress in knowledge and may be regarded as verging towards *hobby science* (Ramsay et al., 2011b).

TABLE 1: ANALYSES OF LIMEHOUSE, LUND'S BRISTOL, AND BOW PORCELAIN BODIES

	Limehouse											Lund's	Bow			Worcester?
	Si-Al		Si-Al-Ca							Mg-P		Mg-P-Pb	Si-Al	Si-Al-Ca	Al-Mg P-Pb	Mg-P
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
SiO_2	76.1	78.1	73.3	72.5	74.8	71.8	73.6	74.4	73.7	62	69.6	55.9	81	59.7	36.9	60.7
TiO_2	0.7	1	0.5	0.8	0.4	0.5		0.2	0.6				0.8		0.5	
Al_2O_3	16	16.9	10.7	10.8	11.6	12.2	12.7	10.8	12.3	3.1	2.7	3.5	14.7	27.7	33	2.4
FeO	0.5	0.7	0.5	0.7	0.2	0.2		1	0.3	0.2			0.3	0.1	0.8	0.5
MgO	0.2	0.2	1	1	0	0.6		0.7	0.3	12.5	9.4	13.9	0.3	0.3	3.1	15
CaO	0.5	0.4	6.7	6.2	6.8	8.1	7.5	7.7	7	8.8	9.8	7	0.3	7.3	8.9	10.9
Na_2O	0.7	0.6	2.5	2.5	2.7	3.3	3	2	2.7	3.7	1	2	0.3	3.7	4.2	2.2
K_2O	1.3	1.4	2.9	3.3	2.7	3	3	3.1	2	2.7	1.7	2.5	1.7	1.2	1.7	1.6
P_2O_5	0.1	0.2	0.3	0.1	0	0		0	0.2	6.7	4.7	5	0.2		2.7	6.7
PbO	<3.8		<1.2	1.3	1.3	0.3			0.2		0.8	10.4			8.3	
SO_4	0.1		0.3							0.5#			0.2#			
	100	99.5	99.9	99.2	100.5	100	99.8	99.9	99.3	100.2	99.7	100.2	99.8	100	100.1	100

S as SO_3

1. Single bulk analysis of Si-Al porcelain body (Owen, 2000) - total Fe as Fe_2O_3
2. Average analysis of 4 Si-Al porcelain bodies (Freestone, 1993)
3. Average analysis of 6 Si-Al-Ca porcelain bodies (Owen, 2000) - total Fe as Fe_2O_3
4. Average analysis of 4 Si-Al-Ca porcelain bodies (Freestone, 1993)
5. Si-Al-Ca body from underglaze blue platter, Fitzwilliam Museum, Cambridge (see Fig. 2a)
6. Si-Al-Ca body from underglaze blue sauce boat (Godden Collection, Bonhams, 2010: Sale No. 18425, Lot 43; see Fig. 2b)
7. Si-Al-Ca body from underglaze blue pickle dish with Chinese vase decoration (private collection; see Fig. 2c)
8. Si-Al-Ca body to broken underglaze blue pickle dish with Chinese vase decoration (Godden Collection)
9. Si-Al-Ca body to polychrome ribbed coffee cup (Watney Collection - Phillips, 2000a: Sale No. 30,924, Lot 538); see Fig. 2d
10. Mg-P body from underglaze blue pickle dish, private collection (private collection; see Fig. 2e)
11. Mg-P body from underglaze blue pickle dish (Godden Collection, Bonhams, 2011: Sale No. 19105, Lot 254; see Fig. 2f
12. Mg-P-Pb body from underglaze blue teapot (Watney Collection - Phillips, 2000b: Sale No. 30,926, Lot 914; see Fig. 2g)
13. Si-Al body to gadrooned underglaze blue *prunus root* plate (private collection; see Fig. 2h)
14. Si-Al-Ca body to covered sugar bowl, Bow first patent body (Ramsay et al., 2004, Ramsay and Ramsay, 2006, 2007b; see Fig. 2i)
15. Al-Mg-P-Pb body to *famille rose* bowl (private collection; see Fig. 2j)
16. Mg-P body to sherd (W12) found at lowest level at Warmstry House (Owen, 1998)

TABLE 2: ANALYSES OF LIMEHOUSE, LUND'S BRISTOL, AND BOW GLAZES

	Limehouse												Lund's	Bow		
	Si-Al		Si-Al-Ca								Mg-P		Mg-P-Pb	Si-Al	Si-Al-Ca	Al-Mg P-Pb
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
SiO_2	70.96	72.8	55.98	47.78	48.1	53.8	54.9	50.8	55	55	54	55	52.5	44.5	74.4	41.5
TiO_2		0.3			0.2	0	0		0.1	0.1						
Al_2O_3	4.24	5.3	7.12	3.3	6.7	0.4	7	9.1	6	6	7	4	5.5		8.3	0.35
FeO	0.49	0.5	0.49		0.4	0.1	0.2	0.2	0.1	0.1					0.4	
MgO	2.35	2.2	1.01	0.4	1.1	0.3	0.4	0.2	1	1	0.4	3	0.6		1.5	0.5
CaO	10.77	7.6	5.15	2.22	4.7	5.7	3.5	5	5.5	5.5	5	1	2.5	0.3	10.7	3.5
Na_2O	4.77	5.1	1.32	0.87	3	1.3	3.5	3	4	4	3	3	3.3	2	2.2	1.25
K_2O	3.8	3.9	2.26	1.68	2.5	4.4	3.5	3	2.5	2.5	2	4	3.3	3	2.5	3.5
P_2O_5	0.58	0.5				1.3	0.2		0.2	0.2	0	0				
PbO		0.4	25.25	40.91	30.5	32.8	26.7	28.5	25.5	25.5	29	29	32.5	50		49
SnO_2	0.35	0.4	1.07	1.22	2.7											
	98.31	99	99.65	98.38	99.9	100.1	99.9	99.8	99.9	99.9	100.4	99	100.2	99.8	100	99.6

1. Glaze to Si-Al porcelain body (Owen, 2000)
2. Glaze to Si-Al porcelain body average of 3 analyses (Freestone, 1993)
3. Low-Pb glaze type (Owen, 2000) total Fe as Fe_2O_3
4. High-Pb glaze type (Owen, 2000) total Fe as Fe_2O_3
5. Glaze to Si-Al-Ca porcelain body average of 2 analyses (Freestone, 1993)
6. Glaze to underglaze blue Limehouse platter, Fitzwilliam Museum, Cambridge (see Fig. 2a)
7. Glaze to underglaze blue Limehouse sauce boat (Godden Collection, Bonhams, 2010: Sale No. 18425, Lot 43; see Fig. 2b)
8. Glaze to broken underglaze blue Limehouse pickle dish with Chinese vase decoration (Godden Collection)
9. Glaze to underglaze blue Limehouse pickle dish with Chinese vase decoration (private collection; see Fig. 2c)
10. Glaze to ribbed polychrome Limehouse coffee cup (Watney Collection - Phillips, 2000a: Sale No. 30,924, Lot 538; see Fig. 2d)
11. Glaze to underglaze blue Limehouse pickle dish (private collection; see Fig. 2e)
12. Glaze to underglaze blue Limehouse pickle dish (Godden Collection, Bonhams, 2011: Sale No. 19105, Lot 254, see Fig. 2f)
13. Glaze to underglaze Lund's Bristol blue teapot (Watney Collection - Phillips, 2000b: Sale No. 30,926, Lot 914, see Fig. 2g)
14. Glaze to gadrooned underglaze blue Bow *prunus root* plate (private collection; see Fig. 2h)
15. Glaze to covered sugar bowl, Bow first patent body (Ramsay et al., 2004, Ramsay and Ramsay, 2006, 2007b; see Fig. 2i)
16. Glaze to *famille rose* Bow bowl (private collection; see Fig. 2j)

MAGNESIUM-PHOSPHATE RECIPE TYPE ATTRIBUTED TO LIMEHOUSE

Routine micro-sampling by the authors of various porcelain items attributed to Limehouse has identified a new recipe type comprising what is assumed to represent crushed silica, steatite, and bone ash. This body equates with the Mg-P type (Owen, 2007). Methods of sampling and analysis are given in Ramsay et al., (2011a, b). Both body and glaze compositions taken from two pickle dishes (Figs. 2e, 2f) are given in Tables 1 and 2. The body comprises 9.4 and 12.5 wt% MgO, 4.7 and 6.7 wt% P_2O_5, 8.8 and 9.8 wt% CaO, and 1 wt% to less PbO. The glaze on both is a moderate lead glaze (29 wt% PbO), distinct Al_2O_3 (4 and 7 wt%), marked Na_2O (3 wt%), and variable MgO (0.4 and 3 wt%). This Mg-P recipe finds close parallels with one of the Lund's Bristol bodies (Ramsay et al., 2011a) except that Lund's recipe contains considerable levels of lead, presumably in the form of a lead glass frit (Table 1: 12; Table 2: 13; Fig. 2g) a potential discriminant from Limehouse wares.

In each case we assume that the source of the magnesium was steatite as suggested by the low Al_2O_3 content in both analyses with typical steatite having the general composition of $SiO2_{45}$,$Al2O3_8$,MgO_{25}, $H2O_{22}$. However we note that in the case of analysis 10, Table 1 the Limehouse porcelain shell dish has a CaO/P_2O_5 ratio (Mol Proportions) of 5.3, well above the established ratio of 3.3 (Owen, 2001) and this could indicate the addition of further calcium over and above that required to account for bone ash, as either a lime alkali glass or as dolomite ($Ca,MgCO_3$). If the latter then some of the magnesium could have come from dolomite, however that could explain but part of the magnesium source.

Owen (1998) has recorded a sherd from the lowest level of Warmstry House (W12) having a comparable Mg-P body and lacking in lead (Table 1). Although the associated glaze has a high PbO content we speculate whether this sherd is of Limehouse origin on the basis of the absence of lead in its body.

Based on the excavations at 20 Fore Street no Mg-P sherds were recovered. At the time Freestone (1993) suggested that this absence represented the vagaries of an archaeological excavation. However we note that in addition, in all three reports of the excavation (Drakard, 1993; Potter, 1998; Tyler et al., 2000), no remains of steatitic clay, animal bones, or calcined bones were reported. These absences suggest to us one of the following possibilities:

1. The vagaries of an archaeological excavation, or
2. Mg-P porcelains were not produced on the 20 Fore Street site.

If the latter is correct then two further possibilities arise:

1. The Mg-P wares described here are not Limehouse in origin, or
2. These Mg-P wares may be attributed to Limehouse but were manufactured on the second site on the north side of Fore Street by early to mid 1747 as discussed in Appendix 1.

Based on our as yet imperfect knowledge of early Bow glaze compositions (Ramsay et al., 2011b) we tend to the view that these Mg-P shell dishes (Fig. 2e, f) are not of a Bow derivation. Moreover the absence of distinct levels of PbO in the porcelain body in each of the shell dishes militates against a Lund's Bristol attribution, based on our limited knowledge of Lund's Bristol porcelain compositions (Ramsay et al., 2011a). Consequently we suggest that the Mg-P recipe was produced at Limehouse, however we note that our knowledge of porcelain compositions of this period is limited and that previous attributions based purely on physical aspects have been unable at times to differentiate between Limehouse and Lund's Bristol.

Fig. 2a

Fig. 2b

Fig. 2c

Fig. 2d

Fig. 2e

Fig. 2f

Fig. 2g

Fig. 2h

Fig. 2i

Fig. 2j

Fig. 2. Images of various porcelains from Limehouse, Lund's Bristol, and Bow.

Fig. 2a. Octagonal platter in underglaze blue. Limehouse Si-Al-Ca porcelain, c. 1746 - May 1747, 22 cm wide. Fitzwilliam, Cambridge. The artist responsible for the border foliage is most likely the same hand found on the border foliage of a Lund's Bristol sauceboat (Ramsay et al., 2011a: Fig. 4). Photograph by the authors. Table 1, No.5; Table 2, No.6.

Fig. 2b. Large sauceboat in underglaze blue. Limehouse Si-Al-Ca porcelain, c. 1746 - May 1747, 21.8cm long. Formerly Geoffrey Godden Collection, (Bonhams, 2010: Sale No. 18425, Lot 43). Bonhams report that a fragment from a sauceboat with an identical scene of a distant cottage was recovered from the Limehouse site and illustrated by Tyler et al., (2000). Photograph courtesy of Bonhams. Table 1, No. 6; Table 2, No. 7.

Fig. 2c. Pickle dish in underglaze blue. Limehouse Si-Al-Ca porcelain, c. 1746 - May 1747, ~10 cm long. Private collection. Photograph by the owner. Table 1, No. 7; Table 2, No. 9.

Fig. 2d. Ribbed polychrome coffee cup. Limehouse Si-Al-Ca body, c. 1746 - May 1747, 5.9 cm high. Formerly Watney Collection (Phillips, 2000a: Sale No. 30,924, Lot 538). Possibly outside decorated. Photograph by the authors. Table 1, No. 9; Table 2, No. 10.

Fig. 2e. Pickle dish in underglaze blue. Limehouse Mg-P body, c. June 1747 - early 1748, 10.7 cm high. Private collection, formerly Watney Collection (Phillips, 2000b, Sale No. 30,926, Lot 898). Photograph by the authors. Table 1, No. 10; Table 2, No. 11.

Fig. 2f. Pickle dish in underglaze blue. Limehouse Mg-P body, c. June 1747 - early 1748, 10.2 cm high. Private collection, formerly Geoffrey Godden Collection (Bonhams, 2011: Sale No. 19105, Lot 254). Photograph courtesy of Geoffrey Godden. Table 1, No. 11; Table 2, No. 12.

Fig. 2g. Teapot in underglaze blue, Lund's Bristol Mg-P-Pb porcelain, c. 1749 - late 1750, 9.5 cm wide. Private collection, formerly Watney Collection (Phillips, 2000b: Sale No. 30,926, Lot 914). Phillips attributed this teapot to Limehouse though they drew attention to the presence of similar painting on a Lund's Bristol coffee can in the same sale (Lot 917). Based on the distinctive amount of lead in the body of this teapot (Table 1) we attribute this teapot to Lund's Bristol. Only recently has it been realised that Benjamin Lund used bone ash in a group of his porcelains as well as steatite (Ramsay et al., 2011a). Photograph by the authors. Table 1, No. 12; Table 2, No. 13.

Fig. 2h. Plate with gadrooned border and decorated with the *prunus root pattern* in underglaze blue, Bow Si-Al porcelain or porcellaneous stoneware, c. late 1730s , 24.1 cm wide. Private Collection. This porcellaneous body has a high content of ball clay as judged by its marked Al_2O_3 content (14.7 wt%) coupled with a distinctive TiO_2 signature (0.8 wt%). Its glaze composition is indicative of Bow with high PbO (50 wt%), K_2O > CaO, and negligible MgO and Al_2O_3. This plate has an unusual rendering of this common pattern. Following its purchase in 1989 an exhaustive search was made through the literature in an endeavour to find another example. Finally, an exact rendering of the design was found on an octagonal plate in the Victoria and Albert Museum exhibited with items of unknown origin. Subsequently the octagonal plate was moved to a cabinet containing a variety of Bow porcelains. When the cabinets were re-arranged in the new Study Centre, the octagonal plate was displayed amongst items currently considered as Limehouse and others belonging to the George II bust group. However the octagonal root patterned plate remains catalogued by the V&A as of 'unknown attribution'. Hilary Young (Curator) explained that he was not confident of its Bow attribution. Recently the two plates (the one shown in Fig. 2h and the one from the V&A) were physically compared at the Museum and Hilary Young agreed that they were manufactured in the same factory and painted by the same hand. Both lack any translucency, but the example in the round with a gadrooned rim shows many more firing faults; in parts, but especially with the underglaze blue painting where the glaze has pitted in some areas and not adhered in others. In both instances the glaze is slightly blued. One self-professed 'expert' out of London has advised (pers. com. 2012), *I am totally familiar with the type; these plates just could not date from the late 30s or early 40s as they (the authors) suggest. Stylistically they must be late 50s at the earliest and are more likely to date from the 1760s/70s.* In reply, we know of no factory operating in the 1760s or 1770s which produced such wares having this distinctive body and glaze composition. This plate is amongst a small group of porcelain items attributed by us to Bow dating to the 1730s. By the early to mid-1740s, if not earlier, the Bow concern was utilising a range of porcelain recipe types including a unique hard-paste body based on imported Cherokee clay from the Carolinas, the use of steatite, and the use of bone ash. Potting forms included moulded, turned, and slip-cast varieties reflecting their Staffordshire heritage. Decorative idioms display an eclectic range of both indigenous (London theatre and engravings by Gravelot/Bickham) and exotic including Asiatic-inspired underglaze blue designs, 'sprigged' decoration derived from *blanc de chine* porcelain, *famille noir*, *famille vert*, *famille rose*, *Kakiemon*, and European influences including fables, harbour scenes, and *indianische Blumen* motifs all interpreted through the prism of Bow. Yet because of the *millstone syndrome* (Ramsay et al., 2011a) and a reluctance to consider composition and integrate with contemporary documents, these pioneering advances by Bow (compositional, technical, and artistic) commencing from the 1730s have largely gone without comment. Photograph by the authors. Table 1, No. 13; Table 2, No. 14.

Fig. 2i. Polychrome covered sugar bowl, Bow Si-Al-Ca hard-paste porcelain, c. 1744, 7.8 cm high. Collection of the Melbourne Cricket Club Museum, accession No. M5369.1. This bowl comprises inferred Cherokee clay (59 wt%) and a lead-free, lime-alkali glass cullet (41 wt%) and it represents the stellar technical, artistic, and commercial heights reached by Bow by the mid 1740s (Ramsay and Ramsay, 2007a, 2007b). It was this English hard-paste composition coupled with the high-style decoration found on this bowl decorated with human figures, which galvanised the French in 1745 to obtain Royal assent to the Vincennes Privilege (Daniels, 2007). Likewise, although these porcelains were clearly referred to in the 1744 patent of Heylyn and Frye (Ramsay and Ramsay, 2006) and the Thomas Frye Tribute (not to be confused with the Frye Epitaph), such contemporary accounts have been overlooked or misinterpreted and for the last half century attributions for these dazzling porcelains have been sought in Italy or Scotland. Photograph by Erin O'Brien. Table 1, No. 14; Table 2, No. 15.

Fig. 2j. Polychrome bowl decorated after the Chinese in *famille rose* colours, Bow Al-Mg-P porcelain, c. 1742-1744, 12.1 cm diameter. Private collection. The body of this bowl has a high-fired appearance as demonstrated by the very high content of aluminium (33 wt% Al_2O_3), is well-potted having a tight-fitting, blemish-free glaze distinctive of Bow, and is highly translucent with a greenish hue. The distinct amounts of P_2O_5 and MgO are assumed to reflect the use of both bone ash and steatite/soapstone by the Bow proprietors. The glaze is a characteristic Bow glaze (Ramsay et al., 2011b) with high PbO, $K_2O \geq CaO$ and low Al_2O_3 and MgO. The decoration on this bowl belongs to a stock pattern produced at Bow over a long period of time, but as with the design of the *prunus root pattern* (Fig. 2h) is rendered very individually by a painter whose hand has only been found on one or two other typically Bow examples, although visual examination indicates the paste composition found in these other bowls differs from this example. Whilst an inordinate degree of discussion is found in the literature regarding the visual appearance of Bow glazes, which might appear to be less than diagnostic, little attention has been afforded a range of Bow body types (Al-P-S, Al-P-Pb, Al-Mg-S, Mg-Pb, Al-P, Al-Mg-P, Si-Al-Ca, and Si-Al) many of which are visually distinctive and highly informative regarding the early development of Bow from the 1730s. The visual appearance and chemical composition of the inferred high-fired body contained in this bowl resonates with that of a Al-Mg-S Bow tea canister decorated with the *Island House pattern* (Ramsay and Ramsay, 2005; 2007a; 2007b). Photograph by the authors. Table 1, No. 15; Table 2, No. 16.

VISUAL IDENTIFICATION AND COMPOSITIONAL STRATIGRAPHY OF THE THREE RECIPE TYPES

The authors recognise three distinct Limehouse porcelain recipes and key chemical and visual features associated with each are presented in Table 3. Visual separation of these three types is reasonably distinct, yet strangely there has been little comment on these differences in the literature with previous descriptions of the body and glaze regarding them as essentially uniform and homogeneous (Spero, 2006: 341; Sandon, 2009: 22). Watney (1993) states that it is visually impossible to distinguish suspected magnesian Limehouse variants even though he was apparently able to indicate differences when much of the Limehouse group was previously attributed to William Reid (Watney, 1963, 1973: 86).

Based on the three recipe types, a compositional stratigraphy can be erected for Limehouse (Table 4). The earliest body is the experimental Si-Al type, of which no extant items have apparently yet been recognised, possibly dates from late 1745.

The second recipe type, namely the Si-Al-Ca body, was probably produced from early 1746 through to around early - mid 1747. In an advertisement in *The Daily Advertiser* for 20th June, 1747 (Gardner, 1928);

To the PUBLICK. THE NEW-INVENTED LIMEHOUSE WARE, consisting of a great Variety of useful and ornamental Vessels, which as to Duration etc. is in no way inferior to China, being now greatly improved,.....

We take this date of June 20th, 1747 to mark the change in production from the less technically accomplished, more refractory Si-Al-Ca body to the more translucent, whiter, lower-firing body of the Mg-P type. We suggest that the failure of Limehouse may not have been because of the production of dirty, messy, and speckled porcelains (Sandon, 2009), as these 'greatly improved' Mg-P wares are typically whiter, cleaner looking, and more translucent.

Of note is a subsequent advertisement in *The Daily Advertiser* for October 28th, 1747 (Gardner, 1928) where it is stated that Mr Pinchbeck on his return from Tunbridge Wells has furnished himself among other things;

..... with great Variety of useful & ornamental Goods in the 'New Limehouse Ware'; which for strength and enduring the Fire, far exceeds China, or any other Ware hitherto invented.

This reference to Limehouse porcelains having a refractory body refers to the former Si-Al-Ca body of which we suggest Mr Pinchbeck was able to acquire a bulk purchase of this now discontinued line. We propose that this October advertisement does not refer to the inferred lower-firing, greatly improved Mg-P body, as advertised previously in June, 1747. Ramsay and Ramsay (2007b) and Ramsay et al. (2011b) have used recipe types to erect a compositional stratigraphy through the Bow soft-paste, phosphatic output and more recently Ramsay et al., (2011a) have subdivided the Lund's Bristol production into a pre late-1750 group and a post late-1750 group based on composition. Likewise Owen (2003) has traced the compositional changes in the porcelain body through time at Worcester and Middleton and Cowell (1993) for Longton Hall.

TABLE 3: CHEMICAL AND PHYSICAL FEATURES ASSOCIATED WITH THE THREE LIMEHOUSE CERAMIC BODIES

	Si-Al experimental	**Si-Al-Ca body**	**Mg-P body**
Composition of the body	~77 wt% SiO_2, 16 wt% Al_2O_3, 1.4 wt% K_2O, 0.5 wt% CaO, negligible PbO	~73 wt% SiO_2, ~11 wt% Al_2O_3, ~6.5 wt% CaO, ~6 wt% Na_2O + K_2O, negligible PbO.	~65 wt% SiO_2, ~3 wt% Al_2O_3, 9-12 wt% MgO, 5-7 wt% P_2O_5, negligible PbO.
Composition of the glaze	~72 wt% SiO_2, ~5 wt% Al_2O_3, ~2 wt% MgO, 7-11 wt% CaO, ~8 wt% Na_2O + K_2O, lead-free	48-56 wt% SiO_2, 4-7 wt% Al_2O_3#, ~3-6 wt% CaO, 2-4 wt% K_2O, 25-33 wt% PbO. Minor Sn reported (Owen, 2000).	~55 wt% SiO_2, 4-7 wt% Al_2O_3, 2-4 wt% K_2O, ~30 wt% PbO.
Nature of the body	Slightly pink body, porous of earthenware type with low-degree of vitrification. Well potted with an experimental appearance.	Thickly potted, less porous than the Si-Al type (more dense), greyish colouration. Matrix to the body is highly vitrified and continuous.	Tends to be more thinly potted, whiter body, and low porosity. Potting possibly more sophisticated.
Refractory body	High-fired	Medium-fired	Lower fired
Firing faults	Underfired with poorly vitrified body.	Often misshapen and can be blistered. A number collapsed during the glaze firing. Often messy, dirty.	Some smoke damage, firing cracks.
Nature of the glaze	Poorly-fitting, often blistered and crazed, and rather opaque. Low viscosity and tendency to devitrify.	Well-fitting, well-controlled glaze.	Glaze well-fitting and tends to bluish-white colour.
Underglaze blue decoration	Rather pale blue with linear and broadly painted floral designs.		
Raw materials used in the body	Ball clay, crushed silica, source of potassium likely to be saltpetre, KNO_3	Ball clay, crushed silica, crushed lime-alkali glass, +/- minor smalt.	Steatite, bone ash, crushed silica, minor lead-free glass frit.
Translucency	Non-existent.	Poorly translucent in shades of brown or orange in thinner parts.	Better translucency in shades of green or grey green.
Extant examples	Only recognised from factory wasters.	Examples recognised.	Examples recognised.

Fitzwilliam platter (Fig. 2a) has 0.4 wt% Al_2O_3
Observations in part after Drakard (1993), Potter (1998), Tyler et al. (2000), and Watney (1963, 1973).

TABLE 4: COMPOSITIONAL STRATIGRAPHY FOR LIMEHOUSE, LUND'S BRISTOL, AND SOME BOW RECIPE TYPES

	Bow	**Limehouse**	**Lund's Bristol**
Late 1750 - early 1752			Mg-Pb body and moderate Pb glaze
1749 - late 1750			Mg-P-Pb body and moderate Pb glaze
June 1747 - early 1748		Mg-P body and moderate Pb glaze	
Early 1746 - June 1747		Si-Al-Ca body and moderate to high-Pb glaze	
Late 1745 - early 1746		Si-Al body and Si-Al-Ca glaze	
1743 - early 1746	Si-Al-Ca body and glaze		
Early - mid 1740's	Al-Mg-P body and high-Pb glaze		
1730's - early 1740's	Si-Al body and high-Pb glaze		

TECHNOLOGY PATHWAY FROM LIMEHOUSE TO LUND'S BRISTOL

The first author to recognise a Limehouse - Lund's Bristol linkage in modern literature appears to be Wallace Elliot (1929) though strangely he dismissed a Bow - Lund's Bristol connection and by implication a Bow - Limehouse link; apparently predicated on the belief that Bow commenced its phosphatic (and magnesian) output around 1748 and hence post-dated Limehouse. This view that the Bow ceramic output was on the one hand broadly contemporary with Benjamin Lund at Bristol and on the other hand post-dated the inception of Limehouse continues today (Tyler et al., 2000: 5; Young, 1999: 197; Gabszewicz, 2000; Spero, 2005: 26, 2011: 10; Christies, 2010; Pietsch, 2010) with Spero (*in* Spero and Burt, undated: 64) arguing that in three particular respects production at Limehouse stood apart from both contemporary Bow and the Chinese importations - an innovative use of moulded ornamentation, a series of models associated with silver forms, and almost certainly, the first use of soaprock on a commercial scale, probably introduced only during the final stages of the factory's brief existence. Moreover Spero (1995: 20, 2002: 28, 2005: 26, 2011:10) and Brian Haughton Antiques (2004: 61) have argued that Limehouse was the first to produce underglaze blue porcelains in England, thus initiating a resonant tradition. From these concepts has arisen the notion that Limehouse was a ceramic innovator with respect to potting, moulding, the use of steatite, and even the inception of the earliest underglaze blue decoration, whereas in contrast Bow, by implication, has been cast as being derivative from Limehouse. Tyler et al. (2000) describe Limehouse as being in the vanguard with Chelsea in attempts to manufacture porcelain in England.

Based on the concept of technology pathways there is a Limehouse - Lund's Bristol link by way of the Mg-P body and a broadly comparable moderate lead glaze (Table 1, Table 2, Figures 2e, f, g). Whilst Elliot (1929) may have been the first to recognise a Limehouse - Lund's Bristol linkage based on historical documents, we can now recognise stylistic linkages and based on this contribution a compositional pathway between the two concerns. The key linking composition with Lund's Bristol is the Mg-P recipe, which is dated by us at Limehouse from at least June, 1747 to closure around early 1748, and at Lund's Bristol from commencement in 1749 through to late 1750.

TECHNOLOGY PATHWAY FROM BOW TO LIMEHOUSE

The three Limehouse compositions and the Si-Al-Ca glaze composition discussed in this paper can be shown to be derivative from Bow. Firstly the Limehouse Si-Al experimental body Table 2, Nos. 1 and 2) is to be found in a comparable Bow body (Table 1, No. 13, Figure 2h) having the distinctive Bow glaze (Table 2, No.14) as characterised by Ramsay et al. (2011b). Based on the distinctive body and glaze analyses obtained from this gadrooned plate with underglaze blue *prunus root* decoration we propose that this example represents an early phase at the Bow factory when a crushed silica (or calcined flint) - ball clay - potassic flux (possibly saltpetre - KNO_3) body was being produced, most likely in the late 1730s. Comparable porcelain bodies, or possibly porcellaneous stoneware bodies, have also been recognised as a product from Lund's Bristol (Camden Society, 1888; Ramsay et al., 2011a), the lowest level at Warmstry House (Owen, 1998), and from William Reid of Liverpool (Owen and Hillis, 2003); however in each instance the associated glazes do not accord with early Bow glaze compositions as found on this plate (Ramsay et al., 2011b). A closely comparable underglaze blue octagonal plate with the same decoration is contained in the collections of the Victoria and Albert Museum (C591-1924) catalogued as of unknown factory and dated *c*. 1750. A discussion on both plates and their relationship with one another is given in Fig. 2h and Appendix 1.

The Limehouse Si-Al-Ca body (Table 1, Nos. 3-9) is derivative from Bow hard-paste, first patent porcelains which were made using refractory Cherokee clay (Table 1, Figure 2i). Unlike Bow, Limehouse was unable to source Cherokee china clay and settled instead for a ball clay, most likely from Dorset.

In addition, Limehouse added crushed silica or calcined flint to the body and the resultant Limehouse body was covered with a lead-based glaze, whereas Bow employed on its first patent wares a Si-Al-Ca glaze, which itself was subsequently utilised by Limehouse on its Si-Al experimental body (Table 2, Nos. 1-2). These Bow porcelains ('A'-marked wares) by early 1745 had reached a high degree of sophistication, as recorded in the Vincennes Privilege (Daniels, 2007). Although this Privilege dates unequivocally the manufacture of the so-called *high-style* porcelains from this group, Daniels' recognition of this significant date in relation to Bow first patent porcelains based on absolute dating is still ignored in the literature in favour of relative dating based on inferred stylistic linkages on the unsubstantiated assumption that the assumed artist went from Bow to Chelsea. If from Chelsea to Bow, then this would date these Bow first patent porcelains to the late 1740s if not the 1750s .

Lastly the Limehouse Mg-P body finds its possible antecedents in Bow (Table 1, Table 2, Figure 2j) but here Bow used in addition a high-clay composition, no doubt influenced by its first patent body (Ramsay et al., 2003) covered with a distinctive Bow lead glaze (Ramsay et al., 2011b). This Bow Al-Mg-P body contains a high level of ball clay, possibly from Dorset, as indicated by its marked TiO_2 content (0.5 wt%). The phosphorus in the body (2.7 wt% P_2O_5) is assumed to represent the addition of bone ash and the magnesium (3.1 wt% MgO) is suggested to reflect the use of steatite in the body. Other possible sources of magnesium could have been magnesite ($MgCO_3$) or more likely dolomite ($Mg,CaCO_3$) as discussed above for one of the Limehouse pickle dishes (Table 1: 10). The notion that Bow never used steatite complements the mindset of a decade ago that Bow could never have produced the 'A'-marked porcelains and this current opposition to the use of steatite by Bow is now the foundation for resistance to the view that the George II busts could have a Bow provenance as proposed by Daniels (2007). Hobbs (1995) summarises much of the evidence available on the early use of steatite and Daniels (2007) discusses the possibility of its use at Bow. Some of this information is included in Appendix 1.

The first evidence that Bow may have been utilising steatite came from an analysis of a polychrome tea canister decorated with the *Island House pattern* in the collections of the National Gallery of Victoria (Ramsay and Ramsay, 2005). At the time the authors believed that the Bow porcelain output could be regarded as compositionally bimodal (Bow first patent, high-Al body and the Bow second patent bone ash body) and consequently they classified this canister with its high-Al body (inferred high-clay) as being a member of the former group ('A'-marked group). However by 2007 (Ramsay and Ramsay, 2007a, 2007b) it became obvious that the Bow recipe types were compositionally polymodal and that a number of porcelain bodies were being produced by Bow by the early 1740s. The authors specifically recanted and described this porcelain canister as having its own distinctive high aluminium - magnesium - sulphur recipe (Al-Mg-S) and hence not conforming to the 'A'-marked or Bow first patent body. Initially the authors (Ramsay and Ramsay, 2005) were uncertain as to the source of the magnesium in the tea canister body and consequently they provided two possible recipe formulae to account for the bulk chemical composition of the tea canister, with Recipe 1 requiring the addition of magnesite (magnesium carbonate). The second theoretical formulation (Recipe 2) required the addition of talc or steatite to the porcelain body. Subsequent to that publication, discussions were held with Professor Ian Freestone and the consensus that arose was that talc or steatite was the more likely source for the magnesium. We contend that Bow magnesian porcelains using steatite would have to date no later than 1747 when the Kynance Cove occurrence had been exhausted, as recorded by Borlase, and the Gew Graze deposits used by Benjamin Lund at Bristol had not yet been discovered.

Currently the use of steatite is postulated to have commenced at Limehouse, with Watney (1993: 29) stating that the potters who left Limehouse may have taken with them the secret of making soapstone porcelain. Based on the Watney model a number of technology pathways have been proposed from Limehouse to Lund's Bristol, to Newcastle-under-Lyme (Pomona), and to Vauxhall (Watney, 1993: Appendix III), yet the critical question that has not been asked is how did this short-lived, little known, unsuccessful factory manage to find the resources to invent and develop the use of steatite (and bone ash), together with two other body types, all internationally innovative compositions, in so short a period? Today it is still almost universally accepted that Limehouse

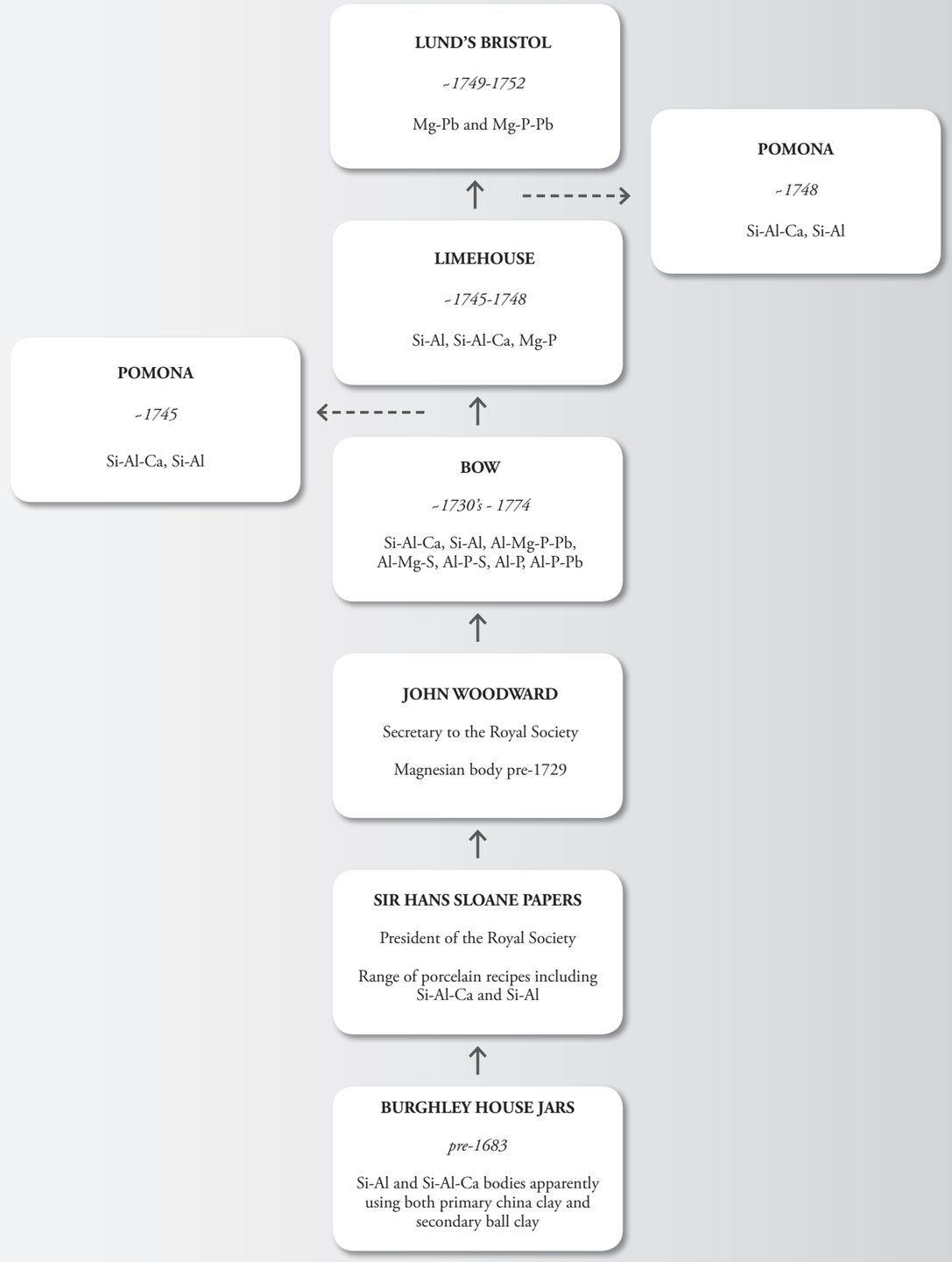
was the originator of the use of steatite or soaprock in English ceramics (Watney, 1993; Sandon, 1993; Spero *in* Spero and Burt, undated: 64).

Earlier workers {Elliot, 1929; Hurlbutt, 1926: 67-68; and possibly Toppin (*fide* Watney, 1975)}, unlike current thinking, accepted or suspected, that Bow used steatite. However because of the *millstone syndrome* (Ramsay et al., 2011a), which has afflicted the thinking in English ceramic studies for the last 100 years, these earlier workers and more recent ceramic historians have been unwilling to accept that Bow was in commercial production before the late 1740s. Hence by implication, Bow must have overlapped with, or post-dated, Limehouse and consequently its use of steatite and bone ash was derivative from Limehouse. Only recently has the notion that Bow used steatite been re-examined, but unlike earlier workers it is now recognised that the use of a number of recipe types at Bow, including both steatite and bone ash, commenced in the early 1740s if not the 1730s. Consequently the technology pathway ran from Bow to Limehouse and thence to Lund's Bristol and supposedly innovative features previously attributed to Limehouse (underglaze blue decoration, the use of steatite, the development of moulded ornamentation, and the utilisation of silver shapes) were all derivative from Bow, which was in commercial operation up to five, if not ten years prior to Limehouse (Daniels, 2007; Daniels and Ramsay, 2009; Ramsay and Ramsay, 2007a, 2007b; Ramsay et al., 2011a, 2011b). Moreover the 1744 ceramic patent of Heylyn and Frye, or Bow first patent (Her Majesty's Stationary Office, 1856; Ramsay et al., 2006) specifies the use of underglaze blue decoration. We wonder whether one of the reasons for the demise of Limehouse may have been the exhaustion of the Kynance Cove steatite deposits by 1747 as recorded by Borlase.

Based on composition, this account argues that there is a technology pathway running from Bow to Limehouse. Firstly the 'Limehouse early' or 'experimental ware' with its Si-Al body and a potassic flux finds its antecedent in a Bow porcellaneous stoneware plate which we date to the early 1740s, if not the 1730s. Moreover the 'failed' Limehouse Si-Al experimental ware is covered with a characteristic Si-Al-Ca glaze which was introduced at Bow around 1743. The subsequent Limehouse porcellaneous wares have a composition which replicates the Bow first patent body, only ball clay was substituted for a primary china clay and crushed silica was in addition added to the Limehouse body. Commerical production of the Bow first patent body dates to around 1743 and the Limehouse Si-Al-Ca body is proposed to date to early 1746 (Table 4). Lastly the Limehouse Mg-P body resonates with the Bow Al-Mg-P body in that although the Bow body is characterised by a high-Al content (inferred high-clay), a feature of very early Bow porcelains dating to the 1730s - mid 1740s (Ramsay and Daniels, in prep) the joint use of bone ash and postulated steatite in the Bow body is replicated at Limehouse by mid-1747 (Table 4) and at Lund's Bristol by around 1749 (Ramsay et al., 2011a).

The most likely method of such technology transfer from Bow was by means of potters moving from Bow to Limehouse, located some 3 kms to the south. One such potter could have been William Ball, who has been shown by Elizabeth Adams from the Land Tax Assessments of St Mary Bow Tower Division for Tax was present in 1745 and 1746 (Appendix 1). Subsequently William Ball moved to Limehouse where an entry in the Land Tax Assessments 6006/Vol.26 (Latham, 1987) has Ball listed for 17th February, 1746/7 and again paying tax in Vol. 27, page 6 (Appendix 1). It is entirely possible that William Ball was responsible for the introduction of the Mg-P body at Limehouse, whereas the use of the Si-Al-Ca body and glaze at Limehouse looks to have preceded William Ball's arrival and may have been associated with someone such as Benjamin Lund, who appears to have had close links with Edward Heylyn. Moreover the Bow first patent specification was entered in April 1745 and may have been disseminated unofficially amongst the potting fraternity. Although Limehouse had some of the Bow compositional knowledge it appears, judging by the failed experimental Si-Al wares, to have lacked the high-temperature kiln technology enjoyed by Bow, most likely supplied by Cromwell Mortimer of the Royal Society (Daniels, 2007).

Fig. 3. Compositional phylogenetic tree from the Burghley House jars to Lund's Bristol. Some compositions listed with 4 components do not follow the classification advocated by Owen (2007)



RECIPE LINKS TO THE ROYAL SOCIETY OF LONDON

A key feature in this discussion on Limehouse and its associated technology pathways relates to the origins of the English porcelain tradition, the development of which has been typically based on the long-held view that earlier Continental technology provided the English with the secrets of porcelain manufacture. In numerous overviews of the early years of the English porcelain industry (Honey,1939; Savage, 1952; Watney, 1963; Fisher, 1965; Sandon, 1989, 2009; Young, 1999; Spero, 1998, 2006; Godden, 2004) little or no attention has been afforded the role and influence of the Royal Society of London, other than passing reference, for example, to Dr Martin Lister (Honey,1939; MacKenna, 1948; Tilley, 1957) or to the use of cobalt found among Robert Hooke's papers (Watney, 1963, 1973). This remained so until Daniels (2007) brought into focus the driving role of the Royal Society of London behind English porcelain development, most likely stretching back to John Dwight and Robert Boyle in the 1650s (Appendix 1). The traditional view held by many English ceramic historians and connoisseurs is that the Royal Society was primarily a purely scientific organisation and although some practical applications may have been attempted, the Society acted more often as an observer than a promoter (Mallet, pers. com. July, 2009). In contrast Daniels (2007: 21) argues that the Royal Society was vitally interested in the firing of porcelains and by the late 1720s was in possession of technical information that detailed the materials and methods of four major types of porcelain made in Britain before the last quarter of the 18th Century - hard-paste, bone ash porcelains, magnesian porcelains, and the glassy French type. The Royal Society was originally named by the founding members *The Invisible Society.* From the very beginning funds were used to support financially any particularly promising industrial or commercial project proposed by private individuals (Appendix 1). One of the earliest promotions, if not the first, was towards the development of lead glass.

Further support for Daniels comes from the private papers of Sir Hans Sloane, President of the Royal Society of London. The Sloane Manuscript No. 3636 housed in the British Library, records a large number of experimental porcelain recipes, glazes, and colours, which appear to have been undertaken or commissioned by members of the Royal Society, during the general period 1708-1713 and contemporary with the development of Meissen porcelain (Table 5) and prior to, or contemporary with, the first of d'Entrecolles' letters. The absence of any mention of bone ash or steatite in the recipes suggests to us that these experimental firings took place prior to ~1720 as indicated by two of the folios - *Folio 70 recto*, dated February 28th, 1707/8 and *Folio 66 recto*, which is headed "For Potters Colors things Tryed in y^{e} year 1713 & found to be good". These recipe formulations were discovered by Margaret Macfarlane on September 11th, 1985 (pers. com., 25th February, 2011).

In particular we draw attention to *Folio 76 Recto, Experiment N*, which contains the following recipe: Crown glass (2-12), Tob. Pipe clay (2-12), and Calcined flints (2-12) (Table 5). Although the person who conducted this firing was less than impressed with the final product, noting that the porcelain body was 'not good' (Table 5), its composition and the raw materials used are closely analogous with the Limehouse Si-Al-Ca body (Tables 1, 6), thus demonstrating a distinct technology pathway from these experimental firings, commissioned, or undertaken by members of the Royal Society dating to the early 18th Century. Compositional parallels can also be drawn with the Bow Si-Al-Ca body (Table 6) although here Cherokee china clay was substituted for pipe clay and crushed silica was not included. Further there are a number of experimental firings listed in the Sloane papers exploring various ratios of calcined flints, ball clay, and saltpetre (KNO_3), whose compositions are analogous to the Bow and Limehouse Si-Al bodies (Table 1, Table 6).

TABLE 5. SELECTED PORCELAIN FORMULATIONS FROM THE SIR HANS SLOANE DOCUMENTS

Folio	Verso/Recto	Number	Raw materials	Proportions	Observations Recorded
76	Recto	N	Crown glass	2 - 12	not good
			Tob. Pipe clay	2 - 12	
			Calcind flints	2 - 12	
76	Recto	M	Pipe clay	2 - 12	good for nothing
			Calcind flints	2 - 12	
			Common salt	2 - 12	
76	Recto	I ?	Flint Calcind	3 -	not good
			Clay pipe	3 -	
			Pott white	2	
76	Recto	T	Calcind Flint	3	
			Pott white	2	
			Pipe clay	3	
76	Recto	V	Flint calcind	3	not good
			Clay pipe	3	
			Salt peter	2-12	
			Zaffer	2	
76	Verso	I	4 to 1 Flints calcind pipe clay Salt peter	 6 3 2-6#	tho best & most liken a China Earth but not very white nor but little transprnt
			# {altered from 3} ye		
			biggest cupp		
76	Verso	?	Flints calcind	2 - 12	This is Greenish white Half
			pipe clay	2 - 12	Transparent & Glassy pretty good
			Salt peter	2 - 12	

RECIPE LINKS TO THE BURGHLEY HOUSE JARS

Of further note are the broad chemical linkages to be seen with the Burghley House *Virtues Jar* (Wesley, 2008, Spataro et al., 2008) of a late 17th Century date and the Si-Al Limehouse body (Table 6). Both bodies appear to be of the high Al_2O_3 (ball clay) type but in contrast to the inferred saltpetre flux in the Limehouse Si-Al body, the flux used in the *Virtues Jar* appears to be dominated by alum (a hydrated, aluminium-potassium-sulphate). Spataro et al. (2008, 2009) state that in addition to the *Virtues Jar* there are two smaller, contemporary, lidded jars from Burghley House and that analyses of the larger *Virtues Jar* and one of these smaller jars and its lid indicate that all three were produced using similar raw materials. However they note that the lid for the smaller jar has a different composition and hence was probably manufactured in another place or at another time. Likewise Nigel Wood (pers. comm., August 2012) speculates as to whether this lid is a later replacement, possibly dating to the 18th or even 19th Century. Whilst this lid may have a different recipe the more significant feature based on the analyses of Spataro et al., (2008) is that the clay used in both the smaller jar and its lid appears to be very different from the clay employed in the larger *Virtues Jar.* The clay used in the *Virtues Jar* has all the features of a secondary ball clay with high TiO_2 and FeO (Table 6). Ramsay and Ramsay (2007b) discuss briefly the mineralogical and chemical features of secondary clays from the Petrockstowe and Bovey Basins (Oligocene age; 28-35 MYBP) and the earlier Wareham Basin (mid Eocene age; 40-50 MYBP) of south west England.

In contrast the composition of the clay used in the smaller of the two jars and its lid is characterised by very low levels of TiO_2, a feature more in keeping with a primary clay (Table 6). So in-keeping is the chemical signature of the clay used in the smaller of the two jars and its lid with a primary china clay that we speculate whether such a clay might have been employed. If so, then one possible source would have been imports of small amounts of china clay from the east. It is known that quantities of china clay (*terre de porcelaine*) were available out of Rome, probably transported there by traders with the East and in 1682 over a hundred tons of this clay was imported into France (Reinaud 1845; Vogt, 1893). To date, no wares have been identified as having come from this 'Rome china clay' but in view of the correspondence between the assumed date of manufacture of the Burghley House porcelains (1683 or earlier), the sale of china clay in Rome, and the distinct primary clay signature in the smaller Burghley House jar and its lid, it is tempting to speculate that we have here examples fired from this clay. An alternative view proposed by Wood (pers. com., August 2012) is that the *Virtues Jar* and the smaller jar (but possibly not its lid if a later replacement) could represent two types of Japanese porcelain stone, both fairly low-grade, but one less pure than the other.

Currently there is some uncertainty as to the origin of manufacture of the Burghley House jars. Wesley (2008: p. 181) appears to accept them as English, stating that the Burghley House material has modified our understanding of English porcelain production in the 17th Century. In contrast Spataro et al. (2008: p. 194) state that it is difficult to be certain whether Fulham, Dehua, or some other manufactory produced the Burghley House jars. Nigel Wood (unpub. May 2010) argues that both the *Virtues Jar* and the smaller jar (but not the lid, which is regarded by him as a later 18th or even 19th Century replacement) are of Far Eastern derivation, possible Japanese 17th Century Arita ware, whilst Mallet (2008) speculates that it is hard to demonstrate that these wares were made by the Duke of Buckingham rather than John Dwight. Glaze analyses have been undertaken (Spataro et al., 2008) and in part these analyses indicate the presence of a high-fired, lime-alkali glaze apparently unknown in Europe until the 18th Century. In addition, some of the glaze analyses indicate the presence of a lower-fired, high-lead glaze. Wood argues that this high-lead glaze was applied in England to an already fired, high-temperature lime-alkali glaze of the Far East. Wood further notes that lime-alkali glazes have been used continuously on Chinese porcelains since at least the 9th Century AD, and later on Korean (10th Century onwards) and Japanese porcelains (early 17th Century onwards) but on current knowledge were unknown in Europe until the 18th Century.

TABLE 6. CHEMICAL COMPARISONS OF SI-AL-CA AND SI-AL BODIES

	Si-Al-Ca bodies					Si-Al bodies			
	1	2	3	4		5	6	7	8
SiO_2	77.2	72.5	62.6	63.6		66.8	69	76.9	81
TiO_2	0.4	0.8	0.2	< 0.1		1.2	0.1	0.71	0.8
Al_2O_3	10.3	10.8	18.1	23.2		18.2	18.9	18	14.7
FeO	0.4	0.7	0.6	0.3		1.1	0.6	0.63	0.3
MgO	0.13	1	0.8	1.3		1.5	0.5	0.31	0.3
CaO	5.3	6.2	6.1	5.1		0.6	1.4	0.34	0.3
Na_2O	2.7	2.5	2.7	4.3		1.6	1.4	0.37	0.3
K_2O	3.6	3.3	6	2.1		4.5	5.8	2.69	1.7
P_2O_5		0.1	0.6			0	0.1		0.2
SO_3			0.2			1.6			0.2
PbO		1.3	1.7			2.2	1.7		
Other #			0.5			0.7	0.4		
Total	100.03	99.2	100.1	100		100	99.9	99.95	99.8

1. Theoretical Hans Sloane composition, Folio 76 recto, Experiment N (1/3 crown glass, 1/3 Tob. pipe clay, 1/3 calcind flints). Recipe calculated using Warham Basin ball clay. (Ramsay and Ramsay, 2007b) and crown glass (CaO 15%, K_2O 7.5%, Na_2O 7.5%)
2. Average analysis of four Limehouse Si-Al-Ca bodies (Freestone, 1993)
3. Burghley House lid to small jar (Spataro et al., 2008)
4. W. W. Winkworth Bow first patent teapot ('A'-mark) (Ramsay and Ramsay, 2007b: Table 4; Fig. 4a)
5. Burghley House 'Virtues' Jar (Spataro et al., 2008). 'Other' includes SnO_2 0.3%, BaO 0.1%
6. Burghley House small jar (Spataro et al., 2008). 'Other' includes SnO_2 0.4 %
7. John Dwight's Fulham fine white ware, FP23 (Tite et al., 1986; Spataro et al., 2008)
8. Bow gadrooned underglaze blue plate. (This account Table 1, No. 13; Fig. 2h)

To our way of thinking the *Virtues Jar*, based on the Spataro et al. analyses reflects the use of ball clay and whilst the body of the smaller Burghley House jar does reflect a composition comparable to 17th Century Japanese porcelains it also reflects a Si-Al body known to have been produced in England dating back to crucible makers of Medieval times (Freestone and Tite, 1986) and experimentally by the Royal Society in the very early 18th Century (Hans Sloane papers). Moreover the minor presence of lead in the body of the *Virtues Jar,* the smaller jar, and its lid, links all three bodies and does not suggest a Far Eastern derivation to us. In addition the presence of both a moderately high K_2O content and sulphur expressed as SO_3 in the body of the *Virtues Jar* (Table 6) supports the addition of alum as recorded by Robert Hooke FRS in his diary of 16th May, 1674 (Appendix 1). We doubt that the lid of the smaller jar is a later replacement as it too has evidence of both a lime-alkali glaze and a lead-based glaze suggesting the same origin as the *Virtues Jar*. We also note that the lid to the smaller of the Burghley House jars has a number of features which resonate with the bulk chemistry of the Royal Society experimental Si-Al-Ca body, the Bow first patent Si-Al-Ca porcelain body and the subsequent Limehouse Si-Al-Ca body (Table 6).

We suggest that the *Virtues Jar*, the smaller jar, and its lid, are linked by the distinct presence of lead in the body of all three items and the presence of a mixed Si-Al-Ca glaze and a lower-firing lead glaze on the Virtues jar and the lid to the smaller jar. In the case of the smaller jar itself, one analysis only of the glaze is currently available and this is strongly lead-bearing. The overall impression, based on the analyses of the Burghley House jars, is that they are of English derivation with both the Si-Al and Si-Al-Ca bodies traced through to recipe types experimented with in the Hans Sloane papers dating back to 1708. Moreover a future study of the lid to the small jar looking for the addition of a lime-alkali glass frit may further establish the local origin of this item. A micro-textural and compositional study of a Bow first patent teapot lid in the white, recovered from the Bow New Canton site in Essex (Owen, in press) has recognised the presence of resorbed glass frit in the body of the lid.

This resorption of the lime-alkali frit is interpreted by Owen to comprise a two-part process involving (1) diffusion of (principally) alkalis and lime into the clayey matrix at subsolidus temperatures and then (2) partial melting near the interface between the relict glass fragments and the adjacent, fluxed (alkaline) clay. We suggest that a similar study of the lid to the smaller jar may likewise establish comparable features if a lime-alkali glass frit was used as we suspect.

The use of a high clay - glass +/- crushed silica is a feature of early to mid 18th Century English recipes, as initially suggested to us by Professor Ian Freestone (pers. com., 2008). Nigel Wood notes that this recipe type finds its antecedents in the 11th Century Middle East in attempts to copy Chinese porcelain. In more 'recent' times this recipe formulation seems to have been a feature of Italian porcelains such as the Medici wares and later types. In summary we are of the opinion that all three members of the Burghley House trio (*Virtues Jar* and one of the two analysed jars with its lid) are contemporaneous and closely related although different clays were used. The distinctive lead content in the body of each (2.2, 1.7, and 1.7 wt% PbO) denies a Far Eastern origin and in the case of the *Virtues Jar* does not reflect contamination by lead from a muffle furnace as the analysis was obtained from broken portions of the jar. Likewise both the *Virtues Jar* and the small lid are linked by the presence of a Si-Al-Ca glaze and a high-lead glaze. We suggest that analyses of the enamels used on the lid and the jars themselves will demonstrate a coherence in composition which would not be expected if the lid were a later replacement.

Although Spataro et al., (2008) have noted differences in bulk chemistry between Dwight's Fulham white ware and that of the Burghley House Jars, it has been pointed out by Green (1999) that Dwight tested numerous recipes in his search for the manufacture of porcelain. This feature was also recorded by Sir John Lowther in a letter to William Gilpen on 12th March, 1697/98 (Appendix 1). We contend that the author of the Burghley House trio was John Dwight of Fulham as previously speculated by Mallet (2008). Based on the diary of Robert Hooke for 17th February, 1673/74 the *Virtues Jar* with its Si-Al body comprising ball clay (Appendix 1) could date back to 1674. Moreover the presence of moderately high K_2O and sulphur as SO_3 in the body of the *Virtues Jar* (Table 6: 5) strongly indicates the use of alum by Dwight, again as recorded by Robert Hooke in his diary (Appendix 1) for 16th May, 1674. In contrast, based on the inferred use of china clay in the smaller of the Burghley Jars (Table 6: 3, 6) we would date this jar and lid to *c*. 1678, again based on the report by Robert Hooke to the Royal Society of 5th December, 1678, *that Mr. Dwight had made some heads of earth as big as the life and that his earth used was as hard as porphyry and that the excellence of the China earth was that it would endure the greatest fire without vitrification*.

From previous observations by Hooke (Appendix 1) it is clear he understood the difference between tobacco clay (ball clay) and china clay. Moreover Hooke records that this china earth was highly refractory. This feature, coupled with the fact that Hooke made this observation, differentiates it from the more typical clays then known in England. Hooke's comments at the Royal Society meeting of December 1678 resonate with an earlier record of a Royal Society meeting of 25th February, 1674/75 at which Robert Hooke, *brought in an artificial head resembling china made in England of English clay so hard and solid that he said nothing would fasten on it except a diamond and that it received its polish in the fire* (Appendix 1). The fact that Hooke specified that this ceramic head was of English derivation made using English clay, we assume by Dwight, tends to suggest that by early 1675 Dwight had access to other clays and materials, not of English origin and Hooke was aware of it.

If there is any basis for these observations based on chemistry and historical eyewitness accounts by various highly reputable scientists, all members of the Royal Society, then the smaller jar and its lid would represent the earliest example in the Western world of a high-fired, aluminous body using china clay dating to *c*. 1678, some 30 years before Meissen. The reference to 'China earth' by Robert Hooke in early December 1678 and 'China Earth' in the Sloane papers (Folio 76, *verso,* No. I - see Table 5) dating to the period *c*. 1708-1713, coupled with the fact that Dr William Sherrard FRS, brought back samples of china clay and china stone from Paris around 1712, demonstrates that the Royal Society was fully aware of primary china clay and its applications to porcelain manufacture.

The problem may have been not so much a technical one but rather a problem of access to a secure primary clay source. Our research questions the long-held view that the discovery of china clay and the production of a hard-paste body in England commenced with William Cookworthy in Plymouth by the third quarter of the 18th Century (Marryat, 1868; Burton, 1906; Eccles and Rackham, 1922; Mackenna 1946; Watney 1963, 1973; Sandon 1989; Spero, 1998; Young, 1999; Hillis, 2001; Godden 2004; Pietsch, 2010) as discussed by Ramsay and Ramsay (2006, 2007b, 2008).

RECIPE LINKS TO SI-AL CRUCIBLES FROM HESSE, GERMANY, AND STAMFORD LINCOLNSHIRE

Two locations in Europe have been identified where refractory Si-Al crucibles were being produced since the 15th Century, namely from Hesse and the region a Bavaria (Martinón-Torres and Rehren, 2009). The Hessian examples were characterised by having very high Al_2O_3 contents for unused crucibles (average of 39.9 wt%). Apparently Medieval high-Al crucibles were also being made in Stamford, UK (Freestone and Tite, 1986). However, these Stamford crucibles did not attain the success achieved by their Hessian contemporaries and Martinón-Torres and Rehren (2009) suggest that the English crucibles were never subjected to the high-temperature pre-firing, which gave the Hessian variants their prized refractory properties.

Pearce and Tipton (2011) record that during the reign of Elizabeth I continental ceramic technology arrived in England by three different routes:

1. Migration of tin-glazed technology to Aldgate in London from Urbino in Italy via Antwerp and Norwich;
2. design and technology changes brought by a single immigrant potter, Herman Reynolds, from the Rhineland; and
3. development of industrial ceramics, essential to the refining of noble metals, in London and the Blackwater Valley and used alongside imports of Hessian crucibles.

According to Pearce and Tipton (2011) in the case of the third development, the Tower of London had a pottery set up well before 1560 to manufacture ceramics for the Royal Mint's own use. With problems associated with Henry VIII's debased currency the new Upper Mint was built in the Tower in 1560 and two new refining houses were constructed; one located within the Tower in Coldharbour and the other, outside the Tower in East Smithfield. The German firm of Wohlstadt was given the contract for metal refining and introduced new technology in the 1560s. A local potter, Richard Dee, apparently commenced making various specialised ceramics needed for metal refining capable of being resistant to concentrated acids at high temperatures and Pearce and Tipton (2011) question how he came to produce such wares. One possibility they suggest is that Dee took on an ex-employee of the pottery at the mint or even an immigrant from Wohlstadt. Another possibility is that Bastian Miller joined Richard Dee after 1586.

Regardless, we have good evidence of Medieval Si-Al ceramics being produced in Stamford with Al_2O_3 levels in the order of 38 wt% (Freestone and Tite, 1986). Subsequently, aluminous ceramics were being produced by the late 1500s both in London and the Blackwater Valley.

FINAL COMMENT

Wesley (2008) states that the high Al_2O_3 body of the 'Burghley House' trio did not represent a stage in the development of other English bodies as did Böttger's porcelain in the development of later Meissen and other German porcelain bodies. We contend that the compositions found in the Burghley House porcelains, in tandem with Dwight's recipe types from Fulham, constitute the very basis of the indigenous English porcelain tradition. This tradition includes a range of refractory Si-Al crucibles stretching from Medieval times in Stamford, Lincolnshire, through the ceramic crucibles made around the 1580s by Richard Dee, to the porcelain experimental work by John Dwight in the latter part of the 17th Century, to the experimental firings recorded in the Hans Sloane documents of the early 18th Century, the 1720s experimental work by John Woodward on magnesian porcelains, through to the brilliant

high-fired, hard-paste wares of the Bow first patent Si-Al-Ca body, Bow's associated higher-fired Al-Mg +/- P bodies, and a range of bone ash types. This development can in turn be traced to Limehouse's three recipe types and Pomona's Si-Al-Ca and Si-Al bodies, to Lund's Mg-P-Pb and Mg-Pb bodies (Fig. 3), and thence to William Reid's Si-Al body in Liverpool, Nicholas Crisp at Bovey Tracey (if not earlier at Vauxhall), and finally in Cookwothy's high-fired Si-Al body in Devon. Likewise, Professor Ian Freestone (pers. com., June 2008) has suggested the idea that glass can be added to clay to make porcelain is an important link between Bow, Limehouse, Pomona, and several other ceramic types dating from the late 17th to the mid 18th Century.

These compositional links give considerable credence to the views of Daniels as to the role of the Royal Society of London and we opine that English porcelain development had less to do with alchemy or foreign technology and more a reflection of rational English science and technology.

CONCLUSIONS

It is concluded that three porcelain compositions were produced at Limehouse. Two of these ceramic bodies (Si-Al and Si-Al-Ca recipes) have been recognised for the last 20 years from wasters and sherds, while a third recipe (Mg-P) is newly identified and tentatively attributed to Limehouse.

In the case of the Mg-P body we propose that the Limehouse proprietors:

- were able to acquire small supplies of soaprock from Kynance Cove slightly before June 1747 at about the time they moved to a new site on the north side of Fore Street. This would answer why no sign of the use of soaprock, animal bones, calcined bones, or the presence of wasters with the characteristic Mg-P composition was detected when 20 Fore Street was excavated in 1990;

- were producing the Mg-P body from the second site located on the north side of Fore Street; or

- did not produce the Mg-P body and this group of wares is not of a Limehouse origin. This second scenario is much more controversial and will require an extensive programme of scientific analyses on early wares that are presently ascribed to Limehouse and/or the discovery of the second Limehouse pottery site, the first Bow site in Middlesex, and/or the Lund's Bristol factory site.

Criteria, both visual and chemical, are provided to separate the three bodies and based on limited data it is proposed that Lund's Bristol wares may be differentiated from Limehouse bodies based on the high levels of lead found to occur in the former. A technology pathway based on the 'Limehouse' Mg-P body extends to the Lund's Bristol Mg-P-Pb body. Likewise, we conclude that Limehouse was derivative from Bow by means of the Si-Al experimental body, Si-Al-Ca body, the Mg-P body, and the use of a Si-Al-Ca glaze on the Limehouse experimental body. We affirm that Limehouse, a failed, infant potworks, was highly derivative from Bow and thence from earlier experimental porcelain firings, supported or undertaken by Fellows of the Royal Society of London, stretching back to the early 18th Century and thence to the 17th Century. In fact the Si-Al refractory body can be traced back to Medieval times at Stamford, Lincolnshire.

Other derivative features found in Limehouse from Bow, in addition to the use of steatite and bone ash, include the use of moulded forms, the production of a variety of silver shapes, and the use of underglaze blue decoration. We note that the Si-Al-Ca body has an intrinsic English character and this body can be traced to the lid of a small jar at Burghley House, which we suggest was made at least 30 years prior to Meissen by John Dwight, through experimental firings of this body type by the Royal Society during the early 18th Century, to the brilliant, high-fired, Si-Al-Ca body found in Bow first patent porcelains (*c.* 1743-1746), and thence to the Limehouse Si-Al-Ca type (*c.* 1746-1747). Evidence is presented to suggest that the English were producing high-fired, hard-paste bodies using both an inferred primary china clay and a secondary ball clay prior to 1683.

This contribution demonstrates that the Royal Society of London was vitally interested in the development of an English porcelain industry from the time of its inauguration, even before the Charter of 1662. Its constant contact with John Dwight, compositional observations by contemporaries, and facts surrounding Dwight's 'China' lead us to the conclusion that the Fulham potter was responsible for the Burghley House jars. Visits to London and contact with Society Fellows by Tschirnhausen in 1675 and Hellot in 1740 may even suggest technology transference from England to Continental Europe. This interest continued right up to the time of the involvement of leading Fellows in the development of an English industry through the Bow Factory commencing in the early 1730s.

We have also shown that the Bow Factory was well established and producing highly sophisticated porcelains before the Limehouse Factory even commenced production in mid to late 1745. This output by Bow includes the technically and artistically brilliant first patent ('A'- marked) wares, the early portrait figures, and the magnificent busts of King George II in 1745-46, as will be discussed by the authors in some detail in a forthcoming monograph.

Based on our research that Bow was producing commercial, high-fired, hard-paste porcelains by 1743-1744 we propose that many notions and beliefs that have sustained English ceramic connoisseurship over the last 100 years (Chelsea being the first to manufacture porcelain and the only porcelain to compare with Meissen, Cookworthy the first to manufacture a hard-paste body, the 1744 patent of Heylyn and Frye being 'hesitant' and 'not worth the paper it was written on', Bow producing bone ash wares only from the late 1740s for the middle classes, the innovative nature of Limehouse, and notions regarding wandering Continental potters) need to be rethought. We contend that by the 1730s London had become the world-leader in porcelain research and technology, yet these developments have remained opaque to previous ceramic studies over the last 150 years.

A feature of this contribution on Limehouse has been that less emphasis has been afforded notions as to the *primacy of the artistic pursuit* (Fisher, 1947) and more reliance placed on historical context, contemporary documents, and porcelain composition. To rephrase Pawson and Brooking (2002: 5),

It has not been seen as of sufficient interest when a belief in the separation of form, decorative idioms, and the shade of grey observed in the glaze; from materials science, composition, and even contemporary documents renders the former central to the enquiry and the latter unproblematic.

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APPENDIX 1: THE ADVANCEMENT OF PORCELAIN TECHNOLOGY IN ENGLAND FROM MEDIEVAL TIME TO THE CLOSURE OF THE LIMEHOUSE FACTORY WITH OBSERVATIONS BY THE AUTHORS

Medieval
High-aluminium refractory crucibles being made in Stamford (Freestone and Tite, 1986).

1560s
Arrival in London of German technology associated with refining noble metals at the Royal Mint through the German firm Wohlstadt (Pearce and Tipton, 2011).

By the late 1500s Richard Dee was producing aluminous refractory crucibles possibly in London and the Blackwater Valley (Pearce and Tipton, 2011).

1581 & 1586
Dates on surviving pieces of Medici Porcelain (?soft paste). A manuscript giving the formula, which included a glassy frit and some kaolin from Vincenza, is preserved in the *Bibliotica Magliabecchiana*. Apparently the manufacture was successful in 1575 after 10 years of experimentation.

1626
On the 24th October 1626, Rous and Cullen, merchants of London obtained a patent for the sole right to manufacture, *Stone Potts, Jugs and Stone Bottells,* in *England or Ireland or Dominions of the same for a period of 14 years* (Toppin, 1937).

1646 – 1672
In 1932 Mrs. Arundell Esdaile pointed out that the recipe for Chinese porcelain and information as to the source of their clay had been known in England through various editions of Sir Thomas Browne's *Pseudodoxia Epidemica* published between 1646 and 1672.

1651/52
Johann Rudolf Glauber (1604-1668) publishes *A Description of New Philosophical Furnaces....*and the English translation appeared in London in 1651/52. This work was largely related to the science of distillation and the making of chemical equipment. As Haselgrove and Murray (1979) point out Dwight working under Boyle could hardly have failed to be familiar with this work.

1655 or early 1656
John Dwight arrives in Oxford to live (Maddison, 1969), as does Robert Boyle.

1660/61
23rd February, 1660/61 John Dwight marries Lydia Parker in London. At about the same time Dwight is appointed Secretary to Bishop Brian Walton of Chester.

1661
The Royal Society of London receives an eye witness account of porcelain-making in Nankin, including a description of china clay and china stone, the location of the deposits, how they were mined, and prepared at the site before transported to the numerous potters working some distance away at Jingdezhen (*Ching-tê-Chên*). The methods of forming, firing, and finishing are also given and it is noted that a percentage of each potter's production was reserved for the Emperor. This involved regular inspections at each pottery by government servants (Royal Society of London, 1660-1741).

Samuel Pepys describes in his diary a journey down the Thames to visit a Porcelain Factory at Limehouse, *alighting at Duke Shore Steps*. The coincidence of the date with the letter containing the above description of china-making and the use of the word 'Porcelain' by Pepys makes us wonder whether Pepys had been aware of its contents and whether porcelain experimentation at a site in Limehouse dating to 1661was being carried out. Pepys was already on familiar terms with several Fellows of the Society, including Robert Hooke, and it is worth noting that the instrument-maker Ralph Greatorex took Pepys to the recently set-up Gresham College in January 1660/1. Among the founding members were his past and future bosses, Lords Sandwich and Brouncker and William Coventry; John Evelyn, destined to become a friend; Petty, Hooke, and Wren; John Wilkins, John Wallis, and William Croone (Tomalin, 2003). Actually the *Invisible Society,* as first named and formed for the purpose of *learning by experimental science* and *sharing of knowledge* was inaugurated at Wadham College, Oxford University and early experiments were carried out in the grounds of the College. John Dwight and Robert Hooke were contemporaries at Oxford at that time with Hooke being appointed the 'first curator of experiments'. Other founding members of the Royal Society were the Duke of Buckingham, 1661, the Earl of Devonshire, 1660, and

soon afterwards Prince Rupert, all associated with early porcelain experimentation in England. On obtaining a Royal Charter from Charles II in 1662 they became known as The Royal Society of London.

Robert Boyle FRS publishes, *The Sceptical Chymst* but this account does not describe the work carried out at Oxford (Haselgrove & Murray, 1979).

29th June, 1661 John Dwight is appointed Registrar and Scribe to Bishop Walton.
September, 1661 John Dwight arrives in Chester to take up his position with the Bishop before setting up his experimental pottery at Wiggan.

17th December, 1661 BCL degree conferred on John Dwight.

1665
The Royal Society's Transactions include notice of *An Intimation of the Way, found in Europe, to make China-dishes.*

Samuel Pepys is admitted as a Fellow of the Royal Society.

4th December, 1665, Philosophical Transactions of the Royal Society Volume 1, 1665 & 1666, page 127. An introduction of a way found in Europe to make China dishes. Secret of Signor Septalio a Canon of Millan making "as good Porcelane as is made in China itself, and transparent, adding that he had seen him make some."

Page 249 (undated). *The Embassy of the Dutch into China. A Geographical description of China by Mons. Thevenot. That the way of making Porcelane is this: (Which is the rather inserted here, because it agrees so well with an account, we received a while since from a very Curious and intelligent person of Amsterdam). There is a Province of Nankin, a Town, call'd Goesisol. whence they draw the Earth for Porcelaine, which is found between the Rocks of Mountains. This earth they beat very small, and stamp it to a very fine Powder and then put it into Tubs fill'd with water; where the finest part sinks to the Bottom. Afterwards it is kneaded in the form of small Cubes of the weight of about 3 Catti (a Catti being 20 ounces). These pieces thus wrought are sold to the people, that commonly in great numbers fetch them, coming from the Town Sintesimo (otherwise Jontiou) in the Province of Kiansy, being about 50 miles distant from Watsing, near the City of KIANSY; which people transport them to their homes, and there bake them in this manner: They heat their ovens well, for the space of 15 days successively, and then keep them so close that no Air may get in; and after 15 other days are pass by they open the oven in the Presence of an Officer who takes every fifth vessel of each fashion for the service of the Emperor. Earth is not prepared in Nankin where it is found because the people of that Province have not the skill of working it as Kanghi who also alone have the art of colouring it, which they keep a great secret not teaching it to any but their children and next kindred.*

It might appear that Mon. Thevenot had access to Johan Nieuhoff's observations, maps, and illustrations made in China between 1655 and 1658 when he was appointed steward of a Dutch East Indies Company mission there. His brother Hendrik made a book of it published in Dutch and French in 1665 and in English in 1669. One of the illustrations probably drawn by Nieuhoff himself in Guangzhou in 1655 was of the "Old Viceroy" of Guangzhou Shang Kexi. This figure was copied exactly in every detail by the Limehouse factory, including the long string of beads. It appeared in the Salisbury rooms of Woolley and Wallis, recognised as Limehouse by John Axford, and later sold by them. The figure also appears in an early transfer print.

The important point here is the statement that it has been inserted because it matches an account, we received a while since. Could this be the account dated 1661 as given above, thus proving that the Royal Society had an account of porcelain making in China sometime before 1665?

1667
Dr Walter Pope's (astronomer) comments on *a piece of the rock called the soapy rock in Cornwall* were included in the Royal Society's Journal (Hobbs, 1995). Apparently Robert Boyle had been asked to assess a specimen of soaprock by the Society. Although his observations do not appear to have been recorded, they may have been reflected in a subsequent account by Nehemiah Grew FRS in 1681.

1671
John Dwight resigns from his position as Registrar and returns to London.

1672
17th April, 1672 John Dwight of Fulham is issued a warrant for the grant of Patent No. 164 at Whitehall and granted under the Great Seal on 23rd April for the manufacture of transparent Earthen ware commonly known by the names of Porcelane or China & Persian ware and also for Stone ware vulgarly called Cologne Ware.

1672
On 23th April 1672 John Dwight of Fulham was granted Patent No. 164 for the manufacture of *transparent earthenware commonly known by the names of Porcelaine or China and Persian ware* and also for *Stoneware vulgarly called Cologne Ware*.

Samuel Pepys is elected to the Council of the Royal Society and continues to serve for over a period of twenty-seven years.

1673
An account of someone attempting to make porcelain using crushed bottle glass though there is uncertainty as to whether this person was John Dwight as recorded in a notebook which finally came into the possesion of Sir Hans Sloane (British Library, Sloane Manuscript 1990 ff.166-7).

1673/4
From the diary of Robert Hooke on 17th February, 1673/74, *Saw Mr. Dwight's English China, Dr. Willis his head. A little boye with a hauke on his fist, Severall little Jarrs of severall colours all exceedingly hard as a flint, Very light, of very good shape. The performance very admirable and outdoing any European potters*. This description coupled with the observations recorded by Dr. Plot in 1677 resonates with the Burghley House jars - especially Plot's comments regarding the problems associated with the glazing as discussed in the body of this manuscript.

From the diary of Robert Hooke on 28th February, 1673/74,.....*Dwights secret consists only in flint powdered and a salt mixt with tobacco pipe clay and a great fire made with dry billet which brings the clay to fusion....*This recipe supplied us by Robert Hooke conforms to a Si-Al porcelain body and the salt used by Dwight was most likely saltpetre or potassium nitrate or in some instances as demonstrated below, alum (hydrated potassium aluminium sulphate). A closely comparable body is to be found in the Burghley *Virtues Jar* (Table 6, No. 5) only here a small amount of lead, presumably in the form of lead oxide was added. The clay used in the *Virtues Jar* looks to have been a ball clay, assumed to have been obtained from Poole in Dorset. The presence of sulphur (1.6 wt% SO_3) in the body of the *Virtues Jar* coupled with a high level of potassium (4.5 wt% K_2O) and the low CaO level is strongly

indicative of the use of alum. We know from the diary entry by Hooke given below that Dwight was also experimenting with alum, chalk or lime.

15th March, 1673/4 before the House of Lords, John Dwight announced that English potters were still unable to produce China (Bimson, 1961). As the bill was introduced *For Encouraging the Manufacturers of England,* and centred on trade and the cost of imports, it is quite likely that Dwight was referring to the fact that English potters were still unable to produce commercial quantities of china, rather than to any experiments of his own.

1674
16th May, 1674 Robert Hooke FRS is joined by Whitaker (?John Whittacre) in a visit to John Dwight's pottery (Haselgrove and Murray, 1979). *First with him to Mr. Dwights. Saw his pottery. I judge it nothing but Tobacco pipe clay. Possibly some burnt allum chalk or lime may be mixed. In glazes with ashes, Very hard and close excessive deer.* The mention of the possible use of alum relates to the composition of the *Virtues Jar* having prominent potassium and sulphur, and negligible calcium, thus ruling out gypsum as the source of the sulphur, recorded as SO_3, in the ceramic body. The mention of ashes in regard to the glaze resonates with the apparently imperfect lime-alkali glaze found on both the *Virtues Jar* and the lid of the smaller jar.

1674/75
25th February, Royal Society meeting at which Robert Hooke, *brought in an artificial head resembling china made in England of English clay so hard and solid that he said nothing would fasten on it except a diamond and that it received its polish in the fire.* This head had to have been made by Dwight and the record demonstrates that at this date he was most likely using a ball clay, possibly from Dorset. We suggest that the head was unglazed. This entry contrasts with an account given by Hooke to the Royal Society some four years later where Dwight had apparently obtained quantities of highly refractory china earth/clay.

1675
Von Tschirnhausen, of future Meissen fame and already a member of the Academy of Sciences in Paris, visits London and works with Robert Boyle, with whom John Dwight had earlier worked. John Mallet (2008) asks whether, *von Tschirnhausen's interest in higher-fired types of porcelain, more resistant to thermal shock, may not have been stimulated by his stay in London, where already in 1762* (sic) *Dwight had registered his first patent for Porcelaine or China.* This comment by Mallet tends to conflict with the long-standing view that English porcelain development was dependent on, or largely dependent on technology transfer from Europe. As Ramsay and Ramsay (2007a) note, *This concept that the early English porcelain industry was in some way indebted to an endowment or 'cuttings' of superior Continental ceramic technology has reverberated through subsequent writings in various forms over the last 100 years. This in turn seems at times to suggest to us that a distinct inferiority complex pervades the study of early English porcelains when compared with the splendours of Meissen and other European ceramics.* As shown in the body of this manuscript and in subsequent publications by the authors, London became the leading centre for porcelain experimentation and development by the 1730s and 1740s.

30th December at a meeting of the Royal Society, blue clay free from sand which Dwight thought very suitable for porcelain (Garner, 1937).

1677
Dr Plot of the Ashmolean Museum, writes of John Dwight, *And hath found out ways to make an Earth white and transparent as porcellane, and not distinguishable frome it by the Eye, or by Experiments that have been purposely made to try wherein they disagree. To this earth he hath added the colours that are usual in the colour'd china-ware, and divers others not seen before. The skill that hath been wanting to set up a manufacture of this transparent Earthenware in England, like that of China, is the glazing of the white Earth, which hath much puzzel'd the Projector, but now that difficulty also is in great measure overcome.* As noted above, this account is accepted by us as a record of wares comparable with the Burghley House jars, especially the comment regarding problems with glazing. From chemical analyses the Burghley jars were initially covered with a higher-fired Si-Al-Ca glaze and then, we surmise to cover imperfections, the wares were covered with a lead glaze.
In addition Dr Plot (1677, p. 250) records the apparent success of John Dwight, who discovered, *the mystery of the Hessian wares, and makes Vessels for reteining the penetrating Salts and Spirits of the Chymists, more seviceable than were ever made in England, or imported from Germany it self.* Pearce and Tipton (2011) suggest that Plot's statement appears to confirm a problem faced by earlier English-made crucibles, that of not being able to hold (resist) aggressive chemicals.

29th December, 1677 from the diary of Robert Hooke, *Met Dwight and discoursd of pipes. He told me he could perfectly make and paint the china ware, that several times burning the hungrest earth would make it vitrify. I suppose his way is mixing the powder of tobacco pipe clay once burnt and heat with other washt tobacco pipe clay, that salt helps the glazing to run, that the greatness of the fire is the secret, and the way of making the fornace.....*As with the account by Dr Plot given above, it might appear that Dwight was making a transparent porcellaneous body, which was subsequently decorated with colours. A key feature was the necessary kiln technology and the ability to high-fire the porcelain body.

1678
5th December, 1678, Royal Society meeting at which Robert Hooke reports that Mr. Dwight had made some heads of earth as big as the life and that his earth used was as hard as porphyry and that the excellence of the **China earth** was that it would endure the greatest fire without vitrification. Previous diary entrys by Robert Hooke clearly recognised tobacco clay so this record by him of a highly refractory China earth resonates with the argument given by the authors in the body of this paper that 'Rome China clay', or possibly china clay from the New World, was being obtained at about this time.

1681
Nehemiah Grew FRS includes 'Soap-Stone, Steatites', which are 'not at all dissoluble in Oil or Water, Nor in any indifferent Fire; by which it only becomes somewhat harder and whiter', in his *Catalogue and Description of the Natural and Artificial Rarities* belonging to the Royal Society.

1683
In 1683 two tiny jars with lids (now known as the Burghley jars owing to their place of discovery) and a larger jar (labelled the 'Virtues' jar because *Prudence, Fortitude,* and *Fidelity* are symbolised in polychrome enamels around the side) were recorded in the Earl of Devonshire's estate. We contend, as set out in this publication, that these jars are of English derivation, most likely by John Dwight of Fulham with assistance and sponsorship of Fellows of the Royal Society. For a detailed

account of these jars and their history we refer readers to the excellent series of papers in Transactions English Ceramic Circle, 20(1), 2008.

A note inscribed, *Duke of Buckingham's China,* in the hand of the 9th Earl of Exeter (1725-1793) was discovered inside one of these tiny jars at Burghley House, hence they were previously known as the *Buckingham jars*. However, a now lost note saying, *Patronised by the Duke of Buckingham,* has also been recorded. It is likely that the Duke was only the financier of the project. Buckingham's periods of exile and hectic life in politics and the military preclude any possibility that he was able to develop such a sophisticated formula. Projects, as well as Royal Society schemes, were regularly sponsored by wealthy Fellows of the Royal Society (see Pepys and Halley below). For instance Committee Members, including Sir Hans Sloane, the Duke of Richmond, and the Earl of Derby contributed considerable sums to the establishment of the Colony of Georgia in 1729/30. According to Pepys the Society was consistently short of funds and was unable to fund projects, private or otherwise, but this did not deter wealthy Fellows from sponsoring worthy schemes. This answers why sponsorship is not recorded in the Philosophical Transactions.

J. J. Becher (1635-1682), a Continental metallurgist publishes posthumously an account of pottery in England around 1680. *I have discovered a mixture of earths here in England which is as white as chalk, One can make any thin ware out of it. It can be fired so strongly that it sings like a bell and is for all that lighter than wood. Prince Rupert has got a potter from Hungary who has found a mixture of earths here in England which is as white as chalk, and which when burnt is half translucent as the East Indies porcelain and this kind of ware is publicly on sale here in London.* (Becher, 1683).

1684

Dr. Martin Lister FRS published in the Philosophical Transactions, *An Ingenious proposal for a new Sort of Maps together with Tables of Sands and Clays.*

19th May 1684, a warrant for the issue of John Dwight's second patent is issued at Windsor. The list of articles included, *transparent Porcellance.*

December 1684 Samuel Pepys is elected President of the Royal Society chosen for his administrative skills and influence. The Society's finances were in trouble but Pepys soon put them into order, expelling members in arrears with their subscriptions; about sixty were dismissed, including the Duke of Buckingham in 1685. Pepys himself always paid his subscriptions and gave extra money when asked. He raised funds and gave advice on how to invest money. He prepared orders for the Society's clerks and insisted they keep minutes in books, not on loose papers, and index the books. He personally presented £50 to the Society, which was used to pay for the plates for *A History of Fishes* it proposed to publish as a commercial venture. He ordered the printing of Newton's *Principia Mathematica* for the Society. When the Society failed to settle the printer's account, Edmund Halley contributed the required funds. In 1729/30 several members of the committee, including Hans Sloane, The Duke of Richmond, and the Earl of Derby paid for Cuming's journey to the clay pits in the New Colony of Georgia. The Royal Society invested some of its funds in Africa Company Stock in 1676 and again in the 1690's; apparently the Fellows were not morally averse to profiteering from the Slave Trade.

1687-1698

The Royal Society recorded in its archives a description, *Of China Ware and Porcelain. How it is made* (Royal Society, 1687-1698). This account is in quite different language, but has a description of porcelain making in China by another unknown correspondent similar to that noted at 1661 above. This letter is undated, but is entered between two letters each dated 1687.

1688

John Clayton FRS reported on his success in finding a satisfactory clay for making crucibles in Virginia, where he had been sent to search for usable New World materials of various kinds. In his report he states, *I have observed that at five or six Yards deep, at the Breaks of some Banks, I have found Veins of Clay, admirable good to make Pots, Pipes or the like of, and whereof I suppose the 'Indians' make their Pipes, and Pots, to boil their Meat in, which they do handsomely, and will endure the Fire better than most Crucibles: I took of this Clay, dryed, powdered, and sifted it; powdered and sifted Potsherds, and Glass; three parts, two parts and one part as I remember, and therewith made a large Crucible, which was the best I yet ever tried in my Life; I took it once red hot out of the Fire, and clapt it immediately into Water, and it started not at all.*

1691

July 1691 an extract from the will of Robert Boyle FRS, *I give and bequeath unto Mr John Dwight and Mr John Whittacre once my servants each of them a Ring of Five pounds price* (Haselgrove and Murray, 1979: 24). Haselgrove and Murray comment that this bequest seems to imply that Boyle employed Dwight for a considerable time in his laboratory in John Crosse's house. Based on the work of Maddison (1986) it appears that Dwight came to live in Oxford late in 1655 or early 1656.

1697/98

Dwight in a communication to William Gilpen of Whitehaven, ...*Artificially the white China being as Cleare and transparent as that which comes from China but for want of Encouragement is partly given over, there being so high a Duty on all Earthen ware.*

1698

Dr. Martin Lister FRS shows his continuing interest in the manufacture of porcelain when he writes in, *An Account of a Journey to Paris in the Year 1698* a description of the, *potterie of Saint Clou,* including details of the decoration and glazing, *the inward Substance and the Matter of the Pots* and notes that it took twenty-five years to perfect. This time-lag has relevance to our current enquiry into the development of Bow from the 1730s. We regard it as untenable, as constantly suggested in ceramic literature, that Heylyn and Frye could have commenced experiments and only a year or two later developed and produced commercial hard-paste porcelain, not to mention a range of other porcelain recipe types.

12th March, 1697/98 Sir John Lowther wrote to William Gilpen,.....*at ye time he liv'd at Wiggan in Lancashire wher having tryed many Experiments, he concluded he had ye secret of making China ware. Thereupon he sold his Office, came to Lond, was encouraged therein by Mr Boyl & Dr Hook, & is now at Fulham, wher he shew'd me 20 0r 30 Varieties more China like than is in ye world besides, nothing in Germany is like his nor had he any help from thence at setting up, but owes al to his studies.....His Clay comes from abt Pool in Dorsetshire.....* (Green, 1999).

The above quote demonstrates the close relationship enjoyed by Dwight with members of the Royal Society and may explain why the Burghley Jar, its lid, and the *Virtues Jar* all have contrasting compositions as discussed in this contribution. Sir John Lowther FRS in 1698 was MP for Cumberland.

1707/8-1713

Experiments carried out apparently in London by an unknown chemist/potter, to develop porcelain bodies, glazes, and colours. The tone of the recordings of this experimental work suggests that these experiments were conducted under the patronage of the Royal Society or Fellows of it. A range of compositions are trialled including Si-Al bodies and a Si-Al-Ca body using ball clay, crushed silica, and glass. Comparable recipes find their expression at both Bow and Limehouse some 30 - 40 years later. These experimental results are preserved in the Hans Sloane Manuscript No. 3636 housed in the British Library as pointed out to the authors by Margaret Macfarlane and as discussed in more detail in this account by the authors.

1708

Chemists von Tchirnhausen and Böttger manage to develop a hard paste porcelain in Saxony from a local impure kaolinitic clay known as Schnorr's white earth and slaked alabaster.

1710

Production of hard-paste porcelain at Meissen commences using slaked alabaster and an impure kaolinitic clay.

1712

The first of two letters written by François Xavier d'Entrecolles, who resided and worked at Jingdezhen (*Ching-tê-Chên*) and wrote accounts of Chinese ceramic practices in 1712 and 1722. These letters were in turn published in Paris in 1717 and 1722 and then incorporated in Jean-Baptiste Du Halde's *The General History…… of the Empire of China, Chinese Tartary, Corea and Thibet*, with the English edition appearing in 1736. However, Dr. William Sherard FRS, had already communicated the information in these letters to the Royal Society and provided specimens of the native rocks of China and of the prepared clay. We note that although this first of two letters by d'Entrecolles is widely quoted by writers as the first account of Chinese porcelain manufacture available in the West, the Royal Society had comparable information available to it by 1661 if not earlier through Browne's *Pseudodoxia Epidemica*.

1727

A surrogate copy of Herman Boerhaave's *New Chemistry* is published in London by Shaw and Chambers. This includes Boerhaave's discovery of "virgin earth" (? bone ash) as a component of a type of porcelain. Dr. Cromwell Mortimer FRS, who studied for five years in Leyden under Boerhaave, becoming MD in 1724, was one of many of the Professor's students who attended his original lectures in Latin and carried his theories abroad.

1728

John Woodward FRS completes his experiments on soaprock from Cornwall and the results are published posthumously in the Royal Society's Transactions in 1729.

1729

Dr. Cromwell Mortimer FRS is appointed assistant to Sir Hans Sloane from 1729-1740 and moves to Bloomsbury Square. It occurs to us that the appointment of Mortimer after Woodward's death on the 23rd April, 1728 is auspicious and suggests that Mortimer may have been selected to carry on with Woodward's experiments.

1729/1730

25th March, 1729/30 Alexander Cuming FRS, sponsored by colleagues, Fellows of the Committee of the Royal Society of London, visits the Clay Pits in the proposed new Colony of Georgia (Daniels, 2007).

1732

Andrew Duchè, a potter from Philadelphia, is in London. We suspect that while in London he was appointed agent for the fledgling Bow concern. On his return to Philadelphia he proceeded to Charleston, South Carolina in 1734. By around April 1735 Duchè was in New Windsor, South Carolina located adjacent to the Savannah River. On 4th October 1735 he applied for 150 acres of land at New Windsor (Rauschenberg, 1991). We suggest that the move from Philadelphia to New Windsor was planned in advance and the New Windsor location, where slaves could be used, was procured so as to act as a site for upgrading Cherokee clay before shipment via the *water route* or the *land route* to London.

1733

Hand-in-Hand insurance company Policy No. 60695 was taken out by Griffith Carr, a distiller, on 20 Fore Street, Limehouse. This Policy was discovered by Frank Britten, which enabled him to identify the exact location of the site at 20 Fore Street later to be occupied by Joseph Wilson and Co. (Britten, 1991).

1735

Dr. Cromwell Mortimer FRS succeeds with his thermometer for measuring and controlling a high temperature furnace.
William Borlase the Cornish scientist sends samples of soaprock to Leyden at the request of John Andrew.

1736

With improvements made by famous instrumentalists, George Graham FRS and John Ellicott FRS, Jackson builds Mortimer's machine. Mortimer has invented a self-fuelling kiln with an athanor and wind-furnace that allows him to regulate temperatures to the point of melting iron (~1550 ^{O}C). Mortimer writes to Boerhaave informing him of his success (Chaldecott, 1969; Daniels, 2007).

As Mortimer finishes his kiln, Andrew Duchè moves to Savannah in order to organise regular small shipments to London of Cherokee china clay (Daniels 2007).

1737

William Borlase sends a further sample of Cornish soaprock to Boerhaave at Leyden and continues to distribute samples elsewhere until 1748.
Edward Heylyn and Benjamin Lund declared bankrupt.

1738

Edward Heylyn, one of the original Bow proprietors, attends a meeting of the Royal Society when a talk on a *stone that will easily vitrify* is given. In Savannah, Georgia, Andrew Duchè shows a sample of porcelain to William Stephens, Secretary to the Trustees. Stephens is not impressed.

1740

Hand-in-Hand Insurance Policy No. 60695, 16th June, 1740 to, *James Desinard of St. Ann Midx Distiller on a Br House vald £300 & a Still House & Stable vald £75 in a yard on ye South*

Side of ye Street a little Eastwd from Duke Shore at Limehouse in ye parish aforesaid in his own possn.

Frank Britten (1991) also noted subsequent amendments.

1. In the third line the word 'Still' is crossed out and the word 'Ware' substituted, indicating that at some time during the validity of this policy renewal the premises ceased being used as a distillery.
2. After *in his own poss'n* is written *Whasher Bettsworth*. In the renewals of 1749 and 1756 the occupant's name is Washer Betsworth. Britten adds, *Nothing is known of this individual*. However, we notice that on J. Horwood's Map of 24th May, 1799 superimposed with names and occupations for 1747 (*Limehouse Ware Revealed,* Plate 1, p. 2,) an Abraham Betsworth is shown as occupying a site further along Fore Street next but one to Duke Shore. Betsworth paid Land Tax for this site each year until moving to 20 Fore Street in 1749.
3. Where the outbuildings are shown as valued at £75 this figure has been crossed out and £100 substituted.
4. In the right hand margin above the renewal notation, is the date 21 July 1747, preceded by an indecipherable squiggle. We read this 'squiggle' as *Vc d* meaning 'Vacated 21 July 1747', which explains why the policy was not renewed when due in June 1747. There is no entry in the 1747 registers and it is clear that renewal was deferred to 1749. Britten then asks *Is it possible that the date 21 July 1747 has some significance to the end of manufacture at the factory?* We believe that it does.

Jean Hellot, the French chemist, visits London and is admitted as a Fellow of the Royal Society.

1741

In Savannah, Georgia, Andrew Duchè shows a further sample of porcelain to William Stephens, who describes the cup as translucent and comparable to their ordinary cups in everyday use, which we assume to be of Chinese origin. We suspect that cup was an example of experimental A-mark porcelain made at Bow.

1742/3

10th February, 1742/3. At a meeting of the Royal Society, as a guest of Dr. Cromwell Mortimer, Thomas Bryand shows samples of 'his' porcelain, which we contend were not Chelsea porcelain as argued by numerous authorities, but rather a hard-paste body. We know of no other hard-paste body being produced in England at that time other than Bow first patent porcelain (A-marked wares). Following Bryand's death in February 1747/8 a dispute arose between his widow and Joseph Farmer of Lane Delph in Staffordshire over a contract made between Bryand and Farmer dated 5th February, 1745/6 and for some reason the Bow proprietors became involved in the settlement. In a series of letters Weatherby and Crowther stressed that Bryand was unable to make porcelain (see Daniels 2007). We contend that there is no known linkage between Bryand and Sprimont of Chelsea as has been widely argued in the literature, rather the links are with Bow.

28th February, 1742/3 William Steers, Merchant of Hoxton in Middlesex, enters a Petition for Patent to secure his invention of, *Transparent Earthenware in imitation of porcelain or China ware after a method entirely new*.

1743/4

20 cwts (1 ton) of *earth unrated* imported into London from Carolina between Christmas 1743 and 25th March, 1744. We regard this clay as Cherokee china clay. Daniels (2007).

John Astbury dies in London.

1744

All Rent & Tax listed below applies to the Districts of Soho, St. Anne's and Fore Street, Limehouse unless otherwise stated.

1st assessment for Land Tax in July (Vol. 21, p. 11), is marked *Empty late James Desinards*. Rent £20, Tax £4-0-0.

1st assessment for Land Tax in July (Vol. 21, p. 5), Thomas Ward, Rent £9, Tax £1-16-0.

This name is included because a Thomas Ward and several others, of Burslem, were amongst the group of Staffordshire potters whom Simeon Shaw mentioned went to Chelsea in 1747. (Shaw, 1829).
William Ball pays Land Tax in the parish of St. Leonard's, Bromley-by-Bow in 1744 (Adams, 1969).
8th October, 1744 Application for a Patent sworn at the Public Record Office by Edward Heylyn, Merchant, of Bow Middlesex and Thomas Frye, Painter, of Stratford, Essex.

29th October, 1744, Application from William Steers is marked in the margin, *Taken out the 29th Oct. 1744*. This action is apparently unique in the history of patent applications.

21st November, 1744. Attorney-General's report on the Heylyn and Frye petition for patent is passed on to the Earl of Granville, one of the Secretaries of State.

6th December, 1744. Heylyn and Frye's application for a Patent is granted.

1744/5

2nd assessment for Land Tax in March 1744/5, (Vol. 22, page 10), Joseph Wilson and Company, Rent £20, Tax £-13-4s.

2nd assessment for Land Tax in March 1744/5 (Vol. 22, p. 5), Thomas Ward, Rent £9, Tax £-6-0.

1745

April 1745 Specification entered by Heylyn and Frye giving technical details of their recipe for hard paste porcelain involving china clay imported from the Chirokee (sic) nation in America. This specification states that up to 80% clay (refractory clay) could be added to the body. To date (Ramsay and Ramsay, 2007b) only amounts up to ~70% Cherokee clay have been identified in the Bow first patent bodies analysed. This patent has been widely regarded in the literature for over 100 years as hesitant or almost certainly unworkable, however a review of this specification (Ramsay et al., 2006) has shown that it is arguably the most important document in English ceramic history.

In an undated letter to Arthur Dobbs of Carrickfergus, Ireland, written around May 1745, John Campbell of North Carolina reports the finding of a clay in Edgecombe County and this clay reminds him of the *white clay* he saw at Bow *for their China ware*. By examining the movements of Campbell across the Atlantic Ocean (Daniels, 2007; Daniels and Ramsay, 2009) it was demonstrated that Campbell was on site at Bow no later than mid 1742 and more likely that visit was in the 1730s, possibly as early as 1732. The authors conclude that this letter represents the earliest eyewitness account of an English porcelain concern.

1st assessment for Land Tax in June (Vol. 23, p. 10), Joseph Wilson & Company, Rent £18, Tax £3-12-0.

1st assessment of Land Tax in June (Vol.23, p. 5), Thomas Ward, Rent £9, Tax £1-16-0.

William Ball paid Land Tax in the parish of St. Leonard's, Bromley-by-Bow in 1745 and also in the parish of St. Mary, Bow (Adams, 1969).

27th July, 1745 (not May as still widely asserted in the literature) William Cookworthy wrote to his friend Richard Hingston describing a meeting with the *person who hath discovered the china earth*. Cookworthy makes it clear that far from this agent (assumed to be Andrew Duchè) visiting him in Plymouth as in the literature he, Cookworthy, had been on an Eastern journey and had been absent from Plymouth for three weeks so he must have interviewed Andrew Duchè during this period in London. We contend that during this meeting in London Duchè gave Cookworthy the opportunity of examining samples of Bow 1st Patent porcelain (Daniels, 2007).

24th July, 1745. In the midst of war with Britain, Louis XV signs the Vincennes Privilege in a military camp, seeking to protect the French from *a new Establishment which has just been formed in England, of a porcelain manufactory which seems finer than that of Saxony by the nature of its composition*. This indicates hard-paste porcelain and must relate to the 'A' marked group being manufactured at Bow (Daniels 2007). Again this reference by the French to such an Establishment had nothing to do with glassy, soft-paste Chelsea porcelain as has been continually claimed in the ceramic literature. Moreover the Privilege refers to decoration with human figures which militates against Chelsea triangle porcelains of 1745 and provides us with an absolute date for the production of high-style Bow first patent porcelains.

In searching for people who were declared bankrupt in 1748 and may therefore have been associated with the failure of the Limehouse concern, Aubrey Toppin considered the name of Alexander Dick, but could not connect him with Limehouse. Toppin however had mistaken the date in the registers and unbeknown to him, there was a strong connection between this London merchant/sea captain and Edward Heylyn of Bow, as he commanded Edward's ship the *Heylin's of Bristol* (also at times spelt *Heylyn's of Bristol*) for many years. The ship was captured by enemy privateers early in 1745 and destroyed.

The authors are now aware that Dick was declared bankrupt in 1745. His bankruptcy was reported in the *London Gazette*, 13th August 1745 and the *St. James's Evening Post*, 17th August, 1745. The *Daily Advertiser* announced on 30th September and 9th October, 1745 the sale of Dick's household goods, *at his house, Head-Court facing the Steel-Yard in Thames Street* and reveals that he was quite wealthy, so perhaps his bankruptcy was caused by the loss of the ship and its cargo. It was not unusual for wealthy merchants to own or part-own ships, as was the case with Edward Heylyn (see Daniels 2007 for Heylyn's ownership of several merchant ships recorded in Savannah, Georgia and Charleston, South Carolina in the 1730s and 1740s). As Edward Heylyn and Benjamin Lund were also declared bankrupt in 1745 could all three merchants have been in partnership with the vessel and its cargo?

Interestingly, Edward Heylyn and Alexander Dick were both signatories to a Petition to the King (*London Gazette* 25/2/1745/6) in which the merchants of London offered to raise a regiment of troops for the defence of London should the Jacobite army advance on the City. Anti-Gallican Stephen Theodore Janssen also signed the Petition. A similar contemporary Petition to the King by popular actors on the London stage, such as David Garrick, James Lacy, Peg Woffington, and poet laureate Colly Cibber, is celebrated in a print titled *A Muster of Bays Troops* (Daniels, 2007).

28th December, 1745. Letter from Mr. James Middleton of Shelton in Staffordshire addressed to "*Mr. William Tams, at the Pot-work in Four-street (sic), nigh Duke-shore in Limehouse, London*". This letter mentions the arrival of the Stuart Army in Shelton, where one of Middleton's relations was held prisoner by the Jacobites for 2-4 days. (Macalister 1933; Drakard, 1993). Tams was back in Shelton, Staffordshire by 13th June, 1750 when he took an apprentice.

1745/6

5th February, 1745/6 Thomas Bryand, previously at Bow, signs a contract to make porcelain with Joseph Farmer of Lane Delph in Staffordshire. (Mountford,1969; Daniels, 2007).

21st March, 1745/6. Before this date William Steers departs his house in Hoxton, Middlesex, for Bell's Pottery at Newcastle-under-Lyme (Bemrose, 1975). We note that Bryand's contract with Farmer in Staffordshire and Steer's arrival at Bell's pottery in Newcastle-under-Lyme are contemporary.

2nd assessment for Land Tax in March (Vol. 24, p.4), Thomas Ward, Rent £9, Tax £-7-6.

2nd assessment for Land Tax in March (Vol. 24, p.10), Joseph Wilson & Co. Rent £18, Tax £-15-0.

The Bow Porcelain Factory during the period 1745-1746 makes steatitic porcelain busts of King George II, some of them accompanied by symbolic wall brackets commemorating the final defeat of the Jacobites at the Battle of Culloden on 10th April 1746. The King wears the cuirass, which indicates his bravery at the head of his cavalry in the Battle of Dettingen. The wall bracket applauds his role as "defender of the faith" in the final destruction of the Catholic cause and the aspirations of Prince Charles Edward Stuart at Culloden (Daniels, 2007; Daniels & Ramsay, 2009; Daniels & Ramsay, in prep.).

1746

Andrew Duchè is apparently informed that clay is no longer required at Bow. He departs Charleston in June and Savannah in September 1746.

1st assessment for Land Tax in June (Vol. 25, p. 5), Empty late Thomas Ward, Rent £9, Tax £1-10-0.

lst assessment for Land Tax in June (Vol. 25, p. 11), Joseph Wilson and Co. Rent £18, Tax £3-12-0.

25th July 1746. Possible date inscribed in blue on the base of a waster bowl recovered during excavations on the Newcastle-under-Lyme (Pomona) pottery site (Bemrose, 1975).

December, 1746. William Ball is included in the Bow baptism registers when his first daughter Susannah is born and in the Land Tax Assessments for St. Mary, Bow in 1746. (Adams, 1969).

The various advertisements connected with the Limehouse Factory, all from *The Daily Advertiser*, (Toppin, 1931; Valpy, 1993) which have so far come to light appear as Appendix 1 of *"Limehouse Ware Revealed"* published by the *English Ceramic Circle* with the collaboration of the *Museum of London*, editor David Drakard, in 1993. These start with an advertisement for -

22/23rd September, 1746.
POT Painters that are good Hands, may meet with very great Encouragement at the Pot-Works at Limehouse.

4th, 6th, 7th and 8th October, 1746.
POT, Fan, or Box Painters, wanting Employment, will meet with great Encouragement by applying to Mr. Wilson, at the Manufactory near Duke-Shore, Limehouse.

1746. The Newcastle-under-Lyme Pottery, which included an oven 'lately built on Purpose to burn China', outbuildings and a commodious House (late in the Occupation of Mr. Bell, and now in the possession of Mr. Steers) is advertised 'To be LETT, at Lady-day next'. For further particulars enquire of Mr. Crowther, at St. Katherine's, near the Tower, of Mr. Bell, in Aldermary Churchyard, Bow-Lane, London, or Mr. Brittain, at Newcastle aforesaid where the Premises may be seen. (Bemrose, 1975).

1746/7
Thursday 1st January, 1746/7.
To the Dealers in China and Earthen Ware.
The Proprietors of the Limehouse Ware give Notice,
that they now have a large Assortment at their
Manufactory, near Dick Shore in Limehouse.

2nd Land Tax assessment in February 1746/7 (Vol. 26, p. 10), Joseph Wilson & Company, Rent on 20 Fore Street, £18, Tax £-12-0.

2nd Land Tax assessment in February 1746/7 (Vol. 26, p. 103), Joseph Wilson, Rent on a second premises on the north Side of Fore Street, £7-10-0, Tax £-5-0. This is bracketed with Messrs. Rayner & Stanton, Rent £1-10-0, Tax £1.

These second premises were on the north side of Fore Street and in the previous assessment in June 1746 (Vol. 25, p. 130) were marked "Empty late George Kirkham, bracketed with Messrs. Rayner & Stanton, Rent £1-10-0, Tax £-6-0.

2nd Land Tax assessment, (Vol. 26, p. 6) in February 1746/7 John Ball, Rent £10, Tax £-6-8. Almost certainly a mistake for William Ball, Potter in Fore Street. as the subsequent Land Tax assessment (Vol. 27, p. 6) records William Ball and both entries are next to Richard Stapells £20. Tax £13-4.

The half year ending June 1746 when Ward departed may be the time when a falling out between the partners operating the Limehouse Porcelain Company erupted, because when the move to the second premises occurred the occupant was named as Joseph Wilson, the 'and Co' being dropped. When Dr. Pococke visited Newcastle-under-Lyme in July 1750 he saw a potter, whom he had previously seen at Limehouse *who promised to make the best china ware but quarrelled with his employers.* This remark would appear to confirm that in mid 1746 a major disagreement within the group of Staffordshire potters occurred and some of them decided to return to Staffordshire. We speculate that Wilson set up on his own in the second premises, 'head hunting' William Ball the experienced Bow potter and probably others, whilst one or two of the original team sought work at Chelsea just as Sprimont was looking for staff after Gouyn had departed, losing most of his funds, and taking workers with him. John Brittain, who was at Newcastle-under-Lyme when the Factory was advertised by Steers as available to rent from Ladyday the 25th March 1746/7, may also have joined Sprimont at this time. Brittain claimed he had worked at Bow, Chelsea, Vauxhall, Plymouth and Bristol; in fact all the factories of England except Worcester.

We speculate that Steers left Newcastle, possibly slightly earlier than 25th March, because in the advertisement it states that John Brittain was available to show the premises to prospective tenants at about the same time that Wilson took on the second premises at Limehouse. Looking at the dates of Steers' arrival around March 1745/6 and departure around Ladyday 25th March 1747 he can have been operating the pottery for only a year. We suggest that this time period may not have been enough to build a porcelain kiln and manufacture the range of wares excavated on the site. If the dated waster bowl were in fact inscribed underneath 26th July 1748, as suggested by Bernard Watney, it probably coincides with Wilson's arrival from Limehouse, which answers why the recipes and shapes associated with the two factories are similar. According to Pococke, Wilson was unable to fire the porcelain successfully and turned to pottery, hence some Limehouse shapes, for instance prunus moulded cups, are only found in earthenware at Newcastle. This would explain why, although a fairly extensive range of shapes was reconstructed from wasters recovered from the site, no extant matching pieces have emerged. Obviously very few successful kiln loads were fired.

Sometime between June 1746 and February 1746/7 Joseph Wilson occupied a second site on the north side of Fore Street as Joseph Wilson, not as Joseph Wilson and Co. whilst continuing to pay rent and tax on 20 Fore Street on the south side of the street, As they did not pay insurance on No. 20 in June 1747 and the insurance register was inscribed "Vacated 21st July 1747" did they transfer their manufacturing operations to the north side at this time? The authors think there is a good reason why this was so. When 20 Fore Street was excavated by the Museum of London, Department of Greater London Archaeology, in 1990, as well as wasters and sherds "large quantities of clay" and "prepared clay" were found on the site, which, when analysed, in all cases proved to be non-steatitic. The new site was less than half the size of 20 Fore Street and being on the north side of the street had no direct access to the River Thames. Wilson may have retained 20 Fore Street for storage of clay already in stock for use on the second site and for direct access to the River for incoming and outgoing deliveries. There would, therefore, be no need for any insurance.

Due to the prevailing arrangements regarding terms of insurance as indicated above, the policy covering 20 Fore Street could not be transferred to the new premises on the north side. It would be most helpful if the exact location of the second site and the relevant insurance policy could be discovered. The following advertisements appeared just as the first land tax was paid on the new premises but before insurance at 20 Fore Street was cancelled on 21st July, 1747 because the site was vacated.

16th & 19th March, 1746/7 and 4th April 1747.

To the Publick.
The new-invented blue and white Limehouse Ware, which as to Duration, Etc., is no ways inferior to China, consisting of great Variety of Sauce-Boats, Tea Pots, and other useful and ornamental Vessels, is to be had at most of the Dealers in China and Earthen Ware in Town. And as it is humbly hoped, all reasonable Encouragement will be given to so necessary and useful an Undertaking, the Manufacturers of the Said Ware, in order to render it as universal as possible are determined to give the greatest Encouragement to such Dealers either in Town or Country, as shall apply for the same, at the Factory near Duke-Shore, at Limehouse, in Middlesex.

1747
According to Simeon Shaw (1829) a number of Staffordshire potters went down to Chelsea in 1747. These included Aaron Simpson, Thomas Lawton (slip-maker), Samuel Parr (turner), Richard Meir (fireman), and John Astbury (painter), all of Hot Lane; Carlos Wedgwood, of the Stocks, a good thrower; Thomas Ward and several others, of Burslem.

However, continues Shaw, *They soon ascertained that they were the principal workmen, on whose exertions all the excellance of the Porcelain must depend, they then resolved to commence business on their own account, at Chelsea, and were in some degree successful; but at length owing to disagreement among themselves, they abandoned it and returned to Burslem, intending to commence there the manufacture of China; but soon after their return Aaron Simpson died, the design was relinquished, and each took the employment quickly offered in the manufacture of white stone ware, then sold readily on the day of drawing the oven…..*"

As was deduced by Daniels (2007) there was probably some basis to Shaw's story about Staffordshire potters leaving for London, but these potters were in London well before 1747 and at least one of them, Richard Meir, fireman, was at Bow for some time before early 1748, by which time he was a trusted employee with his own house on the pottery site and privy to somewhat dubious discussions between Crowther, Frye, Wedgwood, and Heath over the settlement of Mrs. Bryand's claim for compensation following her husband's death and the breaking of terms proscribed in his contract with Joseph Farmer of Lane End. Significantly, John Crowther, partner in the Bow Factory, married a Joyce Meir on 19th June, 1727 at Allhallows, London Wall.

Now we find other Staffordshire potters in London at an earlier date, for instance William Tams in 1745, William Ball and Thomas Ward in 1744. John Astbury died in London in 1743/4. John Bell, brother of Samuel, (proprietor of the Newcastle-under-Lyne pottery), who was originally a mason, lived in Alderbury Churchyard, Bow-lane at least as early as 1732. His name appears on the 'To Lett' advertisement of the Newcastle pot-works together with John Crowther and John Brittain.

Monday 25th May, 1747

"A fire happen'd in Ropemakers Field Limehouse which consumed 11 houses". Reported in the Gentleman's Magazine Volume XV11 , page 245, column two, Historical Chronicle. (Gaye Blake Roberts, *fide* Latham, 1987).

June 20th, 1747

To the PUBLICK. THE NEW-INVENTED LIMEHOUSE WARE,
consisting of great Variety of useful and ornamental Vessels, which as to Duration etc., is no way inferior to China, ***being now greatly improved****, is to be had of most of the Dealers in China and Earthen-Ware in Town, as also in several of the principal Towns in the Kingdom. And in order to render so necessary and useful an Undertaking as universal as possible, the Manufacturers of the said Ware are determined to give all reasonable Encouragement to such Dealers as shall apply for the same, at their Factory near Dick's Shore, at Limehouse in Middlesex.*

After this date all future advertisements referred to sales of their wares with dealers in town and country and nothing was offered for sale at the Factory itself, even to dealers. Was this because the premises at 20 Fore Street were no longer insured and the new, smaller premises on the opposite side of the street had no sales facilities?

1st Land Tax assessment in June 1747 (Vol. 27, p. 6), William Ball, Rent, £12-0-0, Tax £2-8-0

1st Land Tax assessment in June 1747 (Vol. 27, p. 11), Joseph Wilson & Company, Rent on 20 Fore Street, £18-0-0, Tax £3-12-0, Personal Estate £50-0-0

1st Land Tax assessment in June 1747 (Vol. 27, p. 135), Joseph Wilson, Rent on 2nd premises on the north side of Fore Street, £11, Tax £2-4-0.

21st July, 1747,

"Vcd" (Vacated) marked on Insurance Policy No. 60695 covering 20 Fore Street. This appears to be a very significant date in the life of the Factory.

Wednesday, 28th October, 1747.

We are desired by Mr. Pinchbeck to acquaint the Town that he has since his return from Tunbridge Wells made up several new and beautiful Toys in his curious Metal; particularly several Buckles of new Patterns, against the approaching Birth-Day, with great Choice of other Buckles in Stone, Silver, Steel Etc. He has likewise furnish'd himself with a large assortment of Toys Etc. in the Jewelling Way, ***and with great Variety of useful and ornamental Goods, in the New Limehouse Ware****; which for Strength and enduring the Fire, far exceeds China, or any other Ware hitherto invented.*

11th November, 1747.
The Proprietors of the Limehouse Ware Manufactory having already met with great Encouragement, as is evident by the Demands they have for the same, both in Town and Country, they would think themselves guilty of the highest Ingratitude, did they neglect making their publick Acknowledgements. And as the Improvements they have already made, though in the Infancy of their Undertaking, are very considerable; yet by the kind Continuance of the Favours of those generous Minds who are desirous of promoting a British Manufactory, they not only beg Leave to assure the Publick of still daily Improvements, but don't in the least doubt, in Process of Time, to equal a foreign Nation whose Ingenuity has preserv'd it to themselves for many Ages. Note, the said Ware is to be met with at the Principal Dealers in China and Glass, both in Town and Country.

This advertisement is interesting in two ways in that whilst it suggests that by November 1747 sales were widespread only one invoice that includes sales of Limehouse ware survives, which answers why we have no extant invoices of even earlier date with sales of 'A' mark wares or other Bow types, or Chelsea. The other fascinating point is Limehouse appears to be claiming that in the future it intends to manufacture hard-paste porcelain equal to that of China.

25th November, 1747.

John Taylor of Pall Mall to Lord Glenorchy "4 Limehouse Ware sauce Boats …£0.15.0." (Horn, 1987).

1747/8
2nd Land Tax assessment in February 1747/8 (Vol. 27A, p. 5), William Ball, Rent £12, Tax £-12-0.

2nd Land Tax assessment in February 1747/8 (Vol. 27A, p. 9), Joseph Wilson & Company, Rent on 20 Fore Street, £18, Tax ?

2nd Land Tax assessment in February 1747/8 (Vol. 27A, p. 102), Joseph Wilson, Rent on 2nd premises on the north Side of Fore Street, £11, Tax £-11-0. Bracketed with Rayner & Stanton, Rent £1-10-0, Tax £-1-6.

In the St. Anne's Limehouse baptisms for March 8th, 1747-8, Toppin found the baptism of 'Elizabeth, daughter of William Ball, Potter, Fore Street and Mary….

The rest of the advertisements which appeared from 13th May, 1748 to Friday, September 30, 1748 are all to do with the Creditors and sales of the undisposed stock because they are "*Removing soon, the House going to be pulled down*" and are "*obliged to quit the Premises on Tuesday next."* (Tuesday 7th June, 1748).

1748
13th, 16th, 18th, 20th May, 1748
Now selling off cheap, At MR. UNDERWOOD'S, THE UPPER End of Pall- Mall, near St. James's House, the Price being greatly reduced, ALL, the Goods in Trade of the Limehouse Manufactory, commonly called English China; consisting of great Variety of Sauce-Boats, Tea-Pots, etc. Note, Great Allowance will be made to those that take a Quantity.

28th May, 1st June, 1748.
Now selling off very cheap (Removing soon, the House going to be pulled down) At Mr. Underwood's, the Upper End of Pall-Mall, near St. James's House, The undisposed Stock of the Limehouse Manufactory, commonly called English China, still consisting of great Choice of Sauce-Boats, Tea-Pots etc. Note, Great Allowance will be made to those that take a Quantity.

2/3rd. June, 1748.
The Creditors of the Pot Manufactory at Limehouse, are desired to meet at the Castle-Tavern in Lombard Street, this day, by Five O'Clock in the afternoon, upon affairs of Importance.

4th June, 1748.
A final notice again advertises

'the undisposed Stock' as above, *'To be sold very cheap, This Day and Monday, being obliged to quit the Premises on Tuesday next.'*

June 1748 therefore marks the final date when any porcelain was manufactured in Limehouse, either at 20 Fore Street, or at the second premises on the north Side of Fore Street.

25th July, 1748.
Possible date inscribed in blue on the base of a waster bowl recovered during excavation of the 'Pomona' pottery site.

1st Land Tax assessment in August 1748 (Vol. 28, p. 11), Joseph Wilson & Company missing from page 11.

1st Land Tax assessment in August 1748 (Vol. 28, p. 133), Empty late Joseph Wilson, Rent £11, Tax £2-4-0. Bracketed with Rayner & Stanton as above.

1st Land Tax assessment in August 1748 (Vol. 28, p. 6), Empty late William Ball, Rent £12-0-0, Tax £2-8-0

According to this August 1748 assessment all persons living in the area definitely connected with the Limehouse Factory are missing; i.e. William Ball, Joseph Wilson and Co., and Joseph, David and John Wilson. Both the south and north sides of Fore Street have been vacated.

Friday, 30th September, 1748.
Amongst china, stoneware and glass to be sold very cheap at a shop in Berry-Street, two Doors from King-Street, St. James's, were the following –
Limehouse Ware Tea-Pots, Sauceboats, and Potting-Pots of various Sizes.

1748/9
7th March, 1748/9 Benjamin Lund acquires a Licence to mine 20 tons per annum of soaprock at Gew Graze Cove in Cornwall.

1749
1st Land Tax assessment (Vol. 29) in June 1749, all missing as in the August 1748 assessment.

1750
1st Land Tax assessment (Vol. 30, p. 128) Prudence Kirkham, Rent £9, Tax £1-7-0. Bracketed with Messrs. Rayner & Stanton, Rent £1-10-0, Tax £-4-6. This is the Joseph Wilson site on the north side of Fore Street, which, before Wilson's occupation, was in the possession of George Kirkham, perhaps Prudence's late husband.
So, the last advertisement offering goods for sale at 'the House' was June 20th, 1747. This more or less coincides with the cancellation of the insurance on 21st July 1747. From then on announcements and advertisements were all to do with Creditors meetings and disposal of the remaining stock at leading dealers in town and country, but apparently not at the Factory. We can safely say that manufacture at 20 Fore Street ceased by July 1747, but may have continued on the North Side of Fore Street until early 1748.
The use of soapstone at Bow was discussed by Daniels (2007) at some length, including information regarding the involvement of William Borlase, the Cornish scientist, who, as shown above, sent numerous samples starting with two shipments to Leyden in 1735 and 1737 at the request of John Andrew and Gronovius, one of Andrew's tutors. Borlase continued the despatch of samples to various interested parties from 1738 to 1748. Of particular interest are a series of letters that passed between Borlase and Emanuel Mendes da Costa FRS. These reveal that, *Mr. Fry* (sic) *the Painter who makes the London China* had knowledge of steatite and may supply da Costa with, *many useful hints*. Borlase also revealed to da Costa that the soaprock was located at Kynance Cove. A letter written on the 18th July, 1748, informed da Costa that he had sent him, *a small box with several sorts of the Soapy rock* and that, *it is from a new discovery of the same soapy substance in a creek about a mile to the W.N.W. of Kynas* (sic) *Cove and in every respect at least equal to what* ***was*** *there but is now almost eaten out by the sun and other* (Hobbs, 1995).

This situation was confirmed by da Costa when he published his *Natural History of Fossils* in 1757, in which he made the following remark about soapstone. *This is a beautiful white clay…found lying in veins and loose masses, in the new soap rock at Gew Grez (sic) Cove, about a mile from the old soap rock in Cornwall, where it is also found running in veins, about two fingers in breadth* (Hobbs, 1995).

What is important to us in the Limehouse context is the fact that the clay at Gew Graze, where Benjamin Lund obtained his licence, was not discovered until at least the early summer of 1748 and that the earlier deposits at Kynance Cove were more or less depleted. Benjamin Lund of Bristol took out a licence with John West of Bury St. Edmunds to quarry soaprock from Gew Graze Cove on the 7th March, 1748/9.

As both Limehouse premises were abandoned in mid 1748, if steatitic porcelain was produced the soaprock was either rescued in small quantities from Kynance Cove, or trial consignments were supplied to Lund or Joseph Wilson from Gew Graze from the spring of 1747 when land tax on their 2nd premises on the north side of Fore Street was first paid. This would explain the lack of any evidence of steatitic porcelain production following the 20 Fore Street site excavations

APPENDIX 2: PORCELAIN CHEMICAL COMPOSITIONS

Discussions on English porcelains over many years have made reference to porcelain compositions. This tradition traces its origins back to the pioneering work by Sir Arthur Church of the late 19th Century and subsequently to the 'bench mark' paper by Eccles and Rackham (1922). Their classification of porcelain bodies recognised five major types and unfortunately little effort was subsequently afforded in the following years in extending the work of Eccles and Rackham, no doubt in the belief that English porcelain compositions were now fully defined and moreover composition was unlikely to inform further the debate. Consequently, for many years our understanding of porcelain compositions made little progress, being based more on single element drop tests, anonymous analysts, and often little explanation as to what was tested or how it was analysed. These years may possibly be regarded as the *hobby science period* in English ceramic studies (Ramsay et al., 2011b). One attempt to discuss porcelain compositions in relation to chemical analyses was provided by Savage (1952) while Tilley (1957) made a courageous attempt to examine the chemical composition of a large number of porcelain items whose appearance did not, in a number of cases, conform to accepted factory attributions. Unfortunately he appears to have chosen poorly with regard to his analyst. Possibly the first major divergence from the prevailing belief that English porcelains could be divided into five compositional types was the work by Freestone (1996) where he recognised a high-Al body (high-aluminium body) in relation to Bow first patent porcelains ('A'-marked wares), a feature also found in porcelains from Pomona and Limehouse (Freestone, 1996, Hillis, 2001) of a slightly later date and based on our work, derived from Bow. This inferred use of a high-clay recipe is predicated on the high aluminium content observed in analyses obtained from various ceramic bodies.

A further problem encountered in discussing English porcelain bodies has been the almost universal use of a classification based on the inferred use of the raw materials in the porcelain body. Thus we have soapstone porcelains reflected by the presence of magnesium in the body and bone ash porcelains assumed to equate with the high levels of phosphorus in the body. A significant work on 18th Century English and American porcelain compositions with a revised classification of soft paste porcelains was published by Victor Owen (Owen, 2007), where he recognised that many ceramic compositions are recalcitrant in regard to the Eccles and Rackham five-fold classification. Moreover he argued that ceramic classification should be divorced from a terminology based on the inferred use of the raw materials assumed to make up the body.
Consequently in this account on Limehouse the authors have endeavoured to define the various porcelain types based on their chemical compositions and Table 7 below sets out these compositions together with the inferred raw materials used to make such bodies.

TABLE 7. CHEMICAL TERMINOLOGY USED IN THIS ACCOUNT

Terminology used here	Longhand terminology	Inferred raw materials used
Mg-Pb	MgO-PbO	Soapstone and lead glass (+ possible crushed silica)
Mg-P	$MgO\text{-}P_2O_5$	Soapstone + bone ash (+ possible crushed silica)
Mg-P-Pb	$MgO\text{-}P_2O_5\text{-}PbO$	Soapstone + bone ash + lead glass (+ possible crushed silica)
Si-Al	$SiO_2\text{-}Al_2O_3$	Crushed silica + clay (+ possible K added as saltpetre)
Si-Al-Ca	$SiO_2\text{-}Al_2O_3\text{-}CaO$	Clay + lime-alkali glass (+/- crushed silica)
Al-Mg-P-Pb	$Al_2O_3\text{-}MgO\text{-}P_2O_5\text{-}PbO$	Clay + soapstone + bone ash + lead glass (+/- crushed silica)
Al-P-S	Al_2O_3 - $P_2O_5\text{-}SO_4$	Clay + bone ash + sulphate as gypsum or alum (+/- crushed silica)
Al-P	$Al_2O_3\text{-}P_2O_5$	Clay + bone ash (+/- crushed silica)
Al-P-Pb	$Al_2O_3\text{-}P_2O_5\text{-}PbO$	Clay + bone ash + lead glass (+/- crushed silica)
Al-Mg-S	$Al_2O_3\text{-}MgO\text{-}SO_4$	Clay + soapstone + sulphate as gypsum or alum (+/- crushed silica)

APPENDIX 3: SUMMARY OF BURGHLEY HOUSE JARS

We summarise below our view as to attribution, maker, and approximate dates of manufacture for the Burghley House jars.

- The Burghley jars are of English derivation;
- the Burghley jars were made by John Dwight;
- the *Virtues Jar*, the analysed smaller jar, and its lid each has a different composition;
- the *Virtues Jar* comprises ball clay, crushed silica, minor lead (added as lead oxide?), and a flux comprising alum - a hydrated potassium aluminium sulphate (Table 6);
- Robert Hooke in 1674 recorded the possible use of alum in Dwight's ceramic bodies (Appendix 1);
- the mention by Hooke in May 1674 (Appendix 1) of Dwight using ashes in his glaze resonates with the suspected imperfect lime-alkali glaze found on both the *Virtues Jar* and the lid of the smaller jar (Spataro et al., 2008, 2009);
- based on the observations by Robert Hooke we would date the *Virtues Jar* to *c.* 1674 or later;
- the smaller jar and its lid were not made using ball clay (Dorset?) but rather using a china clay/china earth that was highly refractory, as recorded by Robert Hooke in 1678 (Appendix 1);
- the flux in the smaller jar looks to have been saltpetre (KNO_3) whilst the flux in the lid appears to have been a lime-alkali substance - possibly a lime-alkali bottle glass + minor lead oxide (Table 6);
- we propose, based both on their chemical compositions and on Hooke's comments of 1678, that this small jar and lid were made using refractory china clay;
- the china clay (Rome china clay), was most likely that which was imported from the East into Rome around 1680 or slightly earlier. Pat Daniels considers that the china clay possibly came not from the east but from the New World;
- whilst the lid does have a different composition to the small jar this does not mean that it is a later (19th C) replacement. Rather we argue that John Dwight made numerous bodies and in this instance we see an example of *mix and match* by Dwight;
- the lime-alkali glaze covered by a lead-based glaze on both the lid and the *Virtues Jar* (Spataro et al., 2009) links both items and militates against the former being a later replacement;
- we date the smaller jar and its lid to *c.* 1678 based again on Robert Hooke's observations (Appendix 1);
- the recipe used in the *Virtues Jar* possibly has its antecedents in the Si-Al crucibles made at Stamford in Medieval times and the Si-Al crucibles made in the late 16th C by Richard Dee in London/London Basin (Pearce, & Tipton, 2011);
- the recipes used in all three items analysed resonate with experimental recipes of the Royal Society in 1708 (Table 5);
- the recipe in the lid finds its subsequent expression in what must be regarded as England's most important and significant porcelains of the 18th C, namely Bow first patent Si-Al-Ca porcelains (Ramsay et al., 2003);
- however Bow dispensed with crushed silica and used various mixtures of Cherokee clay and lime-alkali bottle glass ranging from 1:1 to 4:1 (Ramsay et al., 2006);
- subsequently Limehouse, which did not have access to Cherokee clay/china clay, resorted to a mixture of ball clay, crushed silica/calcined chert, and bottle glass;
- the Bow first patent Si-Al-Ca body we date to 1743-1746;
- the Limehouse Si-Al-Ca body we date from early 1746-early/mid 1747; and
- we suggest that the Burghley jar and its lid represent the earliest known high-fired porcelains in the Western world made using china clay.

THE LIMEHOUSE PORCELAIN FACTORY

ITS OUTPUT, ANTECEDENTS & THE INFLUENCE OF THE ROYAL SOCIETY OF LONDON ON THE EVOLUTION OF ENGLISH PORCELAIN BASED ON COMPOSITION AND TECHNOLOGY

Our understanding of the development of English porcelains underwent a major watershed during the early years of this millennium with the recognition that by the early to mid 1740s the Bow porcelain manufactory was producing a commercial, hard-paste porcelain using a china clay (Cherokee clay) imported from the New World. Concomitant with this has been the re-examination of many notions and beliefs that have sustained English ceramic studies over the last 100 years or so. It is now recognised that the 1744 ceramic patent of Heylyn and Frye, far from being hesitant, experimental, or not worth the paper it was written on, is in fact a highly significant document in English ceramic history. In addition it is now realised that William Cookworthy was not the first to fire a hard-paste body, that Bow was operating much earlier than recognised to date using a range of ceramic recipes, and the pre-eminent position previously enjoyed by Chelsea needs to be reassessed. This contribution on the Limehouse manufactory continues this enquiry, further establishes the leading position played by Bow, and develops the arguments initiated by Pat Daniels as to the importance of both the Royal Society of London and rational English science and technology back to the 17th Century in the development of the English porcelain industry.