The Evolution and Compositional Development of English Porcelains from the 16th C to Lund's Bristol c. 1750 and Worcester c. 1752 - the Golden Chain

Dr W. Ross H. Ramsay & E. Gael Ramsay

But as the process of reassessment is always silently at work, time gradually imparts in turn the value of each standard book on ceramics. A shift of emphasis, a change of date or provenance in the light of new information may alter the whole surrounding scenery. In the world of scholarship to give and take criticism is all part of the day's work, and each of us in our turn may legitimately criticise our predecessors without being guilty of presumption, so long as we can look forward without rancour to being criticised in our turn by our successors, when our day is past. This is the inevitable destiny of all critics. But the author who is surpassed is not necessarily superseded. If the touchstone of his criticism proves his true metal he has added, like Hobson, one or more links to the golden chain, which long after his intervention is forgotten stands as his contribution to the subject.
after Soame Jenyns (1971, p. 1)

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Cover image
Unmoulded sauceboat in underglaze blue, Lund's Bristol magnesian-phosphatic-plumbian soft-paste porcelain. Formerly in the Geoffrey Godden Collection (Bonhams, June 30th, 2010, Sale No. 18425, Lot 52). Inexplicably this underfired sauceboat with crazed glazing has been regarded for many years as a fake or non-period. We have previously published on this sauceboat (Ramsay et al., 2011b) and we have grouped this item with other similar underfired and crazed porcelains as being produced at Lund's Bristol early in that factory's output prior to graduating to the magnesian-plumbian body.

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ABSTRACT

The evolution of the English porcelain industry is traced from the production of refractory ceramic wares dating back to Roman times and before. By the 16th C industrial ceramic aluminous wares were being manufactured in London and the Blackwater Valley. John Dwight, possibly mentored by Robert Boyle while in Oxford, devised and produced a range of refractory wares by the early 1670's - crucibles, stonewares, and a variety of porcelain bodies including both the silica-alumina (Si-Al) and silica-alumina-calcium (Si-Al-Ca) types. Glazes utilised by Dwight were the high-fired, silica-alumina-calcium (Si-Al-Ca) glaze using ashes and a lower-fired Pb-rich glaze. Subsequent experimentation, initially sponsored by the Royal Society of London, led to the production of a range of porcelain types both refractory and soft-paste possibly at Bow by the late 1730's and certainly by the early - mid 1740's, including the Si-Al-Ca body, a magnesian (Mg), magnesian-phosphorus (Mg-P), phosphatic (P), and possibly the silica-calcium (Si-Ca) recipe type. All of these recipe types are of indigenous English derivation with the possible exception of the Si-Ca glassy recipe. When this fledgling English industry is viewed from the point of view of composition, it is realised that this indigenous porcelain tradition is second to none, having produced high-fired refractory porcelains comprising several recipe types some 35 years prior to Meisssen. It is suggested that there needs now to be a reappraisal of this early English porcelain development with more emphasis given to both indigenous ceramic genius and ceramic composition, and less consideration afforded notions relating to Meissen influence, the Baroque, and Rococo stimuli.

PREFACE

We have been researching and writing on early English porcelains for 16 years now and this account is an attempt to bring together what we see as a largely misunderstood, if not unrecognised contribution by the English to the development of porcelains in the Western world. In this account we offer an Antipodean view, which has grown out of our initial work undertaken from Australia and more recently out of New Zealand. This research developed partly in isolation, may at times seem to be at variance with the currently accepted balanced opinions found in the literature today.

From our investigations, which commenced with our venture into Macon County, in western North Carolina back in 1999 in search for Cherokee clay as specified in the 1744 patent of Heylyn and Frye, we have come to the conclusion and are in agreement with Daniels (2007) that the development of the English porcelain tradition is much more complex and has a much longer history reaching back well beyond some travelling Continental chemist, who supposedly advised Nicholas Sprimont as to the secrets of making glassy porcelains of the French type sometime around 1744-45.

Based on our chemical analyses of Cherokee clay that we obtained from North Carolina coupled with the 1744 patent specification, the conclusion that we came to (Ramsay et al., 2001, 2003) was that 'A'-marked porcelains had to have been made by Bow. Such conclusions were not well received and we enjoyed considerable negative comments (*poorly researched, poorly referenced, unprofessional*) because we had questioned one of the long-held articles of faith, based on form and decoration, that Bow had nothing to do with 'A'-marked porcelains.

Regardless, we became ever more curious as to the bad press that the 1744 patent specification had been subjected to for over a century. Whilst the recipient of a scholarship at Winterthur, we went back through the literature to try to unravel why so many negative comments have occurred in print in regard to this patent. What we found was a combination of incorrect quotes and transcriptions of the patent document dating back to Chaffers (1863), an incorrect interpretation of the specification that the flux was purely potassic (Church, 1881, 1885; Burton, 1902) a condition that still continues today (Adams, 2016, p. 141), coupled with a goodly dose of herd mentality (not unlike the current balanced opinions that the George II busts must relate to Vauxhall) that the patent specification was *uncertain*, *hesitant*, or worse, *not worth the paper it was written on*. Our conclusion from our research into the 1744 patent specification of Heylyn and Frye (Ramsay et al., 2006) is that,

never in the history of English ceramic studies has such a landmark document been so marginalised and/or dismissed, by so many, for so long, based on such unfortunate reasoning.

Having rescued this patent document from the ceramic scrapheap of history we were hoping to receive some favourable comments but all we received were more negative complaints that we had been less than respectful in regard to previous authors. The fact that the patent specification itself, had been shown less than respectful regard apparently was of little or no consequence.

At much the same time we were mystified by an unsubstantiated claim by Bernard Watney (Watney, 1973, p. 9) that,

It is practically certain that as described this 'unaker' formula was unworkable, indeed it may have been patented merely as an attempt to monopolize the use of 'unaker' while experiments were being made to discover the secrets of Chinese hard-paste porcelain as had already been done at Meissen.

To our way of thinking the 1744 patent specification has been subjected to circular reasoning for some time in that on the one hand the recipe was seen to be of little substance thus explaining why no porcelains had been recognised and on the other hand, because no porcelains had been recognised that could be related to the 1744 patent then this would indicate that the specification was hesitant, uncertain, if not unworkable and hence of little substance.

Based on our work to that date we reasoned that the 1744 patent specification was most likely highly viable and on that deduction we set out to fire analogue porcelains based on the patent recipe. To this end we used Cherokee clay (50 wt%) collected by us from Macon County, NC and a lime alkali glass (50 wt%) following the patent specification. The wares were fired to the bisque (~950°C), glazed using a clay-glass mixture, and then fired to a 'heat-work' level of Orton cone 9-90° deflection at 150 °C per hour (1279 °C). Modal mineralogy comprised Ca-plagioclase and two glass phases. The bulk chemistry of the body comprised 64.3 wt% SiO_2, 21.7 wt% Al_2O_3, and 5.6 wt% CaO. The resultant porcelain body was pure white with a pronounced translucency. The inescapable conclusion that we arrived at was the patent specification was anything but unworkable (Ramsay et al., 2004a).

Out of this research we realised that another oft repeated doctrine in the ceramic literature was that William Cookworthy was the first in Britain to fire a hard-paste body. This claim was and has been repeated in virtually every standard reference book on English porcelains. We researched this aspect (Ramsay and Ramsay, 2008) and came to the conclusion that whilst the Cookworthy recipes may have indeed approximated the then current porcelain body made at Jingdezhen as given in reports by Père d' Entrecolles earlier in the 18th C, such a composition was an accident of both geography and timing. In fact a range of refractory bodies both from North and South China were produced and had d' Entrecolles visited Jingdezhen in the 12th C the porcelain body was then dominated by crushed quartz and hydromuscovite with kaolin clay more an optional extra in contrast to its obligatory presence in Western refractory ceramics as noted by Nigel Wood. On that basis, the Bow first patent porcelain body ('A'-mark) was both refractory and high-fired, predating Cookworthy by some 20 years or more. More recent research now indicates four contrasting refractory porcelain bodies, which we ascribe to John Dwight, were produced in or around 1670's and that Limehouse was experimenting with three refractory bodies by 1746, one of which was the Si-Al-Ca body, reflective of the Bow first patent body but using a secondary sedimentary clay. Since our 2008 paper there has been almost total silence in the literature in regard to Cookworthy being the first to fire a refractory porcelain body and our paper itself.

In 2007 we published a compositional transect through what was then regarded as the Bow porcelain output (Ramsay and Ramsay, 2007b). At that time we believed the Bow output to be sequential with refractory Bow first patent porcelains followed by the phosphatic wares. Although we suggested that production at Bow commenced with the first patent wares on or around 1743, we did consider that an experimental phase may have extended back to the 1730's. Nevertheless, the oft repeated view today is that Bow produced phosphatic wares alone and little of these wares were produced prior to *c.* 1747. Anything that that factory might have produced prior to that date was experimental, non-commercial, or not worth a tin of fish. We have described this prevailing attitude to Bow as the *millstone syndrome* (Ramsay et al., 2011b).

Our research into Bow phosphatic compositions was initially suggested to us by Pat Daniels and we built on the prior work on Bow compositions by Adams and Redstone (1981) where they recognised a recipe change in or around 1755. Regardless, we constantly read in catalogues Bow porcelains being dated 1754-1756. Based on the work of Adams and Redstone and our work such porcelains are either 1754-1755 or 1755-1756, not both. Moreover, we set out the visual differences between both groups. Subsequently this work on Bow compositions through time was extended a few years later to include Bow glazes on phosphatic wares (Ramsay et al., 2011a). Here we pushed the Bow *Developmental period* back to the early 1740's and identified a cryptic compositional drift with time in Bow glaze compositions with a minor increase in SiO_2 relative to PbO and a minor increase in K_2O relative to SiO_2 and PbO.

In 2007 Pat Daniels published her book on Bow porcelains (Daniels, 2007). The catalyst for her research was our earlier work on Bow first patent porcelains as she realised by 2003 that if Bow was making stellar refractory porcelains by *c.* 1743 then the history of that concern must stretch back a number of years prior to that date, most likely into the 1730's. Consequently we needed to re-think the current beliefs as to the primacy of Chelsea porcelains and the then current view that the English porcelain tradition commenced with the Chelsea goat and bee jugs of *c.*1745. What struck us with this book was the remarkable level of historical research shown and the number of highly original concepts that were proposed by Daniels. In no particular order some of her major proposals included:

- The role that members of the Royal Society played in promoting or encouraging the development of a porcelain industry in Britain;
- the development of that industry went hand in hand with mercantile expansion into the New World, in particular relating to the founding of Georgia;
- the longevity of Bow which most likely extended back to the early 1730's;
- the development by the English of three contrasting porcelain recipes (Si-Al-Ca, Mg, and P) supported the notion of indigenous English ceramic development not reliant on Continental technology or wandering Continental potters;
- the use of soapstone at Bow and in particular the production of a range of George II busts and wall brackets by 1745-1746;
- the need to think laterally as most primary source material has probably been discovered and we now need to rely on second and third order material; and
- the role that Andrew Duché played with the development of Bow, Bovey Tracey, and Bonin and Morris. In fact the movements of Duché from 1732 onwards can be seen as a proxy for the rise and demise of Bow first patent porcelains.

Our impression is that this research by Daniels has not been well received in that she questioned a number of long-held dogmas and articles of faith, with a result it might appear that this highly original work, and the author herself, have been sent to Coventry. Possibly more than anything that has caused both opposition and antagonism towards Daniels and her book has been her original research into the dating and attribution of the George II busts. Here her research has been largely dismissed as pure novel-writing. Aspects of this debate over her ideas are discussed in passing in Daniels et al., (2013, pp. 1-9) where considerable opposition has been voiced by some members of the London group, even to the level of comparisons being made with *the lunatic fringe*.

It is now some ten years since Daniels outlined her original observations and deductions as to both dates of manufacture and the most likely London factory for these busts and brackets. Based on iconography there are two bust groups, with the first group dated to *c.* mid-1745 and the latter to *c.* mid-1746. Moreover, she and her daughter, Cilla, traced a line of potting and technical development through these busts commencing with the early Willett waster bust. As pointed out by Ramsay and Ramsay (2015) the busts examined were all available for inspection by the end of the nineteenth century but no one bothered preferring instead lengthy discourses on whether the paste looked glassy, the presence of a cold, hard-looking glaze, and comparisons with some hare finial on a tureen. To date there have been 13 subsequent accounts or mentions of these George II busts in the literature, all of which have ignored Daniels's research and that of her co-workers, with the exception of Mallet (2013, p. 139) who dismisses such work with one word, *unconvincing*. We suggest that rather it is the repeated attempts for well over a century to attribute both bust and bracket to a plethora of other concerns and ignoring the symbolism, potting features, house style, social history, and often composition, which are unconvincing.

In comments on this manuscript (Anonymous, 2017) we were advised that,

About the dating of the George II busts the old man there represented cannot have been modelled around 1745-46 at the time of the Battle of Dettingen or Culloden, when George was much younger-looking. Ramsay accepts Pat Daniels's arguments about that as gospel, and concludes for no good reason that they are of early Bow manufacture and, since they contain soap rock, that Bow used soap rock. This comes up again on p.8 of the current typescript. If you accept these premises you are going to distort the entire history of early soft-paste in Britain.

Had this reviewer read Daniels et al. (2013, p. 12) he would have seen that the authors have demonstrated that this constant mantra as to the supposed inappropriate age for the monarch has been negated based on the coinage of the day with the appearance of the *intermediate bust* on the two guineas 1740 coin and the *old bust* on the 1743 crown. The *old laureate bust* perfectly reflects the age of the 60 year old King in 1743 as do the porcelain busts themselves dated by us to 1745 and 1746. We contend that the 60 year old victor of Dettingen was not youngish but on the verge of old age. Likewise, research by Simon Spero (Spero, 2014a) appears to contradict the other oft-repeated major opposition to Daniels and co-workers that the symbolism on bust and bracket could reflect any conflict, be it Dettingen, the Seven Years' War, or even the Peninsular War. If there is any substance to the less than scholarly denial or suppression of our new research and understanding of these monumental busts on the basis that this research brings into question current orthodoxies and articles of faith, then the *On the Origin of Species* might never have seen the light of day to say nothing of the work of Copernicus. Such comments that suggest that because our original research was not published previously by someone else, it must be fallacious is to say the least unfortunate and these comments resonate with the smearing we received close to 20 years ago by members of the London group in regard to our claims based on science that 'A'-mark porcelains were in fact Bow. We have written to several proponents for the notion that the busts and brackets relate to Vauxhall and the mid- to late-1750's, urging them to produce a monograph as we have done (Daniels et al. 2013), setting out why bust and bracket are best attributed to Vauxhall, made in the 1750's, and why our attribution and dating are wrong. We are still waiting.

We next turned our attention to the early use of soapstone in English porcelains commencing with Lund's Bristol (Ramsay et al., 2011b) where we recognised two contrasting porcelain recipe types used by Benjamin Lund (Mg-P-Pb and Mg-Pb). In turn we looked more closely at Limehouse and the claim by Watney (Watney, 1993), that some Limehouse porcelains in private collections were magnesian. Out of this claim has grown the current belief that Limehouse was the first to utilise soapstone. What struck us at the time was the totally unsubstantiated claim by Watney as to magnesian Limehouse lacking substantive evidence and without even images of these supposed magnesian wares. Moreover we were, and still, are perplexed by the way that the ceramic community embraced such claims without even a whisper of dissention or the request of Watney for better substantiation. Although no magnesian sherds or evidence for the stockpiling of soapstone on the Limehouse site were uncovered such negative results were explained away as representing the vagaries of an archaeological excavation (Freestone, 1993). In contrast, when no porcellaneous sherds were found on the Fulham site, Dwight was branded a failure (Tite et al., 1986). Consequently we decided to attempt to track down examples of these alleged magnesian 'Limehouse' porcelains.

Our discovery of such wares after not inconsiderable travails was the first published in the public domain (Ramsay et al., 2013), where we analysed and recognised what we assumed to be representatives of Watney's magnesian 'Limehouse' porcelains, only they are not magnesian as constantly claimed in the literature, but rather magnesian-phosphatic (Mg-P) in composition. We also questioned whether these Mg-P porcelains were ever made at the 20 Fore Street site. Our research into magnesian porcelains was funded by the Grants Committee of the American Ceramic Circle and we submitted our original research to that organisation in December 2011 for publication in the Transactions ACC. One of the peer reviewers out of Canada summed up our manuscript as follows,

This is an important and potentially game-changing paper that, with slightly more careful distinction made between arguments based on assumptions versus empirical evidence, could change the perception of the role played by Bow and Limehouse (and of the Royal Society of London) in the history of the British porcelain industry.

However the second reviewer, a self-professed expert out of London, wrote to the Hon. Editor as follows,

In conclusion, this makes interesting reading, but it is guesswork and it simply doesn't hold together. It is the same old story of trying to make the science fit the known historical facts and then tweaking it all to fit. I think this is dangerous, as once published it will be taken as fact and it quite simply is not.

That manuscript has now been published privately (Ramsay et al., 2013) and interested readers can judge for themselves whether or not we used valuable American Ceramic Circle research money to indulge ourselves in *non-factual guesswork*.

Subsequently we continued this line of research (Ramsay et al., 2015) and argued that this group of suspect soft-paste, Mg-P 'Limehouse' porcelains is not Limehouse in origin based on the following points:

- The absence of any magnesian-phosphatic sherds and the associated raw materials, soapstone and bone ash, from the Limehouse excavation site,
- these suspect 'Limehouse' porcelains have a soft-paste body in contrast to the three refractory bodies characterised by mullite +/- cordierite +/- Ca-plagioclase recovered from the Limehouse excavation,
- based on advertisements in the Daily Advertiser and observations by Mr Pinchbeck it appears that the Limehouse proprietors were solely concerned with the development of a refractory body after the Asiatic,
- in our 2013 contribution we proposed that these new and improved wares might reflect the conversion to a soapstone-based body in mid-1747. However in our subsequent contribution (Ramsay et al., 2015) we dismissed this notion where we recognised that Limehouse never used soapstone and proposed instead that these *new and improved wares* reflected improved firing

techniques thus reducing the production of dirty and smoke-damaged porcelains,

- the efforts in the sourcing of new raw materials, and the experimental research required to convert to a soft-paste Mg-P body from a refractory body, apparently late in the Limehouse output were almost certainly beyond the capacity, both technical and financial, of this concern,
- by mid-1746 we contend that the occurrence of soapstone sourced to Kynance Cove in Cornwall had been depleted or worked out and hence soapstone was unavailable to the Limehouse proprietors during the period mid-1746 - early 1748, and
- for the last 26 years since the discovery of the Limehouse site, there has in our opinion been a significant failure to recognise and differentiate between a high-firing, refractory body containing mullite and/or cordierite and/or calcic plagioclase (genuine Limehouse) and a soft paste Mg-P body (false Limehouse).

We contend that the current understanding and recognition of true Limehouse porcelains is in a total mess and although we first voiced our concerns four years ago, collectors, dealers, and auction houses continue to pretend that both we and our research do not exist. Some of this false, soft-paste 'Limehouse' group will almost certainly be re-attributed to Lund's Bristol, however we contend that a component, if not a considerable component, will remain in London and be attributed to the manufacturer of the George II busts and historical wall brackets dated by us to 1745 and 1746. Scholarly debate has occurred over the last three years with our colleague, Dr. Bill Jay, who tends to the view that the bulk of these false 'Limehouse' wares better resides with Lund's Bristol. The obvious conclusion we have reached is that our understanding of Lund's Bristol porcelains will need reassessing and that the same applies to porcelains currently attributed to Broad Street, Worcester and the earliest, pre-Lund's merger period at Warmstry House.

Of late a set of notes on Limehouse has been provided by Spero (2017, pp. 19-27). For the last 25 years Spero has been a strong advocate that Limehouse was the first to use soapstone, the first to use underglaze blue, and the first to use moulding, yet inexplicably he writes (page 25),

As will be apparent, I still tend to incline to the traditional attributions of these two factories (Limehouse and Lund's Bristol) but keep an open mind to the possibility that some of the 'improved' examples at present attributed to Limehouse may conceivably have been produced elsewhere in the 1740s, but not necessarily at Bristol.

We are puzzled at this unattributed claim, as although Spero does reference our 2013 paper on Limehouse in his bibliography, he declines both to acknowledge our subsequent 2015 paper and to include our arguments as to false or non-genuine Limehouse porcelains in his discussion. In brief, based on our research and that of fellow colleagues (Freestone, 1993; Owen, 2000; Jay and Cashion, 2013) we recognise three genuine Limehouse bodies, these being the Si-Al, Si-Al-Ca, and the transitional body, the latter as recognised by Jay and Cashion (2013). We regard the bodies to be refractory (or in the case of the Si-Al body an attempt at a refractory body) in contrast to a further group of soft-paste porcelains traditionally attributed to Limehouse. We maintain that this group of soft-paste porcelains is not genuine Limehouse and we summarised our reasons in Ramsay et al., (2015). Unfortunately Spero has declined to acknowledge our prior work and discuss it in context with his views. For the interested reader we submit Table A below, which was published in our 2015 paper thus providing the most up-to-date summary of both genuine and false Limehouse. We also note that based on our analyses this false Limehouse porcelain group is not magnesian (soapstone-bearing) as constantly claimed but rather magnesian - phosphatic and by implication contains both soapstone and bone ash.

Moreover, we wonder as to the basis of the vague speculation by Spero (2017, p. 25) that some of these soft-paste Mg-P false Limehouse porcelains may have been produced at some other factory but not necessarily at Lund's Bristol. The question arises as to which factory Spero is alluding that was operating in the 1740's, if not either Limehouse or Lund's and whether this is an unacknowledged reflection of our prior work (Ramsay et al., 2013, 2015) where we propose Bow prior to mid-1746. Spero's comments might even be seen as a Freudian gesture to our joint work with Pat Daniels on the dating of the George II busts and historical wall brackets to 1745 and 1746 (Daniels et al., 2013). If we are correct, this factory, which we deem to be Bow, was producing highly sophisticated Mg-P-Pb and Mg-Pb porcelains by mid-1745.

In addition, we raised our concerns over a group of supposed earliest Worcester porcelains back in 2011 and again in 2015 (Ramsay et al., 2011b; Ramsay and Ramsay, 2015) and we are incredulous that for a number of years attempts to recognise and attribute this group of under-fired and crazed porcelains divorced from composition to earliest Worcester is so widely accepted. Highly creditable analyses of sherds from earliest Warmstry House were published nearly 20 years ago (Owen, 1998) but as with our research, Owen's work on these wasters has been largely ignored in favour of visual perceptions. We suggest that the current recognition of earliest Worcester

TABLE A: CHEMICAL AND PHYSICAL FEATURES ASSOCIATED WITH THREE REFRACTORY LIMEHOUSE BODIES AND A FALSE 'LIMEHOUSE' SOFT-PASTE Mg-P BODY (AFTER RAMSAY ET AL., 2015)

	Refractory Si-Al Experimental Body	**Refractory Transitional Body [&]**	**Refractory Si-Al-Ca Body**	**Soft-Paste Mg-P Body**
Composition of the body	~77 wt% SiO_2, 16 wt% Al_2O_3, 0.5 wt% CaO, 1.4 wt% K_2O, negligible PbO.	~70.6 wt% SiO2, 19.5-15.3 wt Al_2O_3, 2.0-4.4 wt% CaO, 1.3-2.3 wt% K_2O, ~0.6 wt% PbO $\Sigma = 3$	~73 wt% SiO_2, ~11 wt% Al_2O_3, ~6.5 wt% CaO, ~6 wt% Na_2O + K_2O, negligible PbO but see Jay and Cashion (2013, Table 4) wasters from context [404].	~65 wt% SiO_2, ~3 wt% Al_2O_3, 9-12 wt% MgO, 5-7 wt% P_2O_5, +/- 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.	~79 wt% SiO_2, 5.1 wt% Al_2O_3, 4.1 wt% CaO, 3.1 wt% K_2O, 3.4 wt% Na_2O, 0.7 wt% PbO, 0.4 wt% SnO.	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. Some chipping around edges.	Tends to be more thinly potted, whiter body, and lower porosity. Potting possibly more sophisticated. Found in pickle dishes, cream jugs, leaf dishes.
Refractory body	High-fired and refractory. Mineralogy includes mullite, +/- sanidine.	High-fired and refractory. Mineralogy includes mullite, +/- sanidine.	High-fired and refractory. Mineralogy includes mullite, diopside, +/- bytownite.	Lower fired soft-paste body. Tougher & less friable.
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. 'Pepperings' in some glazes, brownish or greyish glaze.	Glaze well-fitting and tends to greyish bluish-white colour. Typically lacks black peppering in glaze.
Underglaze blue decoration	Rather pale blue with linear and broadly painted floral designs.	Pale cornflower blue.	Greyish tone blue.	Typically a darkish or inky blue tone.
Inferred raw materials used in the body	Ball clay, crushed silica, source of potassium possibly saltpetre, KNO_3.	Ball clay, crushed silica, source of calcium possibly lime-alkali glass.	Ball clay, crushed silica, crushed lime-alkali glass, +/- minor cobalt-bearing smalt.	Steatite, bone ash, crushed silica, minor lead-free glass frit. Reanalysis of one shell dish indicates presence of significant PbO.
Translucency	Non-existent.	Unknown but likely to be poor.	Poorly translucent in shades of brown or orange in thinner parts.	Better translucency in shades of green or grey green.
Extant examples	To date, only from factory wasters.	To date, only from factory wasters.	Examples recognised both from collections and from wasters.	Examples in collections recognised but no wasters from Limehouse.

Fitzwilliam platter (Fig. 3c) has 0.4 wt% Al_2O_3

Data in part after Drakard (1993), Potter (1998), Tyler et al. (2000), Watney (1963, 1973), Spero (2013a,b; 2014), and Jay and Cashion[&] (2013)

porcelains, as with Limehouse, is in a state of confusion. Almost certainly this group of under-fired and crazed porcelains, which from limited analyses to date, are magnesian-phosphatic-lead (Mg-P-Pb), will revert to early Lund's Bristol.

Our recognition that this underfired and crazed group of porcelains has more in common with Lund's Bristol was penumbrated by us six years ago (Ramsay et al., 2011b) where we presented the analyses of two such crazed items, one of which was a crazed and underfired sauceboat sold by Spero to Geoffrey Godden in the 1980's as being non-period or 'wrong' (Godden, 2004, p. 572). Subsequently we enlarged on our previous work and presented this to the English Ceramic Circle in November 2015 (see Figure 9, this publication) where we argued that this group has nothing to do with earliest Worcester. We are surprised if not a little concerned at comments by Spero (2016, p. 11), a long-time promoter that such crazed and underfired wares relate to earliest Worcester c.1750, where he now appears to have second thoughts, as with his previous attribution of some supposedly Limehouse porcelains, stating,

An alternative possibility might be that they are the earliest of Benjamin Lund's products at Bristol, also experimental and probably not containing soapstone.

Spero provides no basis for his claims and fails to reference our prior work dating back to 2011 where we clearly attribute two underfired and crazed porcelains to Lund's Bristol. Moreover we are perplexed as to his vague suggestion that such wares probably lack soapstone. Based on our research we have demonstrated that this group is magnesian - phosphatic - lead (Mg-P-Pb) in composition and by implication contains both soapstone and bone-ash. Our published work and additional unpublished analyses that we have been privy to, demonstrate that this group is both magnesian and phosphatic. We wonder as to the source of this unacknowledged reference to soapstone-free, crazed porcelains traditionally attributed to Broad Street, Worcester came from and why our published analyses to the contrary have been overlooked.

We now have a growing perception that both we and our original research (at times in concert with Pat Daniels) which question numerous current orthodoxies and articles of faith in English ceramic literature, have been and still are subjected to numerous negative comments or overlooked;

- the relationship between 'A'-marked porcelains and Bow (Ramsay et al., 2001, 2003; Ramsay and Ramsay, 2007b; Daniels, 2007);
- the efficacy of the 1744 patent of Heylyn and Frye (Ramsay et al., 2004a, 2006);
- the range of recipe types made at Bow over and above the bone-ash recipe (Daniels, 2007; Daniels et al., 2013; Ramsay and Ramsay, 2007b, 2015; Ramsay et al., 2013, 2015);
- the longevity of Bow (Daniels, 2007; Daniels et al., 2013; Ramsay and Ramsay, 2007b; Ramsay et al., 2011a);
- that Cookworthy was not the first to fire a refractory porcelain body in Britain (Ramsay and Ramsay, 2008);
- the dating and hence the attribution of the George II busts and wall brackets (Daniels, 2007; Ramsay and Ramsay, 2007a, 2007b; Daniels and Ramsay, 2009; Daniels et al., 2013);
- our research that indicates that the current understanding of Limehouse is in a mess (Ramsay et al., 2013, 2015; Ramsay and Ramsay, 2015);
- the recognition that more porcelains will in time be attributed to Lund's Bristol and consequently this factory's output needs urgent reassessment (Ramsay and Ramsay, 2015; Ramsay et al., 2015; Dr Bill Jay and Ray Jones, pers. comm. 2015);
- the unfortunate confusion over the identification of Broad Street, Worcester porcelains (Ramsay et al., 2011b; Ramsay et al., 2015; Ramsay and Ramsay, 2015), we contend and have contended that much of this group better resides with Lund's Bristol;
- the recognition that we should try to think in a more lateral manner, whereby experimentation and even different porcelain bodies were at times produced simultaneously (Daniels, 2007, Ramsay and Ramsay, 2007b; Ramsay et al., 2015; Daniels et al., 2013; Ramsay and Ramsay, 2015); and
- as outlined in this paper the recognition of what looks to be the most significant fallacy in Western decorative arts.

Looking back at our research over the last 17 years there is little that we would now disown. Yet with the elision of time the above research, to varying degrees through a process of osmosis or ceramic assimilation, has become or is becoming arguably the new orthodoxy in English ceramic literature, but in a manner where we the authors have been all but air-brushed out of existence.

We are surprised if not disappointed with further writing by Spero (2017, p. 24) where he states, *On this point, one must bear in mind that the mid and later 1740s was a period of experimentation as befitted a ceramic industry still in its infancy. Several different porcelain recipes seem to have been used simultaneously at Bow during this period and possibly at William Reid's Liverpool factory ten years later.*

Unfortunately Spero, fails to substantiate his claims and moreover overlooks prior research stretching back many years into the compositions used at both Bow and Liverpool. To the casual reader it might be inferred that such observations by Spero seem to reflect original research that he himself has undertaken. This is not the case. One major difference between our research and Spero's writings over the last 15 years or so, has been our continual promotion, in concert with Pat Daniels, of the notion that Bow was producing a range of recipe types by the early to mid 1740's, if not earlier based on our scientific analyses. This gradual recognition as to the range and variety of recipe types produced simultaneously at Bow based on our current understanding, has come about through routine sampling and chemical analyses.

Our first recognition that Bow produced other recipes over and above a bone-ash formulation relates to the first patent porcelains or 'A'-marked wares and our claim that they were produced by Bow commencing in the early to mid-1740s (Ramsay et al., 2001, 2003).

In the case of the use of soapstone at Bow, it is Daniels more that anyone in English ceramic literature who has championed this ground-breaking notion that Bow used soapstone by the early to mid-1740's. Back in 2002 she rang us in Australia to encourage us to keep an eye out for any magnesian Bow porcelains during our numerous analytical sessions. To this end she promoted two of our analyses, both containing magnesium, in support of her arguments (Daniels, 2007). However her work on magnesian Bow was dismissed outright by Gabszewicz (2008) claiming that she relied on weak science and taking a scientific fact (singular) and making the objects fit one's scheme as a matter of convenience (whatever that means). When we spoke to the ECC in 2015 we challenged Gabszewicz, who was in the audience, to substantiate his claim as to our weak science or retract and apologise for his fallacious smearing of us and our work. We are still waiting.

Daniels et al., (2013, p. 24) summarise their collective work on magnesian porcelains attributed by them to Bow as follows,

This recognition of the development of a variety of magnesian bodies at Bow by mid-1744 has been arrived at through considered enquiry, thinking outside the square, and the application of rational science. Such conclusions could not have been arrived at simply by handling large numbers of porcelain objects, chat sessions with like-minded connoisseurs, and arriving at what Gabszewicz (2008) claims is a 'balanced opinion'. As argued by Ramsay et al (2013) this 'balanced opinion' has been so negatively influenced by an inherent failure over the last century to understand the very earliest productions from Bow, that recognition of the importance of the Factory, stretching back to the 1730's, has been greatly diminished. Moreover the realisation that by the 1740's London had become the world centre for porcelain technology and development has remained opaque to ceramic connoisseurs.

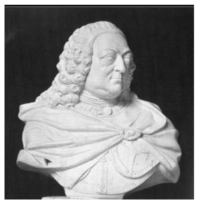
We have also promoted the view that very early Bow was producing a range of high-clay phosphatic wares and also possibly a glassy Si-Ca body (Ramsay and Ramsay, 2015) as discussed below. We would encourage Spero to spell out what these several Bow recipe types are that he alludes to and the basis for his new conclusions.

In the case of the unreferenced claim by Spero as to a range of recipe types produced simultaneously at William Reid's factory a decade later, this pioneering research was published by Owen and Hillis (2003) where they demonstrated that three broad recipe types were produced (phosphatic, Si-Al, and Si-Al-Ca).

When we gave our paper in London on November 2015, the then President of the ECC, Roger Massey spoke at some length at the end of our talk and he admitted that possibly we may be correct in our attribution of 'A'-mark porcelains to Bow. In reply we noted that it has taken some 15 years by some/most ceramic connoisseurs to accept our reasoning as to the attribution and dating of this stellar group, is it going to take another 15 years to recognise the veracity in the dating of the George II busts and wall brackets to 1745 - 1746 by Daniels and co-workers, a further 15 years to recognise the current mess that Limehouse is in, and yet another 15 years to recognise that a group of under-fired and crazed 'Broad Street' porcelains in fact has nothing to do with Broad Street Worcester?

The research in this account given below owes part of its origins to the research by Morgan Wesley (Wesley, 2008) into the Burghley House jars. Whilst a major part of his research revolved around historical and stylistic considerations he did take the unusual step to analyse the *Virtues jar.* We suggest that those analyses in combination with Wesley's historical research have changed our understanding of the development of refractory porcelains in the Western world and moreover point to what can arguably be regarded as one of the more significant fallacies in Western decorative arts. It is our contention that

TABLE B. BOW COMPOSITIONS RECOGNISED FROM OUR WORK AND ALTERNATIVE VIEWS AND COMMENTS

Composition	Comments and References	Alternative Views	
Si-P-Ca, **Si-P-Ca-S**	Range of Bow second patent phosphatic wares, some with inferred gypsum +/- Pb, some early Bow with higher Al (Ramsay and Ramsay, 2007b).	Your chemical analyses mean nothing (Betsie Wilkie, pers. comm., December 2015).	
Si-Al-Ca	Bow first patent body (Ramsay et al., 2001, 2003; Ramsay and Ramsay, 2007b; Daniels, 2007). Generally regarded that all 'A'-marked wares correspond with the 1744 patent spcification, but this may not be so (see Bonhams, 2012 where the snuff box apparently has a Pb-rich glaze). (Refer Appendix 3).	Majority of 'A'-marked wares can be traced to Scotland (Spero, 2006, p. 4). A'-marked wares possibly made at Lambeth, c. 1741-42 (Bridge and Bundock, 2016; Spero, 2015).	
Mg-P-Pb, **Mg-Pb**	Two recipes as used in the George II busts, 1745, 1746 (Daniels, 2007; Ramsay and Ramsay, 2007b; Daniels and Ramsay, 2009; Daniels et al., 2013; Ramsay and Ramsay, 2015).	Highly imaginative speculation (Bimson, 2009). Unconvincing (Mallet, 2013). Ramsay accepts Pat Daniels's arguments about that as gospel, and concludes for no good reason that they are of early Bow manufacture and, since they contain soaprock, that Bow used soaprock (Anonymous, 2017).	
Si-Al-Mg-S	NGV teacanister (Ramsay and Ramsay, 2005); Ramsay and Ramsay, 2007b). Initially we regarded this canister to be 'A'-mark but by 2007 we recognised that it was a separate recipe containing secondary clay, soapstone, a source of sulphur. Recent work demonstrates a Pb-rich glaze and the source of sulphur might be barite.	Weak science (Gabszewicz, 2008). Seems more likely to be Chinese (Spero, 2014b, p.27).	
Si-Al-Mg-P-Pb	High-fired, refractory Bow bowl (Daniels, 2007; Ramsay et al., 2013).	Weak science (Gabszewicz, 2008).	
Si-Ca	Ramsay and Ramsay (2007b, 2015). The high Na_2O in the analysis (3.9 wt%) has been suggested that the porcelain body may be soft-paste Continental.	Phosphatic Bow c. 1752-53 (Spero, 2011b, p. 21).	
Mg-P	Recognition that a group of 'Limehouse' porcelains is not Limehouse (Ramsay et al., 2013, 2015; Ramsay and Ramsay, 2015).	Non-factual guesswork (Self-professed expert out of London, 2013). The blue and white shell dish is believed by all scholars to be of Limehouse type and indeed similar examples have had this contribution supported by scientific analysis. An attribution to Bow can surely only be made by someone unacquainted with the study of early English porcelain (Anonymous, 2017).	
Si-Al	Ramsay et al., (2013) argued that Bow initially used a Si-Al body and we gave this plate as an example Based on the work by Adams (2016) we recognise that this plate is most likely Bovey Tracy.	Adams (2016) most likley Bovey Tracy in origin.	

the dominance of the notion as to the primacy of the artistic pursuit coupled with endless repetitive accounts on Meissen, Baroque, and Rococo stylistic influences on English ceramics has obscured what to us represents indigenous English ceramic genius.

Subsequent to the initial application of science to analysing English porcelains by Simeon Shaw (1837) and Sir Arthur Church (Church, 1881, 1885) the acceptance of what science can offer has progressed, until recently, with glacial rapidity.

On the one hand, various connoisseurs still continue to kick against the application of science,

It is the same old story of trying to make the science fit the known historical facts and then tweaking it all to fit (whatever that means),

and *your chemical analyses mean nothing* (Betsy Wilkie, pers. comm. December 2015).

Yet on the other hand a glance at the recent literature over the last decade or so does indicate that science and its application to English ceramics is slowly becoming more widely accepted. As a result we suspect that the English ceramic landscape may require considerable re-fashioning during the next decade.

INTRODUCTION

In the introduction to their publication *Ancient Egyptian Materials and Technology*, the Editors, Nicholson and Shaw (2000), wrote that over the last several decades the nature of Egyptology has changed with a new emphasis being placed upon technological and sociological questions. These authors reported that this change has created a renewed interest in Egyptian materials and technology such that the traditional Egyptologist is now unable to answer with authority questions in respect of materials composition, provenance, and the means by which various artefacts were produced. Adam Bowett (2009, p. 5) has likewise commented on the influence of connoisseurs on early English furniture and the myth of *Queen Anne*. Traditionally, the primacy of the aesthetic values or the *principles of artistic truth* of furniture have dominated over academic rigour and as Bowett argues the studying of furniture solely from the point of view of form, proportion, colour, and patina has limited potential.

This state of affairs finds a similar situation in the current studies of English porcelains, where notions as to the primacy of the artistic pursuit still permeate the ceramic literature today dominated by in-depth discussions as to the Meissen, Baroque, Rococo influences. In contrast, the all-important approach involving more rigorous empirical research (composition, mineralogy, kiln-firing science, and raw materials) has been seen to be of secondary consideration. As pointed out by Solon (1910),

On the other hand, scientific books on ceramics do not appear to be in great demand in England; their list is, singularly short.

Examples of late where science has been employed in porcelain attribution is the recognition of the compositional relationship of 'A'-mark porcelains with the specification contained in the Heylyn and Frye 1744 patent (Charleston and Mallet, 1971; Freestone, 1996; Ramsay et al., 2001, 2003, 2004a) and more recently, based on science, the recognition that a significant component of Limehouse porcelains has for the last 26 years been misattributed (Ramsay et al., 2013, 2015). Likewise, analyses of sherds from Bovey Tracey have revealed the apparently highly novel presence of barium, added most likely as barite ($BaSO_4$) and from this discovery there has been enhanced Bovey Tracey attributions given a sauceboat and a fuddling cup (Owen, 2011, p. 219). Another example of the importance of science is the work of Morgan Wesley (2008) where seven analyses of the *Virtues* jar coupled with the Devonshire Schedule titled *Conveyance and Schedule of Gift of 1690 at Burghley House*, has changed our understanding of the development of porcelains in the Western world as discussed below. This is not to deny the continued role of connoisseurship in the study of English porcelains, of which a recent example has been the interpretation of the symbolism and hence the dating of the George II busts and historical wall brackets (Daniels, 2007; Daniels and Ramsay, 2009; Daniels et al., 2013); rather there needs to be a better balance than has been to date.

Our approach dominated by composition is in our opinion both rational and objective and through this approach ceramic lineages or ceramic DNA can be discerned stretching over many decades; detailed relationships that current attempts to replicate through the use of decorative idioms are but a pale imitation. Owen and Hillis (2003) used the term *technology pathways*. In contrast, with connoisseurship where repeated attempts to categorise the subtle shade of grey in the porcelain glaze or discussions as to whether a porcelain body is tough or tougher than tough, are in our opinion largely subjective with little basis in the objective, as the variations to such visual parameters are to say the least numerous. As noted, this does not deny the role of connoisseurship which has built up an enviable level of scholarly information and tradition. However we contend that this approach alone, divorced from science, has become both self-serving and self-justifying, and is unlikely to advance our understanding of porcelains into the 21st Century.

CERAMIC CRUCIBLES AND THE ORIGINS OF THE ENGLISH PORCELAIN INDUSTRY

Bayley and Rehren (2007) define crucibles as a major and varied group of ceramic vessels regarded as potentially movable reaction vessels in which high-temperature transformations take place, but with no permanent unidirectional airflow, thus separating crucibles from furnaces (Rehren, 2003). In their classification of crucibles Bayley and Rehren (2007) recognise two major groupings namely;

- Technical considerations, form, fabric, and thermal properties.
- Functional use, cementation, assaying, and metal melting.

Ceramics developed to withstand temperatures above those generally attained for domestic wares are often referred to as *refractories* (Freestone and Tite, 1986). These authors recognise refractories occurring back as far as the third millennium B.C. In the case of post-medieval crucibles dating back to the 14th C, Martinón-Torres and Rehren (2009) identify two major production sites in Central Europe.

The first group were the highly prized Hessian crucibles produced in the German region of Hesse, as early as the 12th C. The second region was Bavaria where 'dark' crucibles made from local graphitic clays were produced. Martinón-Torres and Rehren (2009) record that a key village in this production was Obernzell, located on the banks of the River Danube in Upper Bavaria and lying in the largest graphite deposits of Europe. Written documents demonstrate that Obernzeller crucibles were used at the Linz Mint (Austria) in 1549 and by the early 17th C were being delivered to the Royal Mints in Vienna, Munich, and Prague (Bauer, 1983, p. 30). Chemically the matrices of these crucibles are rich in alumina (~ 28 wt% Al_2O_3), high iron (≥ 7 wt% FeO), with abundant carbon as graphite, typically above 40 modal % (Martinón-Torres and Rehren, 2009).

Refractory crucibles characterised by an aluminous body and used in metalworking have now been found in numerous Late Bronze Age to the Early Historic period sites in Scotland (Sahlén, 2013). In the case of England, Freestone and Tite (1986) record some 500 crucibles or crucible fragments dating from the Roman and early to late Medieval periods having been recovered from excavations in the City of London. A feature of nearly all of these crucibles examined was the high, well-sorted quartz content ranging from 10 - 50 volume %. Chemical analyses showed that the bulk crucible compositions were characterised by less than 10 wt% in total fluxes (CaO, MgO, K_2O, and FeO) and often less than 5 wt%. Freestone and Tite (1986) report that Stamford-ware crucibles comprised a specific form of a widely traded pottery type made at Stamford, Lincolnshire, whose body contained markedly lower levels of fluxes coupled with lower amounts of quartz (~ 10 volume %). Refiring experiments by the authors demonstrated that the Stamford-ware crucibles were typically more refractory than were equivalent wares made in London (Fig. 1).

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 in 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.

Thus, we have good evidence of Medieval refractory 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.

The widely held view in porcelain history is that Johann Friedrich Böttger of Meissen fame was the first to fire a hard-paste porcelain body, initially using impure Colditz clay and alabaster and after his death by around 1720 Meissen used a purer kaolinite clay and a feldspathic flux. A huge amount of literature has been devoted to this notion with E.W. von Tschirnhaus (1651-1708) regarded as Böttger's mentor. The most recent contribution in the literature to this effect was published in 2010 to mark 300 years of Meissen porcelain (*Fascination of Fragility, Masterpieces of European Porcelain*, edited by Pietsch and Witting). However not mentioned in this volume was a paper published two years earlier in the Transactions of the English Ceramic Circle (Wesley, 2008) where the author chemically analysed a representative of the Burghley House jars and demonstrated that it represents an aluminous refractory porcelain body predating Meissen.

Numerous writers have linked the development of Meissen porcelain with the influence of alchemy and the use of refractory crucibles with a calcic flux (Shaw, 1829, 1837; Marryat, 1857; Adamson, 2007; Martinón-Torres et al., 2008; Zumbulyadis, 2010). Although there has been considerable attention afforded two letters by Père d'Entrecolles as to the method of producing Chinese hard-paste porcelains (de Waal, 2015) there is a growing realisation that the production of a porcelain body in the West was inspired more by the manufacture of refractory crucibles well before the d'Entrecolles' letters arrived in Europe. A significant contribution to this thinking was made by Glenn Adamson (2007) who explored the relationships between the Arcanum, porcelain, and the alchemical tradition. Here Adamson argues that alchemy was the logical extension of Neoplatonic philosophy and the logistical basis for the Scientific Revolution with alchemical experiments seen as a continuum with such activities as new textile dyes, tanning solutions, metallurgical alloys and other technological innovations. In fact laboratory processes are seen as inseparable from philosophical reflection on productive practice. Apparently, porcelain, as with the Philosopher's Stone was a substance whose composition was held secret - an Arcanum, the key according to Adamson that unlocks the historical connection between porcelain and alchemy.

John Dwight (*c.* 1633 - 1703) took his law degree at Oxford in December 1661 seven years after matriculation in Oxford in 1654. On 29th June, 1661 Dwight was appointed by Bishop Walton of Chester as his secretary. Records indicate that three such Registrars were appointed in 1662, reflecting the initial work-load left after the Interregnum. In or around 1665 John Dwight moved to Wigan as Bishop Hall's Registrar. It is at Wigan that Dwight commenced experimental work with high-fired, refractory ceramic bodies. At some time in 1668 Dwight resigned as Registrar although there is some suggestion that he did not leave his post till early 1670 with his first ceramic patent granted in April 1672. The immediate question is that this career as a lawyer for the church hardly groomed Dwight to be by 1672 a leading experimental scientist, materials scientist, and arguably the leading exponent of refractory ceramics in the Western world - both transparent Earthen Ware or Porcelane and Stone ware.

Although Dwight obtained his ceramic patent in 1672 for the making of stoneware and porcelain, to date his porcelain has not been identified and on many occasions Dwight has been declared a 'failure'. It now might appear that Dwight was no failure and moreover he pre-dated Meissen by some 35 years in the production of a refractory porcelain body - in fact four porcelain bodies that we know of as discussed below. Our reasons for accepting that Dwight did make porcelain bodies of various compositions are:

- His patent for transparent earthenware and stoneware issued at Whitehall on April 17th, 1672 and issued under the Great Seal of April. For many years there has been a disinclination to accept Dwight's claims with regard to porcelain or transparent earthenware in his patent application, not unlike the negative claims made against the 1744 patent of Heylyn and Frye for over a century. As demonstrated by Ramsay et al. (2006) such unfortunate assertions towards the 1744 patent are of no account and that patent formulation is arguably the most important document in English ceramic history;

- contemporary comments by Robert Plot FRS (1677) where he confirms that Dwight had discovered the *mystery of the Hessian wares* and *ways to make an Earth white and transparent as Porcellane;*

- Robert Plot also recorded that Dwight had problems with his glazing of the white earth and we suspect that this is in reference to his high-firing Si-Al-Ca glaze, problems which he never fully overcame. This explains to a large degree why there is no evidence from excavations that Dwight used an Oriental-style Si-Al-Ca glaze and as noted by Tite et al. (1986) this apparent failure may have been a major problem for Dwight in his making of porcelains. However we contend that this does not deny that Dwight did in fact make a refractory porcelain body and attempted a Si-Al-Ca glaze, arguably the first in the Western world;

- based on the work by Spataro et al. (2009) it might appear that Dwight, in order to save porcelain examples with blemished or imperfect Si-Al-Ca glazes recovered such items with a lower-firing lead glaze;

- personal observations by Sir John Lowther FRS (1698, *fide* Haselgrove and Murray, 1979, p. 142) who was shown by Dwight at Fulham, *20 or 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 own studies.* We interpret this comment to indicate that Dwight made a variety of porcellaneous bodies and this is what we find in both the Burghley House jars and the octagonal Arnold cup. All examples analysed to date are of different compositions with the Virtues jar apparently comprising a secondary clay, possibly from Dorset and the other three items comprising either a very well-washed secondary clay or even a primary clay as noted by Ramsay et al. (2013). This clay with very low TiO_2 contents (Table 1) links the octagonal Arnold cup with the smaller of the Burghley House jars and its lid;

- contemporary accounts by Robert Hooke FRS, who recorded on February 17th, 1674 (Gregorian) the production by Dwight of his English china including both figures, *Severall little Jarrs of severall colours all exceeding hard as a flint, Very light, of very good shape* (Haselgrove and Murray, 1979, p. 48);

- the account by Hooke on May 16th, 1674 where he saw Dwight's pottery, *In glazed with ashes. Very hard and close excessive deer* (Haselgrove and Murray, 1979, p. 48). This mention of ashes by Hooke in reference to glazing by Dwight suggests to us a reference to his attempts at a Si-Al-Ca glaze or a Si-Al-Ca-Pb glaze as found on the Arnold octagonal cup; and

- the detailed analyses of members of the Burghley House jars and a more recent octagonal cup using a Hitachi S-3700N Variable Pressure SEM with an attached Oxford Instruments INCA energy dispersive X-ray spectrometer (Spataro et al. 2009; Spataro end Meeks, 2015), support the notion that a variety of refractory porcelain bodies were being made prior to 1683 and to date such representatives have been found only in England.

THE POSTULATED ROLE OF ROBERT BOYLE FRS

It is slowly being recognised that John Dwight fired the earliest refractory porcelains in the Western world and it is highly tempting to speculate that Robert Boyle FRS acted as Dwight's scientific mentor whilst at Oxford. Although considerable space has been afforded in the literature as to the role of von Tschirnhaus and his influence on Böttger, we suggest that Boyle was acting in this role with regard to Dwight but some 40 years earlier. It may be worthwhile re-examining what we know about Robert Boyle and search for any clues in writings or correspondence that link him to mining, refractory crucibles, or clay.

We suggest that the link was with Oxford University and *the men of Gresham*, involving Robert Boyle and possibly John Wilkins, Master of Wadham College, who later became the Secretary to the Royal Society of London. In 1668 Wilkins became Bishop of Chester. In or around 1656 Boyle took up lodgings at Oxford and in turn worked with Robert Hooke who was his assistant. Little is known as to what Dwight was doing at Oxford prior to his graduation in 1661 but we suggest that he came into contact with both Boyle and Hooke and it was Robert Boyle who acted as mentor to Dwight as to scientific methodologies in relation to refractory ceramic bodies, certainly the Bishop of Chester did not. Moreover there is a suspicion that the appointment awarded to Dwight, especially Registrar at Wigan may have been in part a sinecure (Daniels, pers. comm., 2012). There is the possibility that Boyle, himself, funded or partially funded Dwight whilst at Wigan during his experimental research. From this proposed interaction at Oxford, John Dwight, Boyle, and Hooke became life-long friends. Evidence for a clear Boyle-Dwight link is to be found in the bequest by Boyle as pointed out by Michael Hunter (pers. comm. February, 2016),

I give and bequeath unto Mr John Dwight and Mr John Whittacre once my Servants each of them a Ring of Five pounds price.

This link would date back to Oxford in the 1650's and early 1660's when we contend Dwight worked with Boyle.

Honey (1939, p. 98), whilst not wanting to seem to disparage the English achievement in porcelain, concludes that it had little or no influence on the Continent yet we would contend that at two significant early stages, English ceramic technology had an important influence on Continental porcelain development. One instance was the production of a refractory body at Bow {not Chelsea as correctly noted by Daniels (2007, p. 77)}, as recorded in the Vincennes Privilege of July 24th, 1745, *…..seems finer than that of Saxony by the nature of its composition.*

The second relates to E.W. von Tschirnhaus (1651-1708), a leading mathematician and science philosopher of his day, who with a letter of introduction from Baruch Spinoza (1632-1677) arrived in London in May 1675 to meet with members of the Royal Society and more than likely met with John Dwight and his porcelains through the good offices of Boyle and Hooke. On his return to Paris a few months later, Tschirnhaus suddenly took up porcelain experimentation and while there he first saw the use of a burning mirror by François Villette and observed melting experiments conducted on mineral samples. Mallet (2008) has suggested a link between Tschirnhaus and Dwight but failed to enlarge on this point. We are of the opinion that there is every reason to suspect that the catalyst for Tschirnhaus's interest in porcelains and his subsequent widely publicised mentoring of Böttger at Meissen was the Royal Society of London, John Dwight, and Dwight's assumed scientific mentor, Robert Boyle FRS.

COMMENT ON THE CLASSIFICATION USED HERE

This account broadly classifies the various porcelain types according to chemical composition. A comparable approach was first used by Eccles and Rackham (1922) where they recognised five categories of porcelain namely, hard paste or true kaolinic porcelain, glassy porcelains, bone porcelains, soapstone porcelains, and hybrid porcelains. This approach was subsequently adopted by Freestone (1999). A significant advance in the classification of 18th C British and American soft-paste porcelains was published by Owen (2007) where recent analyses of such porcelains has revealed a wider range ofcompositional types than recognised by Eccles and Rackham (1922). Moreover, Owen notes that attempting to classify porcelains on their inferred use of raw materials can be subjective as there may be difficulties inherent in inferring the nature of the raw materials used. Owen (2007, p. 126) classifies soft-paste porcelains based on a compositional space diagram and this classification has been loosely used in this account. For example a porcelain body rich in silica and aluminium is regarded as being of the silica-alumina (Si-Al) type while a body characterised by magnesium and phosphorus, but lacking lead is characterised as being magnesian-phosphatic (Mg-P).

THE SILICA-ALUMINA (SI-AL) CERAMIC LINEAGE

The silica-alumina (Si-Al) composition or high clay body constitutes the basis for much of the English ceramic industry dating back to pre-historical Scottish and Roman times and thence into the 18th and in part the 19th C. This Si-Al lineage had nothing to do with the glassy French porcelain type. By varying the type and amount of clay with various tempers, amounts and types of fluxes employed, and contrasting kiln-firing conditions a range of ceramic bodies from stoneware, redware, refractory crucibles, creamwares, pearlware, and semi-porcelain to porcelain of the Si-Al type was produced.

THE BURGHLEY HOUSE JARS

The first known use of this recipe type arguably in the Western world for the manufacture of porcelain can be dated to the Burghley House *Virtues* jar and the body of one of the smaller jars (Wesley, 2008; Spataro et al., 2008) with ~18 wt% Al_2O_3 and K_2O varying from 4.5 - 5.8 wt% (Table 1). The source of the clay in the *Virtues* jar containing prominent levels of both TiO_2 and FeO looks to have been a secondary clay, most likely a Dorset ball clay, which Dwight is known to have employed. In the body of the smaller jar, the very low level of TiO_2 being an order of magnitude less than that in the *Virtues* jar, has led Ramsay et al. (2013) to speculate that the clay used was either a remarkably well-washed secondary clay or possibly a primary china clay derived from a parcel of *Rome china clay* or even from the Carolinas. We suggest that the first person to produce a translucent porcelain in the Western World, though widely regarded as a failure (Tite et al., 1986; Hillis, 2001; Adamson, 2007, p. 98), was John Dwight. His patent of April 1672 stated his ability to make a transparent ware and the production of such wares was confirmed by Dr Robert Plot (1677). The first person in modern times to recognise the achievement of Dwight in the making of porcelain and his pre-dating of Meissen by some 35 years was William Chaffers in his Cantor Lecture VII (1867), yet in more recent publications this monumental achievement by Dwight and the important claim by Chaffers have been overlooked.

Fig. 1.

Fig. 2.

Fig. 3. **a.** **b.** **c.**

Fig. 4.

Fig. 1. Refractory ceramic crucible of Medieval Stamford-type with in-turned rim, lip, and pushed in from behind. Courtesy and by permission British Museum, No. 1856,0701.1602.

Fig. 2. Burghley House jars. The central jar is the Virtues jar and comprises a Si-Al body with 18.2 wt% Al_2O_3 and 4.5 wt% K_2O (Spataro et al., 2008). Based on the prominent levels of TiO_2 and FeO the clay used was a secondary clay such as one might expect from Dorset. The body of the jar to the left is likewise of the Si-Al composition with 18.9 wt% Al_2O_3 but the very low TiO_2 level suggests that the clay used was a well-washed sedimentary clay or possibly a primary china clay. The lid to this jar is of the Si-Al-Ca type with 18.1 wt% Al_2O_3 and 6.1 wt% CaO (Spataro et al., 2008). The glaze to this lid comprises an inner higher-firing, lime-alkali glaze and an outer lower-firing, lead-rich glaze (45.5 wt% PbO). Image by courtesy of Jon Culverhouse and the Burghley House Preservation Trust.

Fig. 3. The refractory Si-Al-Ca ceramic lineage through time. Although these three items have different decorative idioms they are all related over a 70 year period by virtue of their indigenous English composition.

a. The refractory Si-Al-Ca lid to the smaller Burghley House jars, c. 1675 (courtesy of Jon Culverhouse and the Burghley House Preservation Trust). The lid also contains two glaze layers; an inner higher-firing, aluminous lime-alkali glaze, and an outer lower-firing, lead-rich glaze.

b. Bow first patent covered sugar bowl, East of London, England, c. 1745. High-fired, refractory Si-Al-Ca porcelain with an underglaze blue 'A' to base. H. 78 mm. (Collection of the Melbourne Cricket Club Museum, accession No. M5369.1, photograph by courtesy of Erin O'Brien.) This bowl comprises inferred Cherokee clay (59 wt%) and lead-free, calciferous glass cullet (41 wt%). The glaze is of the higher firing, aluminous lime-alkali type (Ramsay and Ramsay, 2007b; Ramsay et al., 2004b).

c. Limehouse octagonal platter in underglaze blue, high-fired, refractory Si-Al-Ca porcelain, c. 1747, 220 mm wide. Fitzwilliam, Cambridge. The clay used is an inferred Dorset ball clay and the glaze is a lower-firing lead-rich (32.8 wt% PbO) type (Ramsay et al., 2013, Table 2). The artist responsible for the border foliage is most likely the same hand as found on the border foliage of a Lund's Bristol Mg-P-Pb sauceboat (Ramsay et al., 2011b: Fig. 4). Photograph by the authors.

Fig. 4. Polychrome coffee cup, press-moulded, fluted with decagonal footrim and plain loop handle, private collection. External width of footrim 37 mm, height of cup 60 mm, width across upper rim 65 mm. This cup has an 'A'-mark or Bow first patent shape but has a *Defoe-New Canton period* phosphatic body (24.3 wt% P_2O_5), a lead-rich glaze (53.4 wt% PbO), and can be regarded as the missing link in English ceramic studies. This cup is further testimony to the Trinity, that 'A'-mark porcelains conform to the specification contained in the 1744 Heylyn and Frye patent and these porcelains were made at Bow, but see Appendix 3.

Considerable attention was afforded the work of Wesley (2008) where he chemically analysed the *Virtues* jar belonging to the three Burghley House jars (Fig. 2). For many years these jars (a larger *Virtues* jar and two smaller jars with lids) were debated as to whether they were porcelain, stoneware, or had a glassy body. Based on the limited analyses by Wesley he was able to show that the *Virtues* jar was porcellaneous and using the Devonshire Schedule Wesley was able to argue that the larger *Virtues* jar and the two smaller lidded jars, pre-dated 1683. Wesley's conclusion was that these items have modified our understanding of English porcelain production in the seventeenth century, but he went no further. Spataro et al. (2008, p. 194) were uncertain as to the attribution of the Burghley House jars stating;

It is difficult to be certain whether Fulham, Dehua or indeed some other manufactory produced the Burghley House jars, based on our results and on previous work carried out on early porcelain.

Mallet (2008, p. 225) in the same publication accepts that these porcelains can claim to be Europe's earliest hard-paste porcelains, whether made by the Duke of Buckingham or John Dwight. In our lecture to the English Ceramic Circle on November 21st, 2015 (Ramsay and Ramsay, 2015) we argued that on the balance of probability bearing in mind Dwight's patent and contemporary observations as given above, these refractory, high-fired jars can be attributed to John Dwight, the Fulham potter and most likely dating to *c.* 1675. Moreover using subsequent analyses as published by Spataro et al. (2008, Table 1) three porcelain recipes can be recognised for the Burghley House jars, namely a silica-alumina (Si-Al) variety using a secondary sedimentary clay, a silica-alumina type using either a very well-washed, secondary clay or possibly a primary china clay, and a silica-alumina-calcium porcelain (Si-Al-Ca) body (Table 1). At least two glaze types were employed by Dwight. These being a lower firing, lead-rich glaze and a higher firing, silica-alumina-calcium glaze, the latter being the first such composition applied to porcelains in the Western world.

Although Wesley (2008, p. 179) has suggested that the Burghley House porcelain did not represent a stage in the development of other English bodies, as did Meissen and other German porcelain bodies, but a unique and true porcelain composition in its own right. Ramsay et al. (2013) have argued that these two Si-Al bodies found in the Burghley House jars, in fact can be traced through subsequent development of English porcelains commencing with the Burghley House jars and thence to the experimental work undertaken by the Royal Society of London by 1708 (Sloane Manuscript No. 3636, 1708) (see Table 2, this account). From there this high-clay recipe type can be traced to early Limehouse, Pomona, Lund's Bristol, and to earliest Worcester (Table 3).

At the same time that Meissen was producing its first experimental wares in 1708 the Royal Society of London, or a commissioned ceramist to that Society, was actively experimenting with a range of porcelain recipes of which one of the main ones was the Si-Al type or variants of it (Table 2). It is tempting to speculate that these formulations used by the Royal Society reflected a linkage between John Dwight, Robert Hooke, and Robert Boyle as it is hard to believe that these recipe types, including the Si-Al-Ca lineage discussed below, were discovered *de novo* by the Royal soon after Dwight's death in 1703. We regard these primary source Sloane documents as confirmation of the claims by Daniels (2007) that the Royal Society, far from being a passive observer, was actively involved in supporting various trades including the development of an indigenous English porcelain industry as agreed by Joanna Corden of the Royal Society (Daniels et al., 2013, p. 24). In fact Daniels (2007) claims that by the 1730's members of the Royal Society were very much acquainted with the major porcelain types being produced in London by the mid 1740's. Moreover both Daniels and we regard Bow, which we both contend was possibly in existence by the 1730's, as being the conduit for the expression of a number of these various recipes. These in turn were copied at Limehouse, Lund's Bristol, Worcester, and Vauxhall. What the Hans Sloane experimental results of 1708 provide us with is an insight into the highly creative and intrinsically English experimental thinking in arriving at a range of porcelain recipe types in contrast to the more restricted approach adopted on the Continent. This remarkable range of indigenous ceramic developments dating back to the Burghley House jars in no way supports continued claims in the literature that these early English porcelain achievements were derivative from the Continent.

Manners (2007, p. 429) notes that Dr Martin Lister FRS, recorded that the Master at St. Cloud advised Lister that;

.....he had been twenty five years about the experiment, but had not attained it fully, till within these three Years.

It is this lengthy lead time from initial experimentation through to successful production that we contend would have equally applied to early Bow and thus indicates to us that Bow must have been in existence a significant period of time prior to entering its first patent specification in December 1744. Yet continually we read that Bow did not commence production until *c.* 1748 (Martin, 2016), 1747 (White, 2014), or was still attempting to demonstrate that it could indeed make porcelains by 1746 (Gabszewicz, 2010) thus ignoring the most creative period in Bow's output.

The Si-Al body was used at Limehouse in its experimental ware (Freestone, 1993) or proto-porcelain (Owen, 2000) coupled with the application of a Si-Al-Ca glaze as discussed below. Freestone (1993) describes this porcelain as showing signs of vitrification, yet still porous with SiO_2 ~78 wt%, Al_2O_3 ~16 wt%, and K_2O ~1.5 wt%. Subsequent research on these sherds from contexts 400 and 471 on the Limehouse site (Jay and Cashion, 2013) has demonstrated the presence of mullite +/- cordierite. Jay (pers. com. February 2017) states,

As far as I am concerned, they (sherds) *were high fired. They were attempting to obtain a fully vitrified porcelain and were certainly not trying to make pottery - "stoneware"?*

Ramsay et al. (2013, 2015) summarised these results and argued that the high clay Si-Al Limehouse body was not a cul-de-sac but was linked to the Limehouse Si-Al-Ca body by way of the transitional body as recognised by Jay and Cashion (2013). Moreover Ramsay et al. (2013) argued that body and glaze compositions used at Limehouse were derivative from Bow, thus questioning the long-held claims that Limehouse was in the vanguard of English porcelain development both chronologically and in regard to the first use of underglaze blue, the use of moulding, the first use of silver shapes, and the first use of soapstone arguably late in the output of that potworks (Tyler at al., 2000; Haughton Antiques, 2004, p. 61; Spero, 1995, p. 20; 2002, p. 28; 2005, p. 26; 2011a, 11a, p.10; 2016, p.25; Spero *in* Spero and Burt, undated, p. 64). Panes (2009, p. 46) argues that Limehouse must have influenced Bow yet we contend the reverse and consequently a number of Bow porcelains considered to have potting forms derived from Limehouse, are in fact being dated up to a decade too late and it was Limehouse that was derivative from Bow, both compositionally and stylistically.

Analyses of 20 sherd and waster samples from the Pomona excavations were undertaken by the British Museum Research Laboratory in 1971 (Bemrose, 1973, p. 9). Two main Pomona groups were recognised reflecting Limehouse compositions as ascertained from sherds or wasters from the Limehouse site. One Pomona group of eight sherds was high-fired, contained mullite in the ceramic body, comprised Al_2O_3 15 wt% or more, and showed low CaO in amounts not in excess of 1 wt% (Bemrose, 1973, p. 9). This group equates with the refractory Si-Al or experimental group of Limehouse. The second group of ten Pomona sherds lacked mullite, had CaO varying between 3 - > 7wt%, and had Al_2O_3 contents in nine of the samples equal to or below 10.5 wt%. In concert with some Limehouse Si-Al-Ca wasters from context [404] (Jay and Cashion, 2013, Table 4) the addition of lead was a variable feature of this Pomona Si-Al-Ca body.

Based on the writings of the well-travelled Dr Richard Pococke in late 1750, Benjamin Lund was producing what appears to have been a porcellaneous stoneware belonging to the Si-Al lineage,

.......one called stone china, which has a yellow cast, both in the ware & the glazing, that I suppose is made of Pipe-clay & calcin'd flint.

As yet no extant examples have been recognised as belonging to this Si-Al group from Bristol, however this recipe type characterises what may also represent the earliest wares produced at Warmstry House and by implication at Broad Street, Worcester. The key research that recognised this recipe type at Worcester was by Owen (1998) where he records abundant yellowish sherds at the Warmstry House site, with the analysis of one such sherd comprising some 95 wt% of SiO_2 and Al_2O_3 with a significant level of TiO_2 (1.4 wt%) indicative of a silica source, possibly in the form of calcined flint and a secondary sedimentary clay, in concert with the formulation as recorded for Lund's Bristol by Richard Pococke. Owen makes the pertinent observation that this Si-Al body found at Warmstry House (and by implication at Broad Street) compositionally equates with that of a stoneware body but because of the presence of the lead glaze (45-50 wt% PbO) is not in accord with a salt-glazed stoneware and hence earliest Warmstry House was producing a type of stone china.

THE SILICA-ALUMINA-CALCIUM (SI-AL-CA) CERAMIC LINEAGE:

A variant of the Si-Al ceramic type is the Si-Al-Ca porcelain body apparently representing the addition of a lime-alkali bottle glass to a high-clay body. Although the addition of glass to a clay body can be traced back in Europe to the Medici wares, it is the addition of glass to a high-clay body as suggested by Freestone which appears to be intrinsically English and as pointed out by Ramsay et al. (2013) the first possible use of this recipe in assumed European porcelains might possibly reside with a lid to one of the Burghley House small jars (Spataro et al., 2008). This lid has ~63 wt% SiO_2, ~18 wt% Al_2O_3, and ~6 wt% CaO. Although the raw materials for this lid can only be inferred, the high K_2O (6 wt%) coupled with distinct levels of PbO (1.7 wt%) suggest that minor lead glass was 'inadvertently' included (Fig. 3, Tables 1, 4). As set in Appendix 1 we do not accept that the lead, especially within the interior of the Burghley House porcelain bodies reflects lead contamination from the application and firing of lead-bearing enamels.

Recently an octagonal teabowl has been reported (Manners, 2015; Spataro and Meeks, 2015) (Table 1). Whilst Spataro and Meeks (2015) emphasise the semi-quantitative nature of their analyses the body might appear to be transitional to the Si-Al-Ca type (Table 1). Moreover the Al_2O_3 content (18.1 wt%) resonates with the body analyses of the Burghley House jars and the very low TiO_2 (0.1 wt%) suggests that a similar clay may have been used as found in both the lid and small Burghley House jar as discussed by Ramsay et al. (2013). The glaze to the octagonal cup shows some similarities to the inner Si-Al-Ca glaze to the Burghley House lid (Table 1) but with 7 wt% PbO.

The first clear evidence of the addition of glass to a high clay body being used in England and known to members of the Royal Society was the report in 1688 from John Clayton FRS, Rector of Crofton at Wakefield in Yorkshire on his claimed success in discovering a suitable high-firing clay in Virginia, where he had been sent in search for useful New World raw materials and minerals (Clayton, 1693).

I have obferved, that at Five or Six yards deep, at the breakes of fome banks, I have found veins of Clay, admirable good to make Pots, Pipes, or the like of, and whereof I fuppofe the "Indians" make their Pipes, and Pots, to boil their Meat in, which they make very handfomly, and will endure the Fire better than moft Crucibles: I took of this Clay, dryed, powdered, and fifted it; powdered and fifted potfheards, and glafs; Three parts, Two parts and One part as I remember, and therewith made a large Crucible, which was the beft I have ever tried in my Life; I took it once red hot out of the Fire, and clapt it immediately into Water, and it ftarted not at all.

Based on this account, Clayton used crushed potsherds as a temper rather than crushed silica and from his description the resultant crucible was refractory and resisted 'flying' when placed red-hot in water.

The next report on the Si-Al-Ca body is to be found in the Hans Sloane papers of 1708 (Sloane Manuscript No. 3636, 1708, Folio 76 Recto No. N; Ramsay et al., 2013). Calculation of the theoretical composition gives 10.3 wt% Al_2O_3 and 5.3 wt% CaO (Table 4, No. 3). This addition of glass to a high-clay body was apparently appreciated by members of the Royal Society at an early date and this formulation reappears with the production of Bow first patent porcelains as specified in the Heylyn and Frye patent of December 1744 (Fig. 3, Table 4).

The main difference with the Bow patent specification is that a temper of either potsherds, calcined flint, or crushed quartz sand was dispensed with. The patent specifies that the clay to glass content can vary from 50 - 80% by wt (Ramsay et al., 2004a) and as yet porcelains of up to 70% clay only, have been identified to date.

Although Charleston and Mallet (1971) and Freestone (1996) drew attention to the apparent concordance between the composition of 'A'-mark porcelains and the specification contained in the 1744 patent of Heylyn and Frye, it was Ramsay et al. (2001, 2003) who clearly recognised the relationship between Bow, the 1744 patent specification, and the composition of Bow first patent ('A'-mark) porcelains. This view has not been readily accepted with Spero (2006, p. 4) claiming that the majority of the then recognised 'A'-mark porcelains (approximately 40 total) can be traced to Scotland, in an apparent gesture to Gorgie or by Bridge and Bundock (2015: p. 77) to Thomas Briand at Lambeth. Sandon (2009, p. 17) states that,

Some day we hope a key piece of the research jigsaw will slot into place and we will know for sure where the A-mark porcelain was really made.

Arguably the most salient disagreement with Bow being the source of 'A'-mark porcelains has been the not unreasonable observation by Charleston and Mallet (1971),

.............bears no resemblance whatever, in shapes, details of potting, or enamelling to the later Bow wares.

This view was recently repeated by Spero (2015, p. 6),

No single model associated with the 'A-mark' class corresponds to its presumed heir apparent, a surprising anomaly.

Likewise Adams (2016) points to the apparent dearth of distinctive designs linking 'A'-marked wares to known Bow products. More recently, John Mallet (pers. comm. June 17th, 2016) has now distanced himself from his former position nonchalantly stating,

I have long ago abandoned the full position Robert Charleston and I took about the lack of all technical and stylistic links between 'A'-Marked and Bow.

In Fig. 4 is shown images of a press-moulded, fluted coffee cup with decagonal footrim of 'A'-mark form. Analyses show the cup to be phosphatic (24.3 wt% P_2O_5) with 8.7 wt% Al_2O_3 and the glaze to be of a high-lead type, both in accord with the composition of the Bow *Defoe - New Canton period*, *c.* 1744-mid 1755 (Table 5). We contend that this cup can be regarded as the *missing link* in English ceramic studies in that it has a Bow first patent ('A'-mark) shape yet its composition is of the Bow phosphatic second patent type. Refer to Appendix 3 for further comments.

TABLE 2. SELECTED PORCELAIN FORMULATIONS AND EXPERIMENTAL RESULTS FROM THE HANS SLOANE PAPERS (1708)

THE SLOANE MANUSCRIPT NO. 3636 BY COURTESY OF THE BRITISH LIBRARY

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

This S-Al-Ca body involving the addition of glass to a high-clay paste was replicated at Limehouse by 1747 (Fig. 3, Table 4, No. 6) and this refractory body developed from the experimental Limehouse Si-Al body by means of a refractory transitional type as recognised by Jay and Cashion, (2013). It is this Si-Al-Ca body which was the mainstay of Limehouse production till its demise in late 1747 - early 1748. The main difference between the Limehouse Si-Al-Ca body and that of the earlier recipe used at Bow is that the latter employed a primary china clay (Cherokee clay) imported from the Carolinas. We see no basis for the unsubstantiated claim by Freestone (1996) that Limehouse possibly received a shipment of Cherokee clay from the Carolinas. Subsequently this Si-Al-Ca recipe can be traced to Pomona (Bemrose, 1973) where a Si-Al-Ca body was produced using a secondary sedimentary clay (British Museum Research Laboratory Report, March 16th, 1971, No. 3031).

THE SI-AL-CA GLAZE TYPE

As with the indigenous Si-Al-Ca porcelain body, the development of the high-firing, Si-Al-Ca glaze by *c.* 1675 is one of the great contributions by the English to Western ceramic technology (Table 6). Although it has been pointed out that such high-firing, Si-Al-Ca glazes were unknown in Europe at this early period (Wood, pers. com., 2012) we have the report from Robert Hooke's diary of May 16th, 1674 (Haselgrove and Murray, 1979, p. 48) that Dwight was experimenting with ashes for his glazes. This is not surprising as in the Middle East the use of plant ash as the flux in glass manufacture was well-established by the 8th century (Barkoudah and Henderson, 2006; Brill, 1970). Further evidence can be found on the inner glaze to the Burghley House jar (Spataro, et al., 2008) with 11.9 wt% Al_2O_3 and 15.1 wt% CaO (Tables 1, 6). Robert Plot (1677) reported that Dwight experienced problems with his glaze firing and we suspect that this comment was in reference to the high-fired Si-Al-Ca glaze and not the lower fired Pb glaze. We also surmise that because of this problem Dwight, in order to save some of his less impaired wares, covered the inferred imperfect Si-Al-Ca glaze with an outer, lower-firing, lead-rich glaze (45 wt% PbO) as demonstrated by Spataro et al. (2008, 2009) (Table 1). A lead-bearing Si-Al-Ca glaze (14.1 wt% Al_2O_3, 8,6 wt% CaO) is now recognised on an octagonal teabowl of apparent 17th C English manufacture (Spataro and Meeks, 2015) which on the current balance of probability is related to the Burghley House jars (Manners, 2015).

Early in the 1740's the Bow proprietors had perfected the high-firing, Si-Al-Ca glaze, whose theoretical composition derived from the 1744 Heylyn and Frye patent specification is given by Ramsay and Ramsay (2007b, Table 4) with 12.2 wt% Al_2O_3, 3.6 wt% K_2O, and 7.5 wt% CaO (Table 6). Through the concept of technology transfer, Limehouse was by 1746 attempting to apply a high-firing, aluminous lime-alkali (Si-Al-Ca) glaze to its experimental wares (Freestone, 1993) or proto-porcelains (Owen, 2000) thus supporting our arguments that Limehouse, far from being innovative, was highly derivative from Bow.

THE MAGNESIUM (MG) AND MAGNESIUM-PHOSPHORUS (MG-P) CERAMIC LINEAGE:

The introduction of the magnesian porcelain body to the ceramic tradition represents one of the major innovative achievements by English ceramicists yet constantly this contribution has been ignored or marginalised. The view that the early English porcelain industry was largely a derivative activity, bereft of much originality was promoted by Hobson (1910). Likewise Honey (1939, p. 91) in discussing the relationship between English and Continental porcelains, dismisses what to us represents some of the remarkable triumphs of the indigenous English porcelain tradition, with the claim that the characteristic English modifications to porcelain recipes were of minor account.

We regard the use of soapstone to be another uniquely English contribution, which Honey wrote off with but a few words stating that Cookworthy may have discovered its application in the West of England. This short comment is resurrected with the highly speculative claim by Bimson (2009) that William Cookworthy may have been awarded a bust of George II by the proprietors of Lund's Bristol to thank him for his help and advice on the firing of soapstone porcelains. As has been pointed out (Daniels et al., 2013), in 1749 Cookworthy was a ceramic nobody and was in no position to advise anyone on the making of porcelain, magnesian or otherwise. Lockett (1993, p. 6) made but a passing comment on this highly innovative advance, by stating that soapy rock was merely added to a basic glassy paste usually in the place of china clay. Again this mention of a glassy paste resonates with the glassy French soft-paste recipe, which has been asserted over and over again in the literature as being the basis of the English porcelain industry.

Discussions on the initial experimental work on soapstone by Robert Boyle for the Royal Society in 1667 and the reported production of magnesian porcelains using soapstone apparently sourced to Kynance Cove, the Lizard, Cornwall by the 1720's are given by Woodward (1728), Borlase (1758), Nance (1935), Hobbs (1995), Daniels (2007), Jones (2007), Ramsay et al. (2013, 2015). It is tempting to speculate that Dr John Woodward FRS may have had a significant role, if not in the making of magnesian porcelains, but in the mentoring and the provision of information on soapstone from the Royal Society records. Schleger (1982) claims that the steatitic paste was first developed by Lund's Bristol, apparently based on three aspects, namely the soapstone licence awarded Benjamin Lund in early 1749, the observations of Dr Richard Pococke in his letter to his mother on November 2nd, 1750, and the chemical analyses of Lund's Bristol porcelains by Eccles and Rackham (1922).

With the discovery of the Limehouse site in 1990, the earliest use of soapstone in England was transferred from Lund's Bristol and awarded to Limehouse based on unsubstantiated claims by Watney (1993) that some 'Limehouse' porcelains in private collections are magnesian. His assertion has been widely accepted (Freestone, 1993; Lockett, 1993; Sandon, 1993b; Hobbs, 1995; Spero, 2016, p. 25; Spero and Burt, undated) and it is now axiomatic, based on no published evidence that Limehouse made magnesian porcelains.

Despite reservations by Elliot (1929), Hurlbutt, (1926, pp. 67-68), and possibly Toppin (*fide* Watney, 1975) it is commonly accepted that Bow never used soapstone and it was Limehouse that pioneered this initiative. When Daniels (2007) raised the possibility that Bow did use soapstone prior to Limehouse, her views were rejected by Gabszewicz (2008, p. 338) claiming that she relied on *weak science*. Recent work (Ramsay et al., 2013, 2015) has argued that it was rather Limehouse that never used soapstone and consequently there is a group of Mg-P, soft-paste porcelains attributed to Limehouse over the last 25 years which is not of Limehouse derivation.

We contend (Ramsay et al., 2015) that this group of suspect Limehouse porcelains is not Limehouse in origin as set out in the Preface of this publication. We suggest that some members of this soft-paste, Mg-P false 'Limehouse' porcelains will be reattributed to Lund's Bristol, however we also currently tend to the view that a number of this group were manufactured in London prior to 1747 and hence are likely to have come from the same factory which manufactured the George II busts and brackets. That factory, based on our current knowledge, was Bow.

Based on the work of Daniels (2007), Daniels and Ramsay (2009), Daniels et al., (2013); and Ramsay et al., (2013, 2015) we contend that the earliest extant magnesian porcelains can be attributed to Bow

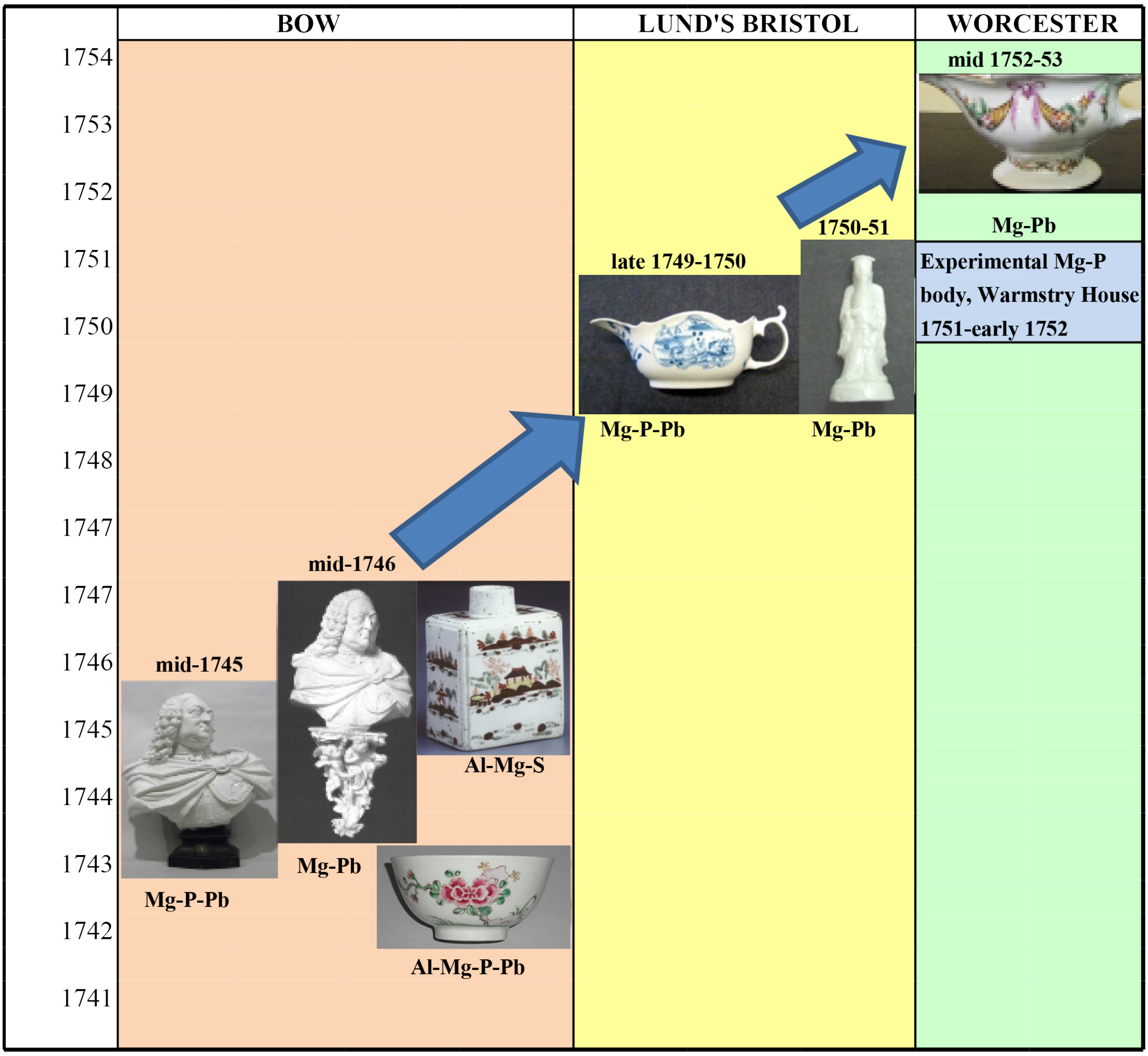


Fig. 5. Evolution of the magnesian (Mg) and magnesian-phosphatic (Mg-P) body through time. Based on our research and that of Daniels it is recognised that Bow produced refractory porcelains using a range of magnesian recipe types including the Al-Mg-P-Pb and the Al-Mg-S bodies. In addition, Bow produced two groupings of the George II busts namely a soft-paste Mg-P-Pb body and a Mg-Pb body.

TABLE 3. CHEMICAL COMPARISONS OF THE Si-Al CERAMIC BODY THROUGH TIME (WT%)

	1	2	3	4	5	6	7	8	9
SiO2	66.8	69	76.9	76.1	78.1	75.3	75	70.3	74.4
TiO2	1.2	0.1	0.71	0.7	1	1.5		0.3	0.07
Al2O3	18.2	18.9	18	16	16.9	19.8	15.5	26.5	18.7
FeO	1.1	0.6	0.63	0.5 $	0.7	0.6	1.8	0.6	1
MgO	1.5	0.5	0.31	0.2	0.2	0.3	0.75		0.15
CaO	0.6	1.4	0.34	0.5	0.4	0.2	0.75		0.2
Na2O	1.6	1.4	0.37	0.7	0.6	0.3	0.6	0.6	0.95
K2O	4.5	5.8	2.69	1.3	1.4	1.7	2.4	1.5	4.2
P2O5	<0.1	0.1	0	0.1	0.2	0.2	0.1		
SO3	1.6	<0.1	0	0.1 #		0	3.6	0.3	
PbO	2.2	1.7	0	<3.8		0			
Other	0.7	0.4							
Total	100	99.9	99.95	100	99.5	99.9	100.5	100.1	99.67

\# sulphur as SO4
$ Total iron as Fe2O3

1. Burghley House 'Virtues' Jar (Spataro et al., 2008), includes 0.3 % SnO_2, 0.1% BaO
2. Burghley House small jar (Spataro et al., 2008), includes 0.4% SnO_2
3. John Dwight's Fulham fine white ware, FP23 (Tite et al., 1986; Spataro et al., 2008)
4. Limehouse single bulk analysis of Si-Al porcelain body (Owen, 2000) - total Fe as Fe_2O_3
5. Limehouse average analysis of 4 Si-Al porcelain bodies (Freestone, 1993)
6. Aluminous 'stone china' waster from the lowest level of Warmstry House, W15 (Owen, 1998)
7. Pomona Si-Al sherd No. 12, The British Museum Research Laboratory Report, March 16th 1971 (Report No. 3031) (Bemrose, 1973)
8. Joseph Benn creamware bowl, Whitehaven (Daniels et al., 2015, Table 1, 3/1)
9. Average of 85 17th Century Japanese porcelains (Wood, unpublished manuscript, May 2012)

TABLE 4. CHEMICAL COMPARISONS OF THE ENGLISH Si-Al-Ca CERAMIC BODY THROUGH TIME (WT%)

	1	2	3	4	5	6	7	8
SiO2	62.6		77.2	63.6	59.7	72.5	80 *	82.6
TiO2	0.2		0.4	<0.1		0.8		0.4
Al2O3	18.1	3 parts clay	10.3	23.2	27.7	10.8	10.5	8.3
FeO	0.6	2 parts potsherds	0.4	0.3	0.1	0.7	0.7 #	0.4
MgO	0.8	1 part glass	0.13	1.3	0.3	1	1.35	0.3
CaO	6.1		5.3	5.1	7.3	6.2	5.5	5.2
Na2O	2.7		2.7	4.3	3.7	2.5	1.3	0.5
K2O	6		3.6	2.1	1.2	3.3	2	2
P2O5	0.6					0.1	0.3	
SO3	0.2							
PbO	1.7					1.3	1.1	0.5
Other	0.5							
Total	100.1		100.03	99.9	100	99.2	102.75	100.2

\# Total Fe as Fe2O3
*Silica by difference

1. Lid to small Burghley House jar (Spataro et al., 2008), includes 0.4% SnO_2
2. John Clayton recipe 1688 as reported to the Royal Society (Clayton, 1693)
3. Theoretical Hans Sloane composition, Folio 76 recto, experiment N (Sloane, 1708) (1/3 Crown glass, 1/3 Tob. Pipe clay, 1/3 Calcind flints). Analysis calculated using Warham Basin ball clay (Ramsay & Ramsay, 2007b) and crown glass (CaO 15%, K_2O 7.5 %, Na_2O 7.5 %)
4. W. W. Winkworth Bow first patent teapot ('A'-mark) (Ramsay & Ramsay, 2007b; Table 4, Fig. 4a)
5. Bow first patent covered sugar bowl; Melbourne Cricket Club Museum, M5369.1 (Ramsay et al., 2004b; Ramsay et al., 2007b, Table 4)
6. Average analysis of four Limehouse Si-Al-Ca bodies (Freestone, 1993)
7. Pomona sherd Nº 18: The British Museum Research Laboratory Report, March 16th, 1971, Nº 3031 (Bemrose, 1973)
8. William Reid Liverpool Sherd (Owen and Hillis, 2003, Table 1, BH19)

in the early to mid-1740's and are to be found in examples of high - Al-Mg-P Bow porcelains (Fig. 5; Table 7), and the Mg-Pb and Mg-P-Pb George II busts, historical wall brackets. (Fig. 5, Table 7). The George II busts and historical wall brackets are outstanding examples of magnesian porcelains.

They represent two things in English ceramic history, namely:

- A remarkable porcelain achievement both in technology and potting, what Jewitt (1878) described in relation to the Cookworthy bust as,

  > *.....it is exquisitely modelled, evidences a very advanced state of Art, and shows great skill, both in body and in firing*; and

- an inverse relationship between the number of unsubstantiated opinions expressed and the amount of basic research undertaken.

No other English porcelain group has had so many recipe types and factory attributions heaped on it as have the George II busts and historical wall brackets (Fig. 6). Several contributions stand out for their original research and scholarship in regard to these busts, these being the work of Delevingne (1963), Daniels (2007), and Daniels et al. (2013).

Recent work by Daniels et al. (2013) has identified two bust groups - the *Dettingen group*, of which 12 extant busts are to date recognised, and the *Culloden commission* of 12 busts and brackets, of which 7 numbered busts are currently known to exist. Both groups can be dated reasonably accurately, with the Dettingen group to *c.* mid-1745 and the Culloden commission to *c.* mid-1746 and predicated on the calculated survival rate of some 58% of the Culloden group, a total of some 33 busts were produced - clearly a commercial initiative by 1745 (Daniels et al., 2013, p. 25). Two recipe types have now been recognised, namely a Mg-P-Pb composition in the waster Willett bust at Brighton and we suspect also the Temple Newsam bust, the assumed first and second extant busts to have successfully emerged from the kiln. All other busts tested are of the Mg-Pb type. Potting features, as elucidated by Daniels et al. (2013, Figs. 23-28), show a progression in technical achievement from the Willett waster bust to the Culloden commission busts of mid-1746, of which the Sir Henry Fox/Darragh bust of Holland House (Number 1 in the Culloden series) now at the Los Angeles County Museum, is shown as a representative (Daniels et al., 2013, Fig. 28).

We contend that the soapstone - bone ash technology, in contrast to the claims of Watney (1993) bypassed Limehouse and reappeared at Lund's Bristol (Fig. 5; Table 7), thus explaining why Benjamin Lund was in production so soon after obtaining his soapstone licence in March 7th, 1749 (Gregorian). Besides the reported Si-Al porcellaneous stoneware body (Godden, 1985), we now argue that Benjamin Lund produced two types of porcelain, namely an inferred earlier Mg-P-Pb body and a later Mg-Pb body (Ramsay et al., 2011b). Both types are linked with a broadly comparable glaze type comprising MgO (1.3 - 3.5 wt%), variable PbO (23 - 40 wt%), distinct Al_2O_3 (3 - 6 wt%), and $K_2O > CaO$. With the selling of the soapstone licence to Richard Holdship in February 6th, 1752 and the *stock, utensils and effects and the process of the said Bristol Manufactory,* on February 21st, 1752 (Sandon, 1993a, p. 198), the transference of the factory in full to Worcester is thought to have been completed by early- to mid-1752, where the Bow - Lund's Bristol Mg-Pb soapstone body continued production (Table 7).

As previously noted, considerable debate continues as to what was produced supposedly in an iron cauldron or temporary kiln at 33 Broad St Worcester on the property of William Davis's apothecary shop and subsequently at earliest Warmstry House from May 6th, 1751 when William Evett leased the property to Richard Holdship for a term of twenty one years (Sandon, 1993a, p. 358) until the buy-out of Lund's Bristol in early 1752. Various criteria have been invoked to recognise this very early period of production at Worcester and to separate it from Lund's Bristol and post mid-1752 Warmstry House (Panes, 2009, p. 114; Sandon, 1993a, pp. 16, 60, 83, 242, 328; Phillips, 2000a, Lot 550; Phillips, 2000b, Lot 918; Dawson, 2007, pp. 28, 30, 32; Spero, 2001, p. 30; Spero, 2005, p. 27; Spero, 2010, p. 59; Spero, 2011a, p. 16; Spero, 2011b, pp. 24, 25; Spero, 2013, p. 63; Spero, 2016, p. 40; Spero and Burt, undated, pp. 92; Sharp, 2015, p. 235). Visual features used to attribute porcelains to Broad St, Worcester *c.* 1750 typically include an experimental appearance, less technically accomplished compared with Lund's Bristol counterparts, underfired, crazed glazing, friable appearance, and almost certainly not containing soapstone. What is of disquiet is that for well over a decade such attributions have failed to complement the visual with chemical analyses. Chemical analyses can now be undertaken in a non-destructive manner (Fig. 7) under low vacuum for a full range of elements, including the light elements Na, Al, and the all-important Mg. Current air-path XRF methods are unable to determine elements with atomic numbers <15. To date the analysis of two such crazed and underfired item has been published (Ramsay 20011b) one being a supposed non-period or 'fake' sauceboat. Based on science it is demonstrated that this underfired and crazed sauceboat comprises both magnesium and phosphorus (assumed to reflect the presence of soapstone and bone-ash) and consequently it has been attributed by the authors to early Lund's Bristol c. 1749-50 (Fig. 5).

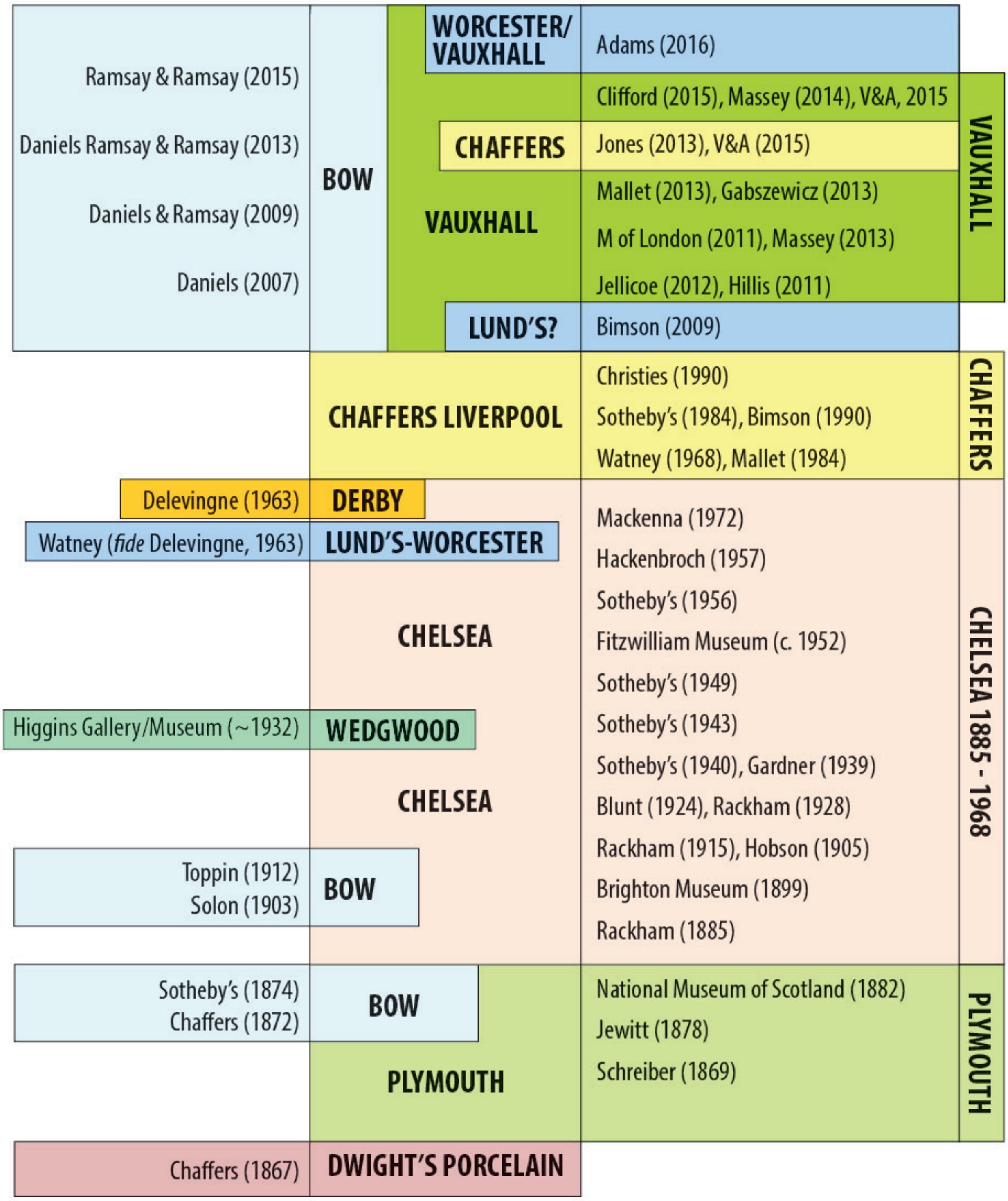


Fig. 6. Attributions of the George II busts and wall brackets through time.
Four major groupings of attributions may be seen with the first being hard-paste Plymouth, as advocated by Lady Charlotte (Schreiber). The Chelsea attribution has been for the longest period stretching through to Watney (1968) when almost overnight the attribution moved to Chaffers, Liverpool. The Chaffers attribution continued to Daniels (2007), who proposed early Bow based in part on the symbolism contained in both bust and bracket. Almost immediately there was a shift instead to Vauxhall with some 13 subsequent publications all ignoring the arguments proposed by Daniels (2007), Ramsay and Ramsay (2007b), Daniels and Ramsay (2009), and more recently Daniels et al. (2013). The most recent attributions are by Clifford (2015), who proposes George III possibly Vauxhall c. 1745 - 1750 and Adams (2016) who suggests either Vauxhall or Worcester.

The most important contribution in recognising earliest Warmstry House, and by implication Broad Street Worcester porcelains, is the work by Victor Owen (Owen, 1998) where he published a number of analyses of wasters from or close to the lowest waster level at Warmstry House (Table 8).

As discussed previously, an analysis published by Owen of a yellowish waster of the Si-Al type, of which a number have been reported from the excavation site, probably reflects the earliest porcellaneous material produced at Warmstry house and by analogy, Broad Street, Worcester. Owen makes the pertinent observation that this Si-Al body found at Warmstry House compositionally equates with that of a stoneware body but because of the presence of a lead glaze (45-50 wt% PbO) is not in accord with a salt-glazed stoneware and hence earliest Worcester was producing a type of stone china or porcellaneous stoneware comparable to that at Bristol.

Owen also gives two analyses of phosphatic wasters, which look to have been attempts to replicate the Bow phosphatic body of the *Defoe-New Canton period*. An Mg-P analysis (Table 8) is also supplied by Owen (1998) and this body is taken to reflect firings immediately before or at the takeover of Lund's Bristol in early 1752. By combining Owen's analyses with our analyses of Lund's Bristol porcelain (Ramsay et al., 2011b) a ternary discriminant diagram can be constructed (Fig. 8). Although based on relatively few analyses, this ternary diagram allows for the preliminary compositional recognition of earliest Warmstry House and the porcelains from Lund's Bristol based on current analytical data. Here the Mg-Pb Lund's Bristol body, which we take to be late or later in the factory output is in compositional accord with the Worcester Mg-Pb body reflecting the post-Lund's takeover and subsequent output from Warmstry House.

A case in point is a Lund's sauceboat discussed above, which has been widely regarded as a 'fake' or non-period because of its underfired body, clear painting, and crazed glazing (Godden, 1985, 2004; Bonhams, 2010, Sale No. 18425, Lot 52), all features that resonate with a number of items attributed to Broad Street, Worcester (Spero, 2016, p. 40). This sauceboat is compositionally concordant with other Lund's early Mg-P-Pb bodies (Ramsay et al., 2011b) and with that of the earliest extant George II busts (Willett waster bust, Daniels et al., 2013). We contend that no faker would have known of this distinctive body and glaze composition. Ramsay and Ramsay, (2015) drew attention to the visual similarities between this early Lund's underfired sauceboat and a number of underfired and crazed, supposed Broad Street porcelains (Fig. 9) and we suggested that these Broad Street porcelains might more reasonably be attributed to earliest Lund's Bristol. This notion was subsequently echoed by Spero (2016, pp. 11, 40).

THE PHOSPHATIC (P) CERAMIC LINEAGE

The phosphatic body has been accepted as Bow's signature recipe type, which again reflects the ingenuity of English ceramic materials science. We disagree with Honey (1939) that this quintessential English development was but a minor modification of a Continental glassy recipe or with Mallet (2008, p. 220) that this phosphatic body merely reflects the addition of bone-ash to a glassy body of the French type. Based on current knowledge, the development of this bone-ash body appears to have commenced in the early 1730's, possibly by Cromwell Mortimer and probably reflecting his prior association with Herman Boerhaave (Daniels, 2007, p. 137). Moreover, for too long the Bow phosphatic body has been regarded as a uniform, homogeneous body with little attempt to catalogue variations in paste type through time.

The first serious published attempt to examine compositional variation in Bow phosphatic porcelains is to be found in Adams and Redstone (1981, Appendix XV) where they recognise a major compositional break at around post-1755 with a reduction in both clay and bone-ash reflecting a deterioration in the quality of the body. More recently Ramsay and Ramsay (2007b, Table 1) have provided a compositional framework for Bow stretching from *c.* 1746 to 1774. This was partially revised by Ramsay et al. (2011a, Table 1) with the *Developmental period* dated to c. 1742-43. A key feature as recognised by Daniels (2007) and discussed by Ramsay and Ramsay (2007b. p. 56) is that production at Bow was not sequential with Bow first patent porcelains followed by the so-called *drab wares* and the *'R' mark* items as assumed by Gabszewicz (2010) and Spero (2015, p. 6). To the contrary, we contend production at Bow was parallel with a range of recipe types produced contemporaneously one with the other and dating back to the early 1740's, if not earlier.

With subsequent research by us, it is now realised that the phosphatic body was being constantly varied during the *Developmental period*, prior to the factory going into mass production *c.* mid-1746, when both the high-fired, refractory Cherokee clay body and the soapstone body were abandoned. Consequently in this account the *Developmental period* could potentially be extended back in time to the early 1740's if not earlier and expanded to include a number of early phosphatic bodies now recognised, typically containing high, or very high clay contents. We regard these more refractory high-Al_2O_3 bodies as predating both the *drab wares* and the *R-mark* wares, whose composition is more in keeping with that of the *Defoe-New Canton period*, albeit with the

TABLE 5 . CHEMICAL ANALYSIS OF 'A'-MARK - SHAPED COFFEE CUP (WT%)

	Body			Glaze	
	1	2		3	4
SiO2	39.7	44.6		41	44.5
TiO2	0.5	0.4			0.1
Al2O3	8.7	8.1		0.4	0.6
FeO	0.2	0.4			0.2
MgO	0.2	0.5			0.2
CaO	24.7	23.4		1	1.9
Na2O	0.5	0.8			0.3
K2O	1.3	1		4	2.4
P2O5	24.3	20.2		0.2	0.3
SO2					0.9
PbO		0.7		53.4	48.7
Total	100.1	100.1		100	100.1

1. Body to 'A'-mark - shaped, pressed-moulded coffee cup
2. Average composition for *Defoe - New Canton period* Bow porcelains c. 1744 - mid-1755, after Ramsay and Ramsay (2007b, Table 9)
3. Glaze to 'A'-mark - shaped, pressed-moulded coffee cup
4. Average glaze composition to *Defoe - New Canton period,* Bow porcelains c. 1744 - mid-1755, after Ramsay et al. (2011a)

TABLE 6. LIME-ALKALI GLAZE COMPOSITIONS THROUGH TIME (WT%)

	1	2	3	4	5
SiO2	53.2	68.3	68.1	74.4	70.96
TiO2	0.1		0.1		
Al2O3	11.9	12.2	11.7	8.3	4.24
FeO	1.1		0.6	0.4	0.49
MgO	1.6	1.8	1	1.5	2.35
CaO	15.1	7.5	13.6	10.7	10.77
Na2O	1.9	6	2.2	2.2	4.77
K2O	3.7	3.6	2.2	2.5	3.8
P2O5	0.4	0.4	0.4		0.58
SO3	0.8				0.35
PbO	7				
Other #	3.1				
Total	99.9	99.8	99.9	100	98.31

1. Inner lime-alkali glaze on lid to Burghley House small jar, includes 1.8% SnO_2
2. Theoretical 1744 patent glaze composition (Ramsay et al., 2003)
3. Glaze to fluted cup Bow first patent (A-mark) porcelain (Ramsay et al., 2003)
4. Glaze composition to Bow first patent covered sugar bowl (Ramsay et al., 2004b)
5. Glaze to Si-Al Limehouse body (Owen, 2000) - total Fe as Fe_2O_3, S as SO_4

use of what we assume may have been gypsum in some but not all examples. The salient feature of all *drab wares* and *R-mark* porcelains analysed by us to date, is their constant Al_2O_3 levels of around 8 - 9 wt% in concert with that of the *Defoe - New Canton period* porcelains and in contrast with what we regard as earlier Bow high-Al bodies that we now recognise. We suggest that all examples of these high-Al_2O_3 - phosphatic bodies reflect the attempts by the Bow proprietors to use high, or very high clay contents, no doubt in an attempt to replicate an Asiatic refractory body as did Limehouse in its subsequent output. Examples of these bodies and their compositions are given in Table 9.

The use of bone-ash in porcelains attributed by connoisseurs to Benjamin Lund has now been established (Ramsay et al., 2011b) while Owen (1998) has demonstrated from waster evidence that bone-ash was trialled on a limited basis at earliest Warmstry House, either on its own or combined with soapstone (Table 8.)

THE SILICA-CALCIUM (SI-CA) CERAMIC LINEAGE

In 2011 a cane handle (Fig. 10) came onto the market attributed to Bow *c.* 1752-1753 (Spero, 2011b, p. 21). Reasons given for a Bow attribution were the texture of the glaze, the palette - especially the yellow and the tone of the green, and the richness of the enamel colours, themselves standing out from the glaze. Analysis of this item (Table 10) demonstrates that it has no bone ash, is rich in CaO, and low in PbO, having SiO2 70.3 wt%, CaO 17.7 wt%, and PbO 1.2 wt% thus suggesting the use of limestone as a raw material. Based on limited published analyses, the low-level of lead tends to militate against either St James's Girl-in-a-Swing, or Chelsea Triangle period. Comparison with a limited number of early Chelsea Raised Anchor or Red Anchor period analyses, shows moderate to poor agreement with the cane handle (Table 10). Likewise there is poor agreement with 'glassy' wasters from Derby with regard to both CaO and PbO (Owen and Barkla, 1997) and in the case of Longton Hall there is poor concordance with PbO (Tite and Bimson, 1991). Based on connoisseurship the cane handle appears to have little in concert with either Chelsea Raised Anchor or Red Anchor, with the decoration more in accord with that regarded as Bow. If there is any validity in this reasoning, the cane handle could represent an example of calciferous Bow dating to the early 1740's. The question that arises is whether there are other examples of calciferous, glassy Bow possibly dating back to the early 1740's that are being misattributed as argued by Ramsay and Ramsay (2007b, 2015). A contrasting view of the origin of this cane handle has been voiced that the high Na_2O levels in the porcelain body is more akin to French soft-paste wares and possibly this cane handle is derived from France and over-painted in England.

At the Rous Lench sale (Christies, May 30th, 1990, Lot 359) was sold a male and female pair of Turks (Fig. 10) for which debate has continued as to whether their attribution is St James's or Triangle Chelsea. An analysis of both Turks (Table 10) indicates that the lead level is higher than that found in the cane handle but well below levels found in either St James's or Chelsea Triangle porcelains based on the limited number of such analyses currently in the literature. The somewhat primitive figure modelling of the pair suggests an early date and if the cane handle is of Bow attribution as argued by Spero (2011b) then, by compositional comparison, the pair of Turks may have a similar attribution. However we note the significantly lower level of Na_2O in the two Turks when compared with that in the cane handle.

It is disappointing to note the dearth of published reliable chemical analyses of early Chelsea and St James's bodies in the public domain. This account has had to rely largely on two Chelsea analyses carried out almost 100 years ago (Table 10).

TABLE 7. CHEMICAL COMPARISONS OF THE MAGNESIAN AND MAGNESIAN-PHOSPHATIC BODIES THROUGH TIME (WT%)

	1	2	3	4	5	6	7	8	9	10	11
SiO2	36.9	52.9	68.8	73.15	60.8	69.6	60.8	66.8	60.7	72.25	71
TiO2	0.5	0.5									
Al2O3	33	32.6	4.2	2.77	3.3	2.7	2.8	3.6	2.4	3.5	3.8
FeO	0.8	2.9	0.4			trace		t	0.5	0.4	0.4
NiO			0.2								
MgO	3.1	4.6	8.6	8.33	11.7	9.4	11.5	11.4	15	8	12.2
CaO	8.9	0.3	5.8	2.91	10.5	9.8	10	0.5	10.9	2.25	1.7
Na2O	4.2	2	1	1.15	2.3	1	2	0.5	2.2	1.5	1.5
K2O	1.7	2.7	2.8	2.6	2	1.7	2	4.4	1.6	3.25	3.4
P2O5	2.7	0.1	2.2		7.8	4.7	7.1		6.7		0.3
SO3		1.9									
PbO	8.3		6.2	9.1	2	0.8	3.5	13.2		8.75	5.8
Total	100.1	100.5	100.2	100.01	100.4	99.7	99.7	100.4	100	99.9	100.1

1. Al-Mg-P Bow high-fired famille rose bowl (private collection)
2. Al-Mg Bow high-fired Island House tea canister (National Gallery of Victoria), S as SO_2
3. Willett George II waster bust (Dettingen group)(Brighton Museum and Art Gallery)
4. Delevingne George II bust (No 3 in the Culloden commission - private collection)
5. False Limehouse Mg-P underglaze blue, shell dish (private collection)
6. False Limehouse Mg-P underglaze blue, shell dish (ex Billie Paine collection)
7. Lund's Bristol Mg-P-Pb underglaze blue sauceboat (Godden Sale, Bonhams, 2010, Sale 18425, Lot 52)
8. 8. Lund's Bristol Lu Tung-Pin Mg-Pb figure in the white, possible Pb glaze contamination (Bristol City Art Gallery and Museum)
9. Warmstry House Mg-P waster W12 (Owen, 1998, Table 4)
10. Early Worcester Mg-Pb polychrome, pedestal sauceboat c. 1752 (private collection)
11. Mean composition of six Mg-Pb first period Worcester sherds (Owen, 1998)

TABLE 8. CHEMICAL ANALYSES (WT%) OF SHERDS FROM WARMSTRY HOUSE, AFTER OWEN (1998)

	1	2	3	4	5	6
SiO2	75.5	60.7	79.3	82.4	75.3	71
TiO2					1.5	
Al2O3	3.2	2.4	3.8	4	19.8	3.8
FeO	0.4	0.5	0.5	0.4	0.6	0.4
MgO	10.7	15	0.5	0.4	0.3	12.2
CaO	2.8	10.9	6	4.9	0.2	1.7
Na2O	1.6	2.2	0.6	0.6	0.3	1.5
K2O	2.7	1.6	3.4	3.2	1.7	3.4
P2O5	0.3	6.7	4.6	2.7	0.2	0.3
SO3			0.4	0.2		
PbO	2.7		0.9	1.2		5.8
Total	99.9	100	100	100	99.9	100.1

1. Sherd W11
2. Sherd W12
3. Sherd W13
4. Sherd W14
5. Sherd W15
6. Mean composition for six Worcester sherds dating from 1750's to 1770's

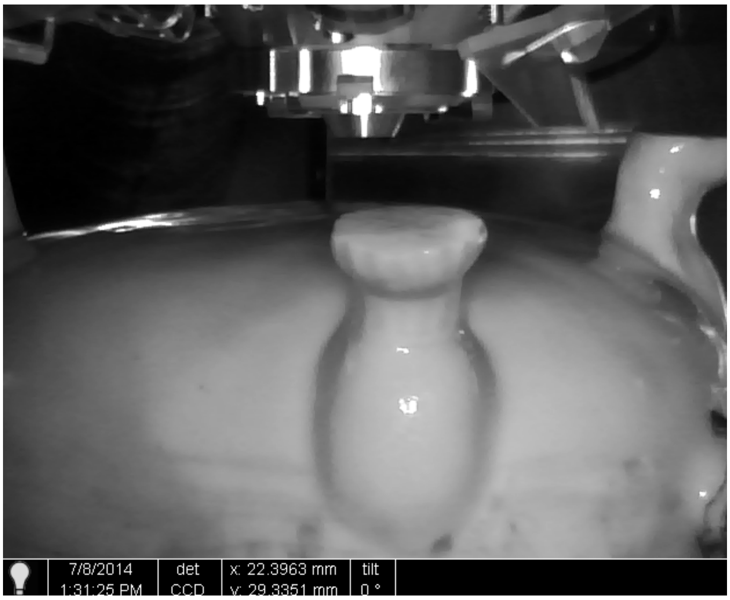


Fig. 7.

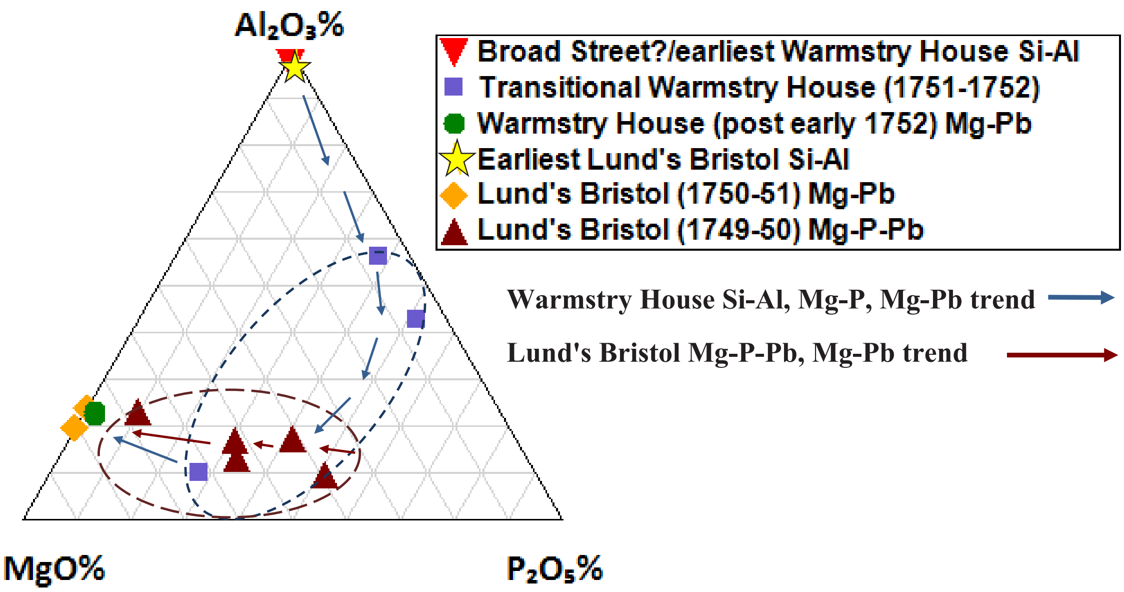


Fig. 8.

Fig. 7. Non-destructive analysis under low-vacuum of an underglaze blue Bow sauceboat *(Defoe-New Canton period)* using a FEI Nova NanoSEM 450™ Field Emission Scanning electron Microscope, which is fitted with a Schottky-type Field Emission Gun has been installed by MCEM. The instrument is capable of providing both high resolution images and EDS analyses under both high- and low-vacuum settings. This instrument is fitted with a Field Emission Gun, a 5-axis stage, IR chamber camera; oil-free pumping system and a retractable DBS annular BSE detector. Low-vacuum imaging, LV-BSE detector is also fitted. When used under low-vacuum operation, no surface coating of the sample to eliminate surface charging is required. The beam landing energy is continually variable over the range of 30 keV down to 0.05 keV. Beam deceleration; in-lens detectors; NavCam; Helix detector; plasma cleaner; cryo-trap together with Bruker Quantax 400 X-ray analysis system and 60mm2 Silicon Drift Detector (SDD) with super light element window (SLEW). In the present research, the microscope was normally operated under low-vacuum mode at 50 Pa and with a spot size of 5.0 with the working distance set to between 5 and 7 mm. Location is at Monash University Centre for Electron Microscopy, Melbourne (image courtesy Dr Bill Jay).

Fig. 8. Ternary discriminant diagram (wt%) for earliest Warmstry House and Lund's Bristol porcelains. Analyses used after Eccles and Rackham, (1922); Owen (1998); and Ramsay et al. (2011b). Notice the concordance in composition between the inferred late Lund's Mg-Pb body and that of post-merger Worcester.

Lund's Bristol		Supposed Broad Street, Worcester
Underfired and friable	Nature of the body	Underfired and friable
Clear and not blurred	Nature of the painting	Clear and not blurred
Crazed glaze	Nature of the glaze	Crazed glaze
Mg-P-Pb	Porcelain composition	Unknown
Moderate PbO, distinct Al2O3, MgO and Na2O	Glaze composition	Unknown

Fig. 9.

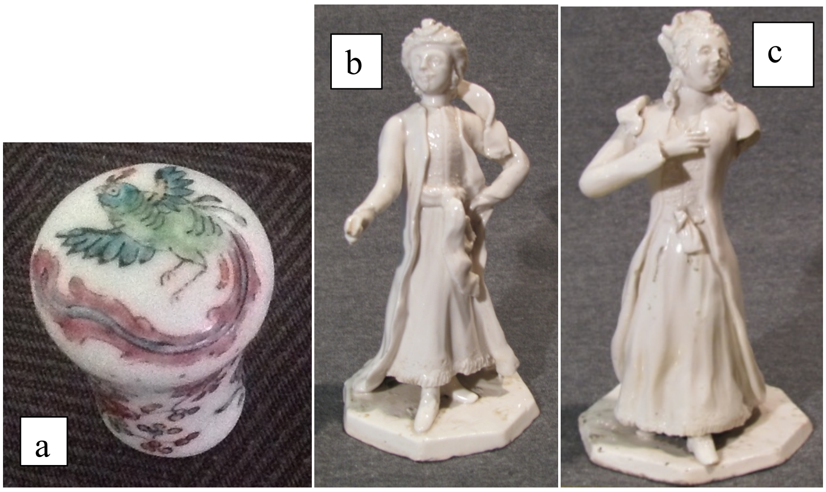


Fig. 10.

Fig. 9. Comparison of an early Lund's Bristol sauceboat with an underfired pickle dish supposedly from Broad Street Worcester as presented by Ramsay and Ramsay (2015). Chemical analysis of the sauceboat (Ramsay et al., 2011b) demonstrates that it is early Lund's Bristol (not a fake), whilst visual comparison with the shell dish suggests a comparable attribution and date of manufacture. For the last decade there has been considerable speculation as to what if anything was produced at Broad Street Worcester but a key determinant as to composition has been ignored.

Fig. 10a. Cane handle, attributed to Bow, soft-paste Si-Ca body c. early 1740's, Taylor Collection. This cane handle has been attributed by Spero (2011b) to Bow c. 1752-53 based on having a Bow-textured glaze, the pallet especially the yellow and tone of green, and the richness of the enamel colours, themselves standing above the glaze. A chemical analysis demonstrates that this item lacks bone-ash, rather it is rich in calcium (17.7 wt% CaO) and the inferred recipe was crushed quartz or calcined flint, limestone, a very small amount of clay to provide plasticity, and a minor amount of lead glass or lead oxide.

Fig. 10b. Male Turk, attributed to Bow, soft-paste Si-Ca body, (Rous Lench sale, Christies, May 30th, 1990, Lot 359), private collection. Compositionally this figure shows some similarities to that found in the cane handle (Fig. 11a) but with higher PbO. If the cane handle does have a Bow attribution as argued by Spero (2011b) then by compositional comparison this Turk figure may have a similar factory attribution. Its lead content (6.5wt% PbO) militates against this figure being either Swing-Girl or Chelsea Triangle period, based on our current knowledge of their compositions. The somewhat primitive modelling coupled with the Si-Ca body suggests a date of early 1740's if not 1730's.

Fig. 10c. Female Turk, attributed to Bow, soft-paste Si-Ca body. (Rous Lench sale, Christies, May 30th, 1990, Lot 359), private collection. This figure has a comparable composition to that of the male Turk (Fig. 11b) with 16.6wt% CaO and 5wt% PbO - see Table 11.

TABLE 9. CHEMICAL COMPOSITIONS OF PHOSPHATIC AND MAGNESIAN-PHOSPHATIC BODIES (WT%)

	1	2	3	4	5	6	7	8	9	10	11
SiO2	36.9	61.1	38	40.6	47.8	39.7	44.7	68.8	69.6	60.8	60.7
TiO2	0.5	0.3	0.5	0.5	0.3	0.5	0.4				
Al2O3	33	14.8	12	12	7.1	8.7	8.1	4.2	2.7	2.8	2.4
FeO	0.8	t	0.5	0.5	0.4	0.2	0.4	t			0.5
NiO								0.2			
MgO	3.1		0.5	0.5	0.4	0.2	0.5	8.6	9.4	11.5	15
CaO	8.9	10	22	23.7	21.5	24.7	23.3	5.8	9.8	10	10.9
Na2O	4.2	1.7	0.7	1	0.5	0.5	0.8	1	1	2	2.2
K2O	1.7	3.2	2	1.1	1.2	1.3	1	2.8	1.7	2	1.6
P2O5	2.7	4	18	19.7	19	24.3	20.2	2.2	4.7	7.1	6.7
SO3					0.5						
PbO	8.3	5	6		1.3		0.7	6.2	0.8	3.5	
Total	100.1	100.1	100.2	99.6	100	100.1	100.1	99.8	99.7	99.7	100

1. Polychrome refractory famille rose, Al-Mg-P Bow bowl, early - mid 1740's (private collection)
2. Underglaze blue Al-Ca-P Bow jug, Developmental period c.early 1740's, Fitzwilliam Museum
3. Figure in the white, refractory Al-P Scowling Harlequin, Developmental period c.early 1740's (private collection)
4. Polychrome refractory Al-P Bow jar with reserves, Developmental period c.early 1740's (Taylor Collection)
5. Drab tripple salt, Taylor Collection, Developmental period c.early-mid 1740's (Ramsay and Ramsay, 2007b, Table 8, Fig. 6a)
6. A-mark shaped coffee cup, Defoe-New Canton period c. 1745 (private collection)
7. Average composition Defoe-New Canton period c.1744-55 (Ramsay and Ramsay, 2007b, Table 9)
8. Willett waster bust of George II, Brighton Museum, early - mid-1745 (Daniels et al., 2013, Table 4)
9. False 'Limehouse' Mg-P shell dish, attributed to Bow c. 1745 (Ramsay et al., 2015, Table 2)
10. Lund's Bristol Mg-P sauceboat c. 1749-1750 (Ramsay et al., 2011a, Table 1, Fig. 4)
11. Mg-P waster, Warmstry House c.1751 (Owen, 1998, W12)

TABLE 10. CHEMICAL COMPARISONS OF THE ENGLISH SILICA-CALCIUM BODIES AND GLAZES (WT%)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
SiO2	70	70.5	69.8	69	64.76	69.1	70.3	63.3	62.9	39	42	46.7	50.7	42.1
TiO2	0.2						0.3		0.2	0	0			
Al2O3	1.7	3.7	3.4	3.5	6	5.9	4.1	3.4	3.2	0.5	1	t	1.7	0.5
FeO	1.3		0.4	t		t	0.2		0.3	0	0			
MnO				t				t						
MgO	1.3	0.5	0.5		t	0.71	0.4	t	0.3	0.5	0.3		t	0.8
CaO	18	15	16.6	10.5	25	20.5	18.8	14.8	19.4	5	4.7	4	4.3	2.9
Na2O	3.9	1.2	1.6	t	1.82	0.69	0.5	1.5		1	2	t	2.3	0.5
K2O	3.2	2.5	2.8	3.25	2.58	3.3	3.5	2.8	1.9	1	1.3	3.3	2.3	4.2
P2O5	0				0.23				1.9	2	0			
SO3														
PbO	1.2	6.5	5	14	0.55		1.9	14.3	9.9	52	49	45.6	39	45.9
Other#														3.1 #
Total	100.8	99.9	100.1	100.25	100.94	100.2	100	100.1	100	101	100.3	99.6	100.3	100

SnO2 3.1

1. “Bow” cane handle (Spero, 2011b, p. 21)
2. Figure of male Turk (Rous Lench, Christies, May 30th, 1990, Lot 359)
3. Figure of female Turk (Rous Lench, Christies, May 30th, 1990, Lot 359)
4. Chelsea triangle salt in the white (private collection)
5. Chelsea raised anchor (Eccles and Rackham, 1922, p. 25, C14-1920)
6. Chelsea red anchor (Eccles and Rackham, 1922, p. 26, C.514-1919)
7. Chelsea red anchor plate fragment (Tite and Bimson, 1991, Table 1, British Museum Research Lab. No. 29103)
8. Seated hound with bulbous eyes in the white, Charles Gouyon's porcelain (private collection)
9. Longton Hall mug (Tite and Bimson, 1991, Table 1, British Museum Research Lab. No. 29098)
10. Glaze to “Bow” cane handle (Spero, 2011b, p. 21)
11. Glaze to male Turk (Rous Lench, Christies May 30th, 1990, Lot 359)
12. Glaze to Chelsea triangle salt in the white (private collection)
13. Glaze to seated hound with bulbous eyes in the white, Charles Gouyon's porcelain (private collection)
14. Glaze to Longton Hall mug (Tite and Bimson, 1991, Table 2, British Museum Research Lab. No. 29098)

DISCUSSION

This account is an attempt to bring together what we perceive as a significant contribution by the English to the development of porcelains in the Western world. We contend that the production of a porcelain body is first and foremost an exercise in materials science and consequently our approach has been not so much predicated on notions pertaining to the primacy of the artistic pursuit, but rather on porcelain composition set in the context of historical documents, and indigenous English ceramic genius. The inescapable conclusion that we reach in this account is that this English porcelain tradition based on composition has for too long been overlooked. We question the widely held view that the English porcelain tradition is essentially derivative both compositionally and stylistically, first from the East and then from the Continent with limited initial indigenous input.

Our research, dominated by composition, is both rational and objective and through this approach *ceramic lineages* or ceramic DNA can be discerned stretching over many decades. Arguably one of the more unfortunate claims made in English ceramic literature relates to Stanley Fisher's stricture that,

repugnant science should have little or no role to play in the study of English porcelains, which is surely an exercise in the artistic pursuit (Fisher, 1947, p. 6).

This notion has dominated studies of English porcelains with major discussions, indeed whole volumes, given over to studies on the Meissen influence here, the Baroque influence there, and of course the Rococo. The overall thrust of these contributions has been to obscure the very essence of the English porcelain tradition as reflected by Hobson (1910), who introduced the concept of the wandering Continental potter or gardener,

......remember that porcelain was not discovered in England by a process of evolution from the native earthenware. It was, on the contrary, an exotic plant of eastern origin, naturalized and, one might say, hybridized on the Continent, and brought to England, as it were, in cuttings which were planted first in the neighbourhood of London and afterwards disseminated in more congenial soils.

We propose that the major 18th C recipe types used in England, with the possible exception of the glassy calciferous body, are essentially of English derivation being traced back in part to the pioneering work by John Dwight and thence back to the production of refractory crucibles dating to the Blackwater Valley and beyond. This range and variety of English porcelain recipe types, not found on the Continent, reflect the creative and independent English mind, enhanced through enquiry by the Royal Society of London, aided by mercantile expansion, and fostered by the freedom to explore and experiment with a view to commercial profit. Moreover, the commencement of refractory, high-fired porcelains pre-dated Continental equivalents by some 30 - 35 years. We regard Bow as possibly the most misunderstood of all English porcelain establishments, a factory where parachronistic aesthetic values have been imposed to the detriment of a better understanding of that concern's contribution to this English ceramic tradition. It was Bow, operating from the 1730's, which was the conduit for much of this compositional expression discussed in this contribution, and consequently we concur with Daniels that a number of early Bow porcelains are being dated up to a decade too late.

In summary, we propose in this contribution that:

- John Dwight is arguably the most important figure in the development of a high-fired, refractory porcelain body/bodies in the Western world;
- Robert Boyle FRS, may have been Dwight's scientific mentor while at Oxford, thus pre-dating the influence of von Tschirnhaus at Meissen by some 40 years;
- members of the Royal Society played an important role over a number of years in fostering research into a range of porcelain bodies in England, as initially proposed by Daniels;
- based on porcelain composition we believe that we can discern technology pathways reaching back into the 17th C if not beyond, an approach that can never be replicated by in-depth analysis of decorative idioms;
- the Bow porcelain works was operating in some form or other much earlier that is accepted today. Again we refer to the prior work by Daniels;
- the most striking figural porcelains in the form of the George II busts and associated historical wall brackets, represent an unfortunate situation in English ceramic studies, where numerous unsubstantiated factory attributions and recipe types have been proposed over many years;
- the most significant research into the George II busts and historical wall brackets is that by Daniels (2007); Daniels and Ramsay (2009), and Daniels et al., 2013) yet this research has

all but been ignored in favour of Chaffers, Liverpool or Vauxhall, attributions for which little evidence of substance exists;

- the current understanding and recognition of Limehouse porcelains is in a 'mess' reflecting a failure to consider, among other aspects, their composition. It will be interesting to review the future accepted Limehouse orthodoxies in the light of our alleged *non-factual guesswork* that Watney's magnesian 'Limehouse' porcelains have little if anything to do with 20 Fore Street;

- the present understanding and recognition of Lund's Bristol porcelains requires to be rethought;

- the existing attempts to recognise earliest Warmstry House porcelains and associated Broad Street wares based on visual features alone and divorced from composition require reconsideration;

- central to this contribution is the need to rethink early English porcelains based on their compositions. To date there has been too much emphasis afforded decorative idioms, the Meissen influence and the Baroque, which collectively imply that the English porcelain tradition owes its origins to exotic sources. Consequently these views have obscured what we regard as indigenous English ceramic genius;

- regardless of what we write we are constantly accused of wanting to 'ditch' connoisseurship in favour of the scientific. This is not so, but we do argue for a better balance as in a number of instances English ceramic experts in arguing for a particular attribution divorced from science are getting it wrong and here attempts to attribute 'A'-marked, Limehouse, Lund's Bristol, and earliest Broad Street Worcester porcelains based in decorative considerations are good examples. In contrast, when calls are made in the literature to 'ditch' repugnant science (Fisher, 1947, p. 6) little comment to the contrary has been made; and

- what is now emerging is shaping up to represent the significant fallacy on Western decorative arts, namely the primacy of Meissen. We suggest that the English were producing several types of refractory porcelain bodies some 35 years prior to Meissen.

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APPENDIX 1

Spataro et al. (2009) analysed representatives of the Burghley House jars (Virtues jar, one of the smaller jars, and its lid) using a variable pressure (VP) Hitachi scanning electron microscope (SEM), with an associated energy dispersive X-ray spectrometer (EDX). These authors went to considerable trouble to demonstrate that variable pressure SEM analyses make it possible to carry out reliable, reproducible EDX analyses of acceptable accuracy on less than ideal fractured samples, provided the usual precautions are taken. These precautions include sample geometry, the pressure used to counteract charging is minimized to reduce 'skirting effects', and the porosity of the fractured material is low.

Subsequently Spataro and Meeks (2015) analysed an octagonal cup and strangely described their analyses as semi-quantitative. This point was taken up by Mallet (2016) where he appears to try to marginalise, what we regard as excellent reproducible analytical results, as being *imprecise*. More recently (Anonymous, 2017) these results are dismissed as being *incomplete*. We would question such claims that the Spataro analyses are either incomplete or imprecise.

A key feature that indicates that these porcelain items are not of Asiatic origin nor of European refractory origin is the presence of lead in both body and glaze and yet debate continues that the lead content, often a high lead content, reflects contamination by lead vapours. We would strongly question these attempts to what amounts to giving away to overseas these brilliant indigenous wares as has been, and still is the case, with 'A'-marked porcelains.

APPENDIX 2

In, *An Attempt Towards a Natural History of the Fossils of England,* Part 1, London MDCCXXIX, p. 6, John Woodward MD, FRS states,
Steatites, White, with Veins of red. From the Soaprock.....Cornwall. A considerable Part of the Cliff near the Lizard Point consists of this earth. From several Trials that have been lately made for the baking and making this Earth into pots, I am satisfied that 'tis not much inferior to that of which Porcelain is made........... We have previously taken this reference to indicate that by around 1727, prior to the death of Woodward in April 25th, 1728, he or agents to the Royal Society were actively continuing the research into soaprock as initiated by Robert Boyle FRS, with a view to making porcelains. In mid-July, 2017 we were contacted by Mike Noble, recent author of *Eighteenth Century English Glass and its Antecedents,* to advise us that he had just come across correspondence by Fk Nicholls dated December 28th, 1728 to Dr Scheutzer at Sr Hans Sloans , Bloomsbury Square, London (EL/N2/11. 28 December 1728, R. S. Archive). In this account Nicholls records that he had been in Paris about two months and he recorded his gratitude to Hans Sloans for a letter, we assume of introduction, to Mons Malpertuys. Apparently this gave Nicholls an introduction to the French Academy, which according to Nicholls was pushing matters with much life. In particular, Nicholls reported in some detail on experimental work undertaken by René Antoine Ferchault de Réaumur for the making of porcelain as reported by Réaumur to that Academy during December 1728. Apparently he obtained two types of earth from China, namely one which would vitrify with ease (we suspect a feldspathic flux or *petunse*) and another fine, white, refractory powder, which Réaumur decided was *talk* (or *talc*). By mixing the two in varying proportions and firing the mixture he claimed to have made good china ware. This letter by Nicholls was read to the Royal Society on February 6th, 1729 - Gregorian. Initially we were sceptical that the refractory, white powder was in fact talc as the description given could equally apply to kaolinite clay, a more likely product from China. However discussions with Dr Bill Jay does suggest that Réaumur with strengths in the natural sciences would have easily differentiated unctuous kaolinitic clay from greasy, soapy-feeling talc.

Of interest to us and to Mike Noble is the close concordance of dates, these being the date of Réaumur's experiments with talc in December 1728 and the publication of Woodward's work posthumously in 1729. However questions remain, these being:

1. Apparently these experiments by Réaumur were not communicated to the French Academy till December 1728 yet Woodward had died the previous April. Was Woodward in close communication prior to his death or had Réaumur learnt of possible experimental work on talc or soapstone by the Royal Society and was attempting to replicate such work?

2. It may even be that both the French and English at much the same time were each independently experimenting with talc/ soapstone with a view to making porcelains.

3. Another possibility is that someone in the Royal Society, who was aware of this work by Réaumur, inserted a short account into Woodward's

manuscript prior to its posthumous publication in 1729. However we note the use of the word *talk* by Réaumur and *steatites* by Woodward which in our mind tends to deny this possibility.

4. Regardless, the English took up experimenting with soapstone with vigour, whereas the French for whatever reason, did not and we would argue that with just over 10 years lead time sophisticated soapstone and bone-ash - soapstone porcelains were being produced in London by the early 1740's. We regard this concern to have been Bow.

5. The role of Frank Nicholls is also of interest. Why was he in Paris, why did Hans Sloane write a letter of introduction to Malpertuys, and why did Nicholls apparently confine himself to reporting experimental work on porcelains by the French?

6. Of note is that this information was communicated between the French Academy and The Royal Society. Such information was most likely denied common English potters and here again, as argued by Pat Daniels, the conclusion we come to is that members of The Royal Society of London played a major role in promoting the development of soapstone and soapstone - bone-ash porcelains.

APPENDIX 3

For some years now (Ramsay and Ramsay, 2006, 2007b; Ramsay et al., 2001, 2003, 2004a, 2004b, 2006) we have been publishing on the relationship between 'A'-marked porcelains, the 1744 patent of Heylyn and Frye, and the Bow manufactory. One of the conclusions that we came to was that 'A'-marked porcelains were synonymous with Bow first patent porcelains; that is 'A'-marked porcelains were produced based on a theoretical composition that we derived from the patent specification using Cherokee clay. More recently with the sale of a polychrome snuff box (Bonhams, 2012) our assumption is repeated by that auction house,

If porcelain was made following the recipe listed in the patent, it would match the results of modern analysis of specimens of A-marked porcelain.

To that end Bonhams produced semi-qualitative scans of two comparable snuff boxes, one from the National Museum of Wales with what looks to be a partial 'A' impression on its base and the second (Lot 168) the subject of this sale. Air-path XRF scans of the glaze on both snuff boxes were carried out by Cranfield University in November 2011 from which it was determined that the glaze on each box matched very closely and consequently it was claimed that Lot 168 was 'A'-mark and hence conformed to the 1744 patent specification of Heylyn and Frye. What struck us with the Cranfield scans of both boxes were prominent peaks at approximately keV 10.5 and at 12.65 and a possible weak Pb Ma at keV 2.35. The presence of these peaks even allowing for a known strong As Kα peak at 10.532 does suggest that Pb is a major component in the glaze of both boxes. If our reading of the rather fuzzy scans is correct, then our deduction is that lead is a major component of each of the two glazes. A feature of our previous work is that both body and glaze of Bow first patent porcelains as specified by the 1744 patent have negligible lead and consequently, if our interpretation of the Cranfield scans is correct, both snuff boxes may belong to the 'A'-marked group but do not conform to the 1744 patent specification. Unfortunately, Bonhams has provided no information as to the porcelain body of either snuff box, but we assume that both appear to be refractory and by implication were high-fired with elevated Al_2O_3. We have to date identified two aluminous, and hence by implication refractory porcelains which we attribute to Bow (Ramsay and Ramsay, 2006; Ramsay et al., 2013; Daniels, 2007) and in each case we have been able to demonstrate that the clay used was most likely a secondary clay as was obtainable from Dorset and not a primary clay such as Cherokee clay. We now suspect, based on our two analyses and the scans published by Bonhams (2012, p. 72) that there may be compositional variation amongst what is regarded as the 'A'-marked group. Unfortunately discussions on the decorative features and semi-quantitative air-path XRF scans of this group, which are unable to detect with any degree of precision elements with atomic numbers < 15, are unlikely to throw more light on this matter. Non-destructive quantitative analyses can now be undertaken with modern, variable pressure electron microscopes where the entire object is inserted into the chamber (Fig. 7 this publication). Such an approach would provide a far better understanding of these snuff boxes.

The Evolution and Compositional Development of English Porcelains from the 16th C to Lund's Bristol c. 1750 and Worcester c. 1752 - the Golden Chain

Of late there has been a shift in the study of early English and American ceramics, in that science is being used in a more routine manner to answer questions about attribution, dating, raw materials, and kiln-firing techniques. One such example is the work of Jay, Cashion, and Blenkinship (2015) in regard to Lancaster delftware and the recognition of the use of Carrickfergus magnesian clay in that ceramic body. Another example is the work by Owen and Hanley (2017) in the recreation of Bartlam porcelain. Such approaches have not been common for much of the 20th C despite very early contributions by Simeon Shaw, Sir Arthur Church, and Eccles and Rackham. This account argues that to understand the development of early English porcelains one has to give consideration to porcelain composition and when this is done the inescapable conclusion that one comes to is the recognition as to the indigenous genius of early English scientists and materials scientists. Unfortunately a constant feature through much investigation and research into English porcelains during the 20th C is reflected in a rephrasing of Pawson and Brooking (2002, p. 5),

It has not been seen 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.

Based on historical documents and porcelain composition we claim that the early English ceramicists hold a highly significant position in the development of porcelains in the Western world and that arguably John Dwight is the father of a high-fired, refractory ceramic porcelain body or more correctly, bodies. We also contend that Bow and its contribution has been greatly underestimated. Based on our analytical work, we argue that a wide range of English porcelain bodies were being trialled and produced in London by the early to mid 1740's and that concern had to have been Bow.