

# A CLASSIFICATION OF BOW PORCELAIN FROM FIRST PATENT TO CLOSURE: c.1743–1774

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Approximately 50 items of Bow porcelain, some of documentary origin, from private and major public collections were subjected to micro-analytical techniques and from these analyses the theoretical recipe used in each case was calculated. Three published recipes pertaining to Bow paste compositions are also noted (the 1744 and 1749 patents and the Josiah Wedgwood formulation of 1759) and all three are examined in the light of these analyses. Based on the calculated paste compositions derived from analysis, three major groups of Bow wares are recognised, namely a hard-paste Si-Al-Ca body with an associated Si-Al-Ca glaze (Bow first patent wares or ‘A’-marked period c. 1743–1745), a soft-paste, bone ash body with a Si-Pb glaze (Bow second patent bone ash wares c. 1746–1774), and a magnesian (steatitic) body (c. mid 1740s). Five recipe classes and a high-lead subgroup are recognised for Bow second patent wares and these changes in paste types are placed in a chronological order and linked to physical attributes of these porcelain wares (body, glaze, weight, hardness, and translucency). A comprehensive classification from the collector’s and museum curator’s viewpoint is presented and it is proposed that the contribution to porcelain development in the English-speaking world by the Bow proprietors has been significantly underestimated.

*Keywords:* Porcelain, Bow porcelain manufactory, chemical analyses, Cherokee clay, bone ash, steatite

*On the other hand, scientific books on ceramics do not appear to be in great demand in England; their list is, singularly short (Solon, 1910)*

STUDIES of English porcelains over the last ten to twenty years, show a divergence or dichotomy in their approach. The traditional methods of ceramic research in developing a coherent chronology of factory output have comprised connoisseurship and artistic scholarship, as for example employed by Tait (1959) in his study on Bow second patent wares and by Spero (2003) for Vauxhall. Mallet (1994: 240) commenting in connection with the ‘A’-marked group of porcelains states that,

Paste, glaze, shape and decoration must remain the criteria for identifying pieces of our group, though it must be recalled that fairly wide variations are encountered both in colour of paste (from greyish to a passably clean white) and in appearance of glaze (from waxy and matt to shiny and wet-looking).

Yet on the other hand science has played an increasing role in our understanding of ceramic wares. Examples of the importance of objective scientific input include constraints as to the identity of unattributed or unprovenanced artefacts (Owen, 2001a; Ramsay et al., 2003), the kiln-firing of analogue wares using original patent specifications (Ramsay et al., 2004a), reconstruction of kiln-firing conditions

(Owen et al., 2000; Ramsay et al., 2004a), documentation of temporal changes to paste and glaze compositions (Owen, 2003; this study), the reconstruction and chronology of possible technology transfer routes between various English porcelain concerns (Owen and Hillis, 2003), and the identification of the sources and composition of raw materials (Freestone, 1996; Freestone et al., 2003; Ramsay et al., 2001). In this connection Owen and Hillis (2003) comment that,

Over the past decade, traditional studies of historically fine ceramics based on subjective “connoisseurship” have been supplemented and even supplanted by more objective research that uses analytical data to understand and interpret these wares.

Likewise Barker (1998) whilst making it clear, that it was not his intention to denigrate the role of connoisseurship in the study of early porcelains writes,

There has also been too much attention devoted to a study of styles of moulding and decoration of early British porcelains. Styles can never be more than a guide to contemporary trends in production, and cannot in themselves be a reliable guide to attribution without other forms of supporting

evidence, and consequently stylistic links between vessels often only serve to confuse.

One of the major challenges for future research into English ceramics will be the need to integrate in a multidisciplinary manner the ever-increasing amount of scientific data (archaeological, chemical, mineralogical) with the considerable body of existing information derived largely through more traditional studies. In the case of the highly important 'A'-marked group of porcelains, a broad reliance over the last 60 years on paste, glaze, shape, and decoration alone for an attribution, in part explains why a variety of obscure, if not fictitious concerns among other manufactories, have been proposed as possible sources for this seminal porcelain group.

In addition to the growing importance of compositional studies to English ceramics, there has been an increasing recognition of the significance of rigorous archaeological investigations of former factory sites (Tyler et al., 2000) and consequently there has been an emerging emphasis on stratigraphical relationships and on detailed site recordings, cross sections, and maps. Significant information can be gained where undisturbed stratigraphical relationships have been preserved, such as the recovery of sherds from the lowest level of a waster pile at the Warmstry House site, Worcester (Owen, 1998). Elsewhere, sherds recovered from excavations often lack or are poorly constrained by any stratigraphical context and consequently chronological development of the ceramic wares can only be guessed. Examples include the 1760s – 1790s biscuit porcelain and creamware wasters from Isleworth at the Hanworth Road site (Massey et al., 2003), wasters from Limehouse (Drakard, 1993; Barker, 1998), and material recovered from William Reid & Co. (Hillis, 2002).

Studies of body and glaze compositions have to date been carried out on various English porcelain factories using waster material and ceramic sherds. However no comprehensive chemical study has been undertaken on the entire known output from the Bow manufactory, dating from its earliest deduced commercial production *c.* 1743 (Daniels, 2003, 2007; Ramsay et al., 2004a) through to closure around 1774. Spero (2003: 350) states,

In assessing the chronology of factories such as Chelsea, Bow, Derby and especially Longton Hall, changes in paste and glaze are of vital assistance, corresponding to constant alterations in the porcelain recipes.

Unfortunately in many instances, visual estimates of paste and glaze constitute an imperfect sur-

rogate for porcelain recipes in that temperature variations and vagaries in oxygen fugacity within one kiln firing, together with minor variations in the level of colorant oxides found in the raw materials used, can result in considerable visual inhomogeneity within a single kiln-batch, yet still having the same paste and glaze compositions. It is this reliance on the physical and visual appearance of both body and glaze coupled with typological studies, which has both forged previous studies of English porcelains and at other times hindered the progress in our current understanding. Such an approach has formed the basis of ceramic scholarship during the 19<sup>th</sup> and 20<sup>th</sup> centuries but we question whether such an approach on its own can sustain such studies through the 21<sup>st</sup> century. The Bow manufactory serves as a good example of a concern which, based on paste, glaze, potting, and decoration alone, produced what appears to be a variety of apparently contrasting wares and for which separate factories or potworks have been proposed, with the most obvious being the dichotomy between Bow first and second patent wares. A further example, discussed in this paper, relates to the perceived discordance in potting and decorative styles found in some of the early Bow second patent wares (Spero, 1989, 2001, 2005). Adams and Redstone (1981: 238) may have been the first to propose with respect to the Bow manufactory,

.....the need for analyses of a large number of specimens which can be dated with reasonable accuracy.

With this in mind, coupled by the urgings of Pat Daniels dating to the early 1990s, the authors have undertaken a chemical survey of some 50 Bow porcelain items. This survey of paste types used has been anchored in part on the ability to re-analyse those items reported by Eccles and Rackham (1922) and Tite and Bimson (1991), thus giving confidence in the reproducibility of analytical results. In addition, a chronological compositional stratigraphy has been developed through the Bow output by the use of documentary porcelain items. Permission was obtained from the British Museum to analyse four dated pieces in its collections. These items are the Target bowl – 1754 (B22<sup>1</sup>), the Bowcock bowl – 1759 (B25), the "Success to Trade" bowl – 1762 (B23), and the Tidswell mug – 1772 (B24). Adams and Redstone (1981: 158) note that the use of dated

<sup>1</sup> Items prefixed with the letter 'B' such as B22 have been chemically sampled and details are given in Appendix 2.

pieces in applying a time scale to a factory output is the traditional method. However they caution that in some instances there may be a hiatus in dated specimens, thus hindering this approach. In the case of Bow porcelain, this point is particularly applicable to the output prior to 1750. Secondly Adams and Redstone note that dated pieces may not be typical of the general output for that period. Should archaeological excavations be carried out on the Bow factory site in the future, evidence for further experimental, or even limited commercial paste types employed during the early years of the manufactory, other than those described here, may be uncovered.

#### CLASSIFICATION OF EARLY ENGLISH PORCELAIN

A further example of the divergence that now exists with regard to the study of English porcelains relates to the classification of these porcelain wares themselves. Based on early chemical analyses, Eccles and Rackham (1922) recognised five main types of early English porcelain body. The first group comprises the hard-paste, or so-called “true” kaolinitic porcelain, whereas the soft-paste porcelains are subdivided into (1) glassy porcelain, (2) bone or bone ash porcelain, (3) soapstone or steatitic porcelain, and (4) hybrid or modern bone porcelain (bone china). More recently Tite and Bimson (1991) recognise glassy porcelains (Chelsea to 1758, Derby to c. 1764, and Longton Hall to 1760), soapstone porcelains such as Worcester, bone ash porcelains such as Lowestoft and Bow, and hard-paste porcelains as found at Plymouth and Bristol. A further paste type, termed the clay-rich porcelain group, was subsequently reported with research into Limehouse, Pomona, and the ‘A’-marked group (Freestone 1999a,b; Ramsay et al., 2003). Subsequently Owen (in press) has argued that modern analytical research has recognised a number of compositional intermediaries or hybrids as well as different categories of wares that become recalcitrant when attempts are made to assign them to this traditional classification. Moreover he states that porcelain bodies referred to as glassy or soapstone should be classified according to composition and not according to inferred paste ingredients. An example, which supports Owen’s contention, may be found with the ‘A’-marked group of porcelains. Although classified as belonging to the clay-rich porcelain group (Freestone, 1999a,b; Ram-

say et al., 2003) both the deduced paste recipe as calculated from chemical analyses of the body (Ramsay et al., 2003) and an electron microscope study of the body of an ‘A’-marked cup (Freestone, 1996) demonstrate that the ‘A’-marked group can equally be regarded as ‘glassy’ both on the basis of the calculated ingredients (up to 50 wt% glass frit) and the observed fired body composition. Modally, the glass component of analogue 1744 patent wares, inferred to represent ‘A’-marked wares, approximates some 70 volume% of the body (Ramsay et al., 2004a). The problem here is that the use of the term glass or glass frit immediately begs comparison with the low-firing French frit porcelains, what Solon (1903) describes as,

It was, in all probability, the same sort of soft porcelain that the makers of Saint-Cloud, Lille, and Chantilly had, long before, vulgarized in France, and the secret of which, having crossed the channel, was chiefly instrumental in the establishment of several English factories.

Owen (in press) notes that three petrological methods present themselves as an approach to the classification of soft-paste porcelains, namely a mineralogically-based scheme, a normative-based classification analogous to the CIPW normative classification of igneous rocks (Cross et al., 1902), and a classification based on elemental compositional data derived from chemical analysis. Owen argues that the elemental system  $\text{SiO}_2\text{-Al}_2\text{O}_3\text{-MgO-CaO-PbO-P}_2\text{O}_5$  adequately encompasses most soft-paste porcelains and consequently a graphical classification can be based on planes located within or on the sides of a 3-dimensional figure (octahedron) using the above six components (Fig. 1).

Such a scheme in our opinion is better than a normative classification as we would question Owen’s comparison between porcelains and volcanic rocks. In the case of volcanic lavas the bulk of the rock, with the exception of any entrained xenoliths and possible cognate inclusions, has undergone extensive if not total melting. With soft-paste porcelain bodies the melt phase or degree of vitrification is generally minor and such porcelains are more akin to migmatites, which have undergone but partial anatexis or melting of the low-temperature components. We agree with Owen that a classification scheme based on compositional data offers a more rational and objective method for describing and classifying the bodies of English soft-paste porcelains. However we note that such a scheme is unlikely to be adopted by the majority of curators and

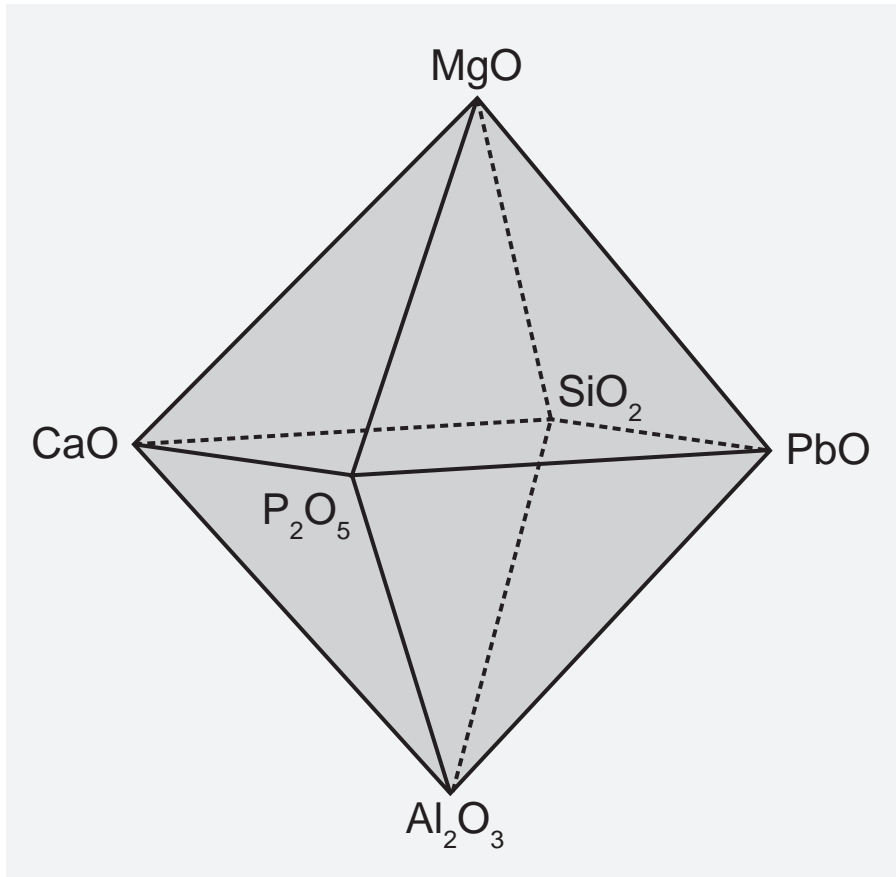


Fig. 1. Six-component octahedron after Owen (in press). Various combinations of these components can resolve the composition of most soft- and hard-paste porcelains. Owen notes that the alkalis ( $\text{Na}_2\text{O}$  and  $\text{K}_2\text{O}$ ) may in many instances comprise a small component of most porcelains but can be disregarded for classification purposes. Bow first patent porcelains ('A'-marked group), which are hard-paste, will plot within the external face  $\text{SiO}_2 - \text{Al}_2\text{O}_3 - \text{CaO}$ , whilst Bow second patent porcelains (bone ash porcelains) plot within the body of the compositional octahedron. Bow magnesian compositions are dominated by  $\text{MgO-SiO}_2\text{-Al}_2\text{O}_3$ , +/-  $\text{PbO}$  +/-  $\text{S}$ .

collectors working in the decorative arts and museums where the traditional classifications, such as used by Eccles and Rackham (1922), have been employed extensively for many decades. Moreover subtle compositional differences, which will result in very different classification names, will only be substantiated with detailed analytical techniques, a recourse beyond most museums and collectors.

Using the Owen compositional classification, the 'A'-marked, or Bow first patent wares, dominated by the elemental oxides  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{CaO}$  and with negligible or non-existent  $\text{PbO}$  and  $\text{P}_2\text{O}_5$ , would plot within the face defined by  $\text{SiO}_2\text{-Al}_2\text{O}_3\text{-CaO}$  (S-A-C). However, Bow first patent wares, or their analogues, comprise hard-paste bodies (Tiffin, 1874;

Binns, 1898; Ramsay et al., 2004a; Ramsay and Ramsay, 2005a, b, 2006). Based on the amount of glass specified in the 1744 patent one might expect the resultant body to reflect a soft-paste frit porcelain after the manner of the French soft-paste porcelains (Solon, 1903; Burton, 1906). Both Binns (1898) and Ramsay et al. (2004a) have noted that it is the presence and the amount of refractory China clay and not the glassy frit which defines whether the resultant body is soft-paste or a high-firing, hard-paste porcelain as observed in Bow first patent porcelain. Compositionally Bow second patent, soft-paste, phosphatic wares plot according to Owen's classification in the system  $\text{P}_2\text{O}_5 - 10\text{xSO}_4 - 10\text{xPbO}$  having  $>5$  wt%  $\text{P}_2\text{O}_5$ . Furthermore, such

phosphatic wares plot in the phosphatic, plumbic phosphatic, sulphurous phosphatic, and the P-S-Pb fields of Owen (in press). In the case of magnesian compositions produced by Bow, a variety of recipe types have been provisionally recognised dominated by  $\text{MgO-SiO}_2\text{-Al}_2\text{O}_3$ , +/-  $\text{PbO}$  +/- S.

#### THE BOW PORCELAIN MANUFACTORY

By 1750 in East London a porcelain manufactory known widely as “New Canton” or more simply as “Bow” was operating and this concern had by 1755 a turn-over in china sold to the value of £18,115 8s 9d (Adams and Redstone, 1981: 55). The proprietors listed on the first extant insurance policy for the Bow China Manufactory with the Sun Assurance Company and dated July 7<sup>th</sup>, 1749 were Thomas Frye, a portrait painter and mezzotint artist, Edward Heylyn, a member of the Saddlers’ Company and an active merchant with the New World, and John Weatherby and John Crowther – both glass sellers with a wholesale pottery business at St Catherine’s-by-the-Tower. A fifth member of the group has generally been assumed to be Alderman George Arnold, a wealthy linen-draper, alderman of the City of London, and an apparent land speculator in the Carolinas. The first documentary evidence that at least two of these proprietors were interested in the manufacture of porcelain relates to the so-called 1744 patent of Heylyn and Frye, which was filed in December 1744 and entered or “inrolled” in April of the following year. This patent specifies the use of white clay known as *uneka*<sup>2</sup>, the produce of the Cherokee nation in America, and a glass, assumed to represent a lime-alkali glass, used in various proportions for both the porcelain body and the glaze. These detailed specifications have for various reasons over the last 100 years been both marginalised and underestimated by numerous workers and Ramsay et al. (2006) review the various reasons as to why these misconceptions and confusion have arisen. The conclusion arrived at by Ramsay et al. (2004a; 2006) is that the 1744 patent of Heylyn and Frye is a landmark document in the history of Anglo-American ceramics which has been largely disregarded and misunderstood by numerous ceramic historians. Moreover they contend that the 1744 patent was not unworkable (Watney, 1963,

1973) and that arguably the most significant Anglo-American porcelains of the 18<sup>th</sup> century are the products of this patent. It is because of this reluctance for over a century to recognise and accept the veracity of the Heylyn and Frye patent that there have been such difficulties in recognising and accepting the brilliant products of this patent. The site of manufacture of these Bow first patent wares is uncertain but is likely to be in the vicinity of Bow village, located on or close to the Middlesex-Essex boundary.

Subsequently Thomas Frye filed a second patent in 1749 known variously as the Bow second patent, the 1749 patent or the 1749 patent of Thomas Frye. This patent stipulates the use of crushed silica, pipe clay, and a substance referred to as ‘virgin earth’. It is widely regarded that it is this recipe or paste specification, which sustained the factory through to closure in 1774. Numerous detailed accounts and/or exhibitions of the Bow factory and its output have appeared commencing with Hurlbutt (1926), followed by Tait (1959), and then more recently by Redstone and Adams (1981), Gabszewicz and Freeman (1982), Bradshaw (1992), Gabszewicz (2000a), and Begg and Taylor (2000). Current research (Ramsay and Ramsay, 2005a; Daniels, 2007) now recognises that the Bow proprietors were experimenting with and producing a third commercial recipe type resulting in magnesian-rich (steatitic) porcelains. The date range for these wares is uncertain but is tentatively suggested to range from the early to the mid 1740s.

#### ARCHAEOLOGICAL BACKGROUND

Archaeological evidence from the Bow factory site has particular significance to the evolution of the early English porcelain industry and summaries of the available archaeological data are provided by Redstone (2004, 2005). The recovery of archaeological material from the Bow site in Stratford High Street, Essex, commenced when wasters were found during trenching adjacent to Bell and Black’s Match Company in Hunts Lane, south of Stratford High Street, by a John Higgins Jr. and his sister in 1867 (Chaffers, 1869; Hobson, 1905: 7; Hurlbutt, 1926: 145). This site may have been adjacent to, or near, one or more of the kilns judging by the quantities of bricks cemented together with vitrified inner surfaces. However this is still conjecture as none of this material was recovered in place (Redstone, 2004). The next reported discovery was made in 1921 by

<sup>2</sup> In this contribution, unless employing a direct quote, the Cherokee spelling *uneka* rather than the Anglicised version *unaker* is used.

Aubrey Toppin (Toppin, 1922) during foundation excavations at Messrs. Wilmer and Sons' iron foundry near the corner of Marshgate Lane on the north side of Stratford High Street. Whilst a large variety of artefacts were recovered, the stratigraphical context was not recorded. In 1936 a further small cache of unglazed and decorated wasters was recovered from Messrs. Wilmer and Sons' iron foundry (Ramsay et al., in prep. b) whilst in 1969 excavations were undertaken (Redstone, 1969, 2004, 2005) located again on the north side of Stratford High Street. The first of six exploratory trenches was dug adjacent to Stratford High Street along the southwest corner of the property 32–66 Stratford High Street, currently occupied by the Barrett Group. The next trench was dug further back to the northwest on the site a little closer to Bow Back River (site D; Redstone, 1969). Redstone records that at a depth of 5 feet (1.52m) a distinct layer of Bow biscuit wasters was found. This layer was above a hard compacted layer of pebbles and flints strewn with broken saggars, kiln pegs, partly burned coal, and unfired clay, which Redstone deduced represented the old back-yard surface of a factory. A wide range of useful wares in the biscuit was recovered with relatively few coloured wares.

A further archaeological excavation was commissioned by The Dane Group and undertaken at their factory at 14–18 Stratford High Street, by the Newham Museum Service (Telfer, 1995). This excavation was necessary for planning permission to construct a lift shaft (Planning Application No. 94/0657/Plan-Condition No. 3, Newham Council). Telfer (1995) reports,

The structures and deposits revealed by the excavation at the Dane Group Factory suggest a continuous industrial occupation of the site over a period of at least two hundred years. The earliest of these was a red brick wall, dating from the 18<sup>th</sup> century and present at a depth of 1.15m below the current floor surface. It was identified as a southern exterior wall and is likely to have been related to the Bow Porcelain Factory.

Telfer (1995) also reports that the Phase V layer, uncovered within the trench (1.6m by 1.4m), was probably a re-deposited layer, in which was found a significant proportion of bottle glass and the presence of kaolin clay.

These collective studies have confirmed that the site of the Bow manufactory probably was located within 14–66 Stratford High Street. Toppin (1922) suggests that the factory occupied both sides of Stratford High Street with the northern site occupied

first. Apparently someone called Bisouth (Toppin, 1922) occupied the opposite site on the south side in 1747. The general absence of any reported ceramic stratigraphy has meant that our current understanding of the chronological evolution of the Bow ceramic output, has relied on:

1. dated and documentary wares (Tait, 1959);
2. comparison of wares with contemporary documents such as the Bowcock papers held by the British Museum (Chaffers 1869; British Museum Additional MSS 45905);
3. visual comparison of paste types, translucency and decoration (Hurlbutt, 1926; Adams and Redstone, 1981; Gabszewicz and Freeman, 1982; Gabszewicz, 2000a; Begg and Taylor, 2000); and
4. stylistic comparison of shapes, palette, and decoration with wares produced in other contemporary ceramic concerns (Tait, 1959; Adams and Redstone, 1981).

On going to press it has been reported that the Museum of London Archaeological Service (MoLAS) has completed an excavation on the Dane Group site in Stratford High Street. The excavation has uncovered open yards and ancillary services with large quantities of broken ceramics and kiln furniture apparently dumped at the end of the factory's life.

#### WHEN DID THE BOW MANUFACTORY COMMENCE?

Early writers have reported that initial experiments may have been undertaken as far back as the 1730s (Chaffers, 1863; Solon, 1903), possibly associated with a glasshouse owned by Heylyn (Burton, 1921). Daniels (2003, written com., 2006) has suggested that the initial experimental kiln or furnace (factory 1) might have been in Middlesex, whilst the next site (factory 2), where large quantities of wares were made as mentioned in Defoe (1748), might have been on the opposite side of the road in the Manor of Stepney, Middlesex. Here Heylyn and Arnold are recorded as having bought land in 1744 (Gabszewicz, 2000a). In contrast, Ramsay et al., (in prep.) deduce that although initial experiments may have been undertaken on a property owned by Edward Heylyn, possibly in Middlesex, the Essex site across the river Lea, later to be enlarged as New Canton, was occupied from an early date.

More recent writers have tended to discount a 1730s inception for the Bow concern, preferring a

founding date from the middle to the late 1740s (Tait, 1965; Watney, 1963, 1973; Adams and Redstone, 1981; Gabszewicz, 2000a, b). This uncertainty has been fuelled in part by doubts associated with the perceived efficacy and veracity of the 1744 patent and the apparent absence of any documentary Bow porcelain dated prior to 1750 as observed by Adams and Redstone (1981) who comment that,

the reluctance of many earlier writers to attribute any Bow porcelain to the period 1748–1750 is understandable in view of the uncertainties about the factory's commencement and the lack of pieces dated prior to 1750.

While documentary porcelain from the factory relating to before 1750 may be lacking, there are various documents and accounts, which attest to the presence of the concern referred to as Bow or New Canton during the late 1740s and very early 1750s. Firstly the Pelham Papers, where it is recorded that in February 1748<sup>3</sup> the Duchess 'Pd. For China made at Bowe £3.0.0' (Gabszewicz, 2000a: 13). Secondly the published advertisement in the 'Daily Advertiser' on 26<sup>th</sup> August, 1748 headed *Bow China* (Valpy, 1983). Thirdly the Marquess of Bute's invoice dated 2<sup>nd</sup> November, 1749 and stating '*Bo of the Porcelain Comp<sup>y</sup>. At New Canton*' (Horn, 1990). In addition there is the General Clayton invoice from John Taylor of Pall Mall for a *Bow ware sugar dish... 4s. 0d.*, sold on 21 February, 1749 (Adams and Redstone, 1981: 85), the insurance policy with the Sun Assurance Company dated 7<sup>th</sup> July, 1749 and taken out in the names of Heylyn, Frye, Weatherby, and Crowther (Adams, 1973), and the reference for a large manufactory lately set up in the village of Bow, in the 4<sup>th</sup> Edition of Daniel Defoe's *Tour of Great Britain*. This volume is thought to have been published around June 1748 (Tait, 1963) or July 1748 (Tait, 1965) although the information for this publication may have been collected by January–February, 1748 or at the earliest December 1747 (Tait, 1963) or by April, 1747 (Daniels, 2003, 2007). Lastly the two letters by Alexander Lind to Lord Milton, both of which mention Bow and are dated 10<sup>th</sup> April and 26<sup>th</sup> August, 1749 (Charleston and Mallet, 1971: 113–115). At the time of going to press new correspondence was announced at the December 2006 meeting of the English Ceramic Circle in London (Bridge and Thornton, 2006). This letter by William Tomlinson Jun. dated 14<sup>th</sup> De-

ember, 1744 mentions a ceramic patent being granted and the Duke (of Bedford) having seen the earth from the Carolinas that they make it of.

Possibly the most intriguing reference to Bow is to be found in a transcript of a partial letter by John Campbell, which is assumed to have been addressed to Arthur Dobbs of Carrickfergus, Ireland and housed in the Public Records Office, Belfast. In this correspondence Campbell mentions his visit to Bow, the presence of white clay, and his less than favourable impression as to the viability of the concern. Whilst both ball clays and fire clays have at times been described as white, we suggest that Campbell was referring to white Cherokee clay or *uneka*, whose whiteness is referred to in the 1744 patent (*... is extremely white, tenacious, and glittering with mica*) and supported by visual inspection (Ramsay et al., 2004a). We suspect that the reason that Campbell was allowed to visit the concern, known for its tight security, was because he was from North Carolina and the proprietors were hoping that he might have knowledge of other sources of this hard to obtain Cherokee clay. Campbell, himself both a trader and a land speculator, would almost certainly have been known to George Arnold, who appears to have been speculating in land in North Carolina since 1736 (Cain, 1988), and to Edward Heylyn, who had various ships trading with the east coast of North America at that time (Daniels, 2007). Moreover being an Ulster Scot, there are grounds for suspecting that Campbell may have been known to, or related to Archibald Campbell, Duke of Argyll. Toppin appears to have been the first to draw attention to this fragmentary correspondence in his address to the English Ceramic Circle on May 9<sup>th</sup>, 1959, although we have so far been unable to locate a transcript of what was said. Tait (1959) referred to the Toppin discovery and he dated the Campbell letter as having been written on 24<sup>th</sup> June, 1749. In his subsequent publication Tait (1965) states correctly that the letter is in fact undated. Watney (1973: 9) claims without any apparent substantiation that this letter was written by a John Campbell L.L.D. on about 24<sup>th</sup> June, 1749. Moreover Watney asserts that this author was,

.....a prolific writer and authority on industry and trade and on the European settlements in America.

Hood (1968) correctly identifies John Campbell as the owner of the 'Lazy Hill' plantation on the Chowan River, North Carolina. Based on current unpublished research we agree with Pat Daniels (written com., 2002; 2007), who was the first to recognise

<sup>3</sup> Gabszewicz gives the year 1748 which we suspect is in the Julian mode. If corrected to the Gregorian mode the year becomes 1749.

the potential significance of this primary source document based on Campbell's eyewitness account, that the letter may have been written considerably earlier than 1749, possibly as early as April or May, 1745. We agree with Daniels (2007) that if the letter was written around April 1745 then Campbell's on-site visit was of a still earlier date, possibly during an experimental phase at Bow. Research into this essentially overlooked document and the most likely date Campbell visited the Bow factory is nearing completion. We suggest that John Campbell's letter represents potentially the earliest eyewitness account of any English porcelain concern, yet the significance of this document has been largely ignored.

With the foregoing we accept the use of the term Bow first patent on the basis that the 1744 patent describes the manufacture of porcelain during the early to mid 1740s, presumably in the vicinity of Bow based on the domicile of the two patentees at that time and the inferences based on continuing research into the Campbell letter. We agree with Daniels (2003, 2007) that the earliest commercial Bow first patent wares probably date to 1743 if not earlier, which in turn raises the question as to how long was the preceding experimental phase leading up to this production date? For an important account of this early experimental period stretching back to 1730 and the hitherto largely unrecognised role of The Royal Society of London reference is made to Daniels (2007).

#### OVERLAPPING, SEQUENTIAL, OR PARALLEL DEVELOPMENT

This account is based for simplicity on a sequential development of the Bow first patent of 1744 with its China clay formula, followed by the bone ash/ball clay body of the Bow second patent of 1749. However it should be noted that several authors have, to varying degrees, implied or proposed parallel or overlapping development of both paste types. Tait (1965: 42) appears to have been the first to propose overlapping development though it is questionable whether he ever accepted the production of Bow first patent wares, other than possibly in a non-commercial form,

.....the basic idea of using bone-ash in porcelain manufacture was first put into effect by Thomas Frye at Bow between 1744 and 1747.

However Tait provides no justification for this assertion. Subsequently Daniels (2003, 2007) has suggested overlapping development of the two paste

types. Even allowing for overlapping development, Errol Manners (written com., December 2003) suggests that based on the apparent dichotomy of forms between the two patent types, there may have been a break in production between first patent wares ('A'-marked wares) and second patent bone ash wares. If this suggestion has merit then one might suspect such a production break somewhere in the period from late 1745 to mid 1746. For simplicity this model has been adopted in this account, thus dating the earliest Bow second patent phosphatic wares of the *Developmental period* from 1746. This date may possibly be a little too late, if one accepts parallel or overlapping development of the two paste types as proposed by Daniels (2007). We also note below the likelihood of an as yet unrecognised earlier experimental phase (*Experimental period*) associated with the second patent wares and this would suggest a date prior to 1746. To complicate matters even further it is now recognised that Bow was experimenting with and producing at least one other porcelain type, namely commercial high-magnesian porcelains which date to the mid 1740s (Ramsay and Ramsay, 2005a; Daniels, 2007) as discussed below.

#### PREVIOUS CLASSIFICATIONS OF BOW PORCELAIN

A major problem to date in recognising and classifying the entire Bow porcelain output has been the uncertainty as to the identity of first patent wares. Two major exhibitions (Tait, 1959; Begg and Taylor, 2000) have both claimed to survey the Bow factory output commencing from the first patent of 1744, yet in each case wares pertaining to the second patent of 1749 only, were exhibited. Tait (1959) gives a detailed discussion of the historical situation as then known, leading up to the inception of the Bow manufactory and he speculates on the possible use of Cherokee clay or *unaker* imported from the Carolinas. Begg and Taylor (2000: 18) note that,

Porcelain which fits the first patent has not been identified, but contemporary accounts indicate that actual production had commenced by 1747, if not before.

In the same exhibition Gabszewicz (2000c: 13) raises the question whether representatives of the so-called 'drab group' could represent,

.....the results of Frye's early experiments on the Middlesex side of Bow Bridge, at a site yet unknown and awaiting discovery?



We contend that any attempted classification and discussion of the Bow porcelain output must integrate all known paste types produced at Bow (magnesian, hard-paste Si-Al-Ca, phosphatic) and not merely concentrate on those phosphatic wares of the Bow second patent of 1749 alone. It is only through the recognition of the importance of composition in discussing early English porcelains that a better appreciation of the Bow manufactory and its output can be realised.

The first serious attempt to classify Bow second patent phosphatic porcelain appears to rest with Hobson (1905), who bases his subdivision on three documentary wares held by the British Museum, namely a polychrome MADE AT NEW CANTON inkwell and dated 1750, the Craft bowl dated 1760, and a plate inscribed, *Mr. Robert Crowther, Stockport Cheshire January 1770*. Hobson notes that the 1750 inkwell has a white, glassy, body with a rich and lustrous glaze of a creamy tint. It is heavy and thick in structure, thus inhibiting any translucency. The Craft bowl of 1760 is described as almost opaque, with a white, soft, and chalky body, whereas the glaze although slightly creamy lacks the mellow luster of the former example. Lastly the Crowther plate is practically opaque and might almost be mistaken for white earthenware of the 'ironstone china' type. Hobson also notes a high level of lead in Bow glazes.

Subsequently Burton (1906) bases his subdivision on three documentary groups or items, namely various inkwells dated 1750, the Craft bowl of 1760, and the Robert Crowther plate of 1770. Based on these items, Burton regards the inkwells as belonging to the earliest, pre-phosphatic phase, which he describes as,

These are nearly always thick in substance, and not very skillfully fashioned.....Where this early ware is thick it is quite opaque, but in thin parts it is translucent and has a beautiful, warm, creamy tone. The glaze on such pieces is sometimes gathered up in drops or patches, when it always has a distinct yellow tint, due to the high proportion of lead, and for some reason it has often become iridescent from surface decomposition. This is the ware which in all probability was introduced from France;.....

The second group related to the Craft bowl is described by Burton as,

.....but after a few years we find an entirely different ware being used, which is much whiter in tone, and this ware undoubtedly contained bone-

ash, probably added to make the earlier porcelain mixture more stable in firing.

Finally the last grouping is referred to as,

The third type of Bow ware, which was mostly made during the decadence of the factory, is of poorer quality, rather harshly white and not very transparent. It would be unwise to attempt to fix definite dates for these changes of composition in the body and glaze.....

Burton does attempt to recognise and integrate a discussion of Bow first patent wares with the above classification, but unfortunately these attempts (Burton, 1902, 1906, 1921) prove to be confusing as discussed in some detail by Ramsay et al. (2006).

Hurlbutt (1926: 35) appears to have been one of the few ceramic researchers of early English porcelain to attempt a classification of the Bow porcelain output, which integrates both first and second patent wares in a more coherent manner, based on correct versions of the two patents and not the inadequate Chaffers' first patent version as initially published in 1863. This misleading version of the first patent given by Chaffers still circulates the literature today and is repeatedly quoted despite expressed concerns by Jewitt (1878). While Hurlbutt failed to recognise the 'A'-marked group as the products of the first patent, he nevertheless argued that any surviving first patent wares would be a glassy porcelain comprising a glassy frit mixed with China clay imported from America. Hurlbutt recognised four main periods (Table 1). The first period was 1744–1749 when glassy first patent porcelains with modifications were produced. The second period of 1749 to about 1754 saw phosphatic frit porcelain made according to the Bow second patent. The third period of about 1754 to about 1758 or 1760 resulted in porcelain composed of phosphatic frit No. II mixed with a portion of ground-up Oriental porcelain wasters (Chinese and Japanese hard-paste porcelain) instead of pipe clay. The final period recognised by Hurlbutt runs from 1758 to the close of the factory in 1776 and during this phase he proposes that a modified and improved phosphatic body, more nearly approaching that of Chelsea, was employed. Hurlbutt argues that the resemblance to Chelsea became even greater after 1765, when, subsequent to Sprimont's second illness and the first attempt to sell the Chelsea factory, a large number of the Chelsea workmen found work at Bow and Worcester.

In the case of the various glazes used by Bow, Hurlbutt (1926: 36) records that the glaze on first patent wares used between 1744–1749, comprises

| Date | Hurlbutt 1926 |  | Tait 1959 |                        | Watney 1973    |                | Adams and Redstone 1981 |       |           | Bradshaw 1992 |         | Godden 2004a |                | Ramsay & Ramsay This paper |   |
|------|---------------|--|-----------|------------------------|----------------|----------------|-------------------------|-------|-----------|---------------|---------|--------------|----------------|----------------------------|---|
|      | All           | Possible experimental phase in Heylyn's glasshouse | All       | Not recognised         | Not recognised | Not recognised | Figures                 | B & W | Enamelled | Body          | Figures | B & W        | Not recognised | Not recognised             | This paper  |
| 1739 |               |  |           |                        |                |                |                         |       |           |               |         |              |                |                            | Experimental phase which possibly extended back to the late 1730s |
| 1741 |               |  |           |                        |                |                |                         |       |           |               |         |              |                |                            |   |
| 1743 |               |  |           |                        |                |                |                         |       |           |               |         |              |                |                            |   |
| 1745 |               | First patent 1744 - 1749                           |           | Porcellaneous material |                |                |                         |       |           |               |         |              |                |                            | First patent or 'A'-marked period ~1743 - ~1745                   |
| 1750 |               | Second patent 1748-1753                            |           | pre- 1750              |                |                |                         |       |           |               |         |              |                |                            | Developmental ~1746   |
| 1755 |               |  |           |                        |                |                |                         |       |           |               |         |              |                |                            | Early or New Canton period 1747 - 1753                            |
| 1760 |               |  |           |                        |                |                |                         |       |           |               |         |              |                |                            | Transitional period 1754  |
| 1765 |               |  |           |                        |                |                |                         |       |           |               |         |              |                |                            | Middle or Bowcock period 1755 - ~1769                             |
| 1770 |               |  |           |                        |                |                |                         |       |           |               |         |              |                |                            |   |
| 1776 |               |  |           |                        |                |                |                         |       |           |               |         |              |                |                            | Late or Tidswell period ~1770 - 1774                              |

B &amp; W Blue and white porcelain

Table 1. Classification of Bow hard-paste Si-Al-Ca and phosphatic bodies by various authors.

the same materials as found in the body but with a larger proportion of the fusible glassy frit, to ensure that the glaze would commence to fuse at a lower temperature than the body. This glazing procedure, in the manner of Meissen or the Chinese, was used by Heylyn and Frye as a crude but efficient optical pyrometer to indicate when the porcelain body was on the verge of becoming pyroplastic during kiln-firing (Ramsay et al., 2004a). Hurlbutt believes that the resultant glaze would contain an appreciable proportion of infusible China clay and consequently he speculates that the glaze would probably be not quite transparent and would be most likely of milky opacity. Hurlbutt notes that subsequently a lead glaze was employed from 1749–1776 and because of the excessive amount of lead in its composition the glaze required a considerable tinting of smalts (cobalt frit) to clear it. However he recorded that some pieces, such as part of the white-glazed sprigged ware and the red, green, blue, yellow, and gold Imari patterns, were not so tinted and are characterised by a rich, creamy body and glaze.

In 1927 Donald A. MacAlister published a chemical classification of English frit porcelains in *The Burlington Magazine*. In the case of Bow he recognises four groups, with three all dated to 1750. Two of the four groups lack the presence of lead, the first having just enough calcium to satisfy the amount of bone ash present, whilst the second having an excess and having an unknown date. The second two groups both dated to 1750 by MacAlister have detectible lead as PbO under 2 wt% with the first group having enough calcium to satisfy stoichiometrically the amount of bone ash present and the second group having an excess of calcium. MacAlister (1927) suggests that this excess calcium may have been added independently of that contained in the bone ash but fails to recognise the potential role that gypsum, as noted by Wedgwood, would have played in providing excess calcium to the porcelain body.

In more recent times the first comprehensive classification of Bow second patent porcelain is by Tait (1959). Tait groups the various exhibited items into four divisions (Table 1). The pre-1750 examples are characterised by a distinctive mushroom-grey or 'drab' appearance, whereas the divisional break at 1758–1759 apparently has more to do with the retirement of Thomas Frye rather than any obvious or recognisable change in porcelain composition, form, or decoration. Watney (1963, 1973) employs a three-fold classification for Bow underglaze blue wares

(Table 1) with a divisional break at 1763–1764, apparently reflecting the bankruptcy of John Crowther and again unrelated to any obvious change in the physical appearance or decoration of the porcelain of that period. Adams and Redstone (1981) subdivide the Bow second patent wares into various groupings (figures, enamelled, transfer printed, etc) and then further subdivide on a chronological basis (Table 1). In the case of enamelled wares, Adams and Redstone (1981:116) recognise earliest (pre-1750), middle (1750–1758), and later enamelled wares (1759–1776). For figures they use a twofold classification into Bow figures prior to the Meissen influence (1747–1752) and figures including animal models produced post-1752 through to 1775. They follow Watney (1972) in the subdivision of transfer printed wares and recognise five subdivisions, which extend from c.1754 into the 1760s.

In discussing underglaze blue wares Adams and Redstone note that it has been customary to divide the manufacture of this group into three periods, 1750–1754, 1755–1763, and 1764–1776, no doubt reflecting Watney's earlier classification. However in their subdivision of these wares they also use early, middle, and late but with a different date range from Watney. Their early period for underglaze blue wares ranges between 1747–1752, their middle period from 1753–c.1765, and their late period from apparently c.1765–1776. They note that the traditional approach in applying a time scale to a factory output is to use dated wares as a framework. However, as noted previously, they draw attention to various limitations to this approach.

Adams and Redstone (1981) also refer to an additional classification that chronologically encompasses all second patent Bow ceramics regardless of form or decoration. Because this classification is discussed on separate pages in their book (pages 98, 109, 110, 168, 169, 238) it has not perhaps received the full recognition it deserves, yet many collectors of Bow porcelain will recognise the simplicity and veracity of this classification, based on visual appreciation of the paste and indeed may have been using it themselves either consciously or unconsciously.

On page 109 Adams and Redstone write,

The body used for the early white wares is the dense, tough, often surprisingly translucent one common to the factory's products of the years 1748–54. Where variation occurs, it appears to be more in the firing than in the basic body composition. . . . . At some time during the mid-to-late fifties, the quality of the body deteriorates.

They continue on page 109 with regard to porcelains made after the mid to late fifties,

The most striking change is in the decreased translucency, which may be due to underfiring; but the possibility of some change of body composition cannot, on present evidence, be excluded.

On page 168 they note, the porcelain body at Bow deteriorates towards the middle fifties. It becomes more porous and less translucent and lighter in weight.

On page 169 Adams and Redstone state,

The quality of the body thenceforward is reasonably consistent until some time after 1770, when there is a further deterioration. The late Bow body has been and still is occasionally mistaken for pottery.

The advantage of this classification by Adams and Redstone is the attempt to categorize the entire second patent phosphatic output based on the visual appearance of the porcelain body irrespective of form, decoration, or historical events at the factory site, such as the retirement of Thomas Frye.

Tite and Bimson (1991) using the analytical results derived from four Bow items, recognise a compositional break in the mid 1750s based on the presence of sulphur assumed by them to represent the addition of gypsum. They however give no acknowledgement to the prior observations for this visual break in the quality of the porcelain made by previous workers such as Adams and Redstone. Bradshaw (1992) subdivides Bow figures into three periods namely *c.*1748–1753, *c.*1754–1764, and *c.*1765–1774. In the case of the Bow figures from the earliest period, Bradshaw observes that the models may be constructed either from a compact paste clad in a greyish glaze or may have a granular body that has a creamy appearance.

Godden (2004a) subdivides the Bow underglaze blue output into three groups (Table 1), *c.*1749 (or 1750) to 1754 (First period), *c.*1755 to 1763 (Middle Period), and *c.*1764 to 1770s (Later period); a classification which closely follows that proposed by Watney. The first period wares are described by Godden as tending to have a hardish, glassy-looking, dense body, which feels rather heavy. The glaze is described as having a lard-like appearance. In the post-1755 period the body of Bow underglaze blue wares becomes more open and floury, less dense, and apparently lighter in weight than earlier examples. The glaze tends to become slightly blued, especially where it has pooled around footrims. In the case of

the later period Bow, Godden notes that potting for both the middle and later periods tends to be rather thick and for porcelains of the early to mid 1770s, Godden quotes Watney stating that such wares are so under-fired as to resemble earthenware.

#### PROPOSED CLASSIFICATION OF BOW PORCELAIN

In developing this proposed integrated classification of the entire recognised Bow porcelain output, approximately 50 ceramic items of Bow porcelain, some documentary, from private and major public collections (Fig. 2) were subjected to micro-analytical techniques and from these analyses the theoretical recipe used in each case was calculated. Three published recipes pertaining to Bow paste compositions are also noted (the 1744 and 1749 Bow patents and the Josiah Wedgwood formulation of 1759) and all three are examined in the light of these analyses (Fig. 3). Based on the calculated paste compositions three major groups of Bow wares are recognised, namely a hard-paste Si-Al-Ca body with an associated Si-Al-Ca glaze (Bow first patent wares or 'A'-marked period *c.* 1743–1745), a soft-paste, bone ash body with a Si-Pb glaze (Bow second patent bone ash wares *c.* 1746–1774), and a magnesian (steatitic) body tentatively dated to the early to mid 1740s.

Of the Bow second patent wares five recipe classes are identified. These are the Bow second patent *Developmental period* (*c.*1746), the Bow second patent *Early or New Canton period* (*c.*1747–1753), the Bow second patent *Transitional or Target period* (1754), the Bow second patent *Middle or Bowcock period* (1755 – *c.*1769), and the Bow second patent *Late or Tidswell period* (*c.*1770–1774) as shown in Table 1. In addition a high-lead sub-group which straddles both the *Developmental period* and the *New Canton period* is defined by >1.25 wt% PbO. A sixth grouping (*Experimental period*) and extending back in time prior to 1746 is postulated although unequivocal examples of this period have as yet not been recognised. These various changes in recipe type are linked with visual attributes of the porcelain wares (body, glaze, and translucency) as initially proposed by Adams and Redstone (1981) and a comprehensive classification from the collector's and museum curator's viewpoint is presented.

During the analytical work associated with this research a third major body type, namely a high-

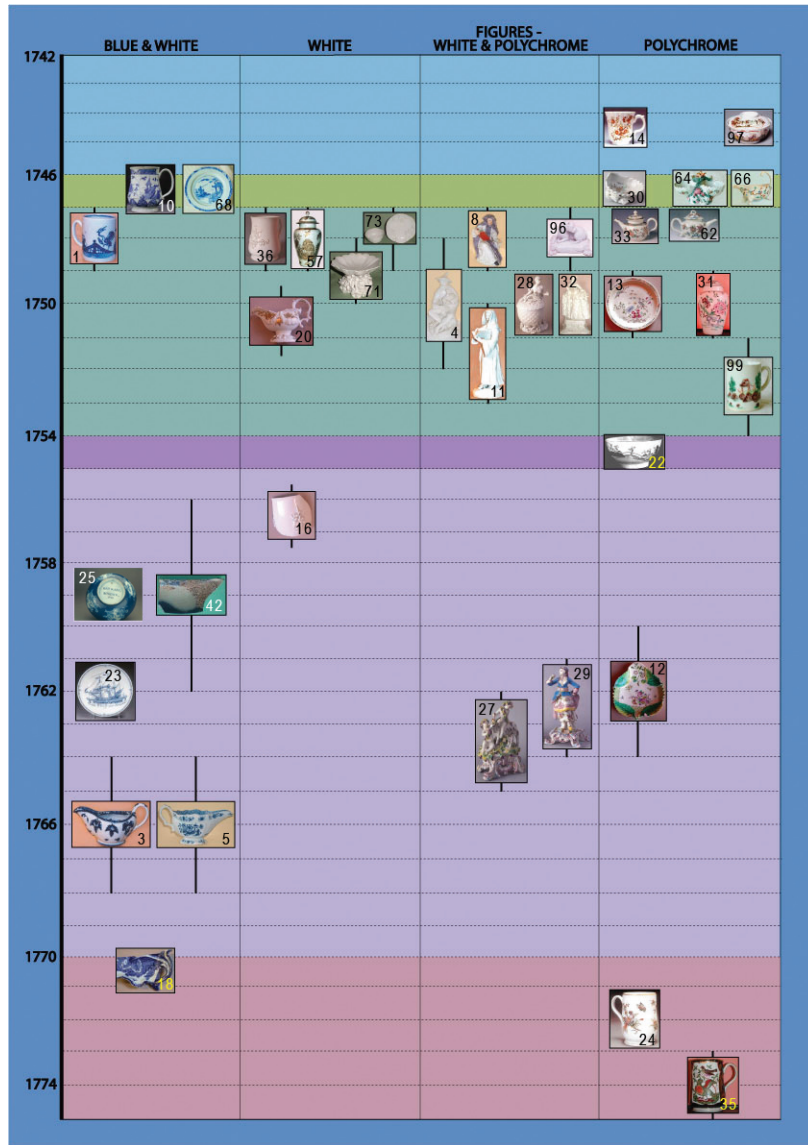


Fig. 2. Proposed chronological classification scheme for Bow first and second patent porcelains showing most of the items analysed and for which ceramic recipes have been calculated. In one or two instances lack of room has meant that some analysed items have not been depicted. Suggested time ranges for each item are shown as vertical black lines; dated, or documentary items, are shown without this time range. The number inserted with each item refers to the numerical list given in Appendix 2.

magnesium porcelain has been recognised (Ramsay and Ramsay, 2005a, Daniels, 2007). Research into this third major porcelain type, apparently pioneered by the Bow proprietors, is continuing and initial comments are given below. A fourth body type should also be borne in mind. Simeon Shaw (1837) recorded that the potters of both Chelsea and Bow

used well-washed (silica) sand from Alum Bay on the Isle of Wight, ground cullet, and pipe clay (ball clay). The fired body was then in turn covered with a lead glaze. Although little credence has been given this record we see no obvious reason why Shaw’s observation should be dismissed out of hand and Ramsay et al., (2006) note that such a recipe should

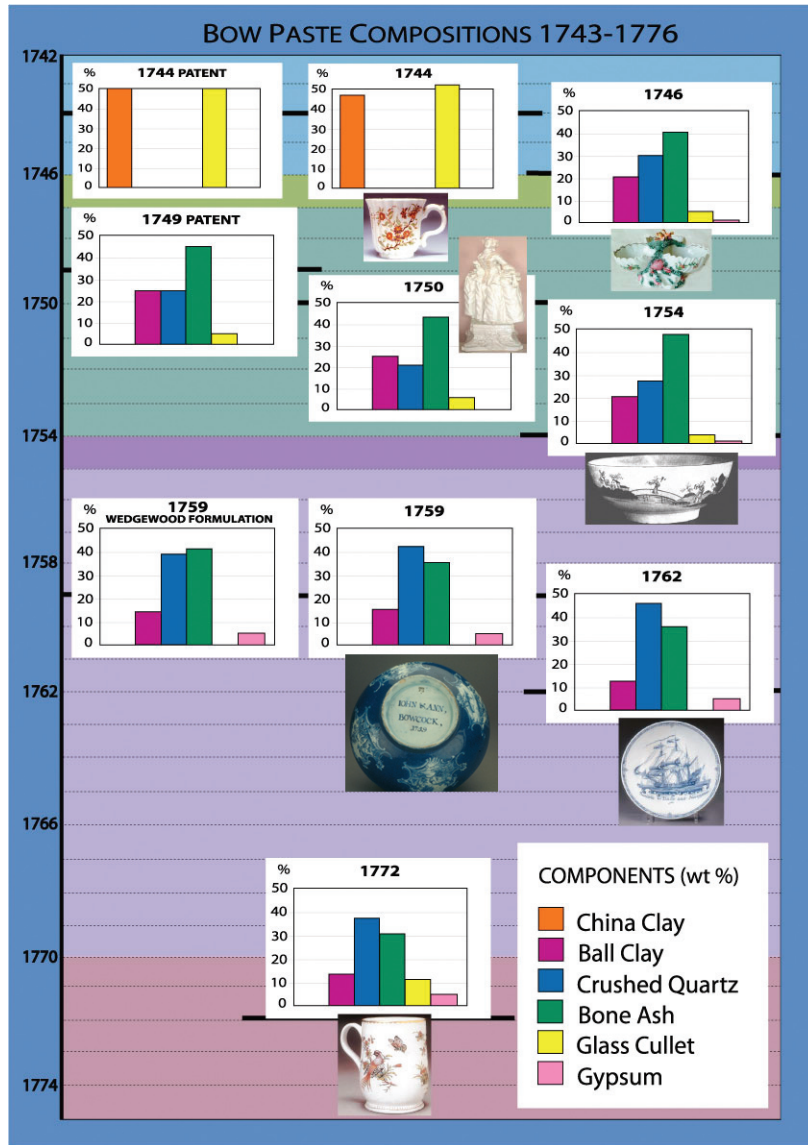


Fig. 3. Key calculated paste recipes used in this contribution. Down the left-hand side of the diagram are three reported recipe formulae (1744 and 1749 patents and the Wedgwood formulation of 1759). In the case of the 1749 patent specification the composition of *virgin earth* during the *New Canton period* is deduced as comprising 90% bone ash, 10% cullet. During the *Developmental period*, *virgin earth* is deduced to have contained, in addition, a small component of gypsum or possibly alum. The Wedgwood formulation of 1759 has been 'corrected' and its revised recipe is given as shown in Table 7. Documentary items for which recipes are calculated are the Target bowl (1754), the Bowcock bowl (1759), the 'Success to Trade' bowl (1762), and the Tidswell mug (1772). For the *New Canton period* (c.1747–1753) the figure of Kitty Clive in the white from a private collection has been used to represent this group and by analogy with a similar dated item in the Fitzwilliam Museum is assumed to approximate a date of 1750.

correspond to that found in Chelsea triangle period wares. It is not inconceivable that Bow did use such a recipe and if so, we suggest that there may be ex-

amples of these porcelain masquerading as early Chelsea, Longton Hall, or even Girl-in-a-Swing porcelain.

### Analytical method and comparison with previous analyses

The classification of Bow porcelain proposed in this paper is based on the analytical results obtained through the analysis of small amounts of ceramic powder obtained from a number of Bow porcelain items. This ceramic powder (and where required associated glaze material) was obtained by lightly abrading unglazed basal footrims or chipped surfaces of each porcelain item. Samples of abraded ceramic powder and glaze were mounted in PVC blocks and each block was then polished.

Presented in Table 2 are the comparative analytical results obtained from four Bow second patent porcelain items, by Eccles and Rackham (1922) using classical gravimetric methods and by Tite and Bimson (1991) and in this study using scanning electron microscope (SEM) techniques with an attached energy-dispersive X-ray spectrometer. In the case of the Tite and Bimson analyses, the results were obtained from solid fragments of porcelain, whereas the analytical results obtained in this study were from abraded powder. The four items analysed

were a white moulded pedestal sauceboat with gilding (B20), a portion of a white prunus coffee cup (B16), a portion of an underglaze blue leaf dish (B18), and a fragment of an underglaze blue bowl (B43). The first three items, from the collections of the Victoria and Albert Museum, have each been analysed by all three groups of workers, whereas the last (B43) held by the British Museum, was analysed by Tite and Bimson and for this study. In the case of this study it should be remembered that the SEM analyses carried out were on small amounts of powder and any inhomogeneity in the porcelain body or in the sample collection and preparation will be reflected in the final analysis. Where powdered material is used for SEM analysis the count rates are invariably lower than where solid ceramic material is used. Consequently detection levels in the former are poorer and precision may be lower.

With the white sauceboat there is reasonable agreement in most instances for the various elements between the various authors, however the amount of PbO reported by Eccles and Rackham (1.75 wt%) is probably in error as the other two analyses record levels of PbO below detection level. In the case of

|                                | A     |       |       | B     |      |       | C     |       |       | D     |       |
|--------------------------------|-------|-------|-------|-------|------|-------|-------|-------|-------|-------|-------|
|                                | 1     | 2     | 3     | 1     | 2    | 3     | 1     | 2     | 3     | 2     | 3     |
| SiO <sub>2</sub>               | 43.58 | 45.6  | 46.4  | 55.1  | 50.7 | 58.4  | 50.38 | 49.2  | 50.31 | 51.2  | 50.8  |
| TiO <sub>2</sub>               | nd    | 0.5   | 0.3   | nd    | 0.2  | 0.2   | nd    | 0.3   | 0.3   | 0.3   | 0.3   |
| Al <sub>2</sub> O <sub>3</sub> | 8.36  | 8.7   | 8.5   | 16.50 | 5.6  | 4.3   | 7.78  | 5.6   | 5.3   | 5.6   | 4.7   |
| FeO                            | nd    | 0.5   | 0.4   | trace | nd   | 0.2   | nd    | 0.3   | 0.3   | 0.3   | 0.3   |
| MgO                            | 0.6   | 0.6   | 0.4   | 0.40  | 0.4  | 0.4   | trace | 0.3   | 0.3   | 0.6   | 0.4   |
| CaO                            | 24.47 | 23.6  | 23.0  | 15.12 | 23.8 | 18.8  | 24.87 | 24.5  | 22.87 | 23.2  | 22.6  |
| Na <sub>2</sub> O              | 1.2   | 0.8   | 0.67  | 0.31  | 0.5  | 0.7   | 0.70  | 0.5   | 0.85  | 0.6   | 0.2   |
| K <sub>2</sub> O               | 0.85  | 1.1   | 0.95  | 0.70  | 0.7  | 0.5   | 0.53  | 0.6   | 0.55  | 0.6   | 0.7   |
| P <sub>2</sub> O <sub>5</sub>  | 18.95 | 18.6  | 19.4  | 11.50 | 15.8 | 14.9  | 13.66 | 16.2  | 16.28 | 15.3  | 17.9  |
| PbO                            | 1.75  | bdl   | bdl   | ?     | bdl  | bdl   | 1.49  | 0.4   | 0.2   | 0.4   | bdl   |
| SO <sub>2</sub>                | nd    | bdl   | bdl   | nd    | 2.0  | 1.6   | nd    | 2.1   | 2.75  | 1.9   | 2.1   |
| Total                          | 99.76 | 100.0 | 100.0 | 99.63 | 99.7 | 100.0 | 99.41 | 100.0 | 100.1 | 100.0 | 100.0 |

1. Eccles and Rackham, (1922)

2. Tite and Bimson, (1991)

3. this study

A. white moulded pedestal sauceboat with gilding (V&A: C.673-1920; B20)

B. portion of a white applied prunus coffee cup (V&A: C.590-1919; B16)

C. portion of an underglaze blue leaf dish (V&A: C16-1920; B18)

D. fragment of an underglaze blue bowl ~1756 (Brit. Museum Research Lab. 32703; B43)

bdl below detection level

nd not determined

? uncertain whether below detection level or not determined

V&A Victoria and Albert Museum

Table 2. Comparative analyses by Rackham and Eccles (1922), Tite and Bimson (1991), Ramsay and Ramsay (this study) of various Bow items.

Na<sub>2</sub>O value of 0.67 wt% recorded by us is probably a little too low. Dorset ball clays have around 0.4 wt % Na<sub>2</sub>O (Table 3) and this clay comprises approximately 25 wt% of the porcelain body associated with the *Developmental, New Canton, and Target periods* as shown in this study. On that basis there should be at least 0.1 wt % Na<sub>2</sub>O in the body of the porcelain. With the further addition of glass cullet, which comprises some 5 wt% of these bodies, a value of at least 0.8 wt% Na<sub>2</sub>O is more likely based on the assumption that many mid 18<sup>th</sup> century alkali glasses had Na<sub>2</sub>O levels in the vicinity of 2–4 wt% .

With the white prunus cup the problem of the determination of Al<sub>2</sub>O<sub>3</sub> gravimetrically is shown in the results obtained by Eccles and Rackham and their value of 16.5 wt% Al<sub>2</sub>O<sub>3</sub> is regarded as incorrect. Both Tite and Bimson and this study report values of 5.6 and 4.3 wt% Al<sub>2</sub>O<sub>3</sub> respectively. The values for SiO<sub>2</sub>, CaO, and P<sub>2</sub>O<sub>5</sub> are somewhat variable between all three analyses. In the case of the underglaze blue leaf dish, both Al<sub>2</sub>O<sub>3</sub> (7.78 wt%) and PbO (1.49 wt%) as determined by Eccles and Rackham are most likely too high, whereas CaO (22.87 wt%) obtained for this study is probably a shade too low. Both Tite and Bimson and this study broadly agree on the amount of sulphur expressed as SO<sub>2</sub> (2.1 and 2.75 wt%) present in the body. Finally in the case of the underglaze blue bowl, which was not analysed by Eccles and Rackham, there is broad agreement between Tite and Bimson's results and our analysis, with the exception of P<sub>2</sub>O<sub>5</sub>, thus giving the Tite and Bimson analysis a bulk CaO/P<sub>2</sub>O<sub>5</sub> (molecular proportions) 3.84 and our analysis 3.20. We question the value of 0.4 wt% PbO recorded by Tite and Bimson. Based on our work we conclude that lead was typically absent during the *Bowcock period* and we suggest that there was negligible lead in B43.

#### BOW FIRST PATENT PORCELAINS

The key document, which has led to the recognition of the identity of the Bow first patent porcelains, is the 1744 patent of Heylyn and Frye. Yet for over one hundred years this document has been marginalised, underestimated, and at times dismissed as not worth the paper it is written on (Burton, 1902), entered merely to make a porcellaneous material and not wares themselves (Tait, 1959), cautious (Tait, 1959), almost certainly unworkable (Watney, 1963, 1973), and experimental (Bradshaw, 1992). In a detailed discussion of this patent, Ramsay et al. (2006) sug-

gest that such claims and attitudes may be without foundation. They contend that a combination of circular arguments, an unfortunate abridgement of the patent's wording (Chaffers, 1863), an incorrect composition for the glass frit as used in the patent (Church, 1881, 1885) and utilised by Burton (1902) in his failed attempts to replicate Bow first patent porcelains, a quote from the patent taken out of context regarding the manufacture of a certain material whereby a ware might be made (Tait, 1959), and unsubstantiated claims by Watney (1963, 1973) possibly derived from Burton that the *uneka*-based formula was almost certainly unworkable, have all combined to diminish the significance of what Ramsay et al. (2004a, 2006) regard as a landmark document in the history of Anglo-American ceramic development.

The startling feature of the Bow first patent of 1744 is that it specifies a clay, or earth, the produce of the Cherokee nation and referred to by these people as *uneka*. Other contemporary documents can be inferred to support the patent in its claim that the source of the clay was located in the New World, on the reasonable assumption that these documents refer to the same ceramic concern. William Cookworthy in his letter to his friend Dr Hingston, both identifies the composition of the clay as China clay and its source as being 'on the back of Virginia'. Robert Dossie (1758) states that this kaolin was found 'on the back of Carolina'. This minor discrepancy in location of the clay or earth is discussed by Gilmer (1948), who notes that the location of the North Carolina-Virginia State border on the ground was uncertain in the 1740s. Furthermore the word *uneka* (spelt *unaker* in the patent and in most subsequent publications) is a Middle Cherokee word for white (DeVorse, 1971), thus suggesting an association with someone who had knowledge of the Cherokee people. Finally these two documents specify that an agent was, or had been sent to procure supplies of this clay, with Dossie recording that the factory concerned, which had an interest in this China clay, was located near London. This specified location near London with an interest in China clay eliminates virtually all known porcelain concerns of the day with the possible exception of Bow and the little understood concern at Greenwich.

Tait (1963: 200) correctly observes that the location of this clay was somewhere in the remote hinterland in the territory of the Cherokee Indians, though he fails to substantiate the basis for its discovery date by Andrew Duché as being 1739. However in the



same publication Tait confuses this location with a second locality, which he claims was on Dobbs' land near water in Edgecombe County, North Carolina. To confuse matters even further Tait (1963: 203) states that this clay from Edgecombe County became 'Duché's mines in America' and he further proposes with little supporting evidence that the clay was imported as ballast into Britain and used in second patent phosphatic wares. This confusion between China clay, pipe clay or ball clay, and the two Bow patents has occurred at numerous times (Tait, 1963; Fisher, 1965; Adeney, 2003). G. Stevenson (written com., October 2004) records,

It is my opinion that Campbell sent to his unknown correspondent a small box with a sample of white clayey marl. Campbell's brother-in-law, Alexander McCulloh of Elk Marsh, lived in the northern part of Edgecombe County (now Halifax County) where one finds clayey shell marls of the Miocene that show a range of calcium carbonate from 36% to 87%. He, Campbell, thought it resembled what he had seen at Bow and sent a sample to his correspondent for his opinion on the subject.

If Stevenson is correct with respect to the Edgecombe County location, then the chemical composition of this calcareous earth grading to a fossiliferous limestone containing between 36–87% CaCO<sub>3</sub>, would effectively deny that this material was ever used at Bow. Moreover mining records for this county in North Carolina fail to identify any mining and export of clay during this period. Freestone (1996) suggests that the most likely source of the *uneka* or China clay was to be found at Spruce Pine or in the Franklin region of far west North Carolina. Ramsay et al. (2001) explored the region north of Franklin, Macon County, NC and discuss in some detail the likely locality of this clay in the catchment of the Little Tennessee River. They identify the most likely mine site, they provide both a chemical analysis and the mineralogy (90% halloysite and 10% kaolinite) of a purified sample of this white clay (Table 3), and they further note that Watts (1913) may have been the first modern authority to link this locality with Bow.

The composition of the glass frit used in the patent has been subject to some debate. In 1885 Church published his book *English Porcelain* and in it, based

|                                | 1      | 2      | 3     | 4        | 5     |
|--------------------------------|--------|--------|-------|----------|-------|
| SiO <sub>2</sub>               | 44.8   | 52.0   | 54.0  | 54.4     | 62.69 |
| TiO <sub>2</sub>               | 0.010  | 0.95   | 1.30  | 1.3      | bdl   |
| Al <sub>2</sub> O <sub>3</sub> | 38.4   | 32.0   | 30.0  | 30.2     | 0.49  |
| FeO                            | 0.04   | 1.3    | 1.2   | 1.2      | 0.76  |
| MgO                            | 0.03   | 0.51   | 0.40  | 0.4      | 29.93 |
| CaO                            | 0.06   | 0.26   | 0.30  | 0.3      | 0.30  |
| K <sub>2</sub> O               | 0.33   | 3.1    | 2.9   | 2.9      | 0.02  |
| Na <sub>2</sub> O              | 0.06   | 0.46   | 0.35  | 0.35     | 0.03  |
| LOI                            | 16.25  | 9.5    | 8.9   | 9.0      | 5.48  |
| Total                          | 100.00 | 100.08 | 99.35 | 100.0(5) | 99.70 |

1. kaolinite clay (*uneka*), Iotla Mine, Macon County, NC (Ramsay et al., 2001: Table 1). This total includes P<sub>2</sub>O<sub>5</sub> 0.02 and MnO <0.01 wt%. Iron is reported as Fe<sub>2</sub>O<sub>3</sub>. A significant list of trace elements for this clay is given by Ramsay et al. (2001). The sample comprises halloysite ~90% and kaolinite ~10 wt% and it is proposed that this clay was used in Bow first patent wares
2. ball clay, Creekmore Sequence, Dorset. Mean analysis based on extensive sampling by Imerys Minerals (A. Deeming, written com., January 2003)
3. ball clay, Broadstone Sequence, Dorset. Mean analysis based on extensive sampling by Imerys Minerals (A. Deeming, written com., January 2003)
4. ball clay, Broadstone Sequence, Dorset. Analysis No. 3 normalised to 100 wt%
5. talc (Deer et al., 1992: Page 329, No. 3)

LOI loss on ignition  
 bdl below detection level

Table 3. Chemical analyses for various clays deduced to have been used at Bow.

on his 1880 cantor lecture (Church, 1881) states that the glass frit comprised one part potash (potassium carbonate,  $K_2CO_3$ ) and one part sand or flint (silica,  $SiO_2$ ),

The two patents taken out in connection with the Bow works disclose two essentially different porcelain-bodies. The 1744 specification of Edward Heylyn and Thomas Frye gives, as the ingredients, one part of potash, one part of sand or flint, and from one to four parts of a kind of porcelain-clay called unaker, from which the sand and mica had been removed by washing, from the Cherokee territory, North America: the glaze contained seven of potash-glass to one of unaker.

However Church provides no basis as to why the only flux used in the manufacture of this glass was potassium, neither does he provide any reason why the proportions should be one part silica to one part potash. Subsequently Burton (1902) attempted to manufacture analogue 1744 patent porcelain wares using Church's proposed glass composition but he complained that such a glass composition, on being ground dissolved with water and then on being mixed with China clay, set like cement. Burton's judgment of the patent's specifications was that they were not worth the paper on which they were written and that no porcelain wares could have been made following the patent recipe.

In a more recent investigation of the glass composition (Ramsay et al., 2006) it is concluded that a potash glass composition, as initially proposed by Church, is not in accord with the patent specifications and that predicated on the use of kelp and other vegetable ashes (as specified in the patent) at least some sodium and the all important glass-stabilizer in the form of calcium (or even some magnesium) would have been present. Based on the results obtained through the firing of analogue 1744 patent wares, Ramsay et al. (2004a) suggest that the glass employed was a lead-free, lime-alkali glass with  $CaO$  ~10 wt%,  $Na_2O$  ~8 wt%, and  $K_2O$  ~5 wt%. Minor levels of  $MgO$  ~2 wt% and even  $P_2O_5$  could also have been present (Freestone, 1996; Owen and Culhane, 2005). They further note that very low levels of lead found in some 'A'-marked wares, indicate that the proprietors may have been buying bulk lots of glass cullet contaminated with a small component of lead-bearing glass, rather than manufacturing their own in-house glass as stated in the patent.

Briefly, the patent requires this China clay or *uneka* (Binns, 1898; Dillon, 1904; Hurlbutt, 1926)

and an lime-alkali glass to be mixed in various proportions ranging from 1 clay to 1 glass through to 4 clay to 1 glass, and then to be formed into various shapes and fired at an inferred moderate temperature (~950°C) to the porous biscuit. Subsequently the wares, provided they emerged very white from the initial firing, were glazed using a diluted mixture of clay to glass and then fired at the final inferred temperature of 1279°C (heat-work level of Orton cone 9–90° deflection at 150°C per hour) as measured by Ramsay et al. (2004a).

Professor Nigel Wood (written com., 2005) makes a significant comment that one of his research students has been working on crystalline glazes (high zinc) and has tested a range of mixtures of China clay and lime-soda glass to make what Wood describes as a mid-temperature glaze. Apparently this student obtained good results at 1170°C with a recipe of 70 glass : 30 clay and at 1200°C this glaze became well matured. Wood also notes that the 1744 patent gives a number of body recipes but one glaze recipe only. This suggests to him that unlike the Cookworthy patent, which was definitely a low-biscuit, hard-glost process, the 1744 patent proposed several high-firing body recipes but one lower-temperature glaze recipe, i.e. one glaze recipe fits all. We note that firstly the patent wording states,

It is then to be dipt into the following glaze:-  
Take unaker forty pounds..... and left of a proper thickness for the ware to take up a sufficient quantity. When the vessels, ornaments, &c, are dry, put them into the kiln in cases, burn them with a clean wood fire.....

From this quote we infer that the various wares were still porous after the initial low-biscuit firing when they were dipped in liquid glaze (...*take up sufficient quantity*). When firing analogue 1744 patent wares (Ramsay et al., 2004a) it was observed that it was difficult to get the glaze to stick to the unglazed, high-fired, porcelain surface. Secondly we note that the patent deals essentially with a 1 clay : 1 glass body and we infer that the glaze specifications refer to that body. Although the patent specifications do mention other possible clay : glass ratios, these additional ratios to our way of thinking are written in a somewhat casual manner and there is no indication that the glaze specifications necessarily apply to these additional variations in body composition. Lastly our glaze composition using Cherokee clay and a lime-alkali glass fully matured at around 1280°C.

*Chemistry of Bow first patent wares*

Ramsay et al. (2001, 2003, 2004a, b) have proposed that the products of the 1744 patent comprise the hitherto enigmatic ‘A’-marked group of porcelains. Collectively this group of porcelains, which numbers some 38 or 39 extant items, is chemically and mineralogically unique among English porcelains (Table 4) with SiO<sub>2</sub> varying from 59.5–65.2 wt%, Al<sub>2</sub>O<sub>3</sub> from 19.5–27.7 wt%, and CaO 5.1–7.3 wt%, with SiO<sub>2</sub>/Al<sub>2</sub>O<sub>3</sub> ~5.2 and SiO<sub>2</sub>/CaO ~10.8 (molecular proportions) (Ramsay et al., 2003, 2004a, b). Binns (1898) appears to have been the first to recognise

that Bow first patent porcelains required the addition of a China clay and that the resultant body, depending on the amount of China clay added, would have been hard-paste. Likewise Tiffin (1874) noted that early Bow porcelains would have been hard-paste but little credence appears to have been given to these highly important observations. Arthur Lane (1958) from visual observation, deduced that this porcelain group comprises some kaolinite clay and that compositionally these porcelains were of a hybrid hard-paste composition. Subsequent work by Ramsay and Ramsay (2006) and Ramsay et al. (2004a; 2005a, b), who in concert with Binns and

|                                | 1     | 2    | 3     | 4     | 5     | 6    | 7     | 8    | 9     | 10    | 11   |
|--------------------------------|-------|------|-------|-------|-------|------|-------|------|-------|-------|------|
| SiO <sub>2</sub>               | 61.8  | 68.3 | 59.5  | 63.5  | 65.2  | 63.6 | 59.7  | 68.1 | 74.4  | 72.9  | 75.6 |
| TiO <sub>2</sub>               | trace |      | nd    | <0.2  | 0.2   | <0.1 | bdl   | 0.1  | bdl   | 0.7   | 0.8  |
| Al <sub>2</sub> O <sub>3</sub> | 22.9  | 12.2 | 26.4  | 19.5  | 19.8  | 23.2 | 27.7  | 11.7 | 8.3   | 10.9  | 9.2  |
| FeO                            | 0.02  |      | nd    | 0.3   | 0.3   | 0.3  | 0.1   | 0.6  | 0.4   | 0.6   | 0.5  |
| MgO                            | 0.02  | 1.8  | 1.17  | 1.2   | 1.3   | 1.3  | 0.3   | 1.0  | 1.5   | 0.8   | 1.2  |
| CaO                            | 7.5   | 7.5  | 5.83  | 6.1   | 5.4   | 5.1  | 7.3   | 13.6 | 10.7  | 6.5   | 4.8  |
| Na <sub>2</sub> O              | 7.7 # | 6.0  | 3.76  | 4.2   | 4.6   | 4.3  | 3.7   | 2.2  | 2.2   | 2.6   | 1.0  |
| K <sub>2</sub> O               |       | 3.6  | 2.76  | 3.6   | 2.2   | 2.1  | 1.2   | 2.2  | 2.5   | 3.1   | 2.9  |
| PbO                            | bdl   | 0.4  | nd    | 0.4   | 0.6   | bdl  | bdl   | 0.4  | bdl   | 1.2   | 2.5  |
| P <sub>2</sub> O <sub>5</sub>  | 0.01  |      | nd    | 0.5   | bdl   | bdl  | bdl   | bdl  | bdl   | 0.4   | <0.3 |
| SnO <sub>2</sub>               | bdl   |      | nd    | trace | bdl   | bdl  | bdl   | bdl  | bdl   | trace | 1.3  |
| SO <sub>3</sub>                | bdl   |      | nd    | nd    | 0.4   | bdl  | bdl   | bdl  | bdl   | nd    | nd   |
| Total                          | 99.95 | 99.8 | 99.42 | 99.3  | 100.0 | 99.9 | 100.0 | 99.9 | 100.0 | 99.7  | 99.8 |

Various oxide ratios (wt%)

|  | 3    | 4    | 5    | 6    | 7    | 10   | 11   |
|--|------|------|------|------|------|------|------|
| SiO <sub>2</sub> /Al <sub>2</sub> O <sub>3</sub> | 2.3  | 3.3  | 3.3  | 2.7  | 2.2  | 6.7  | 8.2  |
| SiO <sub>2</sub> /Na <sub>2</sub> O              | 15.8 | 15.1 | 14.2 | 14.8 | 16.1 | 28.0 | 75.6 |

1. theoretical composition of body made according to the 1744 patent (Ramsay et al., 2001). Na<sub>2</sub>O and K<sub>2</sub>O combined
2. theoretical glaze composition made according to the 1744 patent (Ramsay et al., 2003)
3. teapot lid, V&A Museum, C. 207A-1937. Charleston and Mallet (1971: page 92). Charleston and Mallet (1971) No. 2
4. W. W. Winkworth fluted cup; British Museum, M&LA 1995.11-3.1. Charleston and Mallet (1971) No. 17. Analysis reported by Freestone (1996)
5. fluted cup; private collection. Charleston and Mallet (1971) No. 25. Analysis reported by Ramsay et al. (2003: B14)
6. W. W. Winkworth teapot; private collection. Charleston and Mallet (1971) No. 14. Analysis reported by Ramsay et al. (2003: B51)
7. covered sugar bowl; Melbourne Cricket Club Museum, M5369.1. Charleston and Mallet (1971) No. 10. Analysis reported by Ramsay et al. (2004b: B97)
8. glaze composition to fluted cup (Ramsay et al., 2003)
9. glaze composition to covered sugar bowl (Ramsay et al., 2004b)
10. mean of 13 analyses of Limehouse porcelain body (Freestone, 1996)
11. Pomona porcellaneous body (Freestone, 1993)

nd not determined  
 bdl below detection level  
 # combined Na<sub>2</sub>O + K<sub>2</sub>O

Table 4. Chemical analyses of Bow first patent porcelains of the ‘A’-marked period (~1743–1745).



Fig. 4. Selected images of Bow first patent porcelains. This small group comprises refractory China clay deduced to have been sourced from the Carolinas and a glass frit. This recipe conforms in starting materials and the general proportions to the specifications contained in the 1744 ceramic patent of Heylyn and Frye. The resulting body is both high-fired and hard-paste. Fig. 4a, hexagonal teapot with replacement silver spout, East London, England, c. 1744 (B51). Hard-paste porcelain with an incised 'A' to base. Height (H.) 78 mm. (Private collection). Decorated in the Kakiemon manner in a palette of iron red, bluish green, bright blue, yellow, black, and mauve. Compositionally this teapot comprises China clay (50.1 wt% – hydrous) and lead-free glass cullet (49.9 wt%). Fig. 4b, fluted decagonal cup, East London, England, c. 1744. Hard-paste porcelain, unmarked. H. 60mm. (Taylor collection). Fig. 4c, fluted decagonal cup, East London, England, c. 1744 (B14). Hard-paste porcelain with an incised 'A' to base. H. 60 mm. (Private collection, photograph by courtesy of Mercury Antiques.) This cup suggests the influence of J. G. Horoldt's decorating studio at Meissen with trailing flowers in the *indianische Blumen* manner. Fig. 4d, fluted decagonal cup, East London, England, c. 1744. Hard-paste porcelain with an incised 'A' to base. H. 60 mm. (Private collection, photograph by courtesy of E. and H. Manners.) This cup is likewise decorated in the *indianische Blumen* manner with a brown line to the rim. It is a recent discovery, not listed by Charleston and Mallet, being sold by Dreweatt Neate, Newbury, October 9<sup>th</sup>, 2002, lot 376. A companion unmarked cup with simple rolled handle, resides in the Cecil Higgins Museum, Bedford. Fig. 4e, covered sugar bowl, East London, England, c. 1744 (B97). Hard-paste 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 China clay (59 wt% – hydrous) and lead-free glass cullet (41 wt%). It is decorated with four vignettes derived from 'children's pastimes' and is part of a teaset, which includes in addition a teapot, cream jug, and three saucers.

possibly Tiffin (1874), argue that the porcelain body is in fact a hard-paste composition and hence would pre-date Cookworthy's 'true hard-paste' patent by a quarter of a century (Fig. 4).

Lane (1958) includes a report on spectrographic analyses of four 'A'-marked items by Bimson of the British Museum. In this account Bimson identifies the presence of Si, Al, Mg, Ca, Na with minor amounts of Cu, Sn, Pb, Mn, before exploring Hewelke or Cozzi attributions, both 18<sup>th</sup> century factories located around Venice.

The first reported partial analysis of an item of 'A'-marked porcelain is found in Charleston and Mallet (1971) based on an analytical report provided by Dr M. J. Hughes and M. Bimson. In this study the elements Si, Al, Ca, Mg, Na and K only were reported (Table 4). These results, coupled with the clear wording of the 1744 patent, the recognition that the 'A'-marked group appeared to be of English derivation, and the prescient observations by Tiffin (1874), Binns (1898), Dillon (1904), Hurlbutt (1926), and Lane (1958) constituted the basis for a not unreasonable deduction that there was a significant relationship between Heylyn and Frye, the 'A'-marked group, a hard-paste porcelain body, and the 1744 patent. In addition the first X-ray diffraction study of six samples from the collections of the Victoria and Albert Museum {Nos. 2, 3, 4, 6, 8, 11 (Charleston and Mallet, 1971:92)} is also presented and all six samples demonstrate the presence of a calcium plagioclase (~anorthite). Based on this work, Charleston and Mallet speculate that the either ball clay or China clay may have been used in the body and that if porcelain material produced under the 1744 Bow patent was a kind of modified hard-paste, its formula might have borne some resemblance to that of the 'A'-marked group.

Freestone (1996) carried out an additional chemical analysis on the body of a fluted cup housed in the collections of the British Museum (M&LA 1995.11-3.1) and listed in Charleston and Mallet (1971) as No. 17. Unlike the partial analysis derived from the flange of a teapot (V&A C207A-1937) using a combination of atomic absorption spectroscopy and flame photometry as reported by Charleston and Mallet (1971), Freestone used a scanning electron microscope together with an attached X-ray analyser to obtain his analysis. In addition, a partial qualitative analysis of the glaze on an 'A'-marked teapot, also housed in the British Museum (M&LA 1938.2-15.1) was undertaken. Freestone reports that the body of the porcelain

fluted cup comprises 'islands' rich in aluminium and calcium ( $\text{Ca}/\text{Ca}+\text{Na} \sim 0.75$  = calcium-bearing plagioclase; bytownite) set in a glassy aluminosilicate glass. He also reports the presence of minor amounts of a calcium magnesium-silicate and a silica phase considered to represent relict glass or frit particles, which on analysis demonstrates the presence of around 1% phosphate. Freestone notes that such low amounts of phosphate are the general levels found in many post-medieval glasses. The bulk composition of the body is given in Table 4, with  $\text{SiO}_2$  63.5 wt%,  $\text{Al}_2\text{O}_3$  19.5 wt%, and CaO 6.1 wt%. FeO,  $\text{TiO}_2$ , PbO, and  $\text{P}_2\text{O}_5$  were all shown to be low or below detection level. The partial analysis of the glaze gave around 10 wt% CaO, 4 wt%  $\text{K}_2\text{O}$ , and around 0.5 wt% PbO. The critical elements  $\text{Na}_2\text{O}$  and  $\text{Al}_2\text{O}_3$  were not analysed.

In his conclusions Freestone (1996), although noting the good correspondence between the 1744 patent and 'A'-marked wares, records clear parallels with the bodies produced at both Limehouse and Pomona. We suggest that these parallels are not as close as Freestone might have suggested on the following grounds. Firstly the clay used by the Bow proprietors was a primary residual or China clay, containing very low-levels of  $\text{TiO}_2$  and FeO, whereas both Pomona and Limehouse used what appears to have been a ball clay, probably derived from Dorset or even Devon, and characterised by significantly higher levels of these two colorant oxides. The China clay used at Bow was a refractory, high-firing clay in contrast to the more easily fusible clay used by both Pomona and Limehouse. Freestone (1996) recognises that a China clay may have been employed in the body of 'A'-marked wares and to strengthen a possible Limehouse attribution, speculates that these wares might represent a special cargo of clay received at Limehouse, presumably from the Carolinas. Secondly the body of 'A'-marked wares as specified in the patent, comprises two initial components, namely Cherokee clay and a glass frit. In contrast ceramics from both Limehouse and Pomona contain a third component, in addition to glass frit and clay, and that is crushed or milled silica as noted by Freestone. A third significant difference between Bow first patent porcelain wares and Pomona and Limehouse products can be found in the levels of  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ , and  $\text{Na}_2\text{O}$  with  $\text{SiO}_2/\text{Al}_2\text{O}_3$  for 'A'-marked porcelain ranging between 2.2–3.3 and for Limehouse in the order of ~6.7, and Pomona ~8.0 (Table 4).  $\text{SiO}_2/\text{Na}_2\text{O}$  for the 'A'-marked porcelain body clusters around 15, whereas for Limehouse

around 28 and even higher for Pomona. Various differences in chemistry of the body between these three factories are graphically shown in discriminant ternary diagrams (Ramsay et al., 2003).

In the case of Bow first patent or 'A'-marked glaze composition, two analyses are provided in Table 4. As recorded by Ramsay et al. (2003) the glaze is of a  $\text{SiO}_2\text{-Al}_2\text{O}_3\text{-CaO}$  type with negligible  $\text{TiO}_2$ ,  $\text{FeO}$ , and  $\text{PbO}$ . The key feature of this glaze is that it is most likely a high-firing glaze, assumed to have been fired at the same time as the body in the manner of both the Chinese and Meissen. This temperature has been recorded to be in the order of  $1280^\circ\text{C}$  for a 1 clay : 1 glass frit body (Ramsay et al., 2004a). When plotted on discriminant ternary diagrams (Ramsay et al., 2003) it can be shown that Bow first patent glazes are unique for 18<sup>th</sup> century English compositions with possibly the closest glaze compositions recognised to date for that period occurring on the hard-paste porcelains of Plymouth and Bristol. These latter glazes are highly siliceous with high  $\text{Al}_2\text{O}_3$  (11.8–16.8 wt%) and no  $\text{PbO}$ . However as noted by Ramsay et al. (2003) the  $\text{CaO}$  levels for both Plymouth and Bristol are significantly lower than that in either the theoretical Bow first patent glaze or 'A'-marked glazes.

*Significance of Bow first patent porcelains:* Considerable acknowledgement and accolades have been given by the Chinese and the international community to the earliest Chinese porcelains believed to have originated in north China during the Sui-Tang dynasties. Likewise hard-paste Meissen porcelains produced by Böttger, the earliest soft-paste porcelains out of Rouen and St Cloud, and the earliest commercial porcelains from North America by Bonnin and Morris have deservedly received considerable acknowledgement and regard by the ceramic community. In contrast, in the United Kingdom uncertainty has existed over the identity of any porcelain manufactured by Heylyn and Frye in east London based on their patent of 1744. This uncertainty is all the more inexplicable by virtue of the presence of clearly written and precise specifications, both dated and signed by five people, documents whose equivalents have been essentially denied to the present-day Chinese, French, Americans, and to a large degree the Germans. As demonstrated by Ramsay et al. (2006) this landmark patent has been marginalised and dismissed by many workers as unworkable, and at best regarded as experimental. These doubts, which question the efficacy and significance of the 1744 patent, have embedded themselves in the Eng-

lish ceramic psyche for over a century and one of the foundations, which has supported this unfounded attitude, is an unstated but potent circular train of reasoning. This circular reasoning both tends on the one hand to regard the 1744 patent as unworkable, hesitant, cautious, and at best experimental, thus explaining why no first patent wares can be recognised and on the other hand reasons that because no first patent wares can be readily identified, this must indicate that the patent itself is unworkable, hesitant, cautious, and at best experimental. Consequently an unfounded state of denial can be traced through numerous English ceramic studies both in regard to the 1744 patent and to the products of that patent. These attitudes and views contrast with that of the French, who by mid 1745 recognised the superior compositional qualities of Bow first patent porcelains over their own soft-paste wares and that of Chelsea.

We note that both Hillis (2001) and Freestone (1996) were willing to recognise a possible linkage between the Heylyn and Frye patent based on the specifications and depending on the identification of the clay used, with Hillis emphasizing the lead-free glaze composition recorded by Freestone for an 'A'-marked piece. Likewise Errol Manners as quoted in Emerson et al. (2000), again apparently influenced by Freestone's 1996 paper, appears to have been the first in print to recognise the Trinity namely that the 1744 patent was not unworkable, the products of this patent were the 'A'-marked porcelains, and the proprietors were Heylyn and Frye at Bow.

Based on the wording of the 1744 patent, the work of fellow ceramic historians including Binns (1898), Hurlbutt (1926), Lane (1958), Charleston and Mallet (1971), Mallet (1994), Freestone, (1996), Daniels (2003, 2007), and research to date by Ramsay, Ramsay, and co-workers, we suggest that far from being 'unworkable' the 1744 patent of Heylyn and Frye is one of the major documents in English ceramic history. Moreover the products of this patent are arguably the most significant porcelains to have been produced in 18<sup>th</sup> century Britain. Our reasons for these beliefs include the following;

1. the recognition by Charleston and Mallet (1971) that the 'A'-marked group is probably of English derivation. We regard this observation to be highly important;
2. the presence of the 1744 patent which details how these porcelains were made and without which it is doubtful that an attribution of the 'A'-marked porcelains could have been achieved;

3. the proposal that the 'A'-marked group (Bow first patent wares) dates from c.1743 and represents the earliest commercial porcelains to have been made in the English-speaking world;
4. the remarkable entrepreneurial effort involved in sourcing and transporting Cherokee clay in excess of 8000 km from the interior of the Carolinas and across the Atlantic Ocean. This transportation of the clay involved avoiding Indian objections, evading attacks by 'Crackers,' and minimizing capture on the high seas by either the French or the Spanish. No other nationality or ceramic entrepreneur, to our knowledge, prior to the inception of the Bow manufactory went to such efforts and distances in procuring essential raw materials;
5. the first high-firing, hard-paste commercial porcelains to have been made in the English-speaking world using a refractory China clay. These hard-paste porcelains pre-date Cookworthy's 'true hard-paste' wares by a quarter of a century, yet little attention has been drawn to this remarkable milestone with the exception of Binns (1898) and possibly Tiffin (1874) and Lane (1958);
6. the use of an associated high-firing, Si-Al-Ca glaze, which appears to have been fired contemporaneously with the ceramic body, in the manner of both the Chinese and Meissen. Here we note an alternative suggestion mentioned above as proposed by Nigel Wood;
7. the absence of lead as a significant component in either the body or the glaze, again after the manner of both the Chinese and Meissen;
8. based on the firing of analogue 1744 patent wares (Ramsay et al., 2004a) there is a close physical appearance to Oriental and Meissen porcelain as demonstrated by the presence of a semi-conchoidal fracture, the high-firing character of both body and glaze which we regard as having been fired contemporaneously, the absence of lead in both body and glaze, physical hardness, degree of translucency, the bonding of the glaze to the porcelain body, the distinct retexturing and degree of re-crystallization at the micro level, and ability of the porcelain to exhibit good thermal stress properties. These features are collectively absent from other English porcelain bodies of the 1740s and 1750s, especially early Chelsea;
9. the perceived first use of slip-casting in English porcelains;
10. the remarkable and sophisticated level of enamelling;
11. the first English factory to introduce Meissen-and/or Asiatic-derived decorative themes to English porcelain; and
12. the distinct possibility that the 'A'-marked group of porcelains may owe a considerable, yet unrecognised, debt to the *Philadelphia ceramic tradition* out of colonial America. Ramsay et al. (2004b) have suggested that although fired in London, Bow first patent porcelains may in fact reflect a considerable level of technological input from the New World.

In the case of the 'A'-marked porcelains Charleston (1965) notes the distinct English feel present in their potting, whereas the knobs on the teapots reflect types found on earlier Staffordshire wares. This suggests to us that Meissen prototypes may not have been readily available to the Bow proprietors in the early 1740s (a feature experienced by Chelsea some 6–8 years later) and initially the potting forms found indigenous inspiration. This feature is possibly best seen in an 'A'-marked teapot in the collections of the British Museum (Charleston and Mallet, 1971: No. 1; Ramsay et al., 2004b: Fig. 12) which because of its distinct linkages with Staffordshire or south London stoneware forms, possibly dates to around 1743, if not earlier. What we infer as representing slightly later examples of the 'A'-marked group (c.1744–1745), may show Oriental influences in form, as found for example in the covered sugar bowl (Charleston and Mallet, 1971: No. 10; Ramsay et al., 2004b: Figs 1–6). In the case of the enamelling, inspiration is in part indigenous, derived from the London theatre {a feature which reappears with various early figures associated with the *New Canton period* and again characteristic of Bow (Yarbrough, 1996)}, Meissen, and the Asiatic (either derived from Continental copies or direct from the Oriental). The example of enamelling found on the 'A'-marked snuff box (Charleston and Mallet, 1971: No. 7; Ramsay et al., 2004b: Fig.10) is closely comparable to monochromatic Meissen harbour scenes, first introduced to that factory about 1724 and made popular there during the following decade. Daniels (2003) has drawn attention to William Duvivier as a possible candidate responsible for the decoration on this snuff box and her proposal is supported by the belief that William Duvivier supposedly arrived in England in 1743 and may have been executing harbour scenes at Chelsea by 1751.

Mallet (1994) discusses in some detail a porcelain cane handle, initially procured by Elizabeth Adams and now residing in the collections of the

Victoria and Albert Museum. Four scenes are depicted on the handle and Mallet records,

While not totally discounting the possibility that this intricate design in its entirety might have been derived from a Meissen original, the execution of the piece is sophisticated enough to suggest that whoever painted it was capable of working out such a design problem for himself.

Examples of Asiatic decoration associated with Bow first patent wares can be seen in the Kakiemon-inspired decoration found on the so-called Winkworth teapot now in a private collection (Charleston and Mallet, 1971: No. 14; Ramsay et al., 2004b: Fig. 11), on a two quail-patterned, fluted cup (Charleston and Mallet, 1971: No. 19; Ramsay et al., 2004b: Fig. 9) and on a white, fluted cup with applied prunus blossom, leaf, and twig decoration in the manner of the Chinese *blanc de chine* (Charleston and Mallet, 1971: Nos. 26, 27; Ramsay et al., 2004b: Fig. 9). Both cups are housed in the Dorothy Condon Falknor Collection of the Seattle Art Museum. In the case of the two quail-patterned cup it appears that the pattern was taken from a Meissen example rather than an Oriental original because as noted by Spero, Kakiemon originals typically have both birds in the red, while Meissen examples depict one of the quails in blue. Thus by 1743 it appears that the Bow proprietors were drawing on both indigenous and exotic forms in the modelling of their wares and their enamelling drew inspiration again from indigenous themes, from Meissen, and the Asiatic (Ramsay and Ramsay, 2006b). Such assurance and sophistication, we suggest, reflects a London origin for these porcelains, with much of the output unashamedly directed at the luxury or 'high-end' of the market. These remarkable initiatives predate Chelsea's attempts by at least a year and the inescapable conclusion is that rather than Chelsea holding any sort of leadership role for a short while over other English porcelain manufacturers (Nightingale, 1881; Sandon, 1989; Spero, 2006), it was the Bow proprietors and their porcelain manufactory, which held that enviable position – chronologically, technically, compositionally, and artistically.

#### *The use of steatite by the Bow proprietors*

Whilst in Melbourne to speak at the Chelsea porcelain exhibition held by the National Gallery of Victoria (Legge, 1984), John Mallet arranged for an unmarked tea-canister in the Gallery's collections to

be flown to London, where he compared it visually with other 'A'-marked examples contained in the collections of the Victoria and Albert Museum. In a remarkable testimony to his visual skill, Mallet discounted a Chinese, Bow second patent, Longton Hall, or a Continental origin, proposing instead that this tea-canister belonged to the 'A'-marked group of porcelains of then uncertain attribution (Mallet, 1994).

For many years debate over the attribution of this tea-canister has occurred with some suggesting a Chinese origin, others a Continental attribution, and Sotheby's, in their auction catalogue of 1939, proposing a Bow second patent derivation, c.1765–1770. To add to the level of uncertainty, Mallet notes that the canister is illustrated in a book on Longton Hall porcelain (Bemrose, 1906). The canister was initially recorded as being in the W. T. Lawrence Collection in 1906. Subsequently it was sold at auction at Sotheby's, London on July 6<sup>th</sup>, 1939 – lot 91 and was procured for the National Gallery of Victoria from Felton Bequest funds, where for some time it has been attributed to Bow. Decoratively the canister comprises three motifs as described in Ramsay et al. (2003: Fig. 13). The first is a brown enamelled and gilt multi humped-back island on which grow spiky trees with black-pencilled branches. The second motif, the key decorative feature referred to as the *Island House* pattern, comprises a further island grouping on which is sited an iron-red hut or barn built over a distinct yellow mound or base. The third feature is an iron-red pavilion or tent with distinctive internal curtains or drapes and an overhead banner, the whole being flanked by sage-green willow trees, which Ramsay et al. (2003) relate to large bats in flight. The palette is distinctive and can be traced into subsequent Bow second patent wares in that it comprises black pencil outlines, an iron-red containing a marked vermilion tinge, sage green wash, distinctive yellow, and a thick opaque chocolate brown. Of particular note is the gilding, which we suspect was on-fired.

Ramsay and Ramsay (2005a) discuss this canister and present a chemical analysis of the body (Table 5). Based on these data they support Mallet's attribution that the canister belongs to the 'A'-marked group and they conclude that the tea-canister comprises China clay based on the high Al<sub>2</sub>O<sub>3</sub> content (31.2–36.4 wt % with an average of 32.6 wt%) and TiO<sub>2</sub> low or below detection level, as is PbO. Unlike other 'A'-marked porcelains analysed to date (Table 4), the canister is distinctly magnesian lack-



|  | Analysis 1 | Analysis 2 | Analysis 3 | Average |
|--|------------|------------|------------|---------|
| SiO <sub>2</sub>                                 | 45.8       | 52.9       | 60.0       | 52.9    |
| TiO <sub>2</sub>                                 | trace      | bdl        | bdl        | bdl     |
| Al <sub>2</sub> O <sub>3</sub>                   | 36.4       | 31.2       | 30.3       | 32.6    |
| FeO  | 2.5        | 3.9        | 2.2        | 2.9     |
| MgO  | 6.3        | 5.3        | 2.3        | 4.6     |
| CaO  | bdl        | bdl        | 1.0        | 0.3     |
| Na <sub>2</sub> O                                | 4.2        | 1.7        | bdl        | 2.0     |
| K <sub>2</sub> O                                 | 2.8        | 3.0        | 2.3        | 2.7     |
| P <sub>2</sub> O <sub>5</sub>                    | 0.4        | bdl        | bdl        | 0.1     |
| PbO  | bdl        | bdl        | bdl        | bdl     |
| SO <sub>2</sub>                                  | 1.9        | 2.0        | 1.8        | 1.9     |
| Total  | 100.3      | 100.0      | 99.9       | 100.0   |
| SiO <sub>2</sub> /Al <sub>2</sub> O <sub>3</sub> | 1.26       | 1.70       | 1.98       | 1.62    |

bdl below detection level

| Recipe 1                      | Recipe 2                      |
|-------------------------------|-------------------------------|
| China clay component          | China clay component          |
| China clay ..... 64.3         | China clay ..... 66.6         |
| Frit component                | Added components              |
| Crushed silica ..... 12.3     | Crushed silica ..... 5.1      |
| Alum ..... 5.6                | Alum ..... 5.8                |
| Potassium carbonate ..... 3.2 | Potassium carbonate ..... 3.3 |
| Sodium carbonate ..... 2.7    | Sodium carbonate ..... 2.8    |
| Calcium carbonate ..... 0.4   | Calcium carbonate ..... 0.5   |
| Ferrous carbonate ..... 3.8   | Ferrous carbonate ..... 3.9   |
| Magnesium carbonate ..... 7.7 | Talc ..... 12.0               |

#### Notes:

Theoretical recipe calculated after SO<sub>2</sub> is converted to SO<sub>3</sub> and the total recast to 100%.

Source of the elemental oxides FeO, MgO, Na<sub>2</sub>O, K<sub>2</sub>O, CaO calculated as being derived from carbonate sources. Based in the 1744 patent, vegetable ashes were most likely the source for these elemental oxides.

Alum {KAl(SO<sub>4</sub>)<sub>2</sub>.12H<sub>2</sub>O} assumed to be the source of sulphur.

Table 5. Chemical analysis and calculated recipe compositions (wt%) of a Bow high-magnesium tea-canister (B79).

ing any appreciable calcium. In addition sulphur, deduced to have been added to the paste in the form of alum {K<sub>2</sub>Al(SO<sub>4</sub>)<sub>2</sub>.12H<sub>2</sub>O} not gypsum on account of the negligible level of Ca in the porcelain body. Ramsay and Ramsay (2005a) give two theoretical recipes for this canister, the first accounting for the magnesium in the form of a magnesium-alkali glass frit and the second based on a steatite or soapstone formula.

One of the reviewers of a draft of this manuscript prior to going to press, Dr Ian Freestone, makes the valid point that to have a glass cullet with high-magnesium and negligible calcium is outside our current understanding of 18<sup>th</sup> century glass technology, especially as vegetable ashes, based on numerous chemical analyses, always have calcium greater, if

not significantly greater, than magnesium. On this basis the steatite-based recipe as given in Table 5 is likely to be a more reasonable representation of the paste used. This in turn raises significant questions as the Bow manufactory is not known for having experimented with or utilised steatite, a raw material apparently confined to the wares of early Bristol, Vauxhall, Worcester, some Liverpool factories, and Caughley (Godden, 2004b.)

It is now apparent that the significance of this tea-canister is not so much whether it is a member of Bow first patent porcelains ('A'-marked group) but rather this item is the first creditable example attributable to Bow in which magnesium, here inferred to be steatite, is the key additive. Support for a Bow attribution may be advanced on account of,

1. the nature and range of the palette used which finds parallels in early Bow second patent wares;
2. the use of the on-glaze *Island House* or *Island* pattern on the canister, a motif highly characteristic of Bow second patent wares. Adams and Redstone (1981: 124) record this Chinese-inspired design as being used on Bow tea wares of the middle 1750s. Begg and Taylor (2000: Nos. 15 and 16) likewise illustrate a Bow coffee can with a simplified version of the pattern together with a Kangxi period tea bowl and saucer with the *Island House* pattern;
3. the technical nature of gilding over a brown enamel base, which appears to be unique to Bow and is not found to our knowledge on other porcelains, be they English, Continental, or Oriental. This technique of gilding over a brown base is apparently confined to the early Bow manufactory with examples found on various theatrical and Muses figures as illustrated by Begg and Taylor (2000: Nos. 6, 19, 192, 193, 194, 196). Errol Manners has pointed out (Manners, written com., 2004) that Meissen was gilding by about 1715 and the London over-decorators of Chinese porcelains were gilding by around 1740, while in the case of both glass and enamels, gilding was well developed prior to the 1750s. He further notes that the earliest recorded gilding on English porcelain to date is on Bow Muses-type figures and contemporary wares, where invariably this gilding is characterized by being applied over brown enamel, as with the tea-canister under discussion. This technique can be traced through the Bow output to at least the *Target period* of 1754. Subsequently Manners (2005) recognises gilding on a salt-glazed tankard by John Dwight, c. 1695 and gilding on Chinese wares c. 1720.
4. the high level of  $\text{Al}_2\text{O}_3$  in the body (32.6 wt%) is double to triple the absolute levels typically found in either Pomona or Limehouse Si-Al-Ca porcelain bodies. This high  $\text{Al}_2\text{O}_3$  content is a feature of Bow first patent porcelains, not encountered in other English porcelains until William Cookworthy produced his hard-paste body in 1768. Exceptions to this include two 'true porcelain' sherds recovered from Bovey Tracey with 30.6 and 30.9 wt%  $\text{Al}_2\text{O}_3$  (Owen et al., 2000) and three unglazed Pomona sherds whose mean composition is 27.9 wt%  $\text{Al}_2\text{O}_3$  (Owen and Hillis (2003); and
5. the presence of sulphur, assumed to represent sulphate sulphur in the paste, an additive which

is highly characteristic of a significant proportion of the Bow porcelain output (Tite and Bimson, 1991; Owen and Day, 1998; this study). To our knowledge no other English factory, until Isleworth commenced its bone ash recipe output during the 1760s (Freestone et al., 2001, 2003), added significant levels of sulphate sulphur to its porcelain recipe and consequently we regard this feature, based on current analytical data, to be an early Bow signature feature. In addition we suspect that this sulphur was added in the form of alum, a compound that we have tentatively identified as being used at times in some early Bow second patent wares of the *Developmental period*. To our knowledge no other English 18<sup>th</sup> century porcelain concern utilised alum.

Based on the above reasoning we propose that there is now reasonable evidence to countenance the use of steatite by the Bow proprietors as a third significant paste recipe in its factory output during the mid 1740s. We accept that the above proposal is predicated on our correct assumption that the high-magnesium content reflects the use of steatite and our attribution of the canister to Bow. These deductions will need to be tested alongside other possible steatitic wares of uncertain attribution and any non-phosphatic wasters which might be recovered in the future from the former Bow factory site, be that in Middlesex or Essex. Possibly the most significant point to arise out of this work so far is the recognition that it may no longer be valid to reject a Bow attribution based on the presence of a high-magnesium body and consequently a reassessment of a number of unusual magnesian items that have not fitted well with attributions to Worcester, Chaffers Liverpool or Vauxhall is now required. Research into a number of magnesian items of possible Bow attribution is continuing and on going to press two other high-magnesium examples have been recognised based on analyses undertaken by the authors. One of these is a coffee cup in the Taylor collection (B 100). This cup has what we regard as typical Bow decorative features in the *Island House* pattern, the use of a prominent reddish brown, and the presence of gilding over this characteristic enamel base. The second example relates to the George II busts (Delevingne, 1963; Watney, 1968) and detailed discussions on this numbered group are given by Daniels (2007) and Ramsay and Daniels (in prep).

On going to press the composition of an unglazed waster from the Bow site on Stratford High Street (Redston, 1969) was reported by us (Ramsay and Ramsay, 2007). This waster has 72.5 wt%  $\text{SiO}_2$ ,

9.7 wt% MgO, and 220ppm Ni thus giving a calculated recipe of 10 wt% (hydrous) ball caly, 30 wt% (hydrous) talc, 20 wt% lime-alkali cullet, 15 wt% led cullet, and 25 wt% crushed silica.

### BOW SECOND PATENT PORCELAINS

On 17<sup>th</sup> November 1749 Thomas Frye filed a second patent on his own, which was subsequently ‘inrolled’ on March 17<sup>th</sup> in the following year (HM Stationery Office Patent No. 649 AD. 1749). This patent claimed to be capable of making a certain ware,

..... which is not inferior in beauty and fineness, and is rather superior in strength, than the earthenware that is brought from the East Indies, and is comonly known by the name of China, Japan, or porcelain ware.

The specifications required the use of an indissoluble matter termed ‘virgin earth’, flint white pebbles or clear sand, and pipe clay. The patent records that the ‘virgin earth’ is ground with the flint/white pebbles/or clear sand to form balls or bricks, calcined and then ground ready to be mixed with the pipe clay. The composition of ‘virgin earth’ has been subject to some speculation and the question arises as to why Frye should have attempted to patent a substance of such an ill-defined composition and what protection did he hope to derive from this patent. The 1749 patent differs considerably from the 1744 patent in that the raw materials do not require *uneka* or Cherokee clay and the glaze specified in the 1749 patent is instead a low-firing, lead glaze. As with the 1744 patent the specifications refer to decoration using underglaze blue (smalt or zaffer) with the ability to produce deeper or paler hues of blue.

We can at this stage merely guess at why the Bow proprietors went to the trouble of taking out these two patents because as noted by Hillary Young (1999: 54) such patents in the 18<sup>th</sup> century rarely afforded the patentees much protection. In the case of the Bow first patent there are grounds for suspecting that the patent had more to do with attempts to protect the vital primary resource, Cherokee clay. Based on compositional studies of wasters recovered from both Limehouse and Pomona, it might appear that both concerns were attempting to replicate the Bow first patent, however their inability to source high-firing, refractory, China clay meant that they were forced to rely on lower-firing ball clay and consequently they resorted to the application of a low-firing, lead-based glaze, rather than the higher firing Si-Al-Ca glaze

used on Bow first patent wares. We also suspect that the use of lower-firing, ball clay required the addition of crushed silica (quartz sand or chert) in an attempt to stabilize the body in the face of rapid onset of pyroplasticity (melt phase) during firing. In the case of the Bow second patent, the key material ‘virgin earth’ is so ill defined that we are uncertain as to the reasons for entering this patent. We note that Daniels (written com., 2001) has suggested that a possible catalyst for the filing of this patent by Frye may have been perceived competition from other concerns such as Vauxhall, which was founded in 1751 and is known to have been experimenting with a bone ash recipe (Owen et al., 2000; Bimson and Freestone, 2002).

### *Raw materials used in Bow second patent porcelain*

A major consideration in setting up a ceramic concern is the sourcing of raw materials and the associated costs with supply. Adams and Redstone (1981: 81) note that little attention has been given to the suppliers to 18<sup>th</sup> century ceramic manufacturers with much of our current information derived from the accounts and notes kept by John Baddeley of Shelton in the middle of the century (Mallet, 1966, 1967).

*Ball clay.* Unlike kaolinite or China clay, which is a primary or residual clay used in the 1744 patent, the clay specified in the Bow second patent is a secondary or transported (i.e. detrital) clay. Names used to refer to this material include ball clay, pipe clay, plastic clay, or *argille plastique*. A considerable range of accounts has occurred over the last 170 years as to the nature of the clay used by Bow in its porcelain output. Simeon Shaw (1837:436) records,

The potters of Bow and Chelsea, from compounding well-washed sand from Alum Bay, Isle of Wight, ground cullet, and pipe-clay, fabricated porcelain, which was covered with a glaze, chiefly of lead, which had considerable demand in the early part of the last century.

This recipe corresponds to neither Bow first nor second patent recipes and moreover there is a subsequent reference to this recipe by Burton (1906). We suggest that there may be grounds based on Simeon Shaw’s account for suspecting yet a further recipe type employed at Bow.

Tait (1963) with little substantiation, claims that Duché’s mines in America were the source for much of the clay used in second patent wares, however we can find little to support this claim. Fisher (1965) states that initially up to 1749, the artificial paste

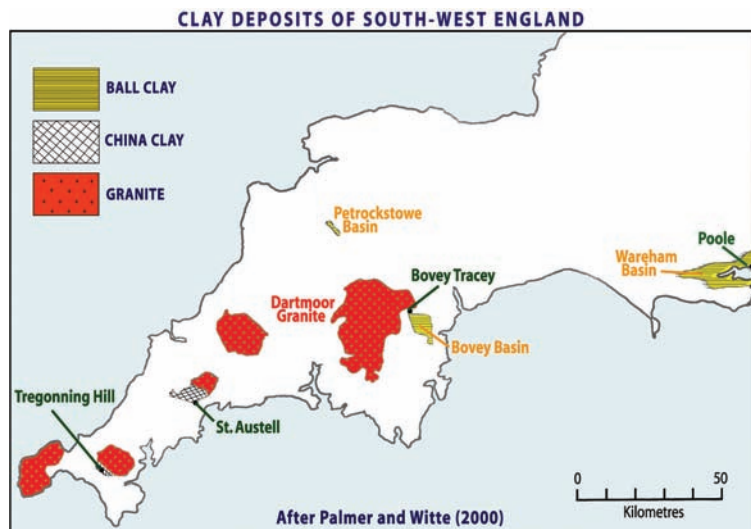


Fig. 5. Sketch map after Palmer and Witte (2000) showing the location of various primary residual and secondary transported clay deposits in SW England. The primary China clay deposits of Cornwall are associated with granite bodies while the various secondary or ball clay deposits relate to sedimentary basins, located in Devon and Dorset. Both the Petrockstowe and Bovey Basins are now fault-bounded. It might appear that the Wareham Basin was the major source of ball clay for Bow second patent porcelains. Not shown is the location on Lizard Peninsula, Cornwall of steatite associated with altered ultramafic rock, used initially by Bow and then by such factories as Worcester, Vauxhall, and Chaffers Liverpool.

was little more than glass, containing pipe clay to give whiteness, but from that time onwards until closure bone ash was added. As recently as 2003 Begg, as reported by Adney (2003), surmises that early Bow second patent wares utilised *uneka* clay from the Americas, in complete contradiction to a significant body of published information and the second patent specifications themselves.

Ball clays are chemically and physically weathered, transported by streams, and then finally deposited under freshwater or paludal conditions. This mode of transport and deposition results in the clay collecting impurities in the form of carbonaceous material (hence the reference to blue or grey ball clay), iron and titanium oxides, and additional amounts of sand and silt. Deposition under reducing conditions has often developed small amounts of sulphide, as for example found in the Creekmore Sequence of the Wareham Basin, Dorset. The term ball clay apparently originates from the former practice of transporting such clay in nine inch cubed blocks, which then assumed a somewhat spherical form reflecting the plastic nature of the clay. John Mallet (1966) records that John Baddeley of Shelton in his account book showing transactions undertaken by Baddeley on behalf of Messrs. Reid and Co. records on 30<sup>th</sup> July, 1758,

Pd Esther Lyon for 200 Balls of Clay £5

South-west England has been the traditional source for ball clay deposits (Fig. 5). Here three main localities have been exploited namely the fault-bounded Petrockstowe and Bovey Basins (Oligocene age: 28–35 million years ago) and the Wareham basin (mid Eocene age: 40–50 million years ago) located further to the east and comprising part of the larger Hampshire Basin in Dorset. Apparently Dorset ball clays were, and still are, prized for their high plasticity and pre-fired strength, and as a result of their relatively low-levels of colorant oxides, they fire white to ivory in color (Palmer and Witte, 2000). Moreover carbonaceous clays, which are highly characteristic of ball clays from the Bovey basin, are largely absent from the ball clay units in Dorset. Where carbonaceous material dominates, the clay may have in addition, high iron levels thus making the clay useless for ceramic purposes. The major components of ball clays include kaolinite, illitic mica or sericite, and fine silica as quartz. Contaminant minerals include pyrite, siderite, anatase, gypsum, and dolomite (Palmer and Witte, 2000). The kaolinite in ball clays differs from that in primary kaolinites in that it has a finer particle size and is predominantly b-axis disordered. Apparently b-ordered kaolinites have been shown to occur as alteration products of albite and chlorite and they often contain some iron in the crys-

tal lattice which gives the clay increased strength and plasticity (Palmer and Witte, 2000).

Church (1881) records that Dorset clay had been worked as early as 1666 and Bovey Tracey clay as early as 1730. According to Latham (1977), Captain Joliffe, Thomas Hyde, and John Calcraft, MP were foremost in the business of transporting Dorset ball clay to London in the mid 18<sup>th</sup> century. Capt. Joliffe wrote that clay pits near Wareham and Poole were utilised and the clay fetched from 14s to 18s per ton in London. Transport costs were seldom under 7s per ton. Joliffe recorded that pipe makers and potters bought directly from the ships at the London wharves.

Adams and Redstone (1981) stated that during the 18<sup>th</sup> century the source for much ball clay used by the pottery industry came from the Teignmouth area in South Devon and from Dorset close to Poole. The mid Eocene Poole deposits constitute the Wareham basin, which is a synclinal deposit with a regional gentle plunge to the east. Palmer and Witte (2000) recognise four main productive clay cycles within the basin. In ascending order these are the lowest Creekmore unit/Sequence, the Oakdale unit/Sequence, Broadstone unit/Sequence and the overlying Parkstone clay. Apparently the Broadstone Sequence, also known as ‘GP’ or ‘Prima’ by Imerys, was the unit most exploited during the 18<sup>th</sup> century and Palmer and Witte (2000) record that an extensive network of open pits up to 30 m deep extend for some 8 km along the southern and eastern parts of the basin. Typical chemical analyses from the Creekmore Sequence and overlying Broadstone Sequence are given in Table 3. Andrew Deeming of Imerys Minerals reports (written com. January, 2002) that the basal Creekmore Sequence is a pale grey to buff-grey, white-firing, ball clay that often contains blue sulphide staining hence earning the informal company name of ‘Povington Blue’. The Broadstone Sequence, another typical white-firing, ball clay, is typically pale grey to brown grey with some traces of red/yellow staining.

*Virgin earth.* Church (1881, 1885) appears to have been among the first to recognise that Bow second patent wares required the addition of bone ash to the paste. He records in 1885,

In the second patent, taken out by T. Frye, November 17<sup>th</sup> 1748, the unaker is replaced by other materials. Two parts of virgin-earth, produced by the calcinations of certain animals, vegetables and fossils, are directed to be mixed with one part of flint or sand and fritted; then of

this frit two parts are taken and mixed with one part of pipe clay. The glaze was made of red lead, saltpeter and sand, with some white lead and smalts. There can be no difficulty in identifying the earth produced by the calcinations of certain animal and vegetable matters with bone-earth, that is calcined bones which consist mainly of phosphate of lime. The patentee, of course, did not desire to be too explicit.

Church then quotes from Dossie’s *Handmaid of the Arts* (1758),

The following composition will produce wares which will have the properties of the true china, if they be rightly managed in the manufacture. Take of the best white sand, or calcined flints finely powdered, 20lbs., add to it very white pearlshes 5lbs., of bones calcined to perfect whiteness, 2 lbs.

Eccles and Rackham (1922) state that there can be little doubt that ‘virgin earth’ was none other than bone ash and that all four Bow porcelain examples analysed by them disclose the presence of this ingredient. Hurlbutt (1926) suggested that this substance comprised phosphatic frit – the product of calcined bones, fossils, oyster shells etc, but no doubt, in practice mainly calcined bones. Honey (1933) notes that bone ash has long been known as a possible ingredient in porcelain as proposed in a work cited by Professor Ernst Zimmermann. Watney (1973) has suggested that based on the work of Herman Boerhaave MD (1668–1738), the term ‘virgin earth’ probably represented the basic material of creation, which could be obtained from animals, vegetables, or fossils of the calcareous kind. Work by Professor Julian Henderson (Henderson, in prep) has recognised significant bone ash concentrations occurring close to the interface layer between glaze and body in Ottoman Iznik ceramics derived from Turkey. Henderson observes that this bone ash occurs in sufficient quantities to indicate that it was added deliberately.

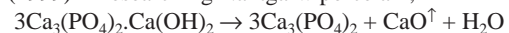
Such an ‘earth’ as stated in the patent, was the fixed indissoluble matter produced by the calcination of animal and vegetable substances and calcareous minerals such as chalk and limestone. Based on the Wedgwood formulation of 1759, Watney (1973) suggests that ‘virgin earth’ in this instance most probably includes both bone ash and gypsum. As will be shown in this account ‘virgin earth’ at the time of the 1749 patent (*New Canton period*), comprised ~90 wt % bone ash and ~10 wt % glass cullet – either flint glass, lime-alkali glass, or a mixture of both, and no gypsum. However during the

*Developmental period* (c.1746) 'virgin earth' comprised bone ash, glass cullet, and variable amounts of sulphate sulphur derived from gypsum or in some instances possibly alum, whereas during the *Bowcock period* (1755 – c.1769) 'virgin earth' comprised bone ash ~90 wt% and gypsum ~10 wt% alone, with no glass cullet.

Adams and Redstone (1981) recorded that bones might have been obtained directly from the knackers' yards in east London. John Baddeley of Staffordshire obtained his bone ashes from Newdick & Nicholas of Cornhill and this firm could have supplied the Bow factory as well. Apparently Newdick and Nicholas also supplied potters with lampblack and smalts (pulverised glass containing dilute cobalt).

The composition of bone ash as published in the literature shows some variability and Owen (2001b) notes that it is difficult to surmise the initial composition of bone ash used in 18<sup>th</sup> century ceramic pastes. Bone matter comprises essentially hydroxyapatite ( $\text{Ca}_5(\text{OH})(\text{PO}_4)_3$  a hydrated calcium phosphate with  $\text{CaO}/\text{P}_2\text{O}_5 = 3.33$  (molecular proportions) (Tite and Bimson, 1991; Deer, Howie, and Zussman, 1992). Hamer (1975) gives a typical analysis of bone as CaO 55 wt%,  $\text{P}_2\text{O}_5$  40 wt%, and the remainder made up of silica, various alkaline oxides, and possibly minor carbon. Owen (2002) uses the composition  $\text{Ca}_3(\text{PO}_4)_2 \cdot \text{Ca}(\text{OH})_2$  which gives  $\text{CaO}/\text{P}_2\text{O}_5 = 4.00$  (molecular proportions). Owen (2001b, 2002) notes that animal bones 'burned' below 1000°C give rise to low-fired bone ash with CaO 58.37 wt%,  $\text{P}_2\text{O}_5$  36.94 wt%, and  $\text{H}_2\text{O}$  4.69 wt% ( $\text{CaO}/\text{P}_2\text{O}_5 = 4.00$  (molecular proportions)). When added to ceramic pastes and fired to temperatures >1000°C bones progressively dehydrate and over a temperature range of 1000–1400°C (St. Pierre, 1955) the anhydrous mineral  $\beta$ -tricalcium phosphate more commonly referred to as *whitlockite*  $\text{Ca}_3(\text{PO}_4)_2$  develops through dehydration (loss of water) and partial volatile-loss of calcium. Consequently on progressing from animal bones to high-fired calcined bones or whitlockite the  $\text{CaO}/\text{P}_2\text{O}_5$  ratio changes from 4.0 to 3.0 (molecular proportions). However if this calcination and subsequent loss of calcium were to take place in the presence of clay contained in the body of the porcelain then there would be a good chance that much of this calcium instead of being lost to the system would react with various clay minerals and form new calcium silicate minerals (e.g. gehlenite), hence resulting in but minor reduction to the initial bulk  $\text{CaO}/\text{P}_2\text{O}_5$  ratio

(Owen et al., 2000). This partial loss of calcium from bone ash has been expressed by Owen and Morrison (1999) in researching Nantgarw porcelain,



Owen (2002) reports that the bulk  $\text{CaO}/\text{P}_2\text{O}_5$  ratio (molecular proportions) for most British phosphatic porcelains tends to range between 3.2–3.84, which would suggest that reaction of CaO with clay in the body was minimal and CaO was lost to the system and/or that the bone ash used was initially high-fired prior to addition to the paste. Where calcium-bearing minerals such as gypsum or limestone are added to the paste in addition to bone ash, then one might expect the CaO loss to be broadly balanced by an increase in bulk  $\text{CaO}/\text{P}_2\text{O}_5$  such that there would be limited departure from the initial theoretical value.

*Quartz sand and flint.* The silica used in the body of Bow second patent porcelains was most likely sourced from variable localities. Wedgwood in his 1759 *Experiment Book* records the use by Bow of Lynn sand, which we assume refers to King's Lynn in Norfolk. It is known that this sand was shipped from the Norfolk coast to London. Adams and Redstone (1981) recorded that Edmund Elsdon, a merchant of Lynn, supplied John Baddeley with sand and from insurance policies he was selling both sand and Baltic timber from as early as 1753–1767. Although Baddeley's works were in North Staffordshire, he sourced his supplies through London dealers. An alternative source of potters' sand was obtained from the Isle of Wight (Shaw, 1837). De La Beche and Reeks (1855) record that the sand used to render the clays perfectly 'dry,' is mentioned as having been obtained from Alum Bay, located on the northern side of the Isle of Wight. This sand has been extensively employed in the manufacture of glass. Chaffers (1869) in reporting on the 1867 Bow site discovery, notes that both calcined flints and pieces of quartz, used in making the frit or glaze were recovered. Toppin (1922) reports the presence of pieces of flint, whilst Redstone (1969) describes a layer of Bow biscuit wasters above a hard compacted layer of pebbles and flints which may have represented an old backyard surface of the factory. Flint, or chert, is a form or microcrystalline or cryptocrystalline silica and in south-east England occurs as nodules or secretions in chalk and limestone deposits.

*Glass cullet.* Unlike the specifications of the Bow first patent, where up to half the paste can comprise a purpose-made glass frit (probably bulk lots of essentially lead-free cullet most likely procured from

glass merchants), the second Bow patent makes no reference to the use of such a material. Chemical analyses undertaken during this research indicate that glass frit was a small but important component of the wares made during the *Developmental*, *New Canton*, *Transitional*, and *Tidswell periods*. Unlike the porcelains of the 'A'-marked period, it is inferred from these analyses that little effort was made to sort the glass used into lead-bearing and lead-free and in a number of instances both types of glass were mixed together and added. Freestone et al. (2003) record a similar feature with the Isleworth factory and they suggest that this variation may indicate deliberate experimentation at Isleworth or poor control over the type of cullet added. In the case of Bow we suspect that the latter is more likely. It is tempting to speculate that two of the Bow proprietors, John Weatherby and John Crowther, who were partners in the Green Yard Glasshouse at East Smithfield in the Tower area, may have supplied this raw material to the manufactory. Telfer (1995) records the presence, on the Bow factory site within the Phase V layer, of a significant proportion of bottle glass.

Owen (2001b) appears to have been the first to recognise the addition of lead glass, or even fritted lead glaze, to the body of phosphatic soft-paste porcelains based on his work on Bonnin and Morris, Philadelphia. Subsequently Freestone et al. (2003) extends these observations to include porcelains from Isleworth and based on analysed material then available, Freestone et al. (2003) conclude that Isleworth porcelains can be distinguished from all other British 18<sup>th</sup> century bone ash porcelains on account of their elevated PbO (2.2–4.2 wt%) and K<sub>2</sub>O (1.6–3.3 wt%) levels. As will be shown in this paper, Bow was apparently adding variable amounts of lead glass (or fritted lead-rich glaze) to its paste by the *Developmental period* c.1746. Although Freestone et al. (2003) note the high levels of both PbO and K<sub>2</sub>O appear to be peculiar to Isleworth bodies, similar high levels are also found in a number of Bow items from both the *Developmental* and *New Canton* (c.1746–1753) periods and to a lesser degree, based on three analyses, the *Tidswell period* (c.1770–1774).

*Gypsum and alabaster.* Josiah Wedgwood on setting out his Bow porcelain formulation in his experiment book for February 13<sup>th</sup>, 1759 records the use of ¼ part gypsum or alabaster out of a total of 8 ½ parts. Adams and Redstone (1981) comment that

Until proved otherwise the use of gypsum (calcium sulphate, CaSO<sub>4</sub>·2H<sub>2</sub>O) in the Bow body must be regarded as highly improbable, as sul-

phates, for reasons not fully understood, cause faults in both body and glaze during firing.

Subsequently Tite and Bimson (1991) confirm the likely use of gypsum in the Bow paste recipe. They also make the interesting deduction that Wedgwood may have been incorrect in stating that gypsum was added to both the earlier fritted body materials as well as the later unfritted components; rather the addition of gypsum may have commenced with the change from the fritted to unfritted procedure. Owen and Day (1998) on analyzing five Bow porcelain sherds demonstrate that the samples contain substantial amounts of sulphur (2.1–2.9 wt%) expressed as SO<sub>3</sub>. They note that these data support previous microprobe analyses carried out by Tite and Bimson (1991) and Owen and Day (1994) and they deduce that the sulphur was introduced in the form of gypsum. Owen (2002) records that sulphur determinations for English porcelain may be underestimating the original amount of sulphur added to the paste because some of the sulphur could have been lost from the porcelain body during firing.

Three 18<sup>th</sup> century factories producing phosphatic wares, which added gypsum or alabaster to their recipe paste, are known to us, these being Bow (Owen and Day, 1998; this study), Bonnin and Morris (Owen, 2001b), and Isleworth (Freestone et al., 2003). In the case of the English concerns, this gypsum was apparently sourced from mines in Derbyshire (Adams and Redstone, 1981: 82).

*Ground Oriental porcelain.* Robert Dossie in his *Handmaid of the Arts* (1758) records that he had seen at one of the ceramics works near London, eleven mills grinding broken Oriental china, which was then mixed with a fluxing agent and a 'new' ceramic ware produced. Apparently the resultant ware was grey, full of flaws and bubbles, and because of the lack of plasticity of the paste used, was wrought in a clumsy manner. Dossie then reports that this ware contrasts with another body produced by a rival factory in the neighborhood of London. This latter body has great whiteness, has the texture of glass, can be formed or cast in a most delicate manner, and lacks the ability to withstand thermal shock. In this case, one might suspect that Dossie was referring to either Chelsea or Gouyen's Girl-in-a-Swing factory. Hurlbutt (1926) assumed that the record of the use of ground Chinese porcelain was in reference to the Bow factory, yet the description in the account of the porcelain ware produced with its greyish cast, flaws, and bubbles does not accord with what we currently know of Bow porcelain. Likewise based on the

chemical analyses contained in this account, we have been unable to substantiate Hurlbutt's belief. Although Dossie claims that he had seen these mills located near London, his report appears to reflect an earlier account (Hill, 1716). Here Hill states,

Let any good Workman in the Potters Proffion, who would benefit himself by this Art, employ fome poor people to buy up the old broken China, which every Houfe can afford him. This Ware he muft grind in a Mill, with a flat Stone and Runner. The Mill is a common one, and every-where to be met with. The Powder, when it comes from the Mill, muft be further reduced and refin'd by the Affiftance of Water, in the manner which juft now defcrib'd.....

Godden (2004a:19) records that the area around the Caughley grind mill contained a huge range of Chinese, as well as English porcelain, fragments of which would, or could, have varied the Caughley 'standard mix' to some extent.

*Alum.* Alum is a hydrated aluminium potassium sulphate  $\{KAl(SO_4)_2 \cdot 12H_2O\}$  and is an unusual addition to porcelain bodies. Church (1881) records that the body or paste of *Vieux Sèvres* or *pâte tendre* comprises 8 parts marl, 17 parts chalk, and 75 parts glassy frit with alum comprising 3.6 parts of the glassy frit out of 100 parts. Dragesco (1993) reports the use of alum in a frit mixture prepared by Jacques Louis Brolliet for the acclaimed French scientist, Jean Hellot, but notes that alum is not an ingredient previously used by porcelain makers and he wonders where Brolliet got the idea. The first probable use of alum in English porcelain is reported in the body of a Bow first patent tea-canister of the 'A'-marked group (Ramsay and Ramsay, 2005a) and the subsequent possible use of this component is traced in this account to some of the wares of the Bow second patent belonging to the *Developmental period* as discussed below.

#### *Previous Chemical analyses of Bow second patent porcelains*

Chemical compositions and deduced paste recipes used in the Bow second patent porcelains can be arrived at by either direct analysis of the porcelain body or by use of two recipe specifications, namely those contained in the 1749 patent and the Wedgwood formulation of 1759. The first reported chemical analyses undertaken on phosphatic ceramic material from an unknown factory source is con-

tained in De La Beche and Reeks (1855). In a footnote to page 28 they record that the chemical composition of English soft-paste porcelains has chiefly engaged the attention of a Mr Cooper, who provided three analyses, all of which were phosphatic with  $P_2O_5$  (+  $Fe_2O_3$ ) varying from 26.4, 15.4, and 15.3 wt% and  $Al_2O_3$  21.5, 24.5, and 24.7 wt%. Based on our current knowledge of phosphatic soft-paste porcelains (Bow, Lowestoft, Isleworth etc) it might appear that the  $Al_2O_3$  values, which we assume were obtained gravimetrically in the so-called classical manner by Cooper, are too high – a problem that plagued subsequent work by Church (1881, 1885), Spelman (1905), and Eccles and Rackham (1922). The accurate gravimetric derivation of  $Al_2O_3$  is notoriously difficult and we assume that unless there is a high-clay, phosphatic paste used by Bow of which we are unaware, then these high  $Al_2O_3$  values are in error.

Church in his Cantor Lecture of 1880 (Church, 1881) reported on the analyses of unglazed ceramic wasters disinterred during draining works carried out by Messrs. Bell and Black on the southern side of Stratford High Street, Essex. Subsequently Church (1885) noted that his analytical results were obtained by means of a careful chemical examination of some fragments of glazed and unglazed porcelain wasters. One analysis only was published by Church (1881, 1885) as given in Table 6.

We are uncertain whether this analysis is taken from one waster alone or whether it represents the average or mean analysis based on a number of analyses. Church continues that the presence of a lead glaze proved that the wasters were not made according to the 1744 patent. Church's published analysis, as with Cooper's three analyses, has a high  $Al_2O_3$  value of 16 wt%, which we suspect is in error as noted above. Based on the  $P_2O_5$  content, Church also calculates the bone ash component of the recipe based on his published analysis as 44.3 wt%. This bone ash value is in close accord with our calculations for wares made between c.1746–1754.

Although the Church analysis demonstrates that the waster was phosphatic, the elements sulphur and lead were not reported. Of note are the comments made by Church (1911) where on reporting on the 1867 waster discovery in Stratford High Street he states that,

The number of specimens free from bone ash was quite insignificant. thus implying that some specimens were not phosphatic. Unfortunately Church does not expand on



|                                | 1     | 2     | 3      | 4     | 5     | 6    | 7    | 8    | 9     | 10   | 11    | 12    | 13    |
|--------------------------------|-------|-------|--------|-------|-------|------|------|------|-------|------|-------|-------|-------|
| SiO <sub>2</sub>               | 40.0  | 43.58 | 42.80  | 55.10 | 50.38 | 43.8 | 38.9 | 49.1 | 45.6  | 50.7 | 49.2  | 51.2  | 53.4  |
| TiO <sub>2</sub>               | nd    | nd    | nd     | nd    | nd    | nd   | nd   | nd   | 0.5   | 0.2  | 0.3   | 0.3   | 0.3   |
| Al <sub>2</sub> O <sub>3</sub> | 16.0  | 8.36  | 8.84*  | 16.50 | 7.78  | 7.8  | 8.3  | 4.8  | 8.7   | 5.6  | 5.6   | 5.6   | 4.6   |
| FeO                            | trace | nd    | nd     | trace | nd    | nd   | nd   | nd   | 0.5   | ?    | 0.3   | 0.3   | 0.2   |
| MnO                            | nd    | nd    | nd     | nd    | nd    | nd   | nd   | nd   | nd    | nd   | nd    | nd    | 0.1   |
| MgO                            | 0.8   | 0.60  | trace  | 0.40  | trace | 0.6  | 0.7  | 0.8  | 0.6   | 0.4  | 0.3   | 0.6   | 0.4   |
| CaO                            | 24.0  | 24.47 | 28.32  | 15.12 | 24.87 | 25.8 | 29.1 | 25.8 | 23.6  | 23.8 | 24.5  | 23.2  | 22.2  |
| Na <sub>2</sub> O              | 1.3   | 1.20  | 1.12   | 0.13  | 0.70  | 1.4  | 1.0  | 1.0  | 0.8   | 0.5  | 0.5   | 0.6   | 0.7   |
| K <sub>2</sub> O               | 0.6   | 0.85  | 0.72   | 0.70  | 0.53  | 1.2  | 0.9  | 1.4  | 1.1   | 0.7  | 0.6   | 0.6   | 0.6   |
| P <sub>2</sub> O <sub>5</sub>  | 17.3  | 18.95 | 18.10  | 11.50 | 13.66 | 18.3 | 20.1 | 16.4 | 18.6  | 15.8 | 16.2  | 15.3  | 14.7  |
| PbO                            | nd    | 1.75  | 0.50   | nd    | 1.49  | 0.74 | 0.53 | 0.44 | ?     | ?    | 0.4   | 0.4   | nd    |
| SO <sub>2</sub>                | nd    | nd    | nd     | nd    | nd    | nd   | nd   | nd   | ?     | 2.0  | 2.1   | 1.9   | 2.8#  |
| Total                          | 100.0 | 99.76 | 100.40 | 99.63 | 99.41 | 99.6 | 99.5 | 99.7 | 100.0 | 99.7 | 100.0 | 100.0 | 100.0 |

1. Church (1881, 1885) Waster from the 1867 excavation
2. Eccles and Rackham (1922) Moulded white and gold sauceboat. C.673-1920 (B20)
3. Eccles and Rackham (1922) Moulded polychrome sauceboat. C.845-1920
4. Eccles and Rackham (1922) Fragment of white prunus coffee cup. C.590-1919 (B16)
5. Eccles and Rackham (1922) Fragment of an underglaze blue fruit dish. C.16-1920 (B18)
6. Adams and Redstone (1981) 'R'-marked waster recovered in 1969. Analysis No. 3 (B119)
7. Adams and Redstone (1981) Polychrome nappy plate. Analysis No 4 (B13)
8. Adams and Redstone (1981) Powder blue-ground plate. Analysis No 5
9. Tite and Bimson (1991) Moulded white and gold sauceboat. C.673-1920 (B20)
10. Tite and Bimson (1991) Fragment of white prunus coffee cup. C.590-1919 (B16)
11. Tite and Bimson (1991) Fragment of an underglaze blue fruit dish. C.16-1920 (B18)
12. Tite and Bimson (1991) Fragment of an underglaze blue bowl. Brit. Museum Research Lab. 32703 (B43)
13. Owen and Day (1998) Bulk analysis of five wasters

\* combined Al<sub>2</sub>O<sub>3</sub> and iron oxide – possibly as Fe+++

# sulphur reported as SO<sub>3</sub>

? unclear whether this element is below detection level or not analysed for  
nd not determined

Table 6. Previous chemical analyses of Bow second patent porcelains.

this comment and one possible tentative conclusion, which we draw, is that these non-phosphatic wasters could have been representatives of one of the other paste types produced at Bow (hard-paste Si-Al-Ca, high-magnesian, or possibly glassy). Another possibility is that such wasters are foreign to Bow.

Herbert Eccles and Bernard Rackham (1922) presented analyses of four items of Bow porcelain (Table 6). Three of the four items have been subsequently reanalysed both by Tite and Bimson (1991) and in this study (Table 6). Again the problem of unduly high Al<sub>2</sub>O<sub>3</sub> (16.5 wt%) is seen in the Eccles and Rackham analysis of a fragment of a white prunus coffee cup now housed in the Victoria and Albert Museum (C.590-1919; B16) (Table 6, No. 4). Likewise an analysis of a Lowestoft unglazed fragment (Spelman, 1905) and quoted by Eccles and Rackham, also demonstrates the high-Al<sub>2</sub>O<sub>3</sub> problem,

with Al<sub>2</sub>O<sub>3</sub> given as 19.14 wt%. Of the four Bow analyses presented by Eccles and Rackham, one lacks a lead determination and all four lack sulphur determinations.

In a paper read to the English Ceramic Circle at Queen Anne's Mansions in 1935 (Hurst, 1937) two Bow analyses are presented. In one instance the total comes to 97.69 wt% and in both instances Al<sub>2</sub>O<sub>3</sub> is unusually high (16.5 and 14.4 wt%). We have to date been unable to substantiate any Bow second patent phosphatic wares with such high levels of Al<sub>2</sub>O<sub>3</sub> and for this discussion we have not included these analyses.

Adams and Redstone (1981: Appendix XV) subsequently published three additional analyses carried out by Dr Alwyn Cox using x-ray fluorescence instrumentation (XRF). The first analysis (Table 6, No 6) is from a scratch 'R' waster recovered during the 1969

site excavation (Redstone, 1969) and they note the close comparison in composition with the sauce boat (C.673-1920) as given in Table 6. Furthermore they note that the Alwyn Cox analysis of a nappy plate (Table 6, No. 7) belongs also to this same group with a comparable composition ( $\text{Al}_2\text{O}_3$  8.3 wt%) and a distinct PbO content of 0.53 wt%. Lastly Adams and Redstone (1981) present an analysis of a powder blue-ground plate (Table 6, No. 8), which they date on stylistic features as from the period 1758–1762. They note a marked compositional change with the proportion of bone ash slightly reduced and an increase in CaO in relation to  $\text{P}_2\text{O}_5$ . Likewise they note the reduction in  $\text{Al}_2\text{O}_3$  and a marked increase in  $\text{SiO}_2$  of about 6 wt% in this example. Adams and Redstone (1981) suggest that the proportions of clay and bone ash in this recipe were reduced and the proportion of silica in the form of either flint or quartz sand was increased, features that are supported by our own analyses for both the *Bowcock* and *Tidswell periods*. They observe that such changes in paste composition accord with the well-recognised deterioration in the Bow body, which occurred some time after 1755, with increased fragility and decreased translucency.

None of the analyses presented by Adams and Redstone includes sulphur, consequently they suggest that the increase in CaO in the powder blue-ground plate might reflect increased silica. Although they note that Josiah Wedgwood had in his entry in his 'Experiment' book for February 13<sup>th</sup>, 1759 recorded the use of gypsum or alabaster in the paste used at Bow, Adams and Redstone discount this possible addition until proven otherwise.

Tite and Bimson (1991) provide four analyses of Bow wares using a JEOL JSM 840 scanning electron microscope (SEM) coupled with an energy dispersive X-ray spectrometer (Link Analytical 860-500 series) attached to the SEM (Table 6, Nos 9–12). Three of the analyses are of items previously analysed by Eccles and Rackham (1922) whereas the fourth is an underglaze blue bowl (BM. 745, B18). All four analyses are given in Table 6. These analyses include  $\text{TiO}_2$ , PbO, and the important element, sulphur, reported as  $\text{SO}_2$ . Tite and Bimson from the presence of sulphur were able to deduce the use of gypsum in three out of the four analyses with the earliest sample (B20), which they dated to around 1750 having a higher clay content and lacking any sulphur. They observe that 'later Bow' can be differentiated from 'early Bow' on the presence of sulphate in the body yet inexplicably they fail to reference prior analyses and pertinent observations

made by Adams and Redstone (1981: 109, 238) who record a marked change in recipe by 1758–1762 and an associated physical change (increased fragility and decreased translucency) in the porcelain body which occurred sometime after 1755.

Owen and Day (1998) note that some of the analytical data in the literature is incomplete insofar as sulphate is not determined; hence the use at Bow of gypsum as reported by Josiah Wedgwood in 1759, cannot be substantiated. Owen and Day (1998) publish the bulk composition of five Bow sherds recovered from the Bow factory site in Essex. These data support the use of gypsum at Bow with sulphur, reported as  $\text{SO}_3$ , varying from 2.1–2.9 wt%. This sulphate sulphur has been demonstrated as partitioning into the calcium phosphate phase, whitlockite, during the dehydration of bone ash. The bulk analysis provided by Owen and Day indicates that the five wasters, all with distinct sulphur levels, conform to the *Bowcock period*. These workers also support Adams and Redstone with the observation that this group is more siliceous than other reported analyses and they suggest that these wasters represent a later period in the factory output.

An unusual analysis carried out by Reginald F. Milton and given by Scott and Scott (1961) on one of a pair of white octagonal plates with applied prunus blossoms, gives  $\text{SiO}_2$  58.0 wt%, combined  $\text{Al}_2\text{O}_3$  and  $\text{Fe}_2\text{O}_3$  8.2 wt%, MgO 1.0 wt%,  $\text{P}_2\text{O}_5$  4.8 wt%, CaO 20.3 wt%,  $\text{Na}_2\text{O}$  1.2 wt%,  $\text{K}_2\text{O}$  2.5 wt%, and PbO 4.0 wt%. Both titanium and sulphur were not determined. The unusual feature of this analysis is the very low  $\text{P}_2\text{O}_5$  relative to CaO and we have not seen any other analysis attributable to Bow second patent wares with  $\text{CaO} \gg \text{P}_2\text{O}_5$ . In view of the association between Reginald Milton and the analysis provided by him for a George II bust (Delevingne, 1963) which appears to have numerous inaccuracies (Watney, 1968; Ramsay and Daniels, in prep) and the comments by Watney (1968) where he states in relation to the George II busts that English ceramic studies have been bedeviled during the past twenty years or so by the publication of a very high proportion of inaccurate analyses, mostly emanating from one source, we have decided to discount this analysis of the Bow octagonal plate.

#### *Previous recipes for Bow second patent porcelains*

Recipes for the Bow second patent paste can be calculated on a theoretical basis after the manner of

Owen (2002) or can be deduced based on the specifications contained in the Bow second patent and in the formulation by Josiah Wedgwood as found in his Experiment Book dated February 13<sup>th</sup>, 1759 (No. 9, p.10) and now preserved in the Wedgwood Museum at Barlaston. In the case of the Bow second patent, the recipe can be calculated on an hydrous basis as given in Table 7, with 'virgin' earth 50 wt%, crushed silica 25 wt%, and pipe clay or ball clay 25 wt%. 'Virgin earth' has since Church (1881, 1885) been generally regarded as comprising bone ash, however in this account we will demonstrate that during the entire Bow output variable amounts of glass cullet and/or gypsum were combined with the bone ash.

Josiah Wedgwood records in his formulation of 1759 the following recipe proportions as given in Table 7, 4 parts bone ash, 4 parts Lynn sand, ¼ part gypsum or alabaster, and ¼ part blue ball clay. Interestingly, Wedgwood states that he was uncertain as to the exact proportions although he was apparently happy as to the correct identity of the various raw materials. Our data confirm that Wedgwood was

correct with respect to the components but may have been in error with respect to some of the proportions. Based on our analyses for the *Bowcock period* given below, we suggest that ¼ part gypsum is too low and ½ part is more likely. Likewise the level of ball clay is also too low as observed by Tite and Bimson (1991) and a full 1 part ball clay gives a better concordance with our analyses for the *Bowcock period*. This would give the 'corrected' Wedgwood formulation as 4 parts bone ash, 4 parts quartz sand, ½ part gypsum or alabaster, and 1 part ball clay (Table 7.).

Owen and Day (1998) in calculating the recipe derived from the bulk composition of five wasters apparently from the *Bowcock period*, give the following recipe in weight %:

|                              |        |           |        |
|------------------------------|--------|-----------|--------|
| whitlockite C <sub>3</sub> P | 32.2 % | limestone | 5.0 %  |
| gypsum                       | 4.8 %  | kaolinite | 10.0 % |
| silica                       | 48.0 % |           |        |

Subsequently Owen (2001b) notes that phosphatic porcelains generally have bulk CaO/P<sub>2</sub>O<sub>5</sub> (molecular proportions) ratios varying from 3.2–3.8 and by assuming an intermediate value with a bone ash

|                                | 1    | 2    | 3          | 4         | 5     | 6    |
|--------------------------------|------|------|------------|-----------|-------|------|
| SiO <sub>2</sub>               | 40.0 | 44.7 | 49.2       | 48.6      | 54.38 | 53.4 |
| Al <sub>2</sub> O <sub>3</sub> | 8.0  | 8.1  | 0.9        | 3.6       | 4.8   | 4.6  |
| CaO                            | 29.2 | 23.4 | 28.0       | 26.2      | 20.7  | 22.2 |
| Na <sub>2</sub> O              | 0.1  | 0.8  | 0.01       | 0.04      | 0.2   | 0.7  |
| K <sub>2</sub> O               | 0.8  | 1.0  | 0.1        | 0.36      | 0.5   | 0.6  |
| P <sub>2</sub> O <sub>5</sub>  | 22.0 | 20.2 | 20.4       | 18.1      | 16.1  | 14.7 |
| PbO                            | -    | 0.7  | -          | -         | -     | -    |
| SO <sub>3</sub>                | -    | -    | 1.4        | 3.1       | 2.7   | 2.8  |
| Ball clay                      | 25.0 | 24.9 | 0.25 part  | 1 part    | 14.6  | 13.7 |
| Bone ash                       | 50.0 | 43.8 | 4 parts    | 4 parts   | 35.8  | 32.7 |
| Lead glass                     |      | 1.7  |            |           |       |      |
| Alkali glass                   |      | 5.6  |            |           |       |      |
| Crushed silica                 | 25.0 | 24.0 | 4 parts    | 4 parts   | 44.1  | 48.0 |
| Gypsum                         |      |      | 0.25 parts | 0.5 parts | 5.5   | 5.6  |

1. calculated composition of the 1749 Thomas Frye patent based on the proportions recorded in that patent assuming that *virgin earth* comprises 100 wt% anhydrous calcined bone ash (CaO<sub>57</sub> P<sub>2</sub>O<sub>5.43</sub>) and ball clay based on the composition from the Broadstone Sequence, Dorset (Table 3)
2. average composition for the *New Canton period* (Table 9). Note the increased levels of K<sub>2</sub>O, Na<sub>2</sub>O, and PbO and this is assumed to represent the combination of crushed cullet with bone ash
3. calculated composition based on the Wedgwood formulation of 1759
4. re-calculated 1759 Wedgwood formulation using 1 part ball clay and 0.5 parts gypsum
5. comparative average composition for the *Bowcock period* (Table 13)
6. comparative bulk composition for 5 wasters (Owen and Day, 1998)

Table 7. Chemical analyses and recipes for Bow second patent wares as calculated for the 1749 Bow patent and the 1759 Wedgwood formulation.

composition of ( $C_{3.3}P$ ) recipe calculations will yield free calcite for samples where the bulk  $CaO/P_2O_5$  ratio is  $> 3.3$ . Consequently in such cases calcite may have not actually been used.

Based on our work and the recipe provided in the Wedgwood formulation we agree with Owen and we find no evidence that the Bow proprietors added limestone or calcium carbonate as a separate phase during the Bow second patent output with the possible exception of two very early octagonal plates (Scot and Scot, 1961). On recalculating the Owen and Day bulk analysis and allocating all remaining CaO to bone ash after stoichiometrical allocation is made to gypsum, we arrive at the following recipe (wt%) with a  $CaO/P_2O_5$  (bone ash) (molecular proportions) ratio of 3.49.

|          |        |           |        |
|----------|--------|-----------|--------|
| bone ash | 32.7 % | ball clay | 13.7 % |
| gypsum   | 5.6 %  | silica    | 48.0 % |

This recipe shows reasonable concordance with the average recipe calculated by us for the *Bowcock period* (Tables 7, 13) and from this we conclude that limestone was not utilised in Bow second patent wares during the *Bowcock period*. Consequently for this period, kiln temperatures may not have been high enough or prolonged enough to attain complete conversion of bone ash to whitlockite. Moreover, according to Wedgwood, during this phase the various components were not initially fritted and made into bricks.

#### *Classification of Bow second patent wares*

In this account the Bow second patent wares have been subdivided into five groups or periods based on their various chemical, physical, and decorative features namely:

- Bow second patent Developmental period *c.*1746
- Bow second patent Early period (or New Canton period) *c.*1747–1753
- Bow second patent Transitional period (or Target period) 1754
- Bow second patent Middle period (or Bowcock period) 1755–*c.*1769
- Bow second patent Late period (or Tidswell period) *c.*1770–1774

These subdivisions are based on the chemistry of the porcelain body and from this chemistry the recipe used in each case has been calculated on a theoretical basis in the manner of Owen (2002).

*Bow second patent Developmental period.* This group is based on five items (Fig. 6). These are a

'scratch-marked' polychrome bowl of the 'B'-marked group (B9, private collection), single polychrome shell-salt (B30) from the Newham Collection (Gabszewicz, 2000a:No. 35), a polychrome triple salt (B64) formerly in the Ainsley Collection and now in the Taylor Collection (Begg and Taylor, 2000: No. 3), and two underglaze blue items. These are a 'scratch-marked' mug known as the Knowles Boney mug (B10) as illustrated in Adams and Redstone (1981: Fig. 23A) and a thickly potted plate (B68) formerly in the Toppin collection, then in the Hewett collection (Amor, 1997: No. 7), and now in the Taylor Collection (Begg and Taylor, 2000: No. 2), with a similar but smaller plate illustrated in Adams and Redstone (1981: Plate 20).

Collectively this group conforms to the Bow second patent recipe, as characterised by wares of the *New Canton period* with approximately 50 wt% 'virgin earth' (bone ash + glass cullet both lead and alkali glass), 25 wt% crushed silica, and 25 wt% ball clay. In addition these items also contain distinct amounts of sulphur and on this basis these wares have been separated out from the *New Canton period* and are assumed to form an early developmental phase based their distinctive composition (Table 8). The use of sulphur in the recipe suggests a compositional and chronological link between these items of the Developmental period and the Bow magnesian tea-canister described above (Ramsay and Ramsay, 2005). The source of the sulphur is of particular interest and two possible sources present themselves namely gypsum (or alabaster) and alum. In an attempt to differentiate between the use of either gypsum or alum in the recipe mix, we have presented in Table 8 two sets of recipes, one calculated on the basis of the sulphur being added in the form of gypsum ( $CaSO_4 \cdot 2H_2O$ ) and the second set calculated on the basis that alum  $\{KAl(SO_4)_2 \cdot 12H_2O\}$  was the source of the sulphur. In the case of B10, and B68, and in particular B9, there is not enough  $K_2O$  in their respective analyses to allow for the stoichiometric addition of alum, so consequently in these instances we assume that gypsum was the source of the sulphur.

For example in the case of B68 after calcium is subtracted to account for the presence of gypsum based stoichiometrically on the level of  $SO_3$  being 4.14 wt% the remaining calcium is assigned to lime-alkali glass (4.3 wt%) and to the phosphorus to form bone ash (33.0 wt%). The resultant  $CaO : P_2O_5$  (molecular proportions) ratio in the bone ash is 2.96 (~3.0) which is very close to the ratio for whitlockite



Fig. 6. Selected images of porcelain from the Bow second patent *Developmental period*. Fig. 6a, triple shell-salt, East London, England, c. 1746 (B64). Soft-paste phosphatic porcelain. Width (W.) 140 mm. (Taylor collection). A triple shell-salt set on a *rocaille* base of shells, algae, and coral. The interior painted with trailing flowers in blue, yellow, red, and puce with fine outlining in brown. The shells are painted in puce and the algae in a dark green. Fig. 6b, shell-salt, East London, England, c. 1746 (B30). Soft-paste phosphatic porcelain. W. 89 mm. (Collection of the London Borough of Newham, photograph by courtesy of Michael Booth.) A single shell-salt with a drab appearance, set on a *rocaille* base of shells and coral. The interior painted with trailing flowers in blue, yellow, red, and puce with leaves picked out in green and blue green wash. The style and manner of painting is comparable to that shown in Figs. 4c,d. Fig. 6c, plate in underglaze blue, East London, England, c. 1746–7 (B68). Soft-paste phosphatic porcelain. Diameter (D.) 305 mm. (Taylor collection). The plate is thickly potted, heavy, and painted in the *disconsolate fisherman* pattern; see Amors (1997: No.7) and Begg and Taylor (2000: No. 2). Fig. 6d, mug in underglaze blue, East London, England, c. 1746–1747 (B10). Soft-paste phosphatic porcelain. H. 148 mm. (Formerly in the Knowles Boney collection and now in a private collection, photograph by courtesy of the owner). Painted in bright blue with a bold divided strap handle and a linear scratch mark to the base; see Adams and Redstone (1981: plates 23A and 23B). Fig. 6e, bowl with shaped rim, East London, England, c. 1746 (B9). Soft-paste phosphatic porcelain. W. 140 mm. (Private collection, photograph by courtesy of the owner). Painted in the *Chinoiserie* manner with vibrant enamels, blue, yellow, puce, brown, two shades of green, and deep aubergine. The porcelain body is distinctly white with a creamish translucency and a clear glaze. Incised on its base with a linear line and marked with a 'B' in on-glaze aubergine. See Begg and Taylor (2000: No. 35) for a comparable shaped incised bowl but lacking the 'B' mark.

|                                | B9     | B10    | B30    | B64   | B68    | Average |
|--------------------------------|--------|--------|--------|-------|--------|---------|
| SiO <sub>2</sub>               | 48.34  | 43.27  | 40.04  | 47.77 | 46.92  | 45.27   |
| TiO <sub>2</sub>               | 0.44   | 0.61   | 0.40   | 0.30  | 0.18   | 0.39    |
| Al <sub>2</sub> O <sub>3</sub> | 5.00   | 9.71   | 6.70   | 7.08  | 7.11   | 7.12    |
| FeO                            | 0.18   | 0.24   | 0.30   | 0.41  | 0.52   | 0.33    |
| MgO                            | 0.33   | 0.72   | 0.60   | 0.36  | 0.34   | 0.47    |
| CaO                            | 22.65  | 22.79  | 25.30  | 21.49 | 21.16  | 22.68   |
| Na <sub>2</sub> O              | 0.88   | 1.15   | 0.30   | 0.49  | 0.55   | 0.67    |
| K <sub>2</sub> O               | 0.68   | 0.69   | 2.70   | 1.25  | 1.49   | 1.36    |
| P <sub>2</sub> O <sub>5</sub>  | 18.43  | 20.00  | 20.00  | 19.00 | 15.07  | 18.50   |
| PbO                            | bdl    | 0.13   | 1.70   | 1.30  | 2.55   | 1.14    |
| SO <sub>3</sub>                | 3.08   | 0.74   | 2.00   | 0.55  | 4.14   | 2.10    |
| Total                          | 100.01 | 100.05 | 100.04 | 100.0 | 100.03 | 100.03  |

Calculated recipes (hydrous wt%) on the basis that gypsum is the source of sulphur.

|   | B9   | B10  | B30  | B64  | B68  |
|---|------|------|------|------|------|
| Ball clay   | 15.0 | 29.8 | 20.5 | 21.8 | 21.5 |
| Bone ash  | 40.1 | 41.9 | 42.8 | 40.4 | 33.2 |
| Lead glass  |      | 0.3  | 4.4  | 3.4  | 6.6  |
| Alkali glass                                      | 6.3  | 6.6  | 12.0 | 4.2  | 4.3  |
| Gypsum  | 6.2  | 1.5  | 4.1  | 1.1  | 8.4  |
| Crushed silica                                    | 32.4 | 19.8 | 16.2 | 29.0 | 26.0 |
| CaO/P <sub>2</sub> O <sub>5</sub> #<br>(bone ash) | 3.0  | 2.7  | 2.8  | 2.7  | 3.0  |
| CaO/P <sub>2</sub> O <sub>5</sub> #<br>(bulk)     | 3.1  | 2.9  | 3.2  | 2.9  | 3.6  |

Calculated recipes (hydrous wt%) on the basis that alum is the source of sulphur.

|  | B10  | B30  | B64  | B68  |
|--|------|------|------|------|
| Ball clay                                      | 28.3 | 20.0 | 21.2 | 16.6 |
| Bone ash                                       | 42.6 | 43.6 | 40.7 | 34.7 |
| Lead glass                                     | 0.3  | 4.3  | 3.4  | 6.3  |
| Alkali glass                                   | 6.6  | 8.3  | 3.3  | 1.8  |
| Alum   | 2.1  | 5.6  | 1.6  | 11.3 |
| Crushed silica                                 | 20.1 | 18.2 | 29.9 | 29.3 |
| CaO/P <sub>2</sub> O <sub>5</sub> # (bone ash) | 2.8  | 3.0  | 2.8  | 3.5  |
| CaO/P <sub>2</sub> O <sub>5</sub> # (bulk)     | 2.9  | 3.2  | 2.9  | 3.6  |

B9. *famille rose* incised bowl (private collection)

B10. underglaze blue Knowles Boney mug (private collection)

B30. polychrome single shell-salt. See Gabszewicz (2000a: No. 35)

B64. polychrome triple shell-salt (Taylor collection)

B68. underglaze blue plate with *Disconsolate fisherman* pattern (Taylor collection)

# molecular proportions

Table 8. Chemical analyses and calculated recipes for the *Developmental period* (~1746).

(~2.99) and not low-fired bone matter (~4.0). However in the case of alum, calculations demonstrate that there is not enough potassium in the analysis to form alum, lime-alkali glass, ball clay, and lead glass collectively and hence in this instance it is considered that the sulphur identified in B68 was added in the form of gypsum, not alum. Likewise with the Knowles Boney mug (B10) where the level of  $K_2O$  (0.69 wt % based on two analyses, 0.68 and 0.70 wt%) is too low to allow for the stoichiometric allocation of potassium to alum. However based on a gypsum recipe the bulk  $CaO/P_2O_5$  ratio (2.88 molecular proportions) is below that of whitlockite suggesting that the bulk level of  $CaO$  with respect to  $P_2O_5$  in the analysis is a little low. Regardless it does appear that gypsum is the source for the sulphur recorded in B10. With B9 the  $K_2O$  level (0.68 wt%) is too low to allow for the presence of alum as well as other phases requiring potassium such as alkali glass and ball clay. Consequently no attempt has been made to calculate a theoretical alum-based recipe for B9 in Table 8 and it is assumed that for this item gypsum was the source of the sulphur in the analysis.

In the case of the Borough of Newham single shell-salt (B30)  $K_2O$  is particularly high in the analysis for the porcelain body (2.4, 2.5, 2.3, and 3.4 wt% with an average value of 2.7 wt%) and it is conceivable that alum was the source for the sulphur. This is supported by the bulk  $CaO/P_2O_5$  (molecular proportions) 3.20. When the recipe is calculated on the basis that gypsum is the source for the sulphur the  $CaO/P_2O_5$  ratio for the bone ash or whitlockite component of the recipe drops to 2.79 (~2.8), which is below that of whitlockite, thus indicating non-stoichiometric whitlockite. In contrast the glass cullet component (lead and lime-alkali glass) for the gypsum-based recipe at 16.4 wt% looks to be too high. On this basis it is suggested that there are grounds for suspecting that alum may have been used in the recipe for B30 with combined glass cullet in the recipe dropping to 12.6 wt% and the  $CaO/P_2O_5$  (bone ash) being 3.0. The triple shell salt (B64) in the Taylor collection likewise could have alum in the recipe but it is difficult in this case to differentiate whether alum and gypsum is the more likely.

The average analysis for the group is given in Table 8. The recipes calculated on a gypsum basis may be incorrect as one, if not two, of the analyses from this group appear to satisfy an alum-based recipe. Characteristic chemical features of this early period at Bow can be seen in the high  $Al_2O_3$  (7.65

wt%),  $TiO_2$  (0.37 wt%), and  $FeO$  (0.37 wt%). The moderate levels of the colourant oxides  $TiO_2$  and  $FeO$  indicate that ball clay was used in contrast to the primary China clay used in Bow first patent wares. Of note are the variable levels of  $K_2O$  and  $PbO$ , assumed to have been introduced through the addition of a lead-rich cullet and in addition in the case of  $K_2O$ , possibly alum. The underglaze blue plate (B68) has the highest lead level of  $PbO$  2.55 wt% and  $K_2O$  1.49 wt% suggesting that Bow, along with both Bonnin and Morris and Isleworth, added lead-rich cullet (Owen, 2001b; Freestone et al., 2003). We suspect that this addition did not represent experimentation on the part of Bow, but rather a lack of quality control with respect to the type of cullet added. We note that both B9 and B68 show some departure from the average of this group. This suggests to us one or more of the following. Firstly there may have been inadequate mixing of the paste at the factory resulting in a compositionally inhomogeneous body, an unlikely event as indicated by Professor Owen (written com., 2006). Secondly the analyses may have been defective and thirdly both may represent an early experimental development of the paste recipe.

In summary the wares of the *Developmental period* are broadly characterised by a ball clay content of around 23 wt% (hydrous), crushed silica of about 27 wt%, and a combined bone ash, crushed cullet, and a variable sulphur source (assumed to be introduced as sulphate sulphur) of around 50 wt% (hydrous). We suggest that with this early group of wares the combined bone ash, cullet, and sulphur source would collectively equate with what Thomas Frye referred to in his patent specifications as 'virgin earth'. Stylistic and decorative features of some members of this small, early group of Bow second patent wares are discussed by Adams and Redstone (1981) and Gabszewicz (2000b).

The concept of a mushroom-grey or drab appearance, which has been applied to a small group of early Bow second patent wares by numerous workers, can be traced back nearly fifty years to Tait (1959) and the Bow Porcelain Special Exhibition. Here Tait groups four enamelled shell-salts, a tankard, a sauce boat, and two undecorated wasters recovered in 1921 from the Essex site, all of which (both glazed and unglazed) were described by Tait as having a markedly (or in one case a less markedly) mushroom-grey appearance. Barrie Taylor (written com., 2006) notes that recorded examples typically are objects which were not made in emulation of the contemporary imported Chinese wares but rather

have strong links to English silver forms, such as shell-form “salts”, sauce boats, and tankards. In addition Tait records that no figures are known with a ‘mushroom-grey or drab appearance’ corresponding to that found in early decorated table-wares and by inference he appears to accept that known figures must date from 1750 or younger. Tait refers to Hurlbutt (1926: page 95 and plate 16b) where Hurlbutt records a pair of single shell-salts displaying what Tait quotes as having a “greyish-drab body and glaze.” However Hurlbutt does not elevate this greyish-drab feature to the descriptive or classificatory significance as used by Tait and instead appears to restrict this description to these salts alone. On page 95 Hurlbutt refers to these two items as having a greyish-drab body and glaze, whereas in the caption to plate 16b, he refers to the body alone having this drab appearance. Subsequent workers have followed Tait with Adams and Redstone (1981) applying this drab appearance to both the body and glaze of a small group of wares, Gabszewicz and Freeman (1982), Gabszewicz (2000a, b) and Spero (1990: No. 13) to the glaze alone, and Begg and Taylor (2000) to the body (No. 3, shell-salt with dense grey body and clear glaze), the glaze (No. 5, pug dog with dense white body and clear grey glaze), or to both body and glaze (No. 51, sauce boat with dense grey body and drab blue glaze).

Based on porcelain composition, as derived from our work, some members of the so-called drab group belong to the *Developmental period* and others, such as a sauce boat with flying handle (B66) and a fluted teapot (B62), which Gabszewicz (2000c) regards as having a drab coloured glaze and Begg and Taylor (2000: No 34) a clear glaze, lack sulphur and are consequently grouped with the *New Canton period*, albeit very early within that period. We regard this drab appearance as essentially an artefact of kiln-firing conditions (Ramsay et al., 2004a) and based on composition, we identify a more diverse group than previously recognised as belonging to the earliest recognisable Bow second patent wares, some of which such as B9 have a distinctly white body and colourless glaze. Consequently we would suggest, based on paste composition, that the use of ‘drab-grey’ or ‘mushroom-grey’ to recognise early items of Bow second patent porcelain should be used with care in that other equally as early items lacking any drabness may be overlooked and consequently given a later date than warranted. A case in point is an incised bowl (Begg and Taylor, 2000: No. 35), which by analogy with B9 may be distinctly earlier than the

date range of 1750–1752 as given by Begg and Taylor. Ramsay et al. (2004a) note that the Bow proprietors may initially have had trouble in firing ball clay with its higher levels of colorant oxides when compared to that found in Cherokee clay and consequently some early members of the second patent may indeed display this reduction drab feature. Nevertheless, through both experimentation and variation in oxygen fugacity within a single kiln firing, a range of wares having variable or non-existent levels of drabness could have been produced from a single or closely contemporary kiln batch. As discussed below, we strongly suspect that there are still earlier extant phosphatic wares, as yet unrecognised, belonging to a hypothetical *Experimental period* which would overlap with, or predate the *Developmental period*. Tait (1963) has speculated on similar ideas with regard to rare figures in the white, such as the Chinoiserie group symbolic of Air.

*Bow second patent Early or New Canton period.* This period is dated to c.1747–1753 and compositionally members of this group approximate the recipe as calculated from the Bow second patent (Table 7), with both ball clay and crushed silica each around 25 wt% and ‘virgin earth’ comprising some 45 wt% (hydrous) bone ash and 5 wt% cullet. This glass cullet comprises variable amounts of either or both flint or lead glass and alkali glass. Neither gypsum nor alum was detected for this period (Table 9, Fig. 7). Three examples analysed and included by us as a sub-group within the *New Canton period*, are unusually enriched in both lead and potassium with > 1.25 wt% PbO. All three are in the ‘white’ (Table 10). The first is a standing Negress with a basket (B28) housed in the collection of the London Borough of Newham (Gabszewicz, 2000b: No. 73). A similar example from the Katz Collection, in the Museum of Fine Arts, Boston has an incised date for 1750. B28 has K<sub>2</sub>O 1.26 wt% and PbO 3.11 wt% and recipe calculations suggest an unusually high glass cullet component with lead glass 8.0 wt% and alkali glass 5.6 wt% giving a total cullet component of 13.6 wt%. The second is a white, finely potted tea bowl and saucer (B73) with applied prunus sprays and an incised ‘R.’ (Begg and Taylor, 2000: No. 161) with PbO 1.86 wt% and K<sub>2</sub>O 1.31 wt%. The third example is a pug dog (B96) with an incised annulet and arrow (Begg and Taylor (2000: No. 5) with PbO 4.15 wt% and K<sub>2</sub>O 1.05 wt%.

A fourth example with high PbO (2.55 wt%) and K<sub>2</sub>O (1.49 wt%) is B68, which has been included with the *Developmental period* because of the pres-



|                                | B1     | B20    | B28    | B31    | B32    | B62    | B117   | B119   | Average |
|--------------------------------|--------|--------|--------|--------|--------|--------|--------|--------|---------|
| SiO <sub>2</sub>               | 44.67  | 46.4   | 41.93  | 42.15  | 41.04  | 50.96  | 48.07  | 42.13  | 44.66   |
| TiO <sub>2</sub>               | 0.26   | 0.3    | 0.26   | 0.35   | 0.59   | 0.56   | 0.30   | 0.38   | 0.38    |
| Al <sub>2</sub> O <sub>3</sub> | 5.99   | 8.5    | 9.38   | 7.09   | 8.31   | 8.91   | 8.74   | 8.11   | 8.13    |
| FeO                            | 0.24   | 0.4    | 0.30   | 0.37   | 0.42   | 0.48   | 0.29   | 0.39   | 0.36    |
| MgO                            | 0.76   | 0.4    | 0.69   | 0.56   | 0.42   | 0.02   | 0.38   | 0.61   | 0.48    |
| CaO                            | 23.19  | 23.0   | 22.83  | 24.67  | 24.52  | 20.53  | 21.57  | 26.60  | 23.36   |
| Na <sub>2</sub> O              | 0.82   | 0.67   | 1.03   | 1.01   | 0.65   | 0.80   | 0.65   | 0.73   | 0.80    |
| K <sub>2</sub> O               | 0.70   | 0.95   | 1.26   | 0.67   | 2.03   | 0.65   | 0.84   | 1.00   | 1.01    |
| P <sub>2</sub> O <sub>5</sub>  | 22.19  | 19.4   | 19.21  | 23.13  | 21.76  | 16.60  | 19.18  | 19.88  | 20.17   |
| PbO                            | 1.18   | bdl    | 3.11   | bdl    | 0.3    | 0.52   | bdl    | 0.17   | 0.66    |
| SO <sub>3</sub>                | bdl    | bdl    | bdl    | bdl    | bdl    | bdl    | bdl    | nd     | bdl     |
| Total                          | 100.00 | 100.02 | 100.00 | 100.00 | 100.00 | 100.03 | 100.02 | 100.00 | 100.01  |

|                | B1    | B20  | B28   | B31   | B32   | B62   | B117  | B119  | Average |
|----------------|-------|------|-------|-------|-------|-------|-------|-------|---------|
| Ball clay      | 18.2  | 26.1 | 28.3  | 21.8  | 25.6  | 27.4  | 26.8  | 25.0  | 24.9    |
| Bone ash       | 46.3  | 42.7 | 42.3  | 48.3  | 45.8  | 37.1  | 41.2  | 46.9  | 43.8    |
| Flint glass    | 3.1   |      | 8.0   |       | 0.8   | 1.4   |       | 0.4   | 1.7     |
| Alkali glass   | 4.8   | 4.4  | 5.6   | 5.9   | 10.8  | 4.4   | 3.5   | 5.2   | 5.6     |
| Crushed silica | 27.6  | 26.7 | 15.8  | 24.0  | 17.0  | 29.8  | 28.5  | 22.6  | 24.0    |
| Total          | 100.0 | 99.9 | 100.0 | 100.0 | 100.0 | 100.1 | 100.0 | 100.1 | 100.0   |

- B1. underglaze blue coffee can with *Stork and banana* pattern (private collection)  
 B20. white and gilt pedestal sauce boat (V&A: C.673-1920)  
 B28. Negress and basket in the white. See Gabszewicz (2000a: No. 73)  
 B31. *famille rose* vase (private collection)  
 B32. Kitty Clive in the white (private collection)  
 B62. polychrome teapot (Taylor collection)  
 B117. scratch 'I' vase from a white and gilt garniture of seven (Hamilton Art Gallery)  
 B119. 'R'-marked waster recovered by Dr D. Redstone from the Bow factory site. Average analysis of Adams and Redstone (1981: page 238, No. 3) and analysis by Ramsay and Ramsay (this publication), normalised to 100%

nd not determined  
 bdl below detection level  
 V&A Victoria and Albert Museum

Table 9. Chemical analyses and calculated recipes for Bow second patent Early or *New Canton period* (~1747–1753).

ence of gypsum in its recipe (Table 8). In some instances such as the pug dog (B96) there is insufficient K<sub>2</sub>O (1.05 wt%) to account for ball clay, alkali glass, and lead glass and there is a suspicion that in these cases additional lead was added to the recipe in the form of litharge or some similar form.

The key chemical feature of members of the early second patent Bow (*Developmental, New Canton, and Target periods*) is the moderately high level of Al<sub>2</sub>O<sub>3</sub> ranging from 7–9 wt% in the porcelain body and this feature applies to all such wares whether thinly or thickly potted in the white, polychrome, underglaze blue, incised, or figures. Owen (2001b, 2002) has developed a binary plot of Al<sub>2</sub>O<sub>3</sub> vs P<sub>2</sub>O<sub>5</sub> wt%, which is used to discriminate chemically be-

tween the various factories that employed a phosphatic recipe. We have reproduced this binary plot, except we have used our data to define the early and later second patent Bow phosphatic fields (Fig. 8).

Our data fall into two distinct fields, namely an early second patent Bow field with higher Al<sub>2</sub>O<sub>3</sub> for a given P<sub>2</sub>O<sub>5</sub> value and a later Bow field, which comprises members of the *Bowcock* and *Tidswell periods*. Although this later field is more constrained in area than that given by Owen, we observe that this plot is capable of separating pre- 1755 Bow second patent porcelains from post- 1754 bodies, with the exception of B9 which has unusually low Al<sub>2</sub>O<sub>3</sub> for a given P<sub>2</sub>O<sub>5</sub> value and may be transitional to an earlier as yet unrecognised *Experimental period*. We



Fig. 7. Selected images of the Bow second patent *New Canton* period. Fig. 7a, seated abbess, East London, England, c. 1747–1748 (B8). Soft-paste phosphatic porcelain marked underneath with a minuscule mark for Regulus of antimony and the letter ‘H’ both in red. H. 150 mm. (Private collection, photograph by courtesy of the owner). Painted in aubergine wash, black, and red with gilding to the edges of the book over brown; see Parkside Antiques (1997: No. 21) and Daniels (2007:269). Fig. 7b, standing nun in white, East London, England, c. 1752 (B11). Soft-paste phosphatic porcelain unmarked. H. 160 mm. (Private collection, photograph by courtesy of the owner). Fig. 7c, shell sweetmeat stand in white, East London, England, c. 1748–1750 (B71). Soft-paste phosphatic porcelain. H. 105 mm. (Private collection, photograph by courtesy of the owner.) Here an open fluted shell-like feature rests on a *rocaille* base of coral, tubeworms, bivalves, and bird’s nests with eggs; see Begg and Taylor, 2000: No. 172. Fig. 7d, coffee can in underglaze blue, East London, England, c. 1747–1750 (B1.) Soft-paste porcelain, unmarked. H. 60 mm. (Private collection, photograph by courtesy of the owner.) Thickly potted and painted in bright blue in the *banana tree, stork, and fence* pattern; see Parkside Antiques (1982: No. 6). Fig. 7e, garniture of vases, East London, England, c. 1748–1750 (B116 and B117). Soft-paste phosphatic porcelain. H. of main lidded vase 309 mm. (Collection of the Hamilton Art Gallery, Victoria.) A set of seven vases, three lidded, decorated in penciled gold with rocks, pagodas, birds, willows, and blossoms. Five are incised on the base with an ‘I’ and two with an ‘R’; see Begg and Taylor (2000: No. 11).

|                                | B28    | B73    | B96   | Average |
|--------------------------------|--------|--------|-------|---------|
| SiO <sub>2</sub>               | 41.93  | 47.76  | 49.52 | 46.40   |
| TiO <sub>2</sub>               | 0.26   | 0.43   | 0.35  | 0.35    |
| Al <sub>2</sub> O <sub>3</sub> | 9.38   | 8.03   | 9.84  | 9.08    |
| FeO                            | 0.30   | 0.24   | 0.35  | 0.30    |
| MgO                            | 0.69   | 0.32   | bdl   | 0.34    |
| CaO                            | 22.83  | 20.42  | 17.2  | 20.15   |
| Na <sub>2</sub> O              | 1.03   | 1.16   | 1.0   | 1.06    |
| K <sub>2</sub> O               | 1.26   | 1.31   | 1.05  | 1.21    |
| P <sub>2</sub> O <sub>5</sub>  | 19.21  | 18.47  | 16.52 | 18.07   |
| PbO                            | 3.11   | 1.86   | 4.15  | 3.04    |
| SO <sub>3</sub>                | bdl    | bdl    | bdl   | bdl     |
| Total                          | 100.00 | 100.00 | 99.98 | 100.00  |

|                | B28   | B73   | B96   | Average |
|----------------|-------|-------|-------|---------|
| Ball clay      | 28.3  | 24.6  | 30.6  | 27.8    |
| Bone ash       | 42.3  | 38.9  | 32.2  | 37.8    |
| Flint glass    | 8.0   | 4.8   | 10.2  | 7.7     |
| Alkali glass   | 5.6   | 7.4   | 5.4   | 6.1     |
| Crushed silica | 15.8  | 24.5  | 21.6  | 20.6    |
| Total          | 100.0 | 100.0 | 100.0 | 100.0   |

B28. Negress with basket in the white. See Gabszewicz (2000a: No. 73)

B73. 'R'-marked tea bowl and saucer in the white with applied prunus sprays. See Begg and Taylor (2000: No. 161)

B96. Pug dog in the white. See Begg and Taylor (2000: No. 5)

bdl below detection level

Table 10. Chemical analyses and calculated paste recipes for the high-lead group, second patent Bow porcelain of the *New Canton period*.

also concur with Owen that the binary Al<sub>2</sub>O<sub>3</sub> vs P<sub>2</sub>O<sub>5</sub> plot can separate almost all Bow porcelain bodies from Bonnin and Morris compositions.

*The incised sub-group of early Bow porcelains.* A survey of this sub-group is given by Gabszewicz (2000b). Members of this group comprise a small number of wares characterised by a scratched or incised 'R' (B36, B73, B119) – at times so poorly executed that it looks like a 'K' (B116). In addition some articles possess an incised 'X' and others an incised line mark (B9, B10, B117), which Gabszewicz (2000b) groups with 'R' marked pieces and states that collectively they form an integral association. The group shows fine potting, marked attention to detail, particularly with regard to handles, spouts, and finials. In fact there is a degree of sophistication in design found to be lacking in 'slightly later', more commercial wares. Gabszewicz (2000b) notes that where relief decoration is applied, it is crisp, whereas the glaze is iridescent, soft, and silky – often with

fritting and surface bubbles. Dry aprons or patches are common towards bases and rims. The pallet comprises sealing-wax red, pink, yellow, and purple with underglaze blue varying in tone from inky grey-blue to a bright vibrant blue. The thickly applied enamels are wet looking with flower petals often having a heaped and piled effect; a feature found in examples of decoration on some members of the 'A'-marked group and some early members of the Bow second patent porcelains, other than the inscribed group.

Spero (2001: 24) speculates as to whether this 'scratch R' group represents an alternative Bow porcelain body, differing in glaze, potting shapes, styles of decoration, and tone of underglaze blue, or a body derived from an entirely separate potworks, which amalgamated with Bow at the opening of New Canton in 1750. This suggestion is examined more closely later in this paper. Gabszewicz (2000b) however writes that the incised group belongs to the body of Bow production, being precursors to the

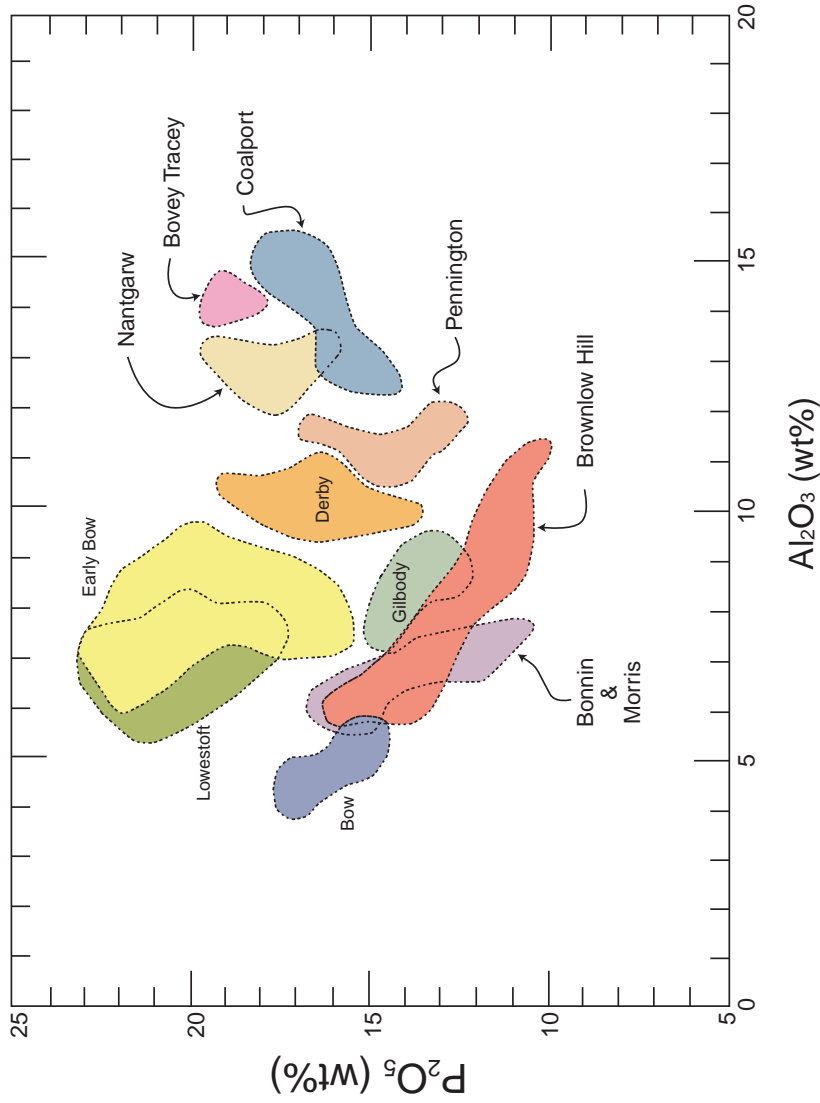


Fig. 8.  $Al_2O_3$  vs  $P_2O_5$  plot for various English and American phosphatic porcelains, modified from Owen (2002). Two fields for Bow second patent porcelains are recognised. The first in yellow is for porcelains of the *Developmental, New Canton, and Target periods* (c.1746–1754). The second more tightly restricted field in blue is for porcelains of the *Bowcock and Tidswell periods* (1755 – c.1774). The relatively restricted field for later Bow porcelains indicates a more uniform paste composition from which it is inferred that there may have been a concomitant reduction in kiln losses when compared with earlier Bow phosphatic compositions. Of note is that our field for later Bow and that given by Owen (2002) both indicate that there is but minimal compositional overlap with Bonnin and Morris on a  $Al_2O_3$  vs  $P_2O_5$  plot.

main factory output, which is broadly dated by him as commencing from around 1750, thus indicating a time range of around 1747–1749. This would indicate, as noted by Gabszewicz, that the incised group might be expected to have evolved from the assumed earlier *Developmental period*, with some members being more sophisticated and better potted in appearance. Some members of the *Developmental period* are regarded by Gabszewicz as being close in general appearance to the triangle-period Chelsea wares, which are generally regarded as dating from c.1745–1749 (Adams, 1987).

During the course of investigation for this study a number of representatives of the incised sub-group (Fig. 7) were sampled and analysed and a representative range of these analyses and calculated recipes are given in Table 11. Collectively the group shows a coherent recipe with two members (B9 and B10) having sulphur added, most likely as gypsum and consequently have been included with the *Developmental period*. Collectively with the possible exception of B9, the composition of the incised group conforms to that of the *New Canton period* (c.1747–1753) with prominent levels of  $\text{Al}_2\text{O}_3$  (7.94–9.71 wt%), and

|                                | B10    | B36    | B73    | B116   | B117   | B119   | Average# |
|--------------------------------|--------|--------|--------|--------|--------|--------|----------|
| SiO <sub>2</sub>               | 43.27  | 46.3   | 47.76  | 47.65  | 48.07  | 42.13  | 46.38    |
| TiO <sub>2</sub>               | 0.61   | 0.6    | 0.43   | 0.33   | 0.30   | 0.38   | 0.41     |
| Al <sub>2</sub> O <sub>3</sub> | 9.71   | 9.5    | 8.03   | 8.86   | 8.74   | 8.11   | 8.65     |
| FeO                            | 0.24   | 0.5    | 0.24   | 0.28   | 0.29   | 0.39   | 0.34     |
| MgO                            | 0.72   | 0.7    | 0.32   | 0.56   | 0.38   | 0.61   | 0.51     |
| CaO                            | 22.79  | 20.5   | 20.42  | 21.57  | 21.57  | 26.60  | 22.13    |
| Na <sub>2</sub> O              | 1.15   | 0.65   | 1.16   | 0.79   | 0.65   | 0.73   | 0.80     |
| K <sub>2</sub> O               | 0.69   | 1.2    | 1.31   | 0.81   | 0.84   | 1.00   | 1.03     |
| P <sub>2</sub> O <sub>5</sub>  | 20.00  | 19.2   | 18.47  | 19.16  | 19.18  | 19.88  | 19.18    |
| PbO                            | 0.13   | 0.9    | 1.86   | bdl    | bdl    | 0.17   | 0.59     |
| SO <sub>3</sub>                | 0.74   | bdl    | bdl    | bdl    | bdl    | nd     | bdl      |
| Total                          | 100.05 | 100.05 | 100.00 | 100.01 | 100.02 | 100.00 | 100.02   |

|                | B10  | B36   | B73   | B116  | B117  | B119  | Average# |
|----------------|------|-------|-------|-------|-------|-------|----------|
| Ball clay      | 29.4 | 29.2  | 24.6  | 27.2  | 26.8  | 25.0  | 26.6     |
| Bone ash       | 42.4 | 40.5  | 38.9  | 41.2  | 41.2  | 46.9  | 41.7     |
| Flint glass    | 0.3  | 2.3   | 4.8   |       |       | 0.4   | 1.5      |
| Alkali glass   | 6.6  | 2.6   | 7.4   | 4.4   | 3.5   | 5.2   | 4.6      |
| Gypsum         | 1.5  |       |       |       |       |       |          |
| Crushed silica | 19.8 | 25.4  | 24.3  | 27.3  | 28.5  | 22.6  | 25.6     |
| Total          | 99.9 | 100.0 | 100.0 | 100.1 | 100.0 | 100.1 | 100.0    |

B10. Knowles Boney underglaze blue mug. See Adams and Redstone (1981: Fig. 23A)

B36. 'R'-marked mug in the white (private collection)

B73. 'R'-marked white tea bowl and saucer with applied prunus sprays. See Begg and Taylor (2000: No. 161)

B116. flange to lid for 'R'-marked vase from white and gilt garniture, Hamilton Art Gallery, Victoria. See Begg and Taylor (2000: No. 11)

B117. base of incised 'I'-marked vase from white and gold garniture, Hamilton Art Gallery, Victoria. See Begg and Taylor (2000: No. 11)

B119. 'R'-marked waster recovered by Dr D. Redstone from the Bow factory site. Average analysis of Adams and Redstone (1981: page 238, No. 3) and analysis by Ramsay and Ramsay (this publication), normalised to 100%

nd not determined

bdl below detection level

# average excludes B10 which contains gypsum

Table 11. Chemical analyses and calculated paste recipes for incised 'I'-marked and 'R'-marked second patent Bow porcelain of the *Developmental* and *New Canton periods*.

variable levels of PbO (bdl – 1.86 wt%), Na<sub>2</sub>O (0.65–1.16 wt%), and K<sub>2</sub>O (0.69–1.31 wt%). The range in amounts of the last three elements suggest either an inhomogeneous body in each case or that the amount and/or composition of glass cullet added, varied between each paste or kiln batch. Analysis of two members of this group, most likely derived from the same paste batch, tends to suggest the latter. Here in the case of the garniture from the Hamilton Art Gallery, Victoria (Begg and Taylor, 2000: 22) the flange of a lid to an ‘R’-marked vase (B116) and the base of an incised ‘I’ lidless vase (B117) have closely comparable compositions (Table 11) thus suggesting that flux additions in the form of glass cullet varied between paste batches, but were essentially constant within batches. This variable range in fluxes, assumed to have occurred between paste or kiln batches, suggests to us that maturation of the porcelain body would have shown considerable temperature variation between kiln batches up to the *Bowcock period* when there was a marked attempt to standardize the paste composition and the associated level of fluxes.

*Bow second patent Transitional or Target period.* This subdivision is based on a single Bow item, namely the Thomas Target bowl (B22), which was originally in the J. A. Ainslie Collection, sold at Sotheby’s (March 7<sup>th</sup>, 1961, lot 185), and is now housed in the British Museum. The bowl is enamelled in deep brown, two shades of green, vermilion red (Tilley uses the term ‘orange’), blue, and maroon with gold over-painting on the on-glaze brown enamel, and shows Chinese figures in an Oriental landscape (see Tait, 1959: No. 64). Frank Tilley (1952) initially described this bowl, where he incorrectly read the name as “Thos Tarock: 1754,” an error picked up by Tait (1959). Tilley records both the use of gold over brown and the translucency, which he describes as typical ‘Bow brown’. In the case of the application of gold over brown enamel, Tilley traces this feature back to include the Muses figures, the Fortune Telling group, and other figures generally assigned to the period 1750–1755. This technical aspect of gold over brown also can be found on an early Bow teacanister (Ramsay and Ramsay, 2005b) and as noted is an apparent Bow signature technical feature. Compositionally the Thomas Target bowl conforms to the recipe used in the *Developmental period* (c.1746) with bone ash at around 45 wt% (hydrous) and both crushed silica and ball clay close to 25 wt% each. The remainder of the recipe is composed of glass cullet and a sulphur-bearing source, which in this case is attributed to gypsum (Table 12). It has been

noted by one of the reviewers of this manuscript, that the low levels of sulphur in the body of the bowl may represent environmental contamination as sulphates are commonly found on artefacts exposed to urban environments such as that of London. Even if this is the case, this bowl still represents a transitional piece based on the observations by Frank Tilley with regard to the brown translucency of the body. This difference in translucency between members of the *Developmental period* (green to grey-green to greyish-white) and the *Target period* (brownish) would consequently not appear to reflect compositional differences based on the analyses presented assuming sulphur contamination. Rather we suspect that the change in translucency around 1754 reflects kiln-firing conditions, or even the possibility that by 1754 the concern had dispensed with the initial fritting phase as recorded by Wedgwood.

*Bow second patent Middle or Bowcock period.* This period coincides with a marked change in the paste recipe used at Bow and is dated to 1755 – c.1769. The type example for this period is the documentary Bowcock bowl (B25) housed in the British Museum. The date for the closure of this period (c.1769) is uncertain but it occurred before 1772 based on the composition of the Tidswell mug, given below. Selected analyses of the *Bowcock period* are given in Table 13. Major recipe changes for this period include a significant drop in the amount of ball clay used from 25 wt% to around 15 wt%, a decrease in the amount of bone ash from around 42–45 wt %

|                                | B22   |                | B22   |
|--------------------------------|-------|----------------|-------|
| SiO <sub>2</sub>               | 43.08 | Ball clay      | 20.9  |
| TiO <sub>2</sub>               | 0.34  | Bore ash       | 46.8  |
| Al <sub>2</sub> O <sub>3</sub> | 6.8   | Alkali glass   | 6.6   |
| FeO                            | 0.37  | Crushed silica | 24.9  |
| MgO                            | 0.95  | Gypsum         | 0.8   |
| CaO                            | 23.76 | Total          | 100.0 |
| Na <sub>2</sub> O              | 0.9   |                |       |
| K <sub>2</sub> O               | 0.87  |                |       |
| P <sub>2</sub> O <sub>5</sub>  | 22.51 |                |       |
| PbO                            | bdl   |                |       |
| SO <sub>3</sub>                | 0.37  |                |       |
| Total                          | 99.95 |                |       |

B22. Target bowl, dated 1754 (British Museum)

bdl. below detection level

Table 12. Chemical analysis and calculated recipe for the Bow second patent *Transitional Period* (1754).

|                                | B3    | B5     | B16    | B23    | B25   | B29    | Average |
|--------------------------------|-------|--------|--------|--------|-------|--------|---------|
| SiO <sub>2</sub>               | 53.09 | 58.57  | 54.32  | 54.72  | 53.6  | 51.98  | 54.38   |
| TiO <sub>2</sub>               | 0.06  | 0.15   | 0.2    | 0.2    | 0.2   | 0.23   | 0.17    |
| Al <sub>2</sub> O <sub>3</sub> | 4.61  | 5.96   | 4.98   | 4.02   | 5.4   | 3.76   | 4.79    |
| FeO                            | 0.34  | 0.18   | 0.1    | 0.29   | 0.2   | 0.11   | 0.20    |
| MgO                            | 0.45  | 0.01   | 0.4    | 0.35   | bdl   | 0.31   | 0.25    |
| CaO                            | 20.73 | 18.14  | 21.19  | 21.13  | 21.9  | 21.07  | 20.69   |
| Na <sub>2</sub> O              | 0.02  | 0.19   | 0.6    | bdl    | 0.1   | 0.25   | 0.19    |
| K <sub>2</sub> O               | 0.62  | 0.50   | 0.6    | 0.39   | 0.4   | 0.52   | 0.51    |
| P <sub>2</sub> O <sub>5</sub>  | 16.89 | 14.59  | 15.32  | 16.31  | 15.9  | 17.74  | 16.13   |
| PbO                            | bdl   | bdl    | bdl    | bdl    | bdl   | bdl    | bdl     |
| SO <sub>3</sub>                | 3.18  | 1.71   | 2.3    | 2.6    | 2.3   | 4.03   | 2.69    |
| Total                          | 99.99 | 100.00 | 100.01 | 100.01 | 100.0 | 100.00 | 100.00  |

|                | B3    | B5    | B16   | B23   | B25   | B29   | Average |
|----------------|-------|-------|-------|-------|-------|-------|---------|
| Ball clay      | 14.1  | 18.4  | 15.5  | 12.4  | 15.8  | 11.6  | 14.6    |
| Bone ash       | 37.3  | 32.1  | 35.8  | 36.4  | 36.6  | 36.7  | 35.8    |
| Gypsum         | 6.4   | 3.5   | 4.8   | 5.4   | 4.7   | 8.3   | 5.5     |
| Crushed silica | 42.2  | 46.0  | 44.0  | 45.8  | 42.9  | 43.4  | 44.1    |
| Total          | 100.0 | 100.0 | 100.1 | 100.0 | 100.0 | 100.0 | 100.0   |

B3. underglaze blue sauce boat (private collection)

B5. underglaze blue sauce boat (private collection)

B16. portion of a white applied prunus coffee cup. Composite analysis from Tite and Bimson (1991) and this study with SO<sub>2</sub> converted to SO<sub>3</sub> and normalised to 100%

B23. underglaze blue bowl "Success to Trade" (British Museum)

B25. Bowcock bowl (British Museum)

B29. figure of a woman in Turkish dress. See Gabszewicz (2000a: No. 86)

bdl below detection level

Table 13. Chemical analyses and calculated recipes for the Bow second patent Middle or *Bowcock period* (1755 – ~1769).

to ~35 wt%, an increase in the amount of crushed silica (either quartz sand or crushed flint) from 25 wt % to around 45 wt%, an apparent absence of glass cullet, and finally the significant appearance of gypsum, as recorded by Wedgwood, of around 5–6 wt%. Overall there is a decline in the quality of the porcelain body and as noted by various workers (Hobson, 1905; Tilley, 1952; Adams and Redstone, 1981) this period (Fig. 9) is characterised by a porcelain body, which becomes lighter in weight, more porous, and chalky in appearance with an inclination to staining on unglazed areas. The body displays what Tilley describes as a 'Bow brown' translucency and there is a tendency for the overall glaze to become duller in appearance. Compositionally the *Bowcock period* is defined also by the use of a more uniform paste than was used during the preceding periods and evidence for this can be seen in both Figure 8 and Table 13.

*Bow second patent Late or Tidswell period.* The type example for this period is the Tidswell mug (B24), dated 1772, and housed in the collections of the British Museum (Fig. 10). The commencement of this period is ill-defined and could range back into the mid to late 1760s. A future research program directed at analyzing documentary wares of the mid to late 1760s would define more accurately the start of the *Tidswell period*. Three items have been used to define this period and these are the Tidswell mug (B24), an underglaze blue leaf dish (B15), and a polychrome mug (B35). Their analyses and calculated recipes are given in Table 14. Compositionally the key feature for this period is the appearance of what is assumed to be the presence of glass cullet {unsorted lead glass and lime-alkali glass as judged by the increase in K<sub>2</sub>O (0.55–1.8 wt%), Na<sub>2</sub>O (0.3–0.85 wt%), and the distinctive presence of lead as PbO (0.2–2.75 wt%)}. The highly variable amounts



Fig. 9. Selected images of the Bow second patent *Bowcock period*. This period marked a distinct change in the recipe resulting in a much more uniform composition. Fig. 9a, sauce boat in underglaze blue, East London, England, c. 1764–1768, unmarked (B3). Soft-paste phosphatic porcelain. H. 100 mm. (Private collection, photograph by courtesy of the owner). Moulded with fruits and painted with Oriental style flowers, insects, and a cell border; see Parkside Antiques (1988: No. 12). Fig. 9b, figure in Turkish dress, East London, England, c. 1762, unmarked (B29). Soft-paste phosphatic porcelain. H. 195 mm. (Collection of the London Borough of Newham, photograph by courtesy of Michael Booth). Fig. 9c, plate in underglaze blue, East London, England, c. 1756–1762, marked underneath with the numeral ‘6’ or ‘9’ in underglaze blue. Soft-paste phosphatic porcelain. W. 175 mm. (Private collection, photograph by courtesy of the owner). Painted with the *golfer and caddy* pattern. Fig. 9d, waster, East London, England, c. 1756–1762, unmarked (B42). Soft-paste phosphatic porcelain. L. 50 mm. (Courtesy of Dr D. Redstone, photograph by courtesy of A. Gabszewicz). This waster was recovered from the factory site in 1968. Its outer wavy blue border with an inner thin line conforms to the *golfer and caddy* pattern or the *van Frytom* pattern. Fig. 9e, sauce boat, moulded and decorated in underglaze blue, East London, England, c. 1762–1766 (B5). Soft-paste porcelain. L. 140 mm. (Private collection, photograph by courtesy of the owner). Decorated both externally and internally with European flowers and an internal cell border.



|                                | B18    | B24    | B35    | Average |
|--------------------------------|--------|--------|--------|---------|
| SiO <sub>2</sub>               | 50.31  | 55.15  | 53.92  | 53.12   |
| TiO <sub>2</sub>               | 0.3    | 0.2    | 0.4    | 0.3     |
| Al <sub>2</sub> O <sub>3</sub> | 5.3    | 4.8    | 4.68   | 4.93    |
| FeO                            | 0.3    | 0.4    | 0.33   | 0.34    |
| MgO                            | 0.3    | 0.4    | 0.03   | 0.24    |
| CaO                            | 22.87  | 17.56  | 19.21  | 19.88   |
| Na <sub>2</sub> O              | 0.85   | 0.3    | 0.34   | 0.50    |
| K <sub>2</sub> O               | 0.55   | 1.8    | 0.99   | 1.11    |
| P <sub>2</sub> O <sub>5</sub>  | 16.28  | 14.26  | 15.56  | 15.38   |
| PbO                            | 0.2    | 2.75   | 0.93   | 1.29    |
| SO <sub>3</sub>                | 2.75   | 2.4    | 3.61   | 2.92    |
| Total                          | 100.01 | 100.02 | 100.00 | 100.01  |

|                | B18   | B24   | B35  | Average |
|----------------|-------|-------|------|---------|
| Ball clay      | 16.3  | 14.0  | 14.3 | 14.9    |
| Bone ash       | 37.2  | 30.1  | 32.3 | 33.2    |
| Lead glass     | 0.5   | 6.8   | 2.4  | 3.2     |
| Alkali glass   | 5.1   | 7.0   | 3.8  | 5.3     |
| Gypsum         | 5.6   | 5.0   | 7.4  | 6.0     |
| Crushed silica | 35.3  | 37.1  | 39.7 | 37.4    |
| Total          | 100.0 | 100.0 | 99.9 | 100.0   |

B18. underglaze blue leaf dish (Victoria and Albert Museum)

B24. Tidswell mug, dated 1772 (British Museum)

B35. blue-ground mug with anchor and dagger mark (private collection)

Table 14. Chemical analyses and calculated recipes for the Tidswell period (~1770–1774).

of lead between the three bodies suggests that batches of mixed cullet were being utilised and, unlike the glass frit used in the body of Bow first patent wares, little effort was made to separate the lead-bearing glass. Some broad similarities can be seen in comparing the recipes used in the *Bowcock period* and the *Tidswell period*. The amounts of ball clay (~15 wt%), bone ash (~35 wt%), and gypsum (~6 wt%) used were essentially the same. The major difference was in the amount of crushed silica employed, which declined from around 45 wt% in the *Bowcock period* to around 37 wt% in the *Tidswell period*. This deficiency of free silica in the *Tidswell period* was made up by the addition of glass cullet (~6 wt%). The reason for this reintroduction of cullet, after its rejection during the previous *Bowcock period*, although speculative at this stage is discussed below.

## MAJOR CHANGES IN THE BOW PASTE COMPOSITION

Several major breaks or changes in paste composition are recognised by us in the Bow porcelain output. The first was during the conversion from a China or Cherokee clay, high-firing body (Bow first patent) to a bone ash and ball clay based, lower-firing body (Bow second patent). This change is suggested to have occurred at some time during 1745–1746 based on a sequential paste model. Minor variations are noted in the paste composition used for first patent wares, with clay:glass frit ratios varying from 1:1 to 2:1. The latter ratio has been recorded for a small number of examples including the so-called *high-style* group of wares (Ramsay et al., 2004b) and this variation accords with the 1744 patent specifications in that a range of compositions ranging from 1 clay:1 glass through to 4 clay:1 glass are proposed. As yet an example of 4:1 has not been recorded. Of note is that all representatives of the group so far analysed contain a lime-alkali glass frit, except the tea-canister from the National Gallery of Victoria, whose composition departs from the specifications of the 1744 patent and contains what may be steatite together with a minor addition of what we deduce to be alum (Table 5).

The subsequent Bow second patent paste composition is characterised by ball clay and bone ash together with crushed silica, glass frit, and initially a sulphur-bearing source, most likely gypsum in many instances. This recipe, with some compositional variation, continued through to and included 1754. The change in paste composition between the Bow first and second patents was profound and was most likely forced on the Bow proprietors because of the inferred termination in the supply of China clay from the Carolinas, probably reflecting Indian opposition and unrest. We suggest that the proprietors made a remarkable and farsighted decision, once it became clear that supplies of high-firing, China clay were unlikely to be available in the short to medium term. This decision resulted in an abandonment of the luxury or ‘high-end’ market, which until then had been catered to by the remarkable Bow first patent wares, and a move to embrace the emerging middle market, using a readily accessible lower-firing, ball clay with an associated lower-temperature lead glaze. Even so, numerous examples from the second patent period were finely potted showing considerable sophistication in form with remarkable decoration. A good example of the quality achieved at Bow with the use of ball clay and



Fig. 10. Selected images of the Bow second patent *Tidswell* period. This period is marked by a more variable composition with the reintroduction of glass cullet – both alkali glass and lead glass. Fig. 10a, ‘Tidswell mug’, East London, England, 1772 (B24). Soft-paste phosphatic porcelain marked ‘RD & MY Tidswell 1772.’ (Collection of the British Museum BM: 3-4.1, photograph by courtesy of A. Gabszewicz). Fig. 10b, fragment of a leaf-dish in underglaze blue, East London, England, c. 1770–1772, (B18). Soft-paste phosphatic porcelain marked with pseudo Oriental marks. (Collection of the Victoria and Albert Museum, C16-1920, photograph by courtesy of A. Gabszewicz). Painted in shades of blue; see Gabszewicz and Freeman (1982: No. 116) for a comparable example. Fig. 10c, blue-ground mug, East London, England, c. 1770–1774 (B35). Soft-paste phosphatic porcelain marked with an anchor and dagger in iron-red. (Private collection, photograph by courtesy of the owner).

bone ash is the fluted, polychrome teapot (B62), formerly in the Watney collection (Phillips, 1999: No.13) and now in the Taylor collection. We question the claim by Schmidt (1932) that Bow has won general affection by her engaging incompetence.

The second major change in paste composition occurred around 1755. This period is of particular note because it was in 1755 that Bow reached its zenith in sales as based on extant account books (Adams and Redstone, 1981; 177). Adams and Redstone continue that,

‘That is entirely understandable (with reference to the dominance of oriental decoration over the new European style) in view of the prosperity achieved, but this very success seems to have in-

duced a reluctance to change when there must have been powerful commercial reasons for doing so. It stands in contrast to the rapid and almost exclusive adoption at Bow of Meissen figure models from the early fifties onwards’.

Although there may have been reluctance by the Bow proprietors to adopt more readily the European designs and decoration in the mid 1750s, there is no evidence that there was a reluctance to change with regard to the technical aspects of porcelain production. During the very period of 1755 when sales were at an all time high the proprietors engaged in a very significant modification of the paste composition used at Bow, with a reduction in both ball clay and bone ash and an increase in crushed silica. Gypsum

makes a distinct and profound reappearance after an absence of some eight years, whereas the use of glass cullet is abandoned. We agree with Tite and Bimson (1991) that this change in paste composition may have coincided with a decision not to frit the bone ash and crushed silica prior to mixing with the ball clay, as had been recorded by Josiah Wedgwood. This aspect may possibly date to c.1754. Debate continues as to the reason for this significant change in the recipe with a concomitant reduction in the quality of the porcelain body – at least to our eyes. One possibility might have been an attempt to reduce the costs of the raw materials used, although without a detailed analysis of the local costs for silica sand, bone ash, ball clay, and glass cullet this is difficult to substantiate. John Mallet (written. com., December 2003) writes that this assumption could possibly be supported by tracing various account books and records relating to ball clay including references found in the Wedgwood archives, the *Transactions of the London Wedgwood Society*, and his own articles on John Baddeley (Mallet 1966, 1967).

Another possibility is that by eliminating the use of glass cullet from the recipe, with its highly variable levels of the fluxes (potassium, sodium, lead, magnesium, and calcium), the proprietors were aiming for a more consistent and chemically homogeneous paste composition. This is assumed to have resulted in more uniform firing characteristics of the porcelain body, which may in turn have helped reduce kiln losses. If there is any basis to this notion, this would mean that by c.1755 the proprietors made an economic decision to try to reduce what we suspect were high or unacceptable levels of kiln wastage and accept a lesser quality porcelain body in return. We suggest that this critical change in the Bow porcelain output and recipe, which we date to c.1755, is a significant avenue for further research.

Features associated with porcelains from the subsequent *Bowcock period* include a more porous and chalky body, which is prone to brownish staining on unglazed areas. The porcelain body is typically lighter in weight, no doubt reflecting the absence of lead-rich cullet. Translucency develops reddish and brownish hues or may deteriorate to become non-existent.

The third significant paste change is less well defined and occurred around 1769–1770, if not before, when glass cullet was apparently reintroduced with the proportion of bone ash remaining essentially the same. The pottery-like nature of the body indicates that kiln-firing problems may have been

occurring and the necessary peak temperatures were not being achieved or such peak temperatures were not being maintained for a long enough period in the kiln. It is tempting to speculate that the reason for the reintroduction of glass cullet was to incorporate additional fluxes with the paste in an attempt to obtain sintering and partial vitrification of the body at lower kiln temperatures. Even so this change in paste composition failed to develop an increased translucency in the fired body suggesting that kiln-firing problems may have continued.

Evidence is now mounting that Bow experimented with and produced commercial wares based on other recipe types in addition to the high-firing, hard-paste Si-Al-Ca and the bone ash bodies discussed. One of these additional recipes required the use of steatite and the most compelling evidence for this contention is to be found in the tea-canister of the collections of the National Gallery of Victoria (Ramsay and Ramsay, 2005a). The most remarkable use of steatite by Bow recognised to date (Daniels, 2007) is to be found in a group of busts of previously enigmatic attribution known as the George II busts (Delevingne, 1963; Watney, 1968). By analogy, Watney groups various nurse and nun figures, including the white nurse in the Rissik Marshall Collection of Worcester Porcelain at Oxford, with these numbered busts, stating that they all have a typical hard, Worcester-like glaze. Current analytical research on a number of these busts and associated socles (Ramsay and Daniels, in prep) supports a Bow attribution and work by Daniels (2007) dates this group of busts to 1744. For a summary on the most recent thinking regarding this recipe type and a discussion on a possible reattribution of a number of high-magnesian porcelains reference is made to Daniels (2007).

A further possible recipe type can be suspected based on comments by Simeon Shaw (1837) where he records that both Bow and Chelsea employed silica sand from Alum Bay, pipe clay, and glass cullet. On this basis we suspect that there may be glassy-looking porcelains of Bow derivation that have to date been misidentified as early Chelsea, early Longton Hall, Gouyin's factory of St Jame's, or even early Derby. Research into this recipe type is continuing.

### POTTING AND DECORATIVE DISCORDANCES IN THE BOW OUTPUT

One feature that characterises the Bow porcelain output is the presence of what can be regarded as discordances or marked differences in both potting and decorative features between contemporary or closely contemporary groups of wares at various times during the factory life. The most obvious is the dichotomy that exists between first and second patent wares, with the widely held belief for many years that the essentially homogeneous small group of 'A'-marked wares showed no linkages or continuum with the Bow second patent porcelains in respect to potting, form, or enamelling. We agree with David Barker that styles can never be more than a guide to contemporary trends in production, and cannot in themselves be a reliable guide to attribution without other forms of supporting evidence, yet this perceived discordance has been highly influential during the last 60 years or so in denying that the 'A'-marked group could be representatives of the Bow first patent. In the case of potting, this difference is at least in part explained by the contrasting materials and potting techniques employed in the manufacture of first and second patent wares. The paste composition specified in the Bow first patent, as deduced from the firing of analogue porcelains (Ramsay et al., 2004a) is a non-plastic or 'short' paste and consequently slip-casting techniques were typically employed for the 'A'-marked wares, possibly introduced through the employment of one or more Staffordshire potters to address this problem. In other words both the paste composition and the kiln procedures required to produce the high-fired, hard-paste body using refractory China clay can partially, if not largely, explain the perceived discordance in both form and potting between the 'A'-marked group and the early members of the Bow second patent.

In the case of the perceived discordance in enamelling, Ramsay et al. (2003) have discussed various decorative features, which collectively suggest linkages between the 'A'-marked group of porcelains and members of the Bow second patent. More recently Ramsay and Ramsay (2005a) have pointed out that the tea-canister (B79) of the 'A'-marked group represents an important 'link piece' with the Bow second patent porcelains on account of the use of the *Island House* pattern, the nature of the palette employed, the technical aspect of gilding over brown enamel (a highly characteristic feature of Bow), and

the compositional use of a sulphur-bearing source in the form of alum. The use of gypsum, or possibly in some instances alum, also appears in the earliest yet recognised Bow second patent wares (*Developmental period*).

Another perceived variance in potting and decorative aspects within the early Bow second patent underglaze blue wares, the Bow Imari variants with underglaze blue and overglaze iron-red and gilt, and the white 'sprigged' porcelains has been proposed by Spero (1989, 2001). Spero (1989) notes this diversity of production and the associated unevenness from an aesthetic standpoint in Bow porcelain, when compared with other 18<sup>th</sup> century factories. In the case of Bow underglaze blue porcelains of the 1748–1755 period, Spero comments on the considerable problems in terms of chronology, glaze differences, decorative styles, and tones of underglaze blue. These underglaze blue wares are broadly subdivided into two groups by Spero, based on potting and decorative features (Table 15).

With regard to the more thickly potted 'chunky' wares or vivid blue group, Spero suggests that the reason for the scarcity of saucers is that they may have been far more thinly potted and hence subject to breakage, thus admitting that both thickly and more thinly potted Bow wares could have been made concurrently at the same potworks. Such is the perceived discordance between these two groups that Spero (1989) comments that in the absence of the compositional evidence in the form of a scratch 'R' waster discovered on the Bow site by Dr David Redstone (Tables 9 and 11) there would be grounds for invoking separate factories to account for these two groups of wares. Spero suggests that there may have been a two-tiered production output at the Bow factory during the early 1750s, with one group directed towards a more discerning public.

Subsequently, Spero (2001) might appear to discount the significance of the 'R'-marked waster discovered on site during the 1969 excavation, and in discussing an early incised 'R'-marked finger bowl of the dark blue, more thinly potted group, he comments on the 'inky' tone of underglaze blue, the well-fitting glaze, and the unpretentious nature of the painting and argues that such features are,

...utterly alien to the mainstream Bow production of 1748–55, with its bright tone of blue, heavy and more forthright potting shapes and softer more porous glaze.

Based on these potting, glaze, and decorative features, Spero (2001) speculates on the possibility that

|                 | Bright blue, thickly potted group   | Dark blue, more thinly potted group   |
|-----------------|---|---|
| potting         | Thickly potted and heavy in weight with simplicity of outline and economy of shape                            | Relatively thin and generally executed with a neatness and refinement seldom associated with early Bow                  |
| glaze           | Thick, softer more porous glaze, prone to bubbling, which often has a double skin, and is prone to crazing    | Smooth, shiny, tactile, well-fitting glaze – far thinner than conventional early Bow, with bluish tinges where it pools |
| underglaze blue | Bright and lighter vivid tone of underglaze blue reminiscent of ‘Quink’ royal blue ink                        | Darkish ‘inky’ tone, sometimes with a ‘sooty’ underfired appearance   |
| decoration      | Typically Oriental with a forthright artless quality with little sense of care and apparently quickly painted | Precise, fluid painting showing both care and sophistication  |
| time range      | 1748 – at least 1754  | 1748–1755   |

Table 15. Comparison of potting and decorative aspects of early Bow underglaze blue porcelain, after Spero (1989, 2001).

this intriguing but small-scale “scratch R” class is the work of an independent London potworks of the late 1740s, which formed a loose association with the newly launched New Canton factory in 1750, sharing the kilns, warehouses, and other facilities of the greatly enlarged Bow enterprise. Previously Spero (1989) had proposed that the ‘R’-marked group had evolved from the earliest Bow (second patent) products, namely the drab-tinted or mushroom-glazed group, characterised by delicate *famille rose* and *Imari* colours and delicate potting forms (*Developmental* and early *New Canton periods*). On this basis, the Spero model would require that both the drab wares and much of the ‘R’-marked group and associated wares produced prior to 1750, to lack a Bow attribution, being instead manufactured by an independent London concern, which subsequently formed this loose association with Bow in 1750. In contrast Gabszewicz (2000b) regards the ‘R’-marked and associated wares, which he dates from 1747–1749, as link pieces between the superb ‘mushroom’ glazed pieces and the general Bow production of about 1750. However he does comment that he finds it hard to credit the factory, which produced the ‘mushroom’ glazed wares with their magnificent potting and fine enamelling, with the same which was responsible for the more thickly potted plates and dishes decorated in bright, vibrant blue. More recently Spero (2005) adopts a more equivocal position stating,

Whether these ‘scratch R’ wares are part of the continuous Bow production or were from an originally separate potworks is a matter of speculation.

Interesting though these suggestions are based largely on typological criteria, we suggest that these observations on being integrated with the archaeological evidence, historical documents, and compositional features confirm that the Bow factory was capable of producing groups of wares of apparently contrasting appearance. Archaeological evidence exhibited by Tait (1959) has demonstrated that undecorated wasters representing the *Developmental period* have been recovered from the New Canton factory site in Essex. The first is a portion of a shell-encrusted base (Tait, 1959: No. 4) recovered in 1921, while the second is a biscuit portion of a sauce-boat with a lion-mask foot (Tait, 1959: No. 7) also recovered from the factory site in 1921. Based on this evidence the conclusion that we draw is that members from the *Developmental* and/or earliest *New Canton periods* were being produced from what was subsequently to become known as the New Canton factory site located in Essex and not from some independent and geographically removed London potworks. Likewise the Spero two-potworks model would require the ‘R’-marked waster recovered from the factory site (Redstone, 1969) to have been produced after the ‘loose merger’ of these two concerns at some time during 1750. However, this model has failed to demonstrate why this ‘R’-marked waster is post- 1750 in date. Compositionally, this waster could just as readily be pre- 1750.

With regard to the compositional data, this study has demonstrated that members of the thickly potted, bright blue group as represented by the plate (B68) and the Knowles Boney mug (B10) have the same

unusual paste composition (ball clay, bone ash, cullet, crushed silica, and gypsum) as other members of the *Developmental period*. This conformity in paste composition for wares, dated by us as being produced from around 1746–1747, conflicts with the separate potworks model, as it is difficult to accept that during this very early period of highly competitive porcelain development in London, two independent and geographically removed porcelain concerns should be using identical and highly unusual paste compositions.

In the case of insurance records (Adams, 1973), for the Bow factory site, Elizabeth Adams has noted that these fairly detailed records, which date from July 7<sup>th</sup>, 1749, prior to this supposed loose merger, give the impression that the entire factory was being insured. It is hard to accept that the Bow proprietors would go to the trouble in subsequent years of insuring the buildings, stock, and utensils of a concern or concerns, which had but a loose association with the Bow factory commencing in 1750.

Based on the above points involving archaeology, paste composition, and historical documents we conclude that the stylistically different groups recognised by Spero are of Bow derivation and were produced on the Essex site in Stratford High Street from possibly around 1746 onwards. Moreover we conclude that one of the key features of Bow porcelain production from c.1743 onwards is the presence of distinct groups of wares which show a range of differences including starting materials, paste recipes, kiln-firing conditions, potting techniques, glaze appearances, and nature of enamelling and associated decoration. Such discordances do not in themselves necessitate the need for different potworks to explain these typological and compositional differences.

#### SUMMARY OF THE CLASSIFICATION OF BOW PORCELAIN

Table 16 presents a classification for the Si-Al-Ca and phosphatic output from the Bow porcelain manufactory commencing with the onset of commercial Bow first patent wares, c. 1743. These Bow first patent porcelains ('A'-marked group) are regarded as hard-paste, high-fired porcelains whose glaze ranges from matt (slightly immature) through to wet looking (mature). Translucency is distinct and varies from white to white with an icy greenish tinge. Within the Bow second patent division five groups or periods are recognised, which are assumed to have

commenced from c. 1746 based on an assumption of sequential development of the Si-Al-Ca body followed by the bone ash wares of the Bow second patent. During this second patent output the initial porcelain body up to 1754 typically is compact, relatively hard, at times distinctly heavy with good translucency, which varies from greenish-grey, to creamish-white to greyish-white. With the onset of the *Bowcock period* in 1755 the porcelain body commences to deteriorate in appearance becoming more chalky and porous. The body becomes lighter in weight (most probably reflecting the absence of lead cullet) and unglazed areas are liable to develop brown staining. Translucency takes on yellowish, brownish, and reddish tinges. At times the body may even be opaque. Finally in the *Tidswell period* the porcelain body assumes an appearance more like that of pottery rather than porcelain. Translucency in examples examined is non-existent. For additional discussions on aspects of translucency as found in Bow second patent wares refer to Burton (1902), Hurlbutt (1926), Tilley (1952), Scott and Scott (1961), Adams and Redstone (1981), Begg and Taylor (2000), and Adeney (2003).

The earliest group of phosphatic wares recognised in this paper is assigned to the *Developmental period*, which based on a sequential model, is dated to c.1746. However we suspect that there may be earlier precursor wares as yet unrecognised, whose composition, assumed to be phosphatic, would be more variable (*Experimental period*). A possible candidate for this hypothetical *Experimental period* is to be found in two octagonal, sprigged plates in the white (Scott and Scott, 1961). On the one hand the warping of both plates could indicate a low bone ash content, which would result in the bulk composition of each plate lying closer to the thermal minimum in the ternary system  $\text{Ca}_3(\text{PO}_4)_2 - \text{SiO}_2 - \text{CaAl}_2\text{SiO}_8$  than more typical phosphatic wares, yet on the other hand the very high CaO relative to  $\text{P}_2\text{O}_5$  suggests that the analysis carried out by Reginald Milton is in error and consequently we have chosen to disregard the results. This is a pity as we might suspect that early members of this notional *Experimental period* at Bow would conceivably contain examples with lower than usual bone ash contents. It would be interesting at some stage to reanalyse one or other of these two octagonal plates to confirm the level of contained bone ash. Based on stylistic grounds we draw attention to the low-flared, sprigged, hexagonal sauceboat (Ramsay et al., 2003: Fig. 11), which could belong to this very early period at Bow and likewise we refer to various

| Classification           | Date   | Recipe  | Visual Appearance  | Translucency   | Notes  |
|--------------------------|--|---|--|--|--|
| <b>First Patent</b>      | 1743 -<br>~1746                                  | The patent specifies a range of compositions ranging from 1 China clay, 1 alkali glass to 4 clay/1 glass. The non-lead glaze comprises clay and glass but with a greater percentage of glass cullet.          | Hard, dense, high-firing body with partial conchoidal fracture (hard-paste porcelain). Typically white, finely granular to glassy paste. Glaze tight fitting, matt to wet-looking. Wares often thinly potted with preference for slip-casting. | Highly translucent varying from cold white to white with an icy-greenish tinge   | A relatively uniform group with characteristic decoration involving gilding and sgraffito. Characteristic palette with artists/as yet unrecognised. Daniels (2003) proposes W. Duvivier as one artist. Arguably the most significant group of 18th century Anglo-American porcelains made in response to Meissen and Chinese hard-paste. |
| <b>Patent</b>            | <b>Develop-<br/>mental<br/>period</b>            | The broad composition conforms to the 1749 patent with ~25% crushed silica, ~25% ball clay, and ~50% <i>virgin earth</i> , which comprises variable amounts of bone ash, cullet, and gypsum or possibly alum. | Superbly to thickly potted, enamelled and blue and white examples. The enamelling is vibrant whilst the blue is typically of the early bright blue. A feature of some in this group is a drab-mushroom appearance.                             | Greenish-grey to creamish  | A somewhat composite group representing the earliest phosphatic wares recognised. The drab hue found in some examples probably represents variations in kiln-firing conditions. Variation in potting from thick to more gracile variants. Earlier experimental phase as yet unrecognised.  |
|                          | <b>Early or<br/>New<br/>Canton<br/>period</b>    | Conforms to the 1749 patent (silica 25%, ball clay 25%, <i>virgin earth</i> 50% - comprising bone ash ~45% and cullet ~5%). Both alkali and lead glass used.  | The body used for the early wares is white, finely granular, dense, and tough. The body is less inclined to stain. The presence of lead glass cullet may impart a heavy feel   | Greenish-grey to greyish white   | Porcelain of this period is characterised by a high quality body, good translucency, and at times a creamish appearance commencing around ca.1750. Analyses demonstrate that <i>virgin earth</i> comprises approximately 90%/wt bone ash and 10% glass cullet.   |
| <b>Second<br/>Patent</b> | <b>Transitional<br/>or<br/>Target<br/>period</b> | A transitional phase conforming to the earlier 1747-1753 period recipe but with the addition of 1% gypsum.  | Vibrant bright underglaze blue extends to this period (Pether, <i>jug</i> , dated 10th May 1754).  | What Frank Tilley describes as 'Bow brown'   | This transitional phase has been identified from sampling of the Thomas Target bowl held by the British Museum. There is the possibility that the small amount of sulphur present may represent contamination.   |
|                          | <b>Middle or<br/>Bowcock<br/>period</b>          | A significant change in recipe with ~35% bone ash, ~44% silica, 15% ball clay, and 6% gypsum. Composition is more uniform with cullet now absent.   | A marked deterioration in the body becoming more porous or chalky and lighter in weight. Unglazed portions tend to stain brown. The glaze is generally duller.   | Translucency is prominent to reduced and varies from warm pale yellowish brown, to darker hues, to reddish, and non-existent in more thickly potted examples | This period represents a major change in paste composition with a reduction in both bone ash and ball clay and an increase in crushed silica. Gypsum is now a small but significant component through to the closure of the concern.   |
|                          | <b>Late or<br/>Tidswell<br/>period</b>           | Glass cullet now reappears with 15% ball clay, 33% bone ash, ~6% cullet, 6% gypsum, and 40% silica.   | A further deterioration with ceramic examples at times likely to be confused with pottery.   | Poor to non-existent.  | This period still conforms to the recipe for the 1755-1769 period but with the marked addition of cullet. The pottery-like appearance of the body suggests underfiring.  |

Table 16. A classification of first and second patent Bow porcelain ~1743–1774.

figures in the white noted by Tait. We predict that very early Bow phosphatic porcelains may have unusual bone ash levels, may have high glass contents, may show evidence of warping, and may often be in the white. A possible date range extending back to the earliest 1740s, if not earlier, might not be unreasonable for phosphatic wares of the *Experimental period*.

Based on wasters derived from the lowest level recovered from Warmstry House, Owen (1998) has been able to demonstrate that William Davis and Dr John Wall had been experimenting up to and/or soon after the acquisition of Benjamin Lund's Bristol manufactory in early 1752, with a range of radically different recipe types, which included (1) talc + flint glass, (2) talc + bone ash, (3) talc-free, bone ash variants, and (4) Si-Al rich types. A similar situation involving different or transitional recipes types has been reported from Limehouse (Freestone, 1993), Nantgarw (Owen et al., 1998), Vauxhall (Owen et al., 2000), and Bovey Tracey (Owen et al., 2000). Owen (1998) concludes that diverse recipes or paste-types were used at particular manufactories, especially during their early experimental phases. We suggest that a similar situation exists for Bow. Support for this notion will come either through archaeological research and/or the analytical testing of unusual looking items thought to represent early Bow porcelain output. Should this suggestion prove to have some basis, then the model for parallel or overlapping development of both Bow first and second patent recipe types as adopted by Daniels (2007), rather than sequential evolution as used in this account, is likely to be more correct.

#### SIGNIFICANCE OF THE BOW MANUFACTORY

The introductory paragraph to Chelsea porcelains by J. V. G. Mallet (1965) possibly encapsulates some of the prevailing attitudes and concepts adopted towards the Bow porcelain manufactory,

Chelsea shares with Bow the claim to have been first amongst the English factories to produce porcelain on a commercial scale, but in other ways the two major London factories were not strictly comparable. When Sprimont, the manager and dominant figure at Chelsea for most of the factory's duration, wrote of the other early English porcelain makers: "Several attempts have likewise been made here; few have made any progress, and the chief endeavours at Bow

have been towards making a more ordinary sort of ware for common uses", he was not so much decrying the wares of a rival as expressing his sense of isolation as the only British manufacturer to concentrate exclusively on the luxury market. The wares of Worcester could better withstand boiling water; Bow wares were cheaper. But to the English world of fashion, Chelsea alone among the native porcelains could stand comparison with the wares of the Saxon or French Court factories.

Mallet notes that these observations by Nicholas Sprimont were drafted at some time between 1752 and 1757 and consequently Sprimont's comments might appear apt with regard to a significant component of Bow's second patent output. If however one accepts our contention that the 'A'-marked group of porcelains is the product of the Bow first patent, it might suggest that Sprimont was either unaware of the 'A'-marked group (an unlikely suggestion) or that by the time he wrote these words, Bow had long since discontinued the production of first patent wares.

This belief that Chelsea porcelains alone could bear comparison with Meissen porcelain (Hobson, 1905; Hurlbutt, 1926; Mallet, 1965; Legge, 1984; Dragesco, 1993; Spero, 2006) has endowed that manufactory with special regard such that Sandon (1989:17) suggests that Chelsea in fact held a monopoly over other English-made porcelains for a short period. Coupled with this notion is the generally held view that Chelsea was the first British commercial porcelain manufactory. Nightingale (1881) commences his account of English porcelains by stating that Chelsea was incontestably the most important, both artistically and otherwise, of any of the English manufactories. More recently Sandon (1989) although noting that collectors will always argue over which was the first English porcelain factory, concludes that Chelsea is the only one which can begin to lay claim to that title.

We suggest that based on the premise that the Bow manufactory was producing commercial, hard-paste porcelains of remarkable technical and artistic brilliance by the early to mid 1740s, the assumed pre-eminence attributed to Chelsea for well over the last century needs to be re-evaluated. The development of a high-firing, Si-Al-Ca body by Bow, when coupled with the innovative second patent bone ash recipe and the pioneering role in developing a high-magnesian (steatitic) recipe, leads us to the conclusion that on considering the entire Bow porcelain output, and not merely the second patent phosphatic



wares in isolation, the experimental, technical, entrepreneurial, and artistic contribution both by this factory and its proprietors to English ceramic development is unrivalled by any other 18<sup>th</sup> century English porcelain manufactory (Daniels, 2007; Ramsay and Ramsay, 2007). This appearance of three uniquely British commercial porcelain recipes during the space of but a handful of years represents a possibly unparalleled period in the history of British decorative arts, yet these achievements have been largely overlooked or forgotten during the subsequent 250 years.

Another feature, which demonstrates the leadership role played by the Bow manufactory and its proprietors, can be found in the desire by rival concerns to replicate the recipes employed at Bow. Whilst many ceramic commentators tend to give prominence to the spread of stylistic and decorative links as supporting evidence for such a leadership role, Barker (1998) suggests that these decorative features more often tend to confuse. It might appear that the spread of paste recipes, by what Owen and Hillis (2003) describe as technological transfer routes, is arguably a more significant and objective method in deducing or inferring the importance and significance enjoyed by any particular factory. As noted, Bow developed at least three remarkable and innovative paste types, which were quickly emulated and copied to various degrees by other concerns.

The Si-Al-Ca body can be recognised as having spread by 1745 to Limehouse, and Pomona (Freestone, 1993, 1996) and by 1756 to W<sup>m</sup> Reid and Co at Brownlow Hill in Liverpool (Owen and Hillis, 2003.) The main difference between the recipe used at Bow and that used at the other sites is that Bow had access to a refractory, high-firing China clay in contrast to the employment of a lower firing ball clay at Pomona, Limehouse, and Brownlow Hill. In the case of glazing Freestone (1993) notes that glazes used on Limehouse 'experimental' wares reflect the lead-free, Si-Al-Ca glaze specified in the Bow 1744 patent whereas the subsequent commercial Limehouse wares reverted to a lead-based glaze.

The use and spread of the bone ash recipe can be regarded as a triumph of Bow ingenuity and its leadership role amongst other contemporary concerns. Based on both waster evidence and the known compositions used by various factories, the following tentative dispersion network involving in the main, crushed silica, bone ash, and ball clay can be suggested for the following concerns: Vauxhall by or after 1751 (Owen et al., 2000), Worcester prior to

February 21<sup>st</sup>, 1752 (Owen, 1998), Chelsea around mid 1750s (Adams, 2001; Godden, 2004b), W<sup>m</sup> Reid and Co by 1756 (Owen and Hillis, 2003), Lowestoft by around 1757 (Owen and Day, 1998), Samuel Gilbody by 1758 (Godden, 2004a), Isleworth some time after 1760 (Freestone et al., 2001), William Ball at Brownlow Hill by 1761 (Phillips, 1999), James Pennington by 1763 (Phillips, 1999), Bovey Tracey by 1766 or 1767 (Owen et al., 2000), Chelsea-Derby by 1770 (Owen and Barkla, 1997), Bonnin and Morris in Philadelphia by 1770 (Hood, 1972; Owen, 2001b), Seth Pennington and John Part by 1778 (Phillips, 1999), Nantgarw by 1813 (Owen et al., 1998), and Swansea by around October 1814 (Owen et al., 1998). In some instances, such as Worcester or Vauxhall, the use of bone ash was apparently limited to an experimental phase as deduced from wasters recovered on site.

Arguably the most significant contribution by the Bow manufactory is the subsequent incorporation of bone ash into what is known today as English bone china. This application was apparently employed by Spode and Minton by the end of the 18<sup>th</sup> century (Godden, 2004b) and then subsequently by a variety of factories such as J. & W. Ridgway, Daniel, and Wedgwood (Godden, 2004b.). It is this recipe type, known today as English bone china comprising some 50 wt% bone ash (Hamer, 1975), which is the Bow manufactory's most enduring legacy.

Evidence presented in this account affirms that Bow was producing a third highly significant recipe of the high-magnesian type during the mid 1740s. Owen and Hillis (2003) comment that Robert Podmore took his knowledge of Worcester's use of soapstone with him to Liverpool, thus indicating a technology pathway from Benjamin Lund of Bristol, to Worcester by 1751, and thence to Richard Chaffers in Liverpool in 1755. However Owen and Hillis note that it is difficult to determine where Lund acquired his knowledge of soapstone, even though it has been claimed that he brought it with him from Limehouse. This possibility now gains support from the claim by Freestone (1993) regarding the presence of soapstone based on XRD analysis in examples attributed to Limehouse, thus suggesting that soapstone technology initially developed in London. A tentative technology pathway involving both soapstone and Si-Al-Ca bodies can be postulated stretching from Bow, possibly through Limehouse and thence to Worcester by 1751 via Lund's Bristol in the case of soapstone. Likewise by the early 1750s Nicholas Crisp was utilizing Bow's steatitic recipe at

Vauxhall. The Vauxhall low-Ca steatitic recipe is mirrored in compositions recognised for Worcester and Chaffers Liverpool (Owen et al., 2000) and Bow itself.

Within much of the writings on early English porcelains there is to be discerned a thread which might suggest an attitude verging on inferiority when compared with the achievements and splendours of both Oriental and Continental porcelain. Hobson (1910) alludes to aspects of this complex where he writes,

.....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.

This view or variants, which suggests that the English are in some way indebted to the Continent for the endowment of superior ceramic technology and associated knowledge has reappeared at numerous times over the last century in various accounts and discussions. We suggest that our understanding of early English porcelain initiatives can only claim to have come of age when it is recognised and accepted that the three recipe types described above, developed and commercialised by Bow, are essentially indigenous to Britain and possible in part to colonial America. The ceramic contribution by Bow and its proprietors represents an hitherto unrecognised triumph for the British ceramic tradition and is in no way subservient to the Continent. This uncertainty, if not denial of the great indigenous English ceramic tradition is nowhere more obvious than in the repeated attempts over many years to give away these brilliant Bow first patent porcelains to the Italians or even the Scots.

### CONCLUSIONS

In this contribution we have presented a classification of Bow porcelain based on the inferred recipes of the paste used, appearance and physical properties of the subsequent bodies produced including translucency, and associated decoration. This classification, which dates the onset of the Bow commercial output to c.1743, has led us to the conclusion that the contribution by the factory proprietors to the develop-

ment of the English porcelain industry has to date not been fully appreciated. We consider that it has now been scientifically demonstrated that whoever was firing the 'A'-marked group of porcelains was replicating the Bow first patent of 1744. We accept that the 'A'-marked group of porcelains represents the 'long-lost' products of this patent and on integrating these remarkable high-fired, hard-paste porcelains with the later Bow phosphatic second patent wares, coupled with Bow's high-magnesian wares, the inescapable conclusion drawn is that the Bow manufactory holds an unparalleled position in English 18<sup>th</sup> century porcelain development. One of these bodies is a hard-paste Si-Al-Ca body with an associated high-fired Si-Al-Ca glaze, the second a bone ash based porcelain, which was to evolve by the end of the 18<sup>th</sup> century into the widely acclaimed English bone ash body. The third paste type relates to the high-magnesian body (steatitic) which current research suggests was being produced commercially by the early to mid 1740s. It is this commercial production of three uniquely British porcelain types, all within a two to three year period and all peculiar to Bow, which more than anything establishes the significance of this concern and the stature of its proprietors at a global level. Other aspects of the Bow concern include the remarkable entrepreneurial energy of the early Bow proprietors in sourcing their refractory clay, used in the high-firing Si-Al-ca body, over 8000 km from the Appalachian ranges, the highly sophisticated melding of indigenous and exotic potting forms and decorative themes into the earliest recognised luxury porcelains of the mid 1740s which can bear comparison with Meissen, and the growth of the business into arguably the largest and most profitable English ceramic concern of its day by the mid 1750s. This confluence in intellect, technological development, entrepreneurial drive, financial acumen, and the linkages with the best in the English artistic world including painting, engraving, and sculpture (Daniels, 2007) all contained within a few years, is possibly unparalleled in the entire history of British decorative arts.

Various distinct divisions are recognised for the Bow output. Although there is an apparent dichotomy in form and decoration between first and second patent wares, there is a greater division between the two paste compositions (refractory China clay vs low-firing ball clay combined with bone ash) yet both patent compositions were entered by Thomas Frye. The Bow first patent specifies various clay to glass ratios ranging from ~1:1 to 1:4, however to

date clay contents ranging from 50–70 wt% hydrous only, have been identified among first patent Bow porcelains. Where analyses are available we conclude that the glass frit was a lime-alkali frit. In one instance we conclude that steatite was being mixed with a high-clay body and alum. These first patent wares are deduced by both us and Pat Daniels to have been commercially produced in London from c.1743 and this raises the questions as to the date when experimental firings at Bow commenced and when the earliest parcels of Cherokee clay arrived in London. Research in this direction is well advanced. In addition there are various contemporary documents dating from 1743, which might appear to refer to Bow first patent porcelains, with the most obvious, other than the 1744 patent itself, being the Vincennes Privilege of July 1745 as recognised by Daniels, the letter written by William Cookworthy likewise in July 1745, and the highly significant comments written by William Tomlinson Jun. and dated 14<sup>th</sup> December 1744. The sudden appearance of hard-paste English porcelain requiring the use of a refractory China clay, high temperature kiln-firing techniques, and its associated decoration showing some parallels with Meissen, was quickly recognised by the French. Daniels also notes with regard to the porcelains exhibited by Thomas Bryand before The Royal Society in February 1743, that no other known group of English ceramics of that date fit the description given (refractory body which is resistant to thermal stress) other than those of the 'A'-marked group, yet there have been numerous attempts to force Chelsea glassy, soft-paste porcelains into this procrustean mould.

We conclude that the 1744 patent of Heylyn and Frye, which specifies the necessary raw materials and the proportions required for the manufacture of Bow first patent porcelains is an hitherto overlooked landmark document in the history of English ceramics. We note also that the potential role played by Andrew Duché and the *Philadelphia ceramic tradition* needs to be re-evaluated. Previous authors, who accepted that Duché did produce porcelain in Savannah (Hommel, 1934; Gilmer, 1947, 1948), were hampered in being unable to recognise any products that could reasonably be related to Andrew Duché. We would contend that this situation may have now changed.

The earliest Bow second patent wares recognised in this paper belong to the *Developmental period* (c.1746), however we note Tait's comments regarding undecorated white wares, which may be at least

as early, if not earlier (*Experimental period*). We predict that such wares might be characterised by low bone ash levels, possible evidence of sagging, and demonstrating higher than normal levels of glass cullet in the initial paste recipe. On a compositional basis, porcelains of the *Developmental period* closely compare with the specifications of the 1749 Bow patent, however wares grouped with this period contain the addition of sulphur, derived most likely through the presence of gypsum or in some instances, possibly alum. Although some early enamelled members of this period do have a drab-grey appearance, we would question whether this feature characterises all early enamelled wares. Rather we regard this drabness to reflect an artifact of variable kiln firing conditions. Translucency of the ceramic body for items conforming to this period is typically greenish-grey to greenish-white to at times creamish-white. Porcelains grouped in the *New Canton period* (c.1747–1753) accord with the composition specified in the 1749 patent but without the addition of a sulphur-bearing component, with approximately 25 wt% crushed quartz, 25 wt% ball clay, and 50 wt% 'virgin earth'. It is shown that for this period 'virgin earth' comprises 90 wt% bone ash and 10 wt% glass cullet. Translucency of the porcelain body during this period is typically greenish-grey to whitish-grey. The Transitional or *Target period* (1754) likewise conforms to the 1749 patent recipe, but with the re-introduction of a small addition of gypsum (~1 wt%) assuming that this low level does not reflect contamination.

Although the Bow manufactory reached its zenith in sales and turnover in 1755 and little change can be seen stylistically in the porcelain output until the late 1750s, it now appears that c. 1755 the proprietors engaged in significant changes to the paste recipe and in the preparation of the raw materials used. During this year ball clay was reduced from around 25 wt% to 15 wt%, crushed quartz increased from 25 wt% to around 40 wt%, and gypsum to around 5 wt% was added. We also infer that glass cullet ceased to be added to the porcelain body from around 1755 and we agree with Tite and Bimson (1991) that this change may have coincided with the cessation of initially fritting the various raw materials. This phase of production, termed here the *Middle or Bowcock period*, continued until around 1769. Translucency during the *Bowcock period* varies from yellow brown and straw through to distinct reddish hues to non-existent. This variation in translucency most likely reflects declining peak kiln temperatures through time

and/or the reduced degree of heat work achieved. A fruitful line of future research would be to try and discern the main reason or reasons, be they economic, improved kiln-firing outcomes, or consumer demand for this profound recipe change, which we regard as a major unanswered question associated with the history of the Bow ceramic output. We have previously suggested that one reason for this change might be associated with attempts to reduce costs associated with the procurement of raw materials. A second, and possibly more likely reason, for this change was the desire to establish a more uniform paste composition and hence reduce inferred kiln wastage. This change to a more uniform composition with a significantly reduced variation in the fluxing elements can be seen visually by comparing the various calculated recipes for the *New Canton period* (Table 9) with those of the subsequent *Bowcock period* (Table 13).

In the Late or *Tidswell period* (c.1770–1774) the proprietors reintroduced glass cullet (both alkali- and lead-bearing) but kiln-firing problems appear to have occurred, thus resulting in a porcelain body often being difficult to distinguish from pottery. Translucency is negligible to non-existent. For this discussion we have placed the basal boundary for the *Tidswell period* at 1770, however it could prove to be a little earlier. A more precise boundary between the *Bowcock and Tidswell periods* needs to be defined and again this offers a further avenue for research.

The third major recipe type developed to a commercial stage by Bow is the high-magnesian body of which a small number of examples are now recognised. Possibly the most remarkable example of these wares is the George II busts, which Daniels (2007) dates to 1744. Next to the 'A'-marked group of porcelains, these numbered busts, of which some 16 examples are known, are arguably the most important early English group yet requiring a compelling attribution (Ramsay and Daniels, in prep).

We note that whereas studies of English porcelains using body, glaze, form, and decoration have been in the past highly useful in grouping like with like, such studies have been less successful in attributing various porcelain groups to a factory source in the absence of supporting information including documentary wares, archival material, compositional data, and archaeological evidence. Possibly the most outstanding example has been the reluctance since the 1930s to recognise the significance of the 'A'-marked group, however other examples of this problem exist. We suggest that although typological

approaches to the study of English porcelains have been very successful during the 19<sup>th</sup> and 20<sup>th</sup> centuries, such approaches on their own will not sustain future scholarship through the 21<sup>st</sup> century. A case in point is that for over the last decade, arguably the most significant body of original research into early English porcelains has come out of Nova Scotia, not the United Kingdom. This research touches on most of the major 18<sup>th</sup> century English factories yet the English ceramic establishment has in many instances largely ignored this work. The future challenge will be to integrate such results and possibly our analytical approach adopted in this contribution, into more broadly based studies of English ceramics. Likewise the importance of rigorous archaeological excavations with full site maps and detailed stratigraphy is only recently being given the prominence required.

In the case of glaze compositions used at the various English concerns, Ramsay et al. (2003) have noted that in many instances, based on the limited number of analyses currently available, such glaze compositions appear to be highly factory specific. As for the glazes used at Bow? Well that is another story for another day.

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## APPENDIX 1: SAMPLE PREPARATION:

Samples of ceramic powder and glaze obtained from various Bow porcelain items were mounted in PVC blocks and polished. Each block was subsequently coated with a film of amorphous carbon (<3nm) to prevent a build-up of charge during analysis. Quantitative chemical analyses were performed using a JEOL 840A scanning electron microscope (SEM) equipped with an Oxford Instruments ATW X-ray Energy Dispersive Spectrometer (XEDS). The microscope was operated at a high-tension of 40 kV, the probe current was set at 6 nA and the working distance at 39 mm. The resolution of the energy-dispersive detector was 147 eV at 5.9 keV. Typically, the live time was 100 seconds. All spectra were acquired using a focused (~1 µm diameter) probe. Bulk compositions were determined by raster analyses of single fields using the maximum available area. All quantitative analyses involved applying the ZAF matrix correction procedure to the measured intensities

of the Na-K $\alpha$ , Mg-K $\alpha$ , Al-K $\alpha$ , Si-K $\alpha$ , P-K $\alpha$ , S-K $\alpha$ , K-K $\alpha$ , Ca-K $\alpha$ , Ti-K $\alpha$ , Fe-K $\alpha$  and Pb-L $\alpha$  characteristic x-ray peaks. Oxygen content was calculated by difference based on the assumed stoichiometry of the oxides. The internal standards and references used in this investigation included apatite (Ca, P), anhydrite (S), plagioclase *An* 65 (Al, Si), tugtupite (Na), sanidine (K), iron (Fe), lead (Pb), magnesium (Mg) and titanium (Ti). The presence of trace quantities of other elements was confirmed by inspecting spectra by eye. Due to peak overlap, it was not possible to confirm visually for (a) sulphur when lead was present and (b) sodium when remote fluorescence from the copper sample holder gave rise to a Cu-L peak. In most instances results are regarded as +/- 5% however in some cases, where the amount of powder was very small, this degree of precision would decrease.

## APPENDIX 2: LIST OF ANALYSED SPECIMENS.

- c China clay, bc ball clay, ba bone ash, lg lead glass, ag alkali glass, s silica, g gypsum, a alum, st steatite.
- B1. Underglaze blue and white coffee can, private collection. (bc18.2, ba46.3, lg3.1, ag4.8, s27.6)
- B3. Underglaze blue and white sauceboat, private collection. (bc14.1, ba37.3, g6.4, s42.2)
- B4. Figure of a bagpipe player in the white, private collection. (bc16.4, ba46.8, lg1.7, ag7.1, s28.0)
- B5. Underglaze blue and white sauceboat, private collection. (bc18.4, ba32.1, g3.5, s46.0)
- B8. Figure of seated abbess, private collection. (bc24.1, ba41.5, ag4.5, s29.9)
- B9. Bowl with incised line and 'B'-marked, private collection. (bc15.0, ba40.1, ag6.3, g6.2, s32.4)
- B10. Mug underglaze blue and white with incised line (Knowles Boney mug) private collection. (bc29.4, ba42.4, lg0.3, ag6.6, g1.5, s19.8)
- B11. Figure of a standing nun in the white, private collection. (bc18.9, ba46.2, lg4.4, ag6.5, s24.1)
- B13. Polychrome plate, private collection. (bc25.1, ba48, lg1.4, ag5.6, s19.9)
- B14. Fluted cup, 'A'-marked, private collection. (c43.4, ag56.6)
- B16. Fragment of an applied prunus cup, Victoria and Albert Museum. (bc15.5, ba35.8, g4.8, s44)
- B18. Fragment of an underglaze blue and white leaf dish, Victoria and Albert Museum. (bc16.3, ba37.2, lg0.5, ag5.1, g5.6, s35.3)
- B20. Pedestal sauceboat in the white with gilding, Victoria and Albert Museum. (bc26.1, ba42.7, ag4.4, s26.7)
- B22. Bowl "Target Bowl," British Museum. (bc20.9, ba46.8, ag6.6, g0.8, s24.9)
- B23. Bowl "Success to Trade," British Museum. (bc12.4, ba36.4, g5.4, s54.8)
- B24. Mug "Tidswell Mug," British Museum. (bc14.0, ba30.1, lg6.8, ag7.0, g5.0, s37.1)
- B25. Bowl "Bowcock Bowl," British Museum (bc15.8, ba36.6, g4.7, s42.9)
- B28. Figure of Negress with basket in the white, Newham Borough Council. (bc28.3, ba42.3, lg8.0, ag5.6, s15.8)
- B29. Figure of female in Turkish costume, Newham Borough Council. (bc11.6, ba36.7, g8.3, s43.4)
- B30. Single shell-salt, Newham Borough Council. (bc20.0, ba43.6, lg4.3, ag8.3, a5.6, s18.2 or bc20.5, ba42.8, lg4.4, ag12.0, g4.1, s16.2)
- B31. Vase, *famille rose*, private collection. (bc21.8, ba48.3, ag5.9, s24.0)
- B32. Figure of Kitty Clive in the white, private collection. (bc25.6, ba45.8, lg0.8, ag10.8, s17.0)
- B33. Teapot, polychrome, private collection. (bc33.0, ba32.8, lg0.3, ag1.4, s32.5)
- B35. Mug blue ground, private collection. (bc14.3, ba32.3, lg2.4, ag3.8, g7.4, s39.7)
- B36. Mug 'R'-marked, private collection. (bc29.2, ba40.5, lg2.3, ag2.6, s25.4)
- B39. Waster, courtesy of Dr D. Redstone. (bc13.2, ba41.1, lg0.5, ag2.3, g4.3, s38.6)
- B42. Waster underglaze blue *Image pattern*, courtesy of Dr D. Redstone. (bc12.4, ba39.3, ag3.4, g5.7, s44.1)
- B43. Bowl blue and white, British Museum. (bc14.4, ba39.4, g5.4, s40.8)
- B51. Teapot 'A'-marked group, private collection. (c50.1, ag49.9)
- B62. Teapot polychrome, Taylor Collection. (bc27.4, ba37.1, lg1.4, ag4.4, s29.8)
- B64. Triple shell-salt, Taylor Collection. (bc21.2, ba40.7, lg3.4, ag3.3, a1.6, s29.9)
- B66. Sauceboat polychrome, Taylor Collection. (bc27.6, ba46.1, ag5.3, s21.0)
- B68. Plate underglaze blue, Taylor Collection. (bc21.5, ba33.2, lg6.6, ag4.3, g8.4, s26.0)
- B71. Shell stand in the white, private collection. (bc22.4, ba39.5, lg1.2, ag13.2, s23.7)
- B73. 'R'-marked cup and saucer in the white, private collection. (bc24.6, ba38.9, lg4.8, ag7.4, s24.3)
- B79. Tea-canister of the 'A'-marked class, National Gallery of Victoria. (c66.6, a5.8, ag15.6, st 12.0)
- B96. Figure of pug dog in the white, private collection. (bc30.6, ba32.2, lg10.2, ag5.4, s21.6)
- B97. Covered sugar bowl 'A'-marked group, Melbourne Cricket Club Museum. (c59.0, ag41.0)
- B116. Lid to vase belonging to a garniture of vases, Hamilton Art Gallery. (bc27.2, ba41.2, ag4.4, s27.3)
- B117. Base to vase belonging to a garniture of vases, Hamilton Art Gallery. (bc26.8, ba41.2, ag3.5, s28.5)
- B119. Waster 'R'-marked, courtesy of Dr D. Redstone. (bc25.0, ba46.9, lg0.4, ag5.2, s22.6)
- B128. Figure *Ki-Mao-Sao* in the white, private collection. (bc21.0, ba52.3, lg0.5, ag7.7, s18.5)