# *Attribution enhanced – 'Isleworth porcelain' re-examined*

*A paper by Nicholas Panes, Ray Howard, and Professor J Victor Owen*
*read by Nicholas Panes at Kensington Central Library on 15th December 2012*

*Introduction*

The Isleworth porcelain factory has had a strange intermittent relationship with porcelain collectors. Known about, collected, and written about[1] in Victorian times it was completely forgotten during much of the 20th century.[2] The rediscovery of the factory following finds by the side of the river Thames was first published in 1998.[3] Interest in the factory then revived quickly, prompting an Exhibition and catalogue which was published shortly afterwards.[4] In 2002 there was a further dramatic find – a huge waste dump of Isleworth sherds was discovered at Hounslow Heath, an area that the factory had moved to. A further catalogue linked to archaeology on this site was published jointly by ECC and the Museum of London (MoL).[5]

The last mentioned publication occurred after collectors and dealers alike had enjoyed three years of study and speculation about the factory following the initial work in 1998. As a result, many pieces were offered for publication in the ECC/ MoL book. Whilst some of these were unlikely additions, a few were accepted for inclusion at the back of the book as 'Possible Isleworth Pieces'. This section was set aside for pieces with some characteristics felt to be Isleworth but for which no excavated evidence had been found during the archaeological field work at Hounslow.

During the ensuing years a few pieces have been found not to be Isleworth, most notably the teabowl on page 106 in the ECC/ MoL book, which has proved to be an extremely rare piece made by John Bartlam of South Carolina, three of which have now been found in England and a fourth in America.[6] However, many other pieces, as well as some other not included in the book appeared on the market and seemed to have become Isleworth by default, without any new evidence being added to strengthen the attribution.

The first part of this paper explains how and why a methodology was developed to compare and contrast chemical analyses of Isleworth and Bow pastes; the second part shows how this work was applied to study pieces previously attributed to Isleworth, sometimes with surprising results.

*Objectives*

The main objective of this paper is to confirm using compositional data that at least some of the pieces catalogued and sold as Isleworth since the ECC/ MoL publication are indeed Isleworth. This required:

1. Expanding the database of chemical analyses for substantiated Isleworth porcelain
2. Developing a test (or tests) which could, from the results of quantitative chemical analysis, distinguish between the phosphatic paste of Isleworth and that of the other manufacturers, most notably the 'next nearest' factory (both geographically and in chemical composition), that is Bow
3. Obtaining samples for testing of wares tentatively attributed to Isleworth which either had been sold as Isleworth or which were included in the rear section of the ECC / MoL publication
4. Proposing a 'more probable' attribution of the analysed pieces as either Isleworth or Bow.

*Why only a 'more probable' attribution?*

It should be noted that the reproducibility of scientific tests on ceramic materials has steadily improved as new technology has been developed since analyses of early British porcelains were first published. However,

the challenges faced by 18th-century manufacturers were such that the precision with which ceramic pastes were manufactured left much to be desired. In many cases continuing experimentation meant that factories made wares of varying composition.

Phosphatic wares provide particular challenges because many factories produced them, so there is considerable potential for overlap in their pastes. As a result of these factors the most satisfactory course for the researcher is to concentrate on the typical paste of a factory without forgetting that variations are likely to exist, possibly ones that make it unwise to be adamant about an attribution. The movement of personnel between factories and the still very small database of results from all English factories must leave potential for existing assumptions and understandings to be contradicted by future research.

For these reasons, any attribution based on compositional data for phosphatic pastes cannot be stated as being any more than 'probable'. When comparing two pastes, comments can only be made on which factory (i.e., Bow or Isleworth) our samples most resemble. As discussed later, this may not mean that the sample was made there in every case.

*Current knowledge of phosphatic pastes*

Geochemical analysis of phosphatic pastes has been undertaken for more than a century. Although no early attempt to analyse Isleworth porcelain is known, a single sample of Bow was analysed in the 1880s, and during the 20th century, analyses of Bow porcelain appeared in at least four publications. In 2007 Ross Ramsay and colleagues attempted to bring order and sequence to this body of data by reporting new analyses of specimens that could be accurately dated.[7] Despite this and the body of work carried out for other porcelain concerns it should be noted that the analytical data base for wares from individual factories is minute compared with their total output (i.e., at most a few dozen analysed samples versus tens to hundreds of thousands of objects manufactured annually). Thus the caveats set out above are vital.

Previous work suggests that phosphatic wares may be tentatively divided by reference to certain 'signature' components, notably lead (perhaps derived from potash-lead glass) and sulphur (derived from gypsum). Phosphatic pastes containing lead are known at Bow (before 1755 and after 1770 but not consistently), at Derby, at Isleworth, and at the American factory Bonnin and Morris (1770-3) where lead is only sometimes present. Phosphatic pastes containing sulphur (shown as $SO_3$ in analyses) were Bow (1755-69), Isleworth, Bonnin and Morris, and another 18th-century American porcelain factory, one managed by John Bartlam. Although exceptions to these rules may certainly exist, current knowledge suggests that Lowestoft and the Liverpool factories generally used neither gypsum nor potash-lead glass in their pastes.

For samples containing sulphur, unless these samples are rare atypical examples of their factories the range of 'more probable' attribution can be narrowed to Bow, Isleworth, and the two American factories. Given the extreme rarity of porcelain from the American factories they can probably be disregarded in most cases. Thus any tests developed to successfully distinguish between Bow and Isleworth could provide a 'more probable' attribution for sulphur-bearing samples.

One final aspect demonstrated by previous work is that the glazes used by manufacturers of phosphatic porcelains tend to be fairly similar, so that distinguishing factories using glazes is difficult. For this reason, this paper focuses more on pastes rather than glaze compositions.

The initial findings from the analysis of the 'possibly Isleworth' samples were that all those tested contained sulphur. We consider that the samples tested date from the decade 1765-75. This narrowed the field of investigation and made it desirable to distinguish the pastes of Isleworth and later Bow.

*Specific aspects of Bow phosphatic paste*

The most comprehensive set of analyses for Bow phosphatic porcelain was published in 2007. The Ramsay et al. exercise, based on analysing pieces which had been grouped into date ranges, showed that the composition of Bow phosphatic paste changed a number of times over the life of the factory. Specific

aspects of these changes are summarised below (Ramsay nomenclature in brackets):

- c 1746 (Developmental period) – Silica ($SiO_2$) consistently below 50%, lead oxide (PbO) varies between zero and 3%; sulphur is present
- 1747-54 (Early period) – Silica consistently below 50%, lead varies between zero and 3%, sulphur is absent
- 1755-69 – (Middle period) Silica consistently above 50%, lead is absent, sulphur is present
- 1770-74 – (Tidswell period) Silica consistently is above 50%, lead is between 0.2% and 2.93%, sulphur is present.

Whilst acknowledging that no phosphatic wares have been attributed to Bow in the earliest documented period of their existence, not all collectors would accept the dating above for 'developmental period' wares.[8] These wares differed from the 'Early period' above only in that they contain sulphur. It is possible that sulphurous pastes were used alongside those lacking sulphur during at least part of the 1747-54 period.

It is not known how the Isleworth porcelain factory obtained the recipe for phosphatic pastes but the movement of workmen from Bow provides a credible explanation. Upon reviewing these early 'Developmental period' sulphur-bearing pastes, they are very similar to the recipe used by Isleworth so based on their compositions, it is extremely difficult to distinguish them except for the fact that some Isleworth wares have relatively high lead contents.

These observations guided the design of tests used to compare Isleworth and Bow pastes. Isleworth too was a long lived factory, but as the authors dated the samples they were about to test in the range 1765-1775, it was desirable to develop comparisons which worked for the second of the two groups of Bow above but which almost certainly would not be effective for the first groups.

The Bow database used in the paper (Appendix 1) is derived from Ramsay, to which were added two late Bow pieces from the Nicholas Panes Collection.

### *Adding to the database of substantiated Isleworth porcelain analyses*

Ian Freestone reported on the compositions of twelve Isleworth sherds.[9] For this paper, the compositions of an additional twenty-two porcelain sherds from the river bank at Isleworth and from the waste dump at Hounslow, three Isleworth creamware sherds, and twelve 'possible Isleworth' intact objects are reported. These data are reported in Appendices 2, 3, and 8.

### *Analytical methods*

New analyses were carried out by J Victor Owen. A slice of each sample was mounted with epoxy on glass, and polished to a high finish using diamond paste on glass and cloth laps in preparation for analysis by energy-dispersive spectroscopy using a scanning electron microscope (SEM) equipped with a silicon drift detector (SDD).

The SEM used in the present study is a LEO 1450VP operated with a beam current of 20kV. It has an Oxford Instrument INCA X-max 80 $mm^2$ SDD. Count times varied according to the size of the area being analysed, and varied between 20 s for individual spot analyses, 100 s for small areas (specifically, the glaze, all of which was rastered), and 300 s for larger areas (~0.2-0.5 $mm^2$ fields) during the determination of the bulk composition of the body of the sample.

At least three fields in each sample were rastered in the determination of bulk paste compositions. This approach has been shown to provide analytical data for major and minor components comparable to wavelength-dispersive spectroscopy (WDS).[10, 11]

### *Problems in the database*

Following the analysis of the new Isleworth sherds and the authors' Bow pieces three results appeared atypical. These were:

1. The Isleworth sherd (**1**) was found to be lead free, thought to be the first lead free phosphatic sample ever analysed from Isleworth
2. The glazed sherd (**2**) is also lead free. As this is a finished glazed item there is a risk that it did not originate from the Isleworth factory although it was found there

1. Isleworth sherd – first found to be lead free phosphatic sample

2. Glazed sherd – also lead free


3. Bow platter with low silica and both lead and sulphur free

3 The Bow platter from the Nicholas Panes Collection (**3**) was found to have low silica and to be both lead and sulphur free. Typically platters of this sort are dated c 1760-65.

However, rather than the analytical results pointing to a different attribution, the paste may be an example of the later use by Bow of an older recipe more typical of the 1747-54 period. This is demonstrated by the analysis shown below, as the analysis of the Bow platter is within the range of values which made up the average of Ramsay analyses:

| Component | Ramsay Bow 1747-54 Average % | Bow Platter % |
|---|---|---|
| $SiO_2$ | 44.66 | 42.80 |
| $TiO_2$ | 0.38 | 0.32 |
| $Al_2O_3$ | 8.13 | 6.24 |
| FeO | 0.36 | 0.16 |
| MgO | 0.48 | 0.53 |
| CaO | 23.36 | 24.10 |
| PbO | 0.66 | 0.00 |
| $SO_3$ | 0.00 | 0.00 |
| $Na_2O$ | 0.80 | 0.94 |
| $K_2O$ | 1.01 | 0.92 |
| $P_2O_5$ | 20.17 | 24.00 |
| | 100.01 | 100.01 |

Table 1 – Comparison of Bow Platter with early Bow recipe

Since the object of the database was to provide typical comparators of substantiated Isleworth and later Bow the three results referred to above were excluded. They remain interesting findings adding to our knowledge of the variability of pastes found at these factories.

*Devising tests to distinguish Isleworth from Bow*

In order to design suitable tests to distinguish Isleworth from Bow, compositional data for sherds (and documentary pieces from Bow) were compiled. Then, the most extreme results (i.e., outliers) were excluded. By comparing the investigated pieces with only the most typical results for Isleworth and Bow the intention is to increase the reliability of any conclusions drawn from such comparisons. The next stage of this process was to identify any elements within the composition which seem to differ between Isleworth and Bow.

**Test 1**: The first and most obvious element to receive this treatment was the lead content. The figures below are derived from the base data (Appendices 1 and 2).

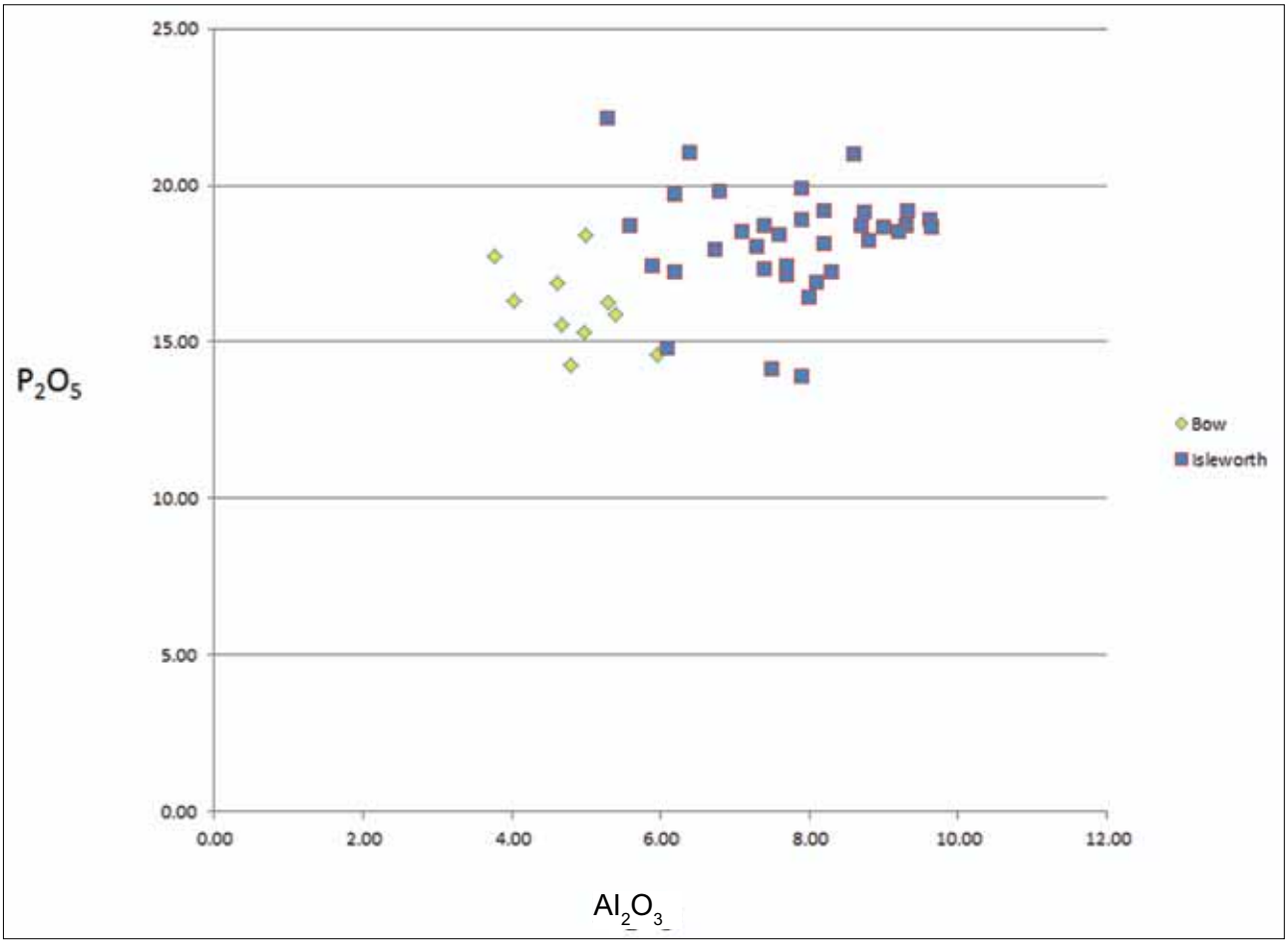
Whilst it can be seen that some high-lead Bow may overlap Isleworth, in more typical results it may be seen that lead below 1% is an indicator of Bow, and lead above 1% an indicator of Isleworth. This first test is rather simplistic and would not be satisfactory alone, but it was selected as one of three tests which the authors used.

| All results | All results | All results | All results | Typical | Typical | Typical | Typical |
|---|---|---|---|---|---|---|---|
| Isleworth | Isleworth | Bow | Bow | Isleworth | Isleworth | Bow | Bow |
| Low % | High % | Low % | High % | Low % | High % | Low % | High % |
| 1.43 | 6.43 | 0.00 | 2.75 | 1.70 | 5.93 | 0.00 | 0.93 |

Table 2 – Range of lead content in paste database

**Test 2**: The second test is based on phosphate and alumina concentrations, the former component being related to the amount of calcined bone ash used in ceramic pastes, the latter to clay. Factories producing bone ash porcelains tended to have their own preferred mix of clay and bone-ash so that scatter diagrams based on $P_2O_5$ and $Al_2O_3$ can distinguish their wares. (**4**)

**Test 3**: The first two tests involve the use of three paste components to try to differentiate Bow and Isleworth wares. In developing a third and final test, additional components ($SiO_2$, MgO, $Na_2O$, $K_2O$) together with $Al_2O_3$ are used for this purpose. Identifying such key elements is similar to a process of connoisseurship, but one which instead of observation uses numeracy to identify the 'shape' of the ceramic paste.



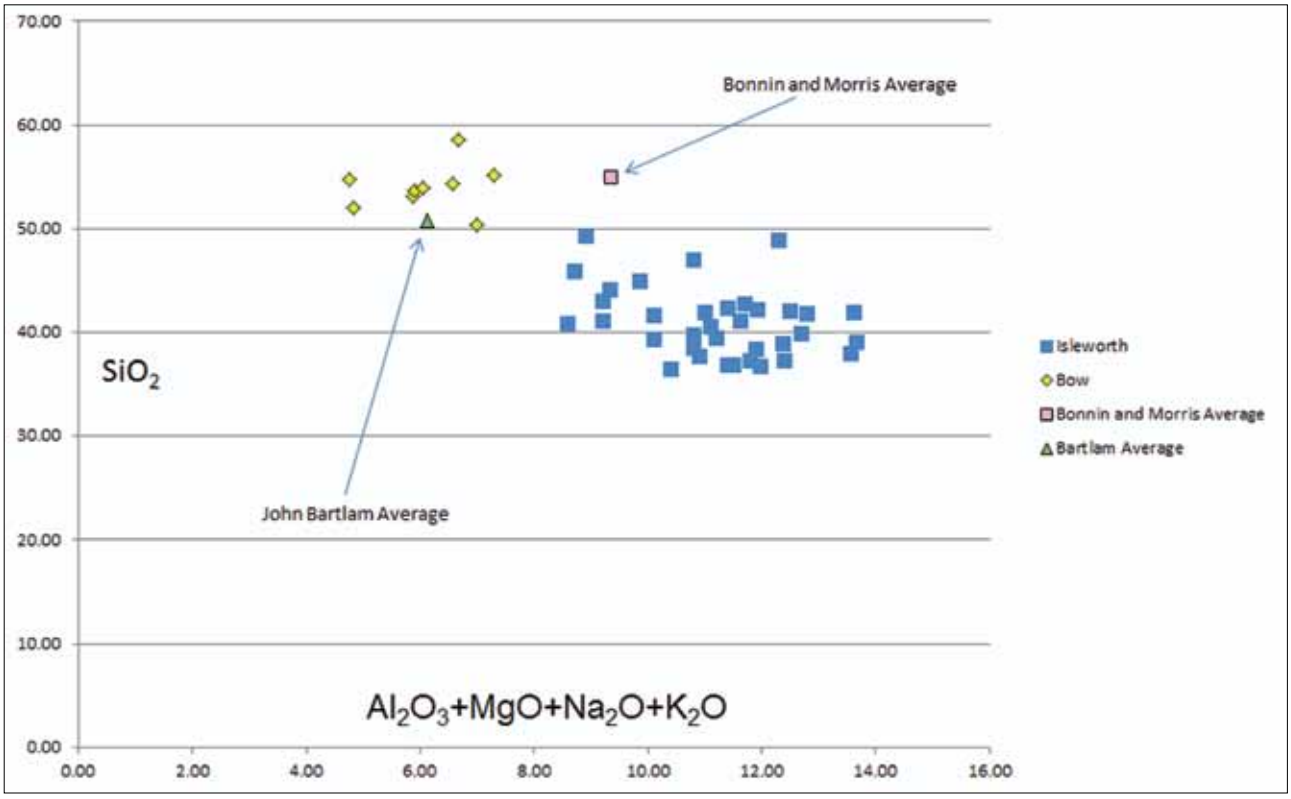

4. Scatter diagram based on $P_2O_5$ and $Al_20_3$

Once outlying data are eliminated it is apparent that the silica in Isleworth is typically lower than in later Bow so generally the other elements (Table 3) are higher in Isleworth than in Bow. Thus a scatter diagram of the silica content plotted against the sum of the other components listed in Table 3 should distinguish between Isleworth and Bow. (**5**) It is interesting to note that on this chart results for John Bartlam porcelain would plot very close to the Bow field, unlike Bonnin and Morris porcelain.

Taken together, these three tests use all but one major element (calcium) contained in the chemical

| | All results Isleworth Low % | All results Isleworth High % | All results Bow Low % | All results Bow High % | Typical Isleworth Low % | Typical Isleworth High % | Typical Bow Low % | Typical Bow High % |
|---|---|---|---|---|---|---|---|---|
| **$SiO_2$** | 36.50 | 49.30 | 50.31 | 58.57 | 36.70 | 48.86 | 51.98 | 55.15 |
| **$Al_2O_3$** | 3.80 | 9.65 | 3.76 | 5.96 | 5.60 | 9.64 | 4.02 | 5.40 |
| **MgO** | 0.38 | 0.73 | 0.00 | 0.45 | 0.40 | 0.72 | 0.01 | 0.40 |
| **$Na_2O$** | 0.43 | 1.50 | 0.00 | 0.85 | 0.60 | 1.38 | 0.19 | 0.60 |
| **$K_2O$** | 1.27 | 3.09 | 0.39 | 1.80 | 1.60 | 2.60 | 0.52 | 0.99 |

Table 3 – Range of further elements in paste content




5. Scatter diagram of silica content versus the sum of the other components

analyses of the pastes. Whilst aluminium was included in this test as well as Test 2, this had little effect on the diagram and would not have changed the conclusions if omitted. If any major element is to be omitted from all three tests it is appropriate that it is calcium as our results show that there is significant overlap between the calcium content of later Bow and Isleworth. Calcium can be derived from bones but also from the raw materials (notably plant ashes)[12] of some of the fluxes (e.g., potash) used to lower the melting point of the paste. Whilst high levels of calcium (e.g. >25%) occur in Isleworth but rarely in Bow, lower levels of calcium (e.g. <23%) occur in wares from both factories

### *The Samples*

A number of 'possibly Isleworth' pieces were obtained for testing. These came from the authors' collections and from those of our fellow ECC members. Some pieces were purchased especially for testing. The majority of these items were of a type illustrated at the back of the ECC/ MoL publication. Most of the samples tested are phosphatic (Appendix 3). Appendix 4 is a scatter diagram showing the results of the phosphate-alumina test on these pieces. Appendix 5 is a scatter diagram for the third test applied, plotting silica against the sum of alumina, magnesia, soda and potash. In the following section the intact, phosphatic specimens are illustrated and a commentary on the results of each analysis is provided.

The phosphatic samples analysed were:

| | |
|---|---|
| 1. A blue and white saucer | 7. An oval powder blue dessert dish |
| 2. A blue and white basket | 8. A 24 lobed powder blue plate |
| 3. A blue and white sauceboat | 9. A 40 flute powder blue dish |
| 4. A blue and white sauceboat | 10. A 23 lobed powder blue plate |
| 5. A blue and white small sauceboat | 11. A powder blue basket |
| 6. An octagonal powder blue plate | 12. An octagonal platter or meat plate |

### *The Results*

Sample 1 is a blue and white saucer (**6**) similar to that illustrated on page 103 of the ECC / MoL book. It contains no detectable lead. Its phosphate content is at the high end of typical Bow but alumina is typical of Bow. Test three places this sample as Bow with a very low aggregate for the minor elements. Silica at 50% is at the low end of Bow. It is concluded that the saucer is more likely to be Bow than Isleworth.

Sample 2 is an interesting porcelain basket well painted in a version of the Pinecone pattern. (**7**) The owner notes that the number of florets in the flower is one greater at six than Bow versions he has seen, and the colour of the blue is lighter than that normally seen on later Bow. Additionally it is marked with a hatched crescent, again a feature not seen on Bow. A number of connoisseurs have viewed this piece and speculated on an Isleworth attribution, but our analytical results do not provide support for that proposition. The basket contains no detectable lead, and its proportions of phosphate and alumina are consistent with Bow. The third test produces an atypical result in that the piece has silica levels similar to Isleworth but the minor elements are more consistent with Bow. Whilst on

6. Sample 1 - Blue and white saucer

7. Sample 2 - Porcelain basket in a version of the Pinecone pattern

balance the analysis is more like Bow than Isleworth it once again raises the question of whether some other as yet undocumented factory is responsible for this piece.

Samples 3, 4 and 5 is a group of three sauceboats. (**8**) One similar sauceboat appeared in the ECC / MoL book at page 107. These sauceboats are considered in the Nicholas Panes' book on sauceboats[13] without a conclusion, although Isleworth was described as the 'favourite'. The deep foot of these sauceboats is of a construction only really seen at Isleworth, although overall the sauceboats resemble contemporary Worcester strap fluted designs. Two of the sauceboats (centre and right) have crescent marks. The handle is a degraded version of the Isleworth norm, with its more flamboyant thumb rest and definite kick at the bottom. In this degraded form it resembles handles sometimes found on Bow and Lowestoft. The fact that Isleworth made another type of inverted rim sauceboat (**9**) throws some doubt as to why they would make two such similar designs.

8. Samples 3, 4 & 5 – Group of three sauceboats

9. Isleworth sauceboat

Indeed it is interesting that many factories made such a design. To date the most surprising absentee from quite a long list of factories[14] is Bow. It was hoped that chemical analysis might solve the problem of these sauceboats but the results are at first sight very puzzling indeed. From left to right (**8**) above, the first sauceboat, the only one without a crescent mark, has 0.3% lead and on the phosphate / alumina diagram sits squarely in the Bow field. It is also in the Bow field in Appendix 5 when Test 3 is applied. The centre sauceboat contains no detectable lead and on both further tests resembles Bow. The final sauceboat on the right contains 1% PbO. On the phosphate / alumina chart (Appendix 4) the sauceboat plots in the Isleworth field, and this is repeated for Test 3 (Appendix 5).

There are thus three sauceboats which it would be difficult to separate on grounds of connoisseurship. Compositionally, one resembles Isleworth, whereas the other two resemble Bow. Are these results definitive? Perhaps not. There is an alternative explanation based on better established facts. It is known that early Bow is very like Isleworth. Looking at the average Ramsay analysis for the Bow 'developmental period' there is quite a close match. Already noted above is one example of the use of an early Bow recipe later in the life of the factory. The sauceboat analysis may present another example, this time of the use of a 'developmental period' sulphur-bearing recipe at Bow during the 1765-75 period.

| | **Bow Development Period Average (Ramsey)** | **' Possibly Isleworth' Sauceboat** |
|---|---|---|
| $SiO_2$ | 45.27 | 44.70 |
| $TiO_2$ | 0.39 | 0.20 |
| $Al_2O_3$ | 7.12 | 6.70 |
| FeO | 0.33 | 0.30 |
| MgO | 0.47 | 0.50 |
| CaO | 22.68 | 24.80 |
| PbO | 1.14 | 1.00 |
| $SO_3$ | 2.10 | 2.30 |
| $Na_2O$ | 0.67 | 0.30 |
| $K_2O$ | 1.36 | 1.90 |
| $P_2O_5$ | 18.50 | 17.20 |
| | 100.03 | 99.90 |

Table 4 - Composition of Bow Development Period versus a 'Possibly Isleworth' Sauceboat (Sample 5)

If this interpretation of otherwise confusing results is accepted, then this whole group of sauceboats is more probably Bow than Isleworth.

*Possible Isleworth powder blue*

The next group investigated is the first of two types of powder blue ware sometimes attributed to Isleworth.

10. Isleworth powder blue sherd

Only one sherd from the two sites supports the idea that Isleworth made powder blue. (**10**) The sherd is rather difficult to read but if anything it hints at a shape of reserve not seen on any extant examples.

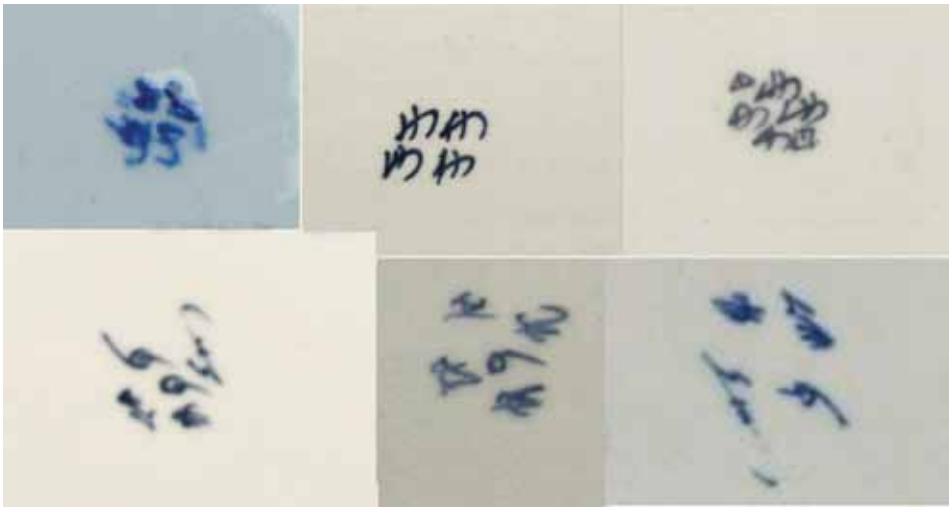
The first group of powder blue tested includes two plates and a dessert dish. (**11**) The two plates, Samples 6 and 8, show a number of aspects in their decoration which distinguish them from the most common powder blue pattern produced by Bow.

The distinguishing features which have been pointed out are:

1. The 'frog spawn' trees, i.e. the fruit of the tree which is smooth and round, thus different from the more typical design which has spiky chestnut-like fruit.
2. The small reserves of Sample 8 have three small rocks in a triangular group.
3. The oval cupola on the roof of the building
4. The marks, shown in the upper row (**12**), are more tightly drawn than the more typical Bow marks in the lower row.
5. Connoisseurs have also pointed to differences in glaze appearance and in the case of Sample 8 that the lobed plate shape is not seen in polychrome Bow so is unlikely to be Bow.

The arguments of connoisseurship put forward in favour of an Isleworth attribution for these plates appear to be dubious. Firstly this is so because the features so often attributed to Isleworth are in some

11. Samples 6, 7 & 8 – Left to right, Powder blue plate, dish and plate



12. Samples 6, 7 & 8 – Top row, marks said to be possibly Isleworth. Bottom row, marks said to be Bow

13. Lobed plate of a shape attributed to Isleworth, but bearing the pattern and type of mark attributed to Bow

cases also seen in acknowledged Bow examples. The pattern on the front of Sample 7 lacks the features in 1. to 3. above and looks like Bow yet the mark is tightly drawn in a manner attributed by some to Isleworth. The plate (**13**) also shows all the decorative features and mark for Bow yet it is in the lobed shape of Sample 8 said not to occur in Bow.

*On Connoisseurship*

Connoisseurship, the observational skill, has led to the current substantial understanding of 18th-century porcelain. Despite the enormous contribution which connoisseurship has made, it has limitations. Let us consider glazes, for example. It is known from scientific analysis that the glazes on many phosphatic porcelains are quite similar, so on the face of it if one such glaze looks different from another it cannot in these cases be because of the formulation.

Crazing on Isleworth porcelain is quite a common feature. Our current understanding is that crazing is caused where there is a mismatch between paste and glaze causing different rates of expansion during firing and / or contraction during cooling. However, it is known that some Isleworth is crazed and some

14. Samples 9, 10 & 11 – Left to right

15. Detail from the reserve of a Bow powder blue plate (left) and from sample 10 (right)

16. Sample 12 – Octagonal platter sometimes attributed to Isleworth

is not, but scientists have yet to identify the specific variation in paste or glaze composition which explains this. It is suggested that firing conditions are the most likely causative feature where glazes of broadly similar composition look different from each other.

Firing conditions can of course vary between two different factories, but also between winter and summer, position in the kiln, and according to the firing / cooling time. Even the skill of the fireman must be a factor here, especially where, in a small factory, firings are infrequent. It flows logically from this argument that differences in glaze appearance between two compositionally similar glazes is unlikely to be diagnostic.

Features of decoration on a piece should not be relied upon as the sole criteria upon which to reach an attribution. Clearly this is especially true amongst London factories where the opportunities for movement of the workforce between factories must have been considerable.

Returning to the group of powder blue wares, the results of the analysis and our diagnostic tests are set out in the Appendices. The lead oxide content in Samples 6 to 8 is 0.4%, 0.2%, 0.0% respectively, suggesting a Bow attribution. Samples 7 and 8 sit in the Bow area on the phosphate / alumina diagram though Sample 6 is atypical of either factory. The results for Test 3 also showed atypical results for the octagonal plate, Sample 6, but Samples 7 and 8 look like Bow. In view of these results, Samples 7 and 8 are more likely to be Bow.

In 1770 Bow lost its head painter (Thomas Frye Junior) and several other workmen[15] and it is generally recognised that the appearance and quality of Bow porcelain deteriorated after this date. The likelihood that differences in appearance, in painting style, and even variability of paste or glaze composition (per Sample 8) would occur when the factory was distressed in our view explains any of the differing features which have in the past caused these pieces to be attributed to Isleworth.

The final point in relation to the above group is that they have appeared on the market many times as Isleworth in the last decade, perhaps too many times. Isleworth remains a rare factory and a profusion of pieces should be viewed with caution.

The issue of rarity fits better with the second group of powder blue to be considered. (**14**) Only a handful of similar examples are known. A lidded honey pot of this type is illustrated in the ECC/ MoL publication on page 110 and there is a similar basket in the Victoria and Albert Museum.

These pieces seem to suffer from running of the blue pigment on sloping areas. The pattern is different from the previous group, and the sharply acute angle of the lower part of the outer reserves also distinguishes it from typical Bow. Also notable is that (despite the running of colours) no attempt has been made to paint a line round the edge of the outer reserves. On Bow examples (and the samples tested above) it is possible to see that such a line has been painted, perhaps as an attempt to stop the pigment running. (**15**, left). The back of all three of these pieces has no decoration and no mark.

The lead oxide contents of Samples 9, 10 and 11 are 1.2%, 2.2% and 2.2% respectively, suggesting an Isleworth attribution. On the phosphate-alumina diagram (Appendix 4) all three pieces appear on the edge of the Isleworth field, but not very far from the edge of the Bow field. Test three (Appendix 5) places these samples in the Isleworth field with low silica although low alumina causes the minor element aggregate to be slightly low compared with typical Isleworth samples. On balance there is sufficient evidence from these tests to support an Isleworth attribution for this rare group of wares, though notionally the later re-use of an early recipe by Bow cannot entirely be ruled out.

### *An octagonal platter*

Sample 12 is the octagonal platter (**16**), an example of another class of wares sometimes attributed to Isleworth. An auction house which sold a similar plate added the following commentary:

> This unrecorded Isleworth plate has been attributed on the basis of related painting, in particular the curious open rocks and the dark roof finials, similar to panels on powder blue wares that have been identified as Isleworth. This shape and pattern are copied directly from Bow of slightly earlier date.

It is not certain which class of powder blue wares is referred to above. It seems doubtful that the auction house itself was the originator of the attribution points relied upon. However, perhaps this illustrates the power of connoisseurship – get the initial attribution right and much good further work will follow, get it wrong and there is a severe risk of contagion.

The test results for our platter show that the lead content is zero, suggesting a Bow attribution. Of course the auction cataloguing above referred to Bow as the originator of the painted design, though it has not been possible to find a recorded Bow version. Both the subsequent tests place Sample 12 in the Bow area of the diagrams. It is therefore concluded that the platter is more likely to be Bow than Isleworth. This was the last of the tests carried out on phosphatic pastes but this particular design again is covered again later. The suggestion that both Bow and Isleworth had produced these wares was explored by testing further samples.

*Glaze composition – phosphatic porcelains*

As stated above, the glaze compositions of many phosphatic porcelains are broadly similar, making it difficult to distinguish between factories. However, an attempt was made to find differences between Bow and Isleworth by using the same numerical analysis as for the pastes. By reviewing the percentage occurrence of each element in the glaze only two minor elements were found, which seemed to be clearly different in the two factories, alumina and soda. In carrying out this analysis the Bow results from a paper by Ramsay[16] were used plus Isleworth results from Freestone and our own testing. In sampling Isleworth sherds and our test samples, it was not always possible to capture glaze so the sample is slightly smaller than for the pastes. Amongst the tested items perhaps the most disappointing omission is a failure to get glaze for the sauceboat which sampled like Isleworth (and early Bow).

A plot of the alumina against soda for the base data is compared with the tested samples added in red. (**17**) As will be seen, the spread of base data is considerable so that definable areas for Bow and Isleworth are a little more difficult to see. However, only the three labelled samples (**9**, **10**, **11**) fit into the Isleworth area, and these are the second group of powder blue attributed to Isleworth. Also of interest is that both of the more probably Bow powder blue plates (Samples 6 and 8) from the other group have glazes typical of neither Bow nor Isleworth. For Sample 6 therefore, neither paste nor glaze is typical.

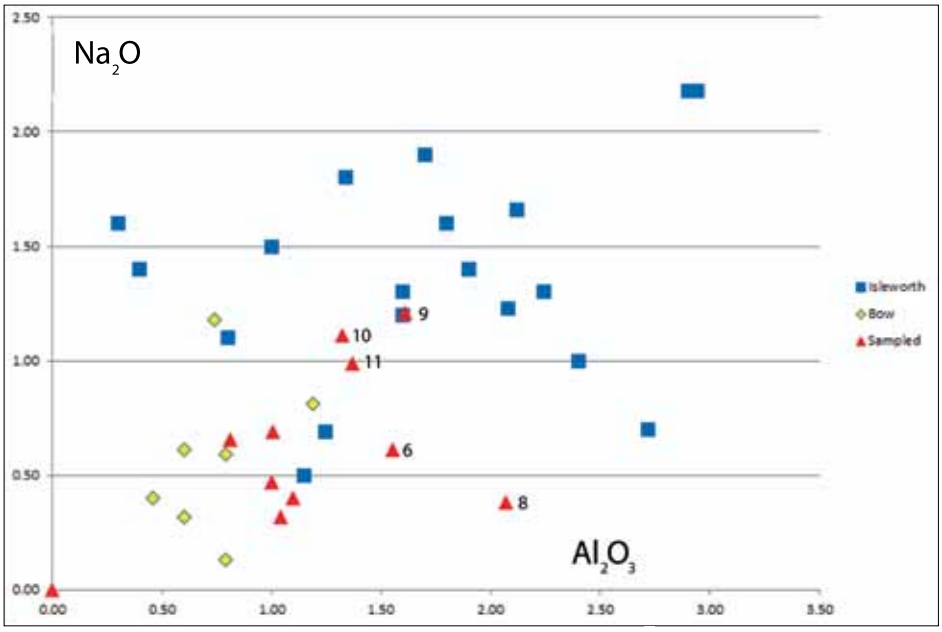
These glaze results are presented for what they are worth. It is interesting that they seem to corroborate the Isleworth results for one powder blue class. There are, however, significant pitfalls in drawing conclusions from glaze data. Victor Owen and colleagues at St Mary's University have done some test firings in a small kiln in which glazes which contained no alumina were fired in ceramic crucibles, following which they were found to have taken up alumina from the crucibles.

In effect, glazes can act as open systems, sucking up materials (particularly alumina) around them. There can also be a substantial loss of lead to the atmosphere during the firing, particularly at higher temperatures. These effects are both temperature and time dependent. These findings[17] predicate against using quantitative analysis of glazes as a reliable tools for attribution. They also underpin the contention that if a glaze looks different to a connoisseur, firing conditions are likely to be a significant factor.

*More octagonal plates*

The wish to test more examples of the class of plate similar to the platter (Sample 12) led in a totally unexpected direction. Two plates with the same painted pattern were tested, as well as two other octagonal plates which seemed to be of the same class. One of these other plates is of a type illustrated in the ECC / MoL book at page 109 and the other, a printed example, shares some features of the other plates. (**18**)

Samples 13 and 14 (top left and right) share the painted pattern with the probably Bow platter (Sample 12). Sample 15 (bottom left) is a variation of a common *Bamboo and Peony* Bow design, and Sample 16 has a painted Bow border pattern with a printed version of the Plantation pattern in the central reserve. These




17. Plot of alumina against soda for base data compared with tested samples added in red

18. Octagonal plates, Samples 13 & 14 (top left and right) and Samples 15 & 16, (bottom left and right)

four pieces have a slightly off white appearance, less bright than is usual for Bow, and in a number of cases the underglaze blue has run on the sloping areas during firing, a feature noted on the 'probably Isleworth' class of powder blue reviewed above. Underneath they have no painting or marks, and there are a variety of footrim treatments including the very small footrim recorded on Isleworth sherds at the Museum of London.

The analysis of these plates surprisingly showed that they were a form of 'hard paste' recipe, that is to say a paste high in silica and alumina, although as the glazes all contained lead the plates must have been fired twice, a high firing in the biscuit followed by a lower temperature firing for the decoration and glaze. The results of the paste analyses are shown in Table 5.

| | Sample13 | Sample 14 | Sample 15 | Sample 16 | Average |
|---|---|---|---|---|---|
| $SiO_2$ | 79.0 | 80.0 | 80.9 | 81.2 | 80.3 |
| $TiO_2$ | 0.7 | 0.9 | 0.8 | 0.8 | 0.8 |
| $Al_2O_3$ | 16.7 | 14.8 | 15.0 | 15.3 | 15.5 |
| FeO | 0.7 | 1.1 | 0.7 | 0.6 | 0.8 |
| MgO | 0.2 | 0.3 | 0.0 | 0.0 | 0.1 |
| CaO | 0.5 | 0.5 | 0.4 | 0.4 | 0.4 |
| PbO | 0.0 | 0.0 | 0.0 | 0.0 | 0 |
| $SO_3$ | 0.0 | 0.2 | 0.0 | 0.0 | 0.1 |
| $Na_2O$ | 0.8 | 0.9 | 0.9 | 0.6 | 0.8 |
| $K_2O$ | 1.4 | 1.1 | 1.4 | 1.1 | 1.2 |
| $P_2O_5$ | 0.0 | 0.3 | 0.0 | 0.0 | 0.1 |
| | 100.0 | 100.1 | 100.1 | 100.0 | 100.1 |

Table 5 – Composition of the paste of octagonal plates, Samples 13 to 16

| | Samples 13-16 Average | 1754 Isleworth sherd | Freestone BM14 | MOL3 | MOL4 |
|---|---|---|---|---|---|
| $SiO_2$ | 80.3 | 79.7 | 80.8 | 63.4 | 71.8 |
| $TiO_2$ | 0.8 | 0.3 | 0.5 | 0.5 | 0.5 |
| $Al_2O_3$ | 15.5 | 7.1 | 8.2 | 11.3 | 9.9 |
| FeO | 0.8 | 0.3 | 0.3 | 0.9 | 0.6 |
| MgO | 0.1 | 0.1 | 1.1 | 0.0 | 0.1 |
| CaO | 0.4 | 0.6 | 1.2 | 7.3 | 4.3 |
| PbO | 0 | 8.4 | 3.3 | 5.3 | 6.3 |
| $SO_3$ | 0.1 | 0.2 | <0.2 | 0.0 | 0.0 |
| $Na_2O$ | 0.8 | 0.5 | 1.2 | 1.4 | 1.4 |
| $K_2O$ | 1.2 | 2.7 | 3.3 | 3.5 | 3.9 |
| $P_2O_5$ | 0.1 | 0.1 | <0.2 | 5.5 | 0.7 |
| | 100.0 | 100.0 | 100.3 | 99.1 | 99.5 |

Table 6 – Comparison of our siliceous plates with previous siliceous Isleworth examples and Museum of London sherds

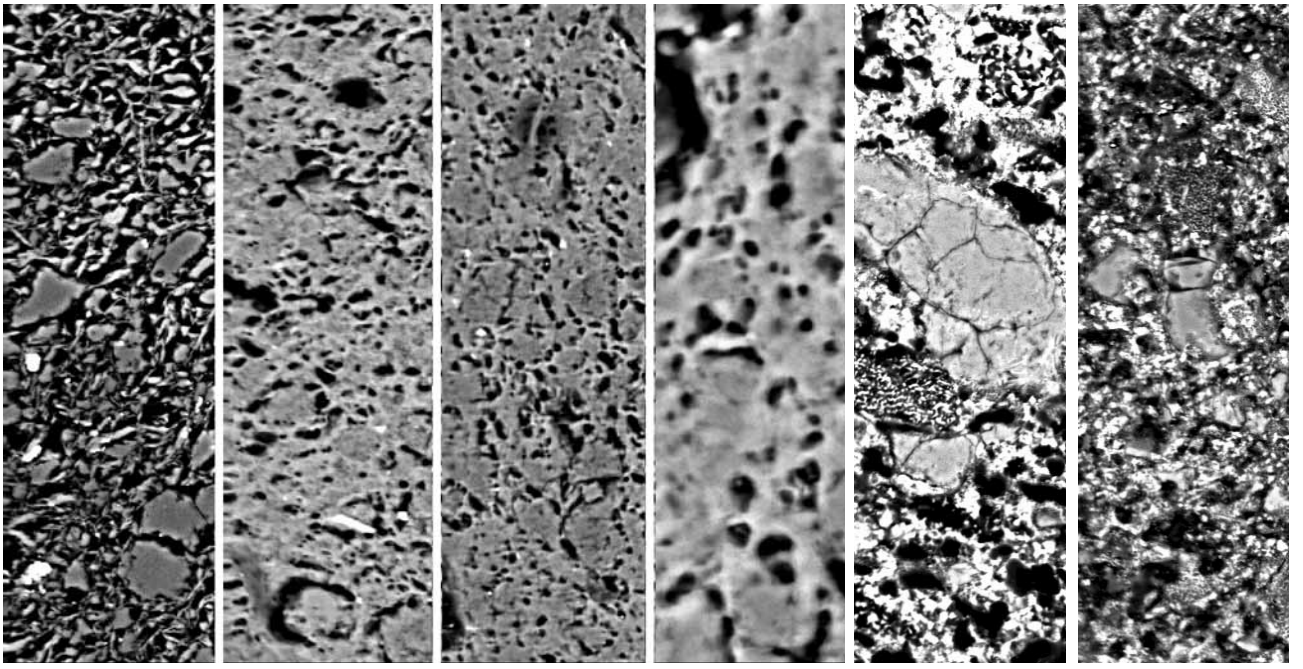
There is a close correlation between all samples, showing that they were manufactured to a tightly controlled recipe. But manufactured by whom? The first course of the action was to investigate an Isleworth attribution further. Tests by Freestone of a 1754 marked Isleworth sherd and one further sherd ('BM14') showed that Isleworth did experiment with a form of hard paste recipe. However, at first sight the recipe was inconsistent with our samples.

As siliceous pastes of this sort sometimes fluoresce under ultra-violet light differently from phosphatic pastes, the sherds at the Museum of London were examined to see if further examples could be found. Six samples were selected for testing. Two were sherds from a class of plates with very small footrims, these being chosen not by ultra violet but simply because Sample 13 which was tested had a similar footrim. Four more samples were in two pairs, one pair fluoresced very white and the other slightly purple in colour. The whitish pair of sherds together with the small footrim sherds all proved to be phosphatic and unremarkable. However, the two purplish sherds were different. The results are shown in the comparative Table 6.

All the recorded Isleworth high-silica recipes appear to have high lead, a feature they share with the phosphatic pastes. They also have 7-11% alumina. However our octagonal plates are lead free with 15.5% (average) alumina. It is concluded that there is insufficient similarity between these pastes to support an Isleworth attribution for the octagonal plates.

Notwithstanding the conclusion above, it was of great interest to note the novel composition of sample MOL3. The phosphate ($P_2O_5$) content of 5.5% shows the use of bone ash in an experimental hard paste, a previously unrecorded recipe for Isleworth (or any other factory).

There is a fairly close relationship between the composition of hard paste recipes and that of creamware. In view of this it was desirable to ensure that the octagonal plates, as well as the MoL samples, were indeed porcelain. Some Isleworth creamware



Creamware (90) | Sample 13 (110) | Sample 15 (~140) | Sample 16 (35) | MOL 3 (75 microns) | MOL 4 (80 microns)

19. Backscattered electron images, showing the granular appearance of Isleworth creamware and the more vitrified porcelains. Diameter of strip images is shown in microns in brackets

sherds provided by Ray Howard were analysed. The results of these analyses are set out in Appendix 6. None resembled the analysis of the octagonal plates. The objective was then achieved by examining both the creamwares, the octagonal plates, and the MoL samples under a scanning electron microscope. The results, shown as backscattered electron images (essentially 'compositional photographs') (**19**), demonstrate that particles of un-vitrified material can be identified in the creamware sherds.

The appearance of the plate and of the MoL sample show less well defined areas, the loss of definition being due to the materials vitrifying. From the differences in composition and in appearance of the paste under magnification it is concluded that both the MoL sherd and the octagonal plates, despite a lack of translucency in the latter, were indeed attempts to make porcelain.

Having failed to find a compositional match between the octagonal plates and Isleworth porcelains other options were considered. As all these plates have some element of Bow decoration, an experimental Bow paste could not be ruled out, particularly in the circumstances have already described which prevailed in the last four years of the factory's existence.

However as there is no evidence of such a paste from archaeology this is not a theory that can be proved. Hard paste following the 'high biscuit plan' (i.e. second firing with a lead glaze) was made at Bovey Tracey according to Cookworthy.[18] Analyses of some examples were published in 2000.[19] Of three hard paste sherds identified from the Bovey Tracey site, only one came close to resembling our sample.

| | Samples 13-16 Average | Bovey BT11 |
|---|---|---|
| $SiO_2$ | 80.3 | 77.6 |
| $TiO_2$ | 0.8 | 0.0 |
| $Al_2O_3$ | 15.5 | 17.2 |
| FeO | 0.8 | 0.5 |
| MgO | 0.1 | 0.2 |
| CaO | 0.4 | 0.3 |
| PbO | 0 | 0.0 |
| $SO_3$ | 0.1 | 0.1 |
| $Na_2O$ | 0.8 | 1.1 |
| $K_2O$ | 1.2 | 2.6 |
| $P_2O_5$ | 0.1 | 0.3 |
| | 100.1 | 99.9 |

Table 7 – Analyses of Samples 13-16 with a hard paste sherd from the Bovey Tracey site

| | Samples 13-16 Average | Tankard | Limehouse Sample 4 | Worcester 'Stone china' NW2 |
|---|---|---|---|---|
| $SiO_2$ | 80.3 | 80.6 | 78.2 | 79.0 |
| $TiO_2$ | 0.8 | 0.3 | 0.9 | 0.0 |
| $Al_2O_3$ | 15.5 | 16.0 | 17.0 | 16.7 |
| FeO | 0.8 | 0.5 | 0.7 | 0.5 |
| MgO | 0.1 | 0.2 | 0.2 | 0.3 |
| CaO | 0.4 | 0.5 | 0.4 | 0.2 |
| PbO | 0 | 0.0 | 0.3 | 0.0 |
| $SO_3$ | 0.1 | 0.1 | 0.0 | 0.1 |
| $Na_2O$ | 0.8 | 0.3 | 0.6 | 0.8 |
| $K_2O$ | 1.2 | 1.2 | 1.4 | 1.2 |
| $P_2O_5$ | 0.1 | 0.1 | 0.3 | 0.0 |
| | 100.1 | 99.8 | 100.0 | 98.8 |

Table 8 – Comparison Samples 13-16, a Tankard, Sample 4 and Worcester 'Stone China' NW2

The other sherds had lower silica, and indeed the sherd BT11 probably represents the highest silica content likely in true porcelain. The 80% silica content in the plates must have been obtained by the addition of additional sand or flint in the recipe. A Bovey Tracey attribution for these plates cannot be ruled out but the minute number of known samples of Bovey hard paste recipes is insufficient to allow conclusions to be drawn.

Upon undertaking a further review of compositional analyses two results were found which matched the analysis of these plates. One was the analysis of a tankard in Nicholas Panes' collection (formerly in the Godden Reference Collection) (**20**) which was unattributed. When sold at auction attention was drawn to the shape which was common in Liverpool, but also to the possibility that it too had a West Country origin. Taking Liverpool as the model, tankards of this sort typically date from 1759-65 and the later end of this date range may be contemporary with the plates, though the plates may be later.

The type of paste represented by the tankard and the octagonal plates is one that owes more to early English experimental pastes such as those referred to by Pococke as 'stone china' at Limehouse and those at Pomona.[20] Upon further research the second match was identified, and this related to a single glazed sherd from the lowest level of the Worcester porcelain manufacturing site. A comparative table of these results is set out in Table 8. The Limehouse example analysis in that table is an average of four analyses of siliceous-aluminouse Limehouse porcelains undertaken by Ian Freestone and published by the ECC in *Limehouse Ware Revealed* in 1993.

20. Unattributed tankard which analysis has shown has a similar recipe to the Octagonal plates

From the point of view of connoisseurship there were few further avenues of investigation for these pieces. The print on one plate (Sample 16) presented one opportunity. As will be seen (**21**), it closely resembles a similar print on a Worcester saucer (to the right). Various versions of the Plantation pattern attributed to Bow and Isleworth were reviewed but the Worcester example produced the closest match. However, it may be no guide to origin as plate makers worked independently and offered printing plates to more than one factory.

21. Printed pattern on Sample 16 (left and a similar Worcester print (right)

22. Rear and front of a delft plate attributed to Liverpool (left and centre) with the rear of porcelain plate that is Sample 13

There are a few porcelain factories described in documentary sources to which no wares have been attributed. Oxford, Birmingham, and John Bolton's attempt at Kentish Town were 1750s enterprises so are too early for these pieces. John Bolton seemed set to try again in the 1760s when this caused concern to William Cookworthy[21] but there is no evidence that he actually did manufacture poecelain again. There is also no information as to what experiments Josiah Wedgwood was undertaking in porcelain manufacture. In 1768 he sent an emissary to South Carolina to locate white clays, and experiments with porcelain making are likely to have occurred. Finally, it is not known what experiments took place during Brown and Hay's brief time at Bow; the painting of the octagonal plates potentially links them to that factory.

23. Liverpool delft plate with pattern used at Bow

Barbara Blenkinship, after seeing one of our sample plates (Sample 13) provided photographs of a delft plate attributed to Liverpool. (**22, left & centre**). She has been studying Liverpool delft and believes that the painting on the rear of such plates can be diagnostic. The rear of Sample 13 plate (**22, right**) is shown for comparison. It is the case that Liverpool delft plates also sometimes carry patterns seen on Bow porcelain, possibly as a result of the migration of painters from London to Liverpool.

The front of a delft plate attributed to Liverpool (**23**) bears the 'Bamboo and Peony' pattern seen on Bow (**3**) and on one of our sampled plates, Sample 15. (**18**) This leads to speculation into the origin of the sampled plates.

Migrant potters who had experience of early porcelain paste compositions might have taken these skills elsewhere. Limehouse workers almost certainly went to Liverpool.[22] At Worcester Richard Podmore (or Padmore) would have had knowledge of the early Worcester experimental pastes. Podmore is better known for leaving Worcester and taking the soapstone recipes to Chaffers in Liverpool; he worked and lived in the Liverpool area for several years during the relevant period. Liverpool had the technology to produce printing plates for ceramics and the skill

to copy Worcester designs. The tankard (**20**) has a Scotia-footed shape also popular in Liverpool. The octagonal shape in English porcelain is very rarely used for plates unless they are made at Bow or in Liverpool. Bringing all these strands together, could these plates and the tankard have been made from an experimental paste in Liverpool?

Shortly after the presentation of this paper to ECC members, a new publication on Limehouse by Ross Ramsay and others[23] became available. This publication attributed two pieces which appear to be similar to our sample plates to 'late 1730s' Bow porcelain. The 1730's Bow attribution was used in Ramsay's argument that Limehouse pastes were derivative of Bow. Both plates referred to in the publication use a copy of the painted Prunus Root pattern used by Worcester between around 1752 and 1780.

The piece illustrated by Ramsay is of gadrooned shape very similar to that employed on Whieldon ware plates of silver shape between 1765 and 1780. Having examined the second of the two pieces, an octagonal plate which is in the Victoria and Albert Museum (Catalogue C.591-1924), it is clear that it belongs to the same class of plates being investigated and the chemical analysis of the gadrooned example, illustrated and reported on by Ramsay, supports this.

Ramsay made his 1730's Bow attribution after discounting the importance as a comparator of the early Worcester sherd (NW2 reported above) because it was glazed. It is never possible to assert with certainty that any glazed sherd (other than an obvious waster) was manufactured where it is found. Also discounted was the advice of an expert that the plate dated much later than Ramsay asserted, more likely to the 1760s/1770s. This advice was apparently discounted because the authors of the publication knew of no factory in the later period making such wares.

This puzzlement over the source of these wares is shared but so are the views of the unnamed expert as to their dating. The absence of an attribution does not in any way invalidate the connoisseurship used to come to such a view. It would appear that the existence of a printed plate in this class (Sample 16, copying a printed pattern popular at Worcester in the 1760s) supports the argument as well as making a 1730s dating impossible.

Notwithstanding our own speculation, there is no evidence which provides a robust attribution for these plates. Whilst Isleworth cannot be ruled out, it is no stronger a contender than any other factory and perhaps less strong than (late) Bow or Liverpool. It is proposed to name this class of wares as the 'Siliceous Octagon class'. It is somewhat of a mouthful but it describes the plates and may have to remain until future researchers find a home for these objects.

### *Conclusions*

During the research undertaken for this paper, some interesting new variants of Isleworth porcelain were discovered, namely a lead-free phosphatic paste and a 'hard paste' containing bone-ash.

The search for confirmation that a number of pieces tentatively or firmly attributed to Isleworth were indeed from that factory was largely unsuccessful. One rare class of powder blue wares does indeed seem to originate there, but the other phosphatic wares tested all seem more likely to be Bow.

It is acknowledged that some collectors and dealers will find these results hard to accept. Some of the pieces undoubtedly look different from Bow, and it is in the nature of connoisseurship that this single factor may have dominated the thinking which resulted in them being given to Isleworth. The factors that may cause a difference of appearance have already been commented on and many of these relate to firing conditions which can as much vary due to changed circumstances at one factory rather than arising because they were made at different concerns.

A few of the pieces subject to quantitative analysis were also marginal for Bow, even if less like Isleworth. It is known that Isleworth produced a paste like early Bow, but despite increasing the number of analysed Isleworth sherds significantly none were found which prove they made a paste similar to later Bow recipes. To those who still wish to attribute some of the wares tested to Isleworth, against the scientific evidence, the onus is on them to prove that Isleworth made such a paste.

The possibility that some of these wares are derived from the changes taking place at Bow in its final years should not be ruled out. Neither should the possibility that a few of these wares originate from an unknown factory or factories as yet unrecognised by ceramic historians. Only time will tell.

Perhaps the greatest mystery is the origin of the 'Siliceous Octagon class' of wares. These unusual items might have a late Bow or Liverpool origin but these are tentative suggestions. They are not 1730s Bow as recently asserted. Only further archaeology and more extensive chemical analysis of the wares from English factories will enable similar wares to be identified in the future. Further work on sherds of known archaeological origin will extend our knowledge of the output and experiments of the English porcelain factories and may result in a few of the puzzles being solved.

**Appendix 1:** Bow paste data sourced from Ramsay (except NP8) – See endnote 7

| | Ref | $SiO_2$ | $TiO_2$ | $Al_2O_3$ | MgO | FeO | CaO | $Na_2O$ | $K_2O$ | $P_2O_5$ | $SO_3$ | PbO | $As_2O_5$ | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Middle or** | B3 | 53.09 | 0.06 | 4.61 | 0.45 | 0.34 | 20.73 | 0.20 | 0.62 | 16.89 | 3.18 | 0.00 | 0.00 | 100.17 |
| **Bowcock** | B5 | 58.57 | 0.15 | 5.96 | 0.01 | 0.18 | 18.14 | 0.19 | 0.50 | 14.59 | 1.71 | 0.00 | 0.00 | 100.00 |
| **Period** | B16 | 54.32 | 0.20 | 4.98 | 0.40 | 0.10 | 21.19 | 0.60 | 0.60 | 15.32 | 2.30 | 0.00 | 0.00 | 100.01 |
| **1755-1770** | B23 | 54.72 | 0.20 | 4.02 | 0.35 | 0.29 | 21.13 | 0.00 | 0.39 | 16.31 | 2.60 | 0.00 | 0.00 | 100.01 |
| | B25 | 53.60 | 0.20 | 5.40 | 0.00 | 0.20 | 21.90 | 0.10 | 0.40 | 15.90 | 2.30 | 0.00 | 0.00 | 100.00 |
| | B29 | 51.98 | 0.23 | 3.76 | 0.31 | 0.11 | 21.07 | 0.25 | 0.52 | 17.74 | 4.03 | 0.00 | 0.00 | 100.00 |
| **Tidswell** | B18 | 50.31 | 0.30 | 5.30 | 0.30 | 0.30 | 22.87 | 0.85 | 0.55 | 16.28 | 2.75 | 0.20 | 0.00 | 100.01 |
| **Period** | B24 | 55.15 | 0.20 | 4.80 | 0.40 | 0.40 | 17.56 | 0.30 | 1.80 | 14.26 | 2.40 | 2.75 | 0.00 | 100.02 |
| **1770-1774** | B35 | 53.92 | 0.40 | 4.68 | 0.03 | 0.33 | 19.21 | 0.34 | 0.99 | 15.56 | 3.61 | 0.93 | 0.00 | 100.00 |
| **Bow powder blue plate** | NP8 | 49.00 | 0.30 | 5.00 | 0.50 | 0.40 | 21.10 | 0.50 | 0.90 | 18.40 | 3.90 | 0.00 | 0.00 | 100.00 |

**Appendix 2.1:** Isleworth paste data sourced from Freestone (See endnote 9)

| Ref: | $SiO_2$ | $TiO_2$ | $Al_2O_3$ | MgO | FeO | CaO | $Na_2O$ | $K_2O$ | $P_2O_5$ | $SO_3$ | PbO | $As_2O_5$ | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **BM1** | 43.0 | 0.4 | 5.9 | 0.5 | 0.6 | 24.3 | 0.6 | 2.2 | 17.4 | 2.5 | 3.0 | 0.0 | 100.4 |
| **BM2** | 36.8 | 0.3 | 7.4 | 0.7 | 0.3 | 28.1 | 0.9 | 2.4 | 17.3 | 2.1 | 4.2 | 0.0 | 100.5 |
| **BM4** | 36.9 | 0.3 | 8.2 | 0.7 | 0.3 | 27.9 | 0.7 | 1.9 | 18.1 | 2.5 | 2.8 | 0.0 | 100.3 |
| **BM5** | 38.5 | 0.3 | 8.0 | 0.5 | 0.4 | 27.8 | 0.7 | 1.6 | 16.4 | 2.9 | 3.2 | 0.0 | 100.3 |
| **BM6** | 37.3 | 0.4 | 8.3 | 0.8 | 0.4 | 28.2 | 0.9 | 1.8 | 17.2 | 2.3 | 3.1 | 0.0 | 100.7 |
| **BM7** | 42.7 | 0.4 | 7.7 | 0.6 | 0.3 | 22.4 | 1.2 | 2.2 | 17.1 | 2.5 | 3.0 | 0.0 | 100.1 |
| **BM8** | 37.2 | 0.4 | 8.8 | 0.6 | 0.4 | 25.4 | 0.7 | 2.3 | 18.2 | 2.9 | 3.6 | 0.0 | 100.5 |
| **BM9** | 49.3 | 0.6 | 6.1 | 0.4 | 0.4 | 20.4 | 0.6 | 1.8 | 14.8 | 2.6 | 3.2 | 0.0 | 100.2 |
| **BM10** | 36.5 | 0.3 | 7.3 | 0.7 | 0.3 | 29.0 | 0.8 | 1.6 | 18.0 | 3.0 | 2.9 | 0.0 | 100.4 |
| **BM11** | 41.1 | 0.3 | 5.6 | 0.4 | 0.4 | 26.6 | 0.6 | 2.6 | 18.7 | 2.0 | 2.2 | 0.0 | 100.5 |
| **BM12** | 39.5 | 0.4 | 8.1 | 0.6 | 0.4 | 26.0 | 0.6 | 1.9 | 16.9 | 2.5 | 3.3 | 0.0 | 100.2 |
| **BM13** | 46.9 | 0.4 | 7.5 | 0.5 | 0.5 | 20.8 | 0.6 | 2.2 | 14.1 | 2.9 | 3.8 | 0.0 | 100.2 |

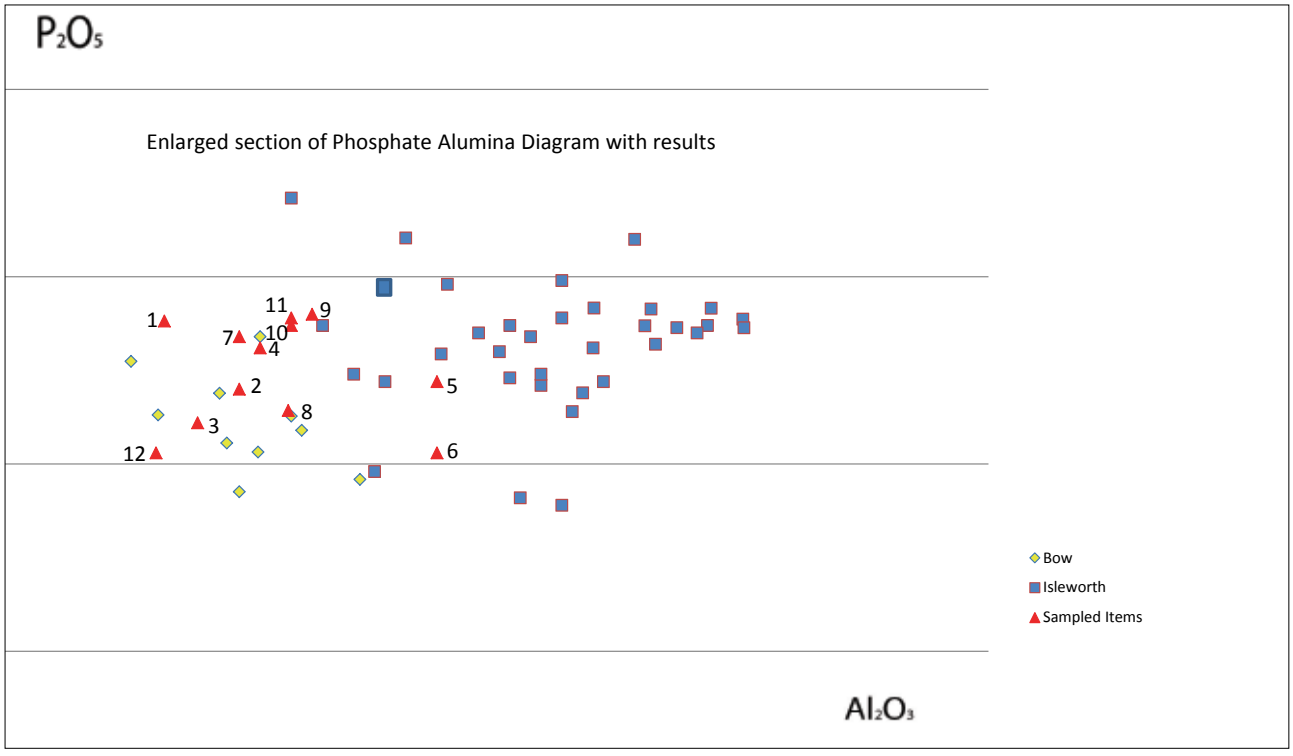
**Appendix 2.2:** New Isleworth paste analyses by J Victor Owen

| Ref | $SiO_2$ | $TiO_2$ | $Al_2O_3$ | MgO | FeO | CaO | $Na_2O$ | $K_2O$ | $P_2O_5$ | $SO_3$ | PbO | $As_2O_5$ | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ISL-1** | 44.03 | 0.24 | 6.40 | 0.51 | 0.33 | 21.19 | 1.16 | 1.27 | 21.04 | 1.37 | 2.38 | 0.09 | 100.00 |
| **ISL-2** | 37.99 | 0.35 | 9.64 | 0.56 | 0.27 | 20.50 | 1.09 | 2.28 | 18.87 | 2.50 | 5.93 | 0.00 | 99.98 |
| **ISL-3** | 38.93 | 0.36 | 8.76 | 0.47 | 0.42 | 21.44 | 0.80 | 2.34 | 19.14 | 2.24 | 5.02 | 0.07 | 100.00 |
| **ISL-4** | 44.88 | 0.31 | 6.74 | 0.53 | 0.69 | 20.71 | 0.80 | 1.78 | 17.94 | 2.81 | 2.63 | 0.19 | 100.01 |
| **ISL-5** | 41.80 | 0.20 | 9.30 | 0.70 | 0.30 | 19.40 | 1.20 | 1.60 | 18.70 | 3.20 | 3.60 | 0.00 | 100.00 |
| **ISL-6** | 42.10 | 0.30 | 9.20 | 0.50 | 0.90 | 19.90 | 1.00 | 1.80 | 18.50 | 2.50 | 3.30 | 0.00 | 100.00 |
| **ISL-7** | 42.16 | 0.34 | 8.70 | 0.57 | 0.62 | 20.52 | 0.95 | 1.71 | 18.69 | 2.51 | 3.12 | 0.00 | 99.89 |
| **ISL-8** | 36.70 | 0.39 | 9.01 | 0.53 | 0.35 | 22.95 | 0.80 | 1.62 | 18.64 | 2.52 | 6.47 | 0.00 | 99.99 |
| **ISL-9** | 41.92 | 0.40 | 7.70 | 0.60 | 0.40 | 24.30 | 0.90 | 1.80 | 17.40 | 1.80 | 2.80 | 0.00 | 100.02 |
| **ISL-10** | 41.89 | 0.29 | 9.65 | 0.72 | 0.26 | 19.59 | 1.38 | 1.86 | 18.64 | 2.20 | 3.52 | 0.00 | 100.00 |
| **ISL-11** | 39.08 | 0.29 | 9.34 | 0.73 | 0.28 | 21.55 | 1.34 | 2.27 | 19.16 | 2.73 | 3.23 | 0.00 | 100.00 |
| **ISL-12** | 41.13 | 0.28 | 8.21 | 0.68 | 0.34 | 20.77 | 1.04 | 1.71 | 19.17 | 2.85 | 3.72 | 0.00 | 99.89 |
| **R1** | 40.50 | 0.40 | 7.90 | 0.40 | 0.60 | 22.50 | 1.00 | 1.80 | 18.90 | 2.80 | 3.30 | 0.00 | 100.10 |
| **R4** | 38.30 | 0.30 | 7.90 | 0.80 | 0.60 | 22.50 | 1.10 | 2.10 | 19.90 | 2.80 | 3.80 | 0.00 | 100.10 |
| **R5** | 40.80 | 0.30 | 5.30 | 0.40 | 0.40 | 23.30 | 0.70 | 2.20 | 22.10 | 3.00 | 1.40 | 0.20 | 100.10 |
| **R6** | 42.30 | 0.30 | 6.80 | 0.60 | 0.40 | 20.60 | 0.90 | 3.10 | 19.80 | 2.20 | 2.80 | 0.00 | 99.80 |
| **EX1** | 45.90 | 0.30 | 6.20 | 0.30 | 0.40 | 20.50 | 0.50 | 1.70 | 17.20 | 2.70 | 4.40 | 0.00 | 100.10 |
| **EX2** | 39.30 | 0.30 | 7.10 | 0.60 | 0.50 | 24.70 | 0.80 | 1.60 | 18.50 | 2.80 | 3.70 | 0.00 | 99.90 |
| **EX3** | 39.70 | 0.30 | 7.60 | 0.60 | 0.60 | 24.30 | 1.00 | 1.60 | 18.40 | 2.50 | 3.40 | 0.00 | 100.00 |
| **EX4** | 48.90 | 0.50 | 7.90 | 0.90 | 0.30 | 16.30 | 0.90 | 2.60 | 13.90 | 2.60 | 5.20 | 0.00 | 100.00 |
| **EX5** | 37.70 | 0.30 | 7.40 | 0.70 | 0.60 | 25.10 | 1.10 | 1.70 | 18.70 | 3.00 | 3.70 | 0.00 | 100.00 |
| **RH3** | 41.60 | 0.40 | 6.20 | 0.50 | 0.50 | 22.70 | 1.50 | 1.90 | 19.70 | 3.30 | 1.70 | 0.00 | 100.00 |

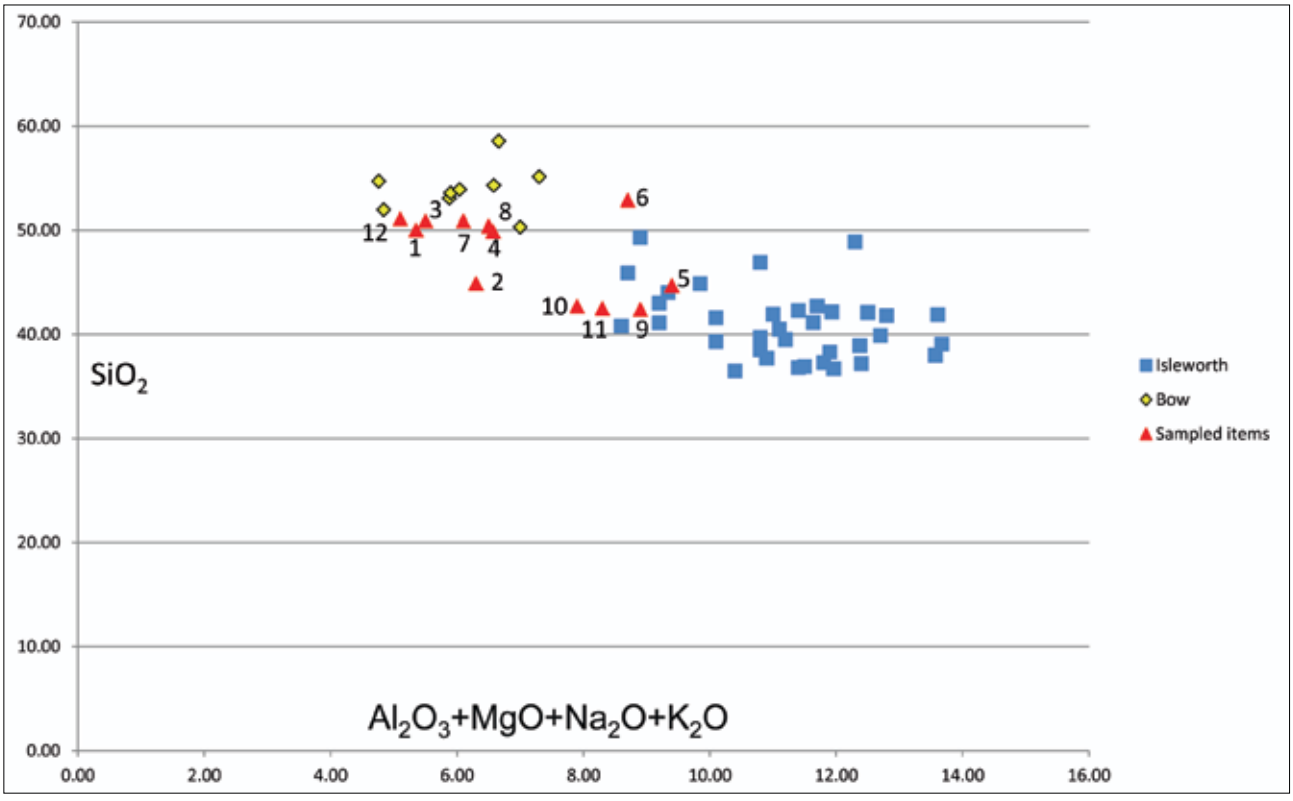
**Appendix 3:** Analytical results by J Victor Owen for phosphatic samples tested in this paper

| Sample | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Saucer | Basket | Sauce-boat | Sauce-boat | Sauce-boat | PB Plate | PB Dessert Dish | PB Plate | PB Lobed dish | PB lobed Plate | PB Basket | Platter |
| $SiO_2$ | 50.03 | 44.9 | 50.9 | 50.4 | 44.7 | 52.9 | 50.9 | 49.9 | 42.4 | 42.7 | 42.5 | 51.1 |
| $TiO_2$ | 0.00 | 0.3 | 0.2 | 0.2 | 0.2 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 |
| $Al_2O_3$ | 4.08 | 4.8 | 4.4 | 5.0 | 6.7 | 6.7 | 4.8 | 5.3 | 5.5 | 5.3 | 5.3 | 4.0 |
| FeO | 0.00 | 0.3 | 0.2 | 0.3 | 0.3 | 0.4 | 0.5 | 0.3 | 0.7 | 0.5 | 0.5 | 0.2 |
| MgO | 0.00 | 0.4 | 0.3 | 0.4 | 0.5 | 0.4 | 0.3 | 0.4 | 0.5 | 0.4 | 0.4 | 0.3 |
| CaO | 22.35 | 28.4 | 24.3 | 21.8 | 24.8 | 18.5 | 21.8 | 23.4 | 24.4 | 23.1 | 24.3 | 25.7 |
| PbO | 0.00 | 0.0 | 0.3 | 0.0 | 1.0 | 0.4 | 0.2 | 0.0 | 1.2 | 2.2 | 2.2 | 0.0 |
| $SO_3$ | 3.45 | 2.5 | 2.5 | 2.7 | 2.3 | 3.5 | 2.0 | 3.2 | 3.2 | 4.7 | 2.9 | 2.4 |
| $Na_2O$ | 0.73 | 0.3 | 0.2 | 0.5 | 0.3 | 1.3 | 0.4 | 0.3 | 0.8 | 0.5 | 0.5 | 0.5 |
| $K_2O$ | 0.54 | 0.8 | 0.6 | 0.6 | 1.9 | 0.3 | 0.6 | 0.6 | 2.1 | 1.7 | 2.1 | 0.3 |
| $P_2O_5$ | 18.82 | 17.0 | 16.1 | 18.1 | 17.2 | 15.3 | 18.4 | 16.4 | 19.0 | 18.7 | 18.9 | 15.3 |

**Appendix 4:** Enlarged section of alumina diagram with results



**Appendix 5:** Scatter diagram of results for Test 3




**Appendix 6:** Glaze results for our phosphatic samples, where captured

| | $SiO_2$ | $TiO_2$ | $AL_2O_3$ | MgO | FeO | CaO | $Na_2O$ | $K_2O$ | $P_2O_5$ | $SO_3$ | PbO | $As_2O_5$ | MnO | $Sb_2O_5$ | Cl | BaO | CoO | $SnO_2$ | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 45.50 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.80 | 0.00 | 0.00 | 50.70 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 100.00 |
| 2 | 40.88 | 0.39 | 1.01 | 0.17 | 0.39 | 1.70 | 0.69 | 3.57 | 0.37 | 0.29 | 46.71 | 0.00 | 0.26 | 0.43 | 0.07 | 0.69 | 0.39 | 2.02 | 100.03 |
| 3 | 46.29 | 0.10 | 1.04 | 0.03 | 0.14 | 1.33 | 0.32 | 3.02 | 0.34 | 0.09 | 45.92 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.37 | 99.99 |
| 4 | 46.80 | 0.00 | 1.10 | 0.00 | 0.00 | 2.20 | 0.40 | 4.70 | 0.40 | 0.00 | 44.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 100.00 |
| 6 | 37.87 | 0.00 | 0.53 | 0.20 | 0.55 | 1.27 | 0.58 | 3.83 | 0.00 | 0.00 | 55.19 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 100.02 |
| 7 | 47.41 | 0.00 | 1.00 | 0.00 | 0.34 | 2.18 | 0.47 | 3.32 | 0.69 | 0.00 | 44.59 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 100.00 |
| 8 | 40.42 | 0.00 | 2.07 | 0.00 | 0.00 | 8.72 | 0.38 | 3.49 | 4.61 | 0.00 | 40.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 99.99 |
| 9 | 48.70 | 0.00 | 2.02 | 0.00 | 0.00 | 2.41 | 1.25 | 4.14 | 0.00 | 0.00 | 41.50 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 100.02 |
| 10 | 53.23 | 0.00 | 1.32 | 0.00 | 0.34 | 1.24 | 1.11 | 4.71 | 0.00 | 0.00 | 37.86 | 0.18 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 99.99 |
| 11 | 47.45 | 0.00 | 1.71 | 0.00 | 0.36 | 0.00 | 1.22 | 5.98 | 0.00 | 0.00 | 43.28 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 100.00 |
| 12 | 43.99 | 0.34 | 0.81 | .14 | 0.41 | 1.36 | 0.65 | 3.82 | 0.15 | 0.17 | 45.03 | 0.00 | 0.23 | 0.30 | 0.07 | 0.57 | 0.34 | 1.63 | 100.01 |

**Appendix 7.1:** Database of Bow Glaze results per Ramsay (See endnote 16)

| | Tidswell | Bowcock | Bowcock | Bowcock | Bowcock | Bowcock | Bowcock |
|---|---|---|---|---|---|---|---|
| | **B18** | **B3** | **B27** | **B41** | **B42** | **B61** | **B77** |
| $SiO_2$ | 51.36 | 48.63 | 50.85 | 50.99 | 53.87 | 46.67 | 49.05 |
| $TiO_2$ | 0.15 | 0.00 | 0.06 | 0.18 | 0.15 | 0.10 | 0.21 |
| $Al_2O_3$ | 0.46 | 0.79 | 0.79 | 1.19 | 0.74 | 0.60 | 0.60 |
| FeO | 0.21 | 0.05 | 0.13 | 0.07 | 0.79 | 0.15 | 0.11 |
| MgO | 0.16 | 0.00 | 0.00 | 0.48 | 0.65 | 0.04 | 0.40 |
| CaO | 1.68 | 1.67 | 1.47 | 0.50 | 2.29 | 4.00 | 0.72 |
| $NaO_2$ | 0.40 | 0.59 | 0.13 | 0.81 | 1.18 | 0.61 | 0.32 |
| $K_2O$ | 4.14 | 4.00 | 3.33 | 4.43 | 4.66 | 2.13 | 2.58 |
| $P_2O_5$ | 0.00 | 0.19 | 0.20 | 0.00 | 0.00 | 0.08 | 0.00 |
| PbO | 40.11 | 43.24 | 42.83 | 41.39 | 35.71 | 44.51 | 44.23 |
| $SO_3$ | 1.38 | 0.90 | 0.24 | 0.00 | 0.00 | 1.16 | 1.83 |
| | 100.05 | 100.06 | 100.03 | 100.04 | 100.04 | 100.05 | 100.05 |

**Appendix 7.2:** Appendix of Isleworth glaze results (source Freestone – endnote 9)

| | BM1 | BM2 | BM4 | BM6 | BM7 | BM8 | BM9 | BM11 | BM12 | BM13 |
|---|---|---|---|---|---|---|---|---|---|---|
| $SiO_2$ | 47.3 | 49.4 | 46.6 | 49.6 | 50.0 | 47.2 | 49.1 | 49.5 | 48.9 | 49.4 |
| $TiO_2$ | | | | | | | | | | |
| $Al_2O_3$ | 0.8 | 1.8 | 1.7 | 1.6 | 1.9 | 2.4 | 0.4 | 1.0 | 1.6 | 0.3 |
| FeO | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.1 | 0.2 | 0.1 | 0.0 | 0.1 |
| MgO | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| CaO | 1.0 | 1.3 | 0.8 | 0.7 | 0.6 | 1.0 | 1.2 | 1.3 | 1.4 | 1.6 |
| $NaO_2$ | 1.1 | 1.6 | 1.9 | 1.2 | 1.4 | 1.0 | 1.4 | 1.5 | 1.3 | 1.6 |
| $K_2O$ | 4.8 | 5.5 | 6.8 | 6.4 | 5.9 | 5.3 | 6.4 | 5.7 | 5.4 | 5.8 |
| $P_2O_5$ | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.0 |
| PbO | 41.2 | 39.5 | 41.3 | 40.0 | 39.9 | 41.9 | 39.0 | 40.7 | 41.2 | 40.8 |
| Cl | 0.4 | 0.2 | 0.6 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 |
| $SO_3$ | 3.3 | 0.8 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 |
| | 100.3 | 100.5 | 100.3 | 100.2 | 100.5 | 99.5 | 98.3 | 100.4 | 100.4 | 100.0 |

**Appendix 7.3:** New Analyses of Isleworth glazes by J Victor Owen

| | ISL2 | ISL9 | ISL11 | ISL12 | R3 | R4 | R5 | R6 | RH3 |
|---|---|---|---|---|---|---|---|---|---|
| $SiO_2$ | 50.42 | 52.92 | 47.71 | 49.62 | 44.45 | 54.24 | 45.90 | 50.88 | 50.55 |
| $TiO_2$ | 0.13 | 0.10 | 0.10 | | | | | | |
| $Al_2O_3$ | 2.94 | 2.12 | 2.76 | 2.33 | 1.15 | 2.08 | 2.72 | 1.17 | 1.34 |
| FeO | 0.21 | 0.25 | 0.19 | 0.00 | 0.45 | | 0.95 | 0.11 | 0.35 |
| MgO | 0.15 | 0.00 | 0.00 | 0.00 | | | | | |
| CaO | 4.86 | 1.83 | 3.37 | 1.69 | 0.84 | 2.82 | 3.97 | 2.68 | 1.63 |
| $NaO_2$ | 2.18 | 1.66 | 1.78 | 0.99 | 0.50 | 1.23 | 0.70 | 0.78 | 1.80 |
| $K_2O$ | 4.62 | 4.42 | 4.70 | 3.92 | 3.51 | 3.10 | 3.72 | 2.67 | 4.83 |
| $P_2O_5$ | 2.97 | 0.22 | 0.00 | 0.00 | | | 2.06 | 0.28 | 1.22 |
| PbO | 31.61 | 36.31 | 39.49 | 41.44 | 49.10 | 36.52 | 36.15 | 41.44 | 38.17 |
| $SO_3$ | 0 | 0.00 | 0.00 | 0.00 | | | | | |
| $As_2O_5$ | | | | 0.00 | | | 2.06 | | 0.10 |
| Co | | | | 0.00 | | | 0.91 | | |
| Ni | | | | 0.00 | | | 0.86 | | |
| | | 99.83 | 100.10 | 99.99 | 100.00 | 99.99 | 100.00 | 100.01 | 99.99 |

**Appendix 8:** Analysis of Isleworth Creamware sherds

| | $SiO_2$ | TiO2 | $Al_2O_3$ | FeO | MgO | CaO | $Na_2O$ | $K_2O$ | $P_2O_5$ | $SO_3$ | CuO | ZnO | PbO | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CR1 paste | 71.6 | 1.2 | 23.6 | 0.6 | 0.2 | 0.0 | 0.6 | 2.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 99.9 |
| CR1 glaze | 40.7 | 0.3 | 6.4 | 0.2 | 0.0 | 0.2 | 0.0 | 0.6 | 0.0 | 0.0 | 0.0 | 0.0 | 51.7 | 100.0 |
| CR2 paste | 77.5 | 1.0 | 17.1 | 0.7 | 0.4 | 0.0 | 1.0 | 2.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| CR2 glaze | 53.4 | 0.6 | 13.2 | 0.5 | 0.1 | 0.0 | 0.6 | 2.2 | 0.0 | 0.0 | 0.0 | 0.0 | 29.3 | 100.0 |
| CR3 paste | 71.9 | 1.1 | 23.2 | 0.7 | 0.2 | 0.1 | 0.9 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 100.0 |
| CR3 glaze | 40.4 | 0.2 | 7.6 | 0.4 | 0.0 | 0.0 | 0.0 | 0.7 | 0.0 | 0.0 | 2.2 | 1.2 | 47.3 | 100.0 |

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## NOTES

[1] For example in Jewitt, Llewellyn, *The Ceramic Art of Great Britain*, 1878

[2] Godden, Geoffrey: 'Isleworth porcelain in Victorian Collections', *ECC Transactions*, Vol 20 Pt 1 (2008)

[3] Howard, Ray: 'Isleworth Pottery: Recognition at last?', *ECC Transactions* Vol 16 Pt 3 (1998)

[4] Gabszewicz, Anton and Jellicoe, Roderick: *Isleworth Porcelain*, 1998

[5] *Isleworth Pottery and Porcelain* ECC/ MoL, 2002

[6] Panes, Nicholas and Owen, Prof. J Victor: 'Attribution Enhanced – Possible 18th C American porcelain finds in England', *ECC Transactions*, Vol 23 (2013)

[7] Ramsay W R H, Ramsay E G, 'A Classification of Bow Porcelain from First Patent to Closure, 1743-1774', *Proceedings of the Royal Society of Victoria*

[8] Ramsay op. cit., p 37 for details of the items tested

[9] Freestone, I, Joyner, L, and Howard, R, 'The composition of porcelain from the Isleworth manufactory', *ECC Transactions*, Vol 18, Pt 2 (2003)

[10] Owen, J Victor, 'Double corona structures in 18th century porcelain (1st patent Bow, London, mid-1740s): a record of partial melting and subsolidus reactions', *Canadian Mineralogist* 50, 1255-1264 (2012)

[11] Ritchie, N W M, Newbury, D E & Davis, J M, 'EDS measurements of X-ray intensity at WDS precision and accuracy using a silicon drift detector', *Microscopy and Microanalysis* 18, 892-904 (2012)

[12] See Table 1 in Jackson, C M and Booth, C A (2005). 'Glass by design? Raw materials, recipes and compositional data', *Archaeometry* 47, 781-795

[13] Panes, Nicholas, *British Porcelain Sauceboats of the 18th century* (2009), p 220

[14] Inverted rim sauceboats, whether strap-fluted or otherwise, were made by Worcester, Caughley, Derby, Lowestoft, Isleworth, Christian, Plymouth and Champions Bristol

[15] Panes Nicholas, 'Mr Ball the English potter and the American China Manufactory', *ECC Transactions*, Vol 20, Pt 3 (2009)

[16] Ramsay W R H, Sutton K & Ramsay E G, 2011. 'Bow porcelain: Glaze compositions associated with the phosphatic wares ~1742–1774'. *Proceedings of the Royal Society of Victoria* 123(2): 161-171. ISSN 0035-9211

[17] These experiments are still being conducted

[18] Wills, Geoffrey, 'The Plymouth Porcelain Factory: Letters to Thomas Pitt 1766-1769.' *Apollo* Nos. 226 and 227; December 1980-January 1981

[19] Owen, J Victor, Adams, Brian, & Stephenson, Roy (2000). '*Nicholas Crisp's 'Porcellien':* A Petrological Comparison of Sherds from the Vauxhall (London; ca. 1751–1764) and Indeo Pottery (Bovey Tracey, Devonshire; ca. 1767–1774) Factory Sites'. *Geoarchaeology* 15, 43-78

[20] See Limehouse sample analyses published in Owen, J Victor and Hillis, Maurice, 'From London to Liverpool: Evidence for a Limehouse–Reid Porcelain Connection Based on the Analysis of Sherds from the Brownlow Hill (ca. 1755–1767) Factory Site'. *Geoarchaeology: An International Journal*, Vol 18, No. 8, 851–882 (2003)

[21] Wills, Geoffrey, op.cit.

[22] Owen and Hillis, op.cit.

[23] *The Limehouse Porcelain Factory, its output, antecedents & the influence of the Royal Society of London on the evolution of English porcelain based on composition and technology.* Ramsay W Ross H, Daniels, Pat, & Ramsay, E Gael, 2013.