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New Ash Glazes from Arable Crop Waste:

Exploring the use of straw from Pisum sativum *(Combining Pea) and*

Vicia faba *(Field Bean)*

Carol Metcalfe

A thesis submitted in partial fulfilment
of the requirements of the
University of Sunderland
for the degree of
Doctor of Philosophy

March 2008

Carol Metcalfe - New Ash Glazes from Arable Crop Waste:

Exploring the use of straw from Pisum sativum *(Combining Pea) and* Vicia faba *(Field Bean)*

Abstract:

The Chinese first developed stoneware ash glazes about 3500 years ago, when their kiln technology progressed sufficiently to reach temperatures high enough to fuse such glazes. More than 2000 years went by before this knowledge reached Japan and Korea, where ash glazes were also subsequently produced. In Britain, the advent of studio pottery in the 20th century led to interest in oriental approaches to ceramics, including ash glazes. A number of studio potters used and indeed continue to use ash glazes in their work. The great majority of these glazes have, throughout history, been made of wood ash and are mainly fired to high stoneware temperatures of at least 1280°C, Cone 10. Worldwide interest in this subject continues today; however, a general increase in environmental concern, especially fuel economy, raises a number of issues for contemporary ceramic practitioners. This research addresses these issues by employing multiple methods in a 'composite' methodology, rooted in art practice, the aims being:

- To develop a range of new glazes, for lower stoneware temperature (1240°C, Cone 7) oxidised firings, using ash from arable crop waste as an environmentally sensitive ingredient.
- To demonstrate and articulate the possible creative, practical and environmental benefits of the new glazes for contemporary ceramic practitioners, principally through artworks.
- To offer a model for investigating the potential of a new source of ash, as a glaze material.

The plant species explored are the Combining pea and Field bean, neither of which is documented in any of the contextual sources located. Both plants are widely grown as protein crops in many countries of the world and were available in North Yorkshire for this research.

Glaze calculation methods and empirical approaches to glaze development have been investigated and the ashes have been analysed. From this information, glaze recipes have been developed and tested. Since the appearance of a glaze is affected by the clay body to which it is applied, the compositions of available clays have been studied and four widely differing examples chosen for the tests. Case studies have been undertaken of contemporary ceramic practitioners, whose approaches to ash glazing vary widely. These studies further develop the context for the new glazes and provide a framework within which to assess their significance. The creative potential of the glazes developed has been explored through their application in ceramic artworks, exhibited both during and at the end of the research. During the creation of these artworks, a theme emerged, closely linking them to their place of origin. In addition to the new artworks, the research contributes both a range of new ash glaze recipes and a model for exploring the potential of ash from a new source.

This research attracted a Part-time Award for Doctoral Study from the Arts & Humanities Research Council.

Contents

List of practical work submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy

Glaze tests:

- 4 sets of quadraxial blend glaze tests, comprising a total of 144 tiles
- 8 sets of triaxial blend glaze tests, comprising a total of 224 tiles
- 8 sets of line blend glaze tests, comprising a total of 64 tiles
- 4 bean ash test bowls (harvests 1999-2002)

Creative artworks:

- A pair of large square bowls
- A group of experimental round bowls with printed texture
- *Nettle Plate* – a pivotal experimental small square plate
- *Squarish Series* – a range of experimental plates and dishes with feet and textured rims
- *Plant Plates* – a series of plates decorated with impressions of plants and poured glazes
- *Flow Series* – a group of plates and dishes with poured decoration
- *Patchwork Dishes* – a cluster of small textured dishes, constructed from textured slabs and featuring richly coloured glazes
- *Tall Form* – a pivotal experimental piece formed using a square extruded section
- *Tall Pots* – a series of pots constructed from extrusions and textured slabs
- A trio of lidded boxes developed from the *Tall Pots* design
- *Patchwork* P*lates* – a group of 4 small textured plates with feet, constructed from textured slabs and featuring richly coloured glazes
- *On The Wild Side* – a series of ‘squarish’ plates with figurative wildflower drawings in oxides

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Author declaration

According to the regulations, I declare that during my registration I was not registered for any other degree. Material for this thesis has not been used by me for another academic award.

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The subjects of my case studies; Mike Dodd, Lis Ehrenreich, Eric James Mellon and Jim Robison, are established artists, who have kindly given their valuable time and generously shared their experience with me. I thank them sincerely for their interest, especially Mellon who invited me to take part in a collaborative ash glaze-testing project and to contribute to the resulting publication, *Decorating Stoneware* (Mellon & Foster, 2007). I am also very grateful to:

- Christine Constant, co-author of *The Potter's Palette* (Constant & Ogden, 1996), for her advice on the development of artworks
- Emmanuel Cooper OBE, editor of *Ceramic Review*, for his interest in my research and for publishing two articles that allowed me to begin dissemination of the findings
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- Margaret West of the Society of Glass Technology for featuring a case study of this research on the European Society of Glass Science & Technology website and for inviting me to give presentations at two of their annual events
- Phil Rogers for his interest in the early stages of the research and for including an illustration of my work in the second edition of his book *Ash Glazes* (Rogers, 2003)
- My fellow members of the Northern Potters' Association with whom I was able to exhibit in a group show at Oxo Tower Gallery, London in 2005
- The Biscuit Factory, Newcastle-upon-Tyne and Blandscliff Gallery, Scarborough, who accepted artworks developed through this research for selected exhibitions
- The Phoenix Gallery, Richmond and Red House Gallery, Bedale for showing work
- My husband, David Metcalfe, to whom special thanks go, for his assistance, support and tolerance throughout.

1 Introduction

This chapter describes the starting point for this research, outlines the contextual review and gives an overview of historical and contemporary ash glaze practice, in order to establish the context within which the practical research has taken place. The issues, from which the rationale for the investigation is derived, are then discussed. Next the aims are stated and objectives identified, together with the methodology employed to meet them. Finally the components of work constituting the research results are listed.

1.1 The starting point for this research

Stoneware ash glazes have a long history, starting in China 3500 years ago when ash from the wood fired kilns was used to produce the earliest examples. Today few ceramicists use wood to fire their kilns, so this research explores the use of an abundant alternative source of ash, waste products from arable crops, to develop a model for investigating the potential of a new ash.

Figure 1:
'*Conjunction 6'*, linseed ash glazed piece from my earlier work (1999). Height approximately 45cm.

[Photography: Carol Metcalfe]

My interest in ash glazes began whilst studying for my BA (Hons) Arts & Design at the University of Sunderland. In the spirit of the ancient Chinese, who used locally available waste materials in their glazes, I looked to my immediate environment when selecting new possibilities. Initially I used linseed straw ash to create glazes, an example of which is shown in Figure 1 above. However, this crop became unavailable when changes to European agricultural policies resulted in its cultivation becoming no longer financially viable. This research therefore focuses on *Pisum sativum* (Combining pea) and *Vicia faba* (Field bean), two leguminous species, which are widely grown as protein crops, not only in Great Britain but also in many other countries. The waste products from these particular crops do not generally have any other use and are usually just reincorporated into the ground. A search of both printed and electronic sources, showed a variety of plant species, for example lavender and corn cobs, being used for ash glazes (De Montmollin, 1997, p.39 & *Clayart Archive*, 2007) but found no mention of the species selected for this research, except for one recipe from Katharine Pleydell-Bouverie (Crafts Council, 1986). This contains a mixture of pea and bean ash, though neither the proportions of each nor the particular species used is specified. The table below lists the wide range of plant species found to have been used for glazes and identifies the location of the new species explored in this research. Further information as to the classification of the plant families is to be found in Appendix I, p.163.

FAMILY	GENUS/SPECIES	COMMON NAME
Aceraceae	*Acer pseudoplatanum*	Sycamore
Betulaceae	*Betula*	Birch
Buxaceae	*Buxus*	Box
Compositae	*Helianthus annus*	Sunflower
Cruciferae	*Brassica napus*	Oilseed rape
Fagaceae	*Fagus*	Beech
Fagaceae	*Quercus*	Oak
Gramineae	*Zea mays*	Maize (corn cob)
Gramineae	*Oryza*	Rice
Gramineae	*Triticum*	Wheat
Grossulariaceae	*Ribes nigrum*	Blackcurrant
Hippocastanaceae	*Aesculus hippocastanum*	Horse chestnut
Labiatae	*Lavandula*	Lavender
Leguminosae	***Vicia faba***	**Field bean**
Leguminosae	*Trifolium repens*	Clover
Leguminosae	***Pisum sativum***	**Combining pea**
Leguminosae	*Phaseolus vulgaris*	Navy bean
Leguminosae	*Glycine max. vulgaris*	Soy bean
Linaceae	*Linum grandiflorum*	Linseed
Oleaceae	*Fagus*	Ash
Onagraceae	*Oenothera biennis*	Evening primrose
Philadelphaceae	*Philadelphus*	Philadelphus
Polygonaceae	*Fagopyrum esculentum*	Buckwheat
Pteridiophyta	*Pteridium aquilinum*	Bracken
Rosaceae	*Malus*	Apple
Rosaceae	*Crataegus*	Hawthorn
Rosaceae	*Prunus*	Plum and cherry
Rosaceae	*Pyrus communis*	Pear
Salicaceae	*Populus*	Poplar
Salicaceae	*Salix*	Willow
Ulmaceae	*Ulmus glabra*	Elm
Vitaceae	*Vitis vinifera*	Vine

Table 1:
Plant species identified as having been used in ash glazes, together with the species used in this research (shown in Bold)

1.2 Outline contextual study

The contextual review for this research consisted of several strands. In addition to the information needed for the introduction to identify the context and rationale for the research, an exploration of glaze recipe calculations and of glaze testing methods was required. The approach used also demanded the analysis of ashes and the botanical background of ash sources to be investigated. As the research progressed, a framework for the positioning of the new glazes was developed through studies of selected contemporary ceramicists, who use ash glazes. As a theme relating to 'place' also emerged, the need arose to review other ceramic work of this genre. The diagram in Figure 2 below gives an overview of the different aspects comprising the contextual review underpinning this research.

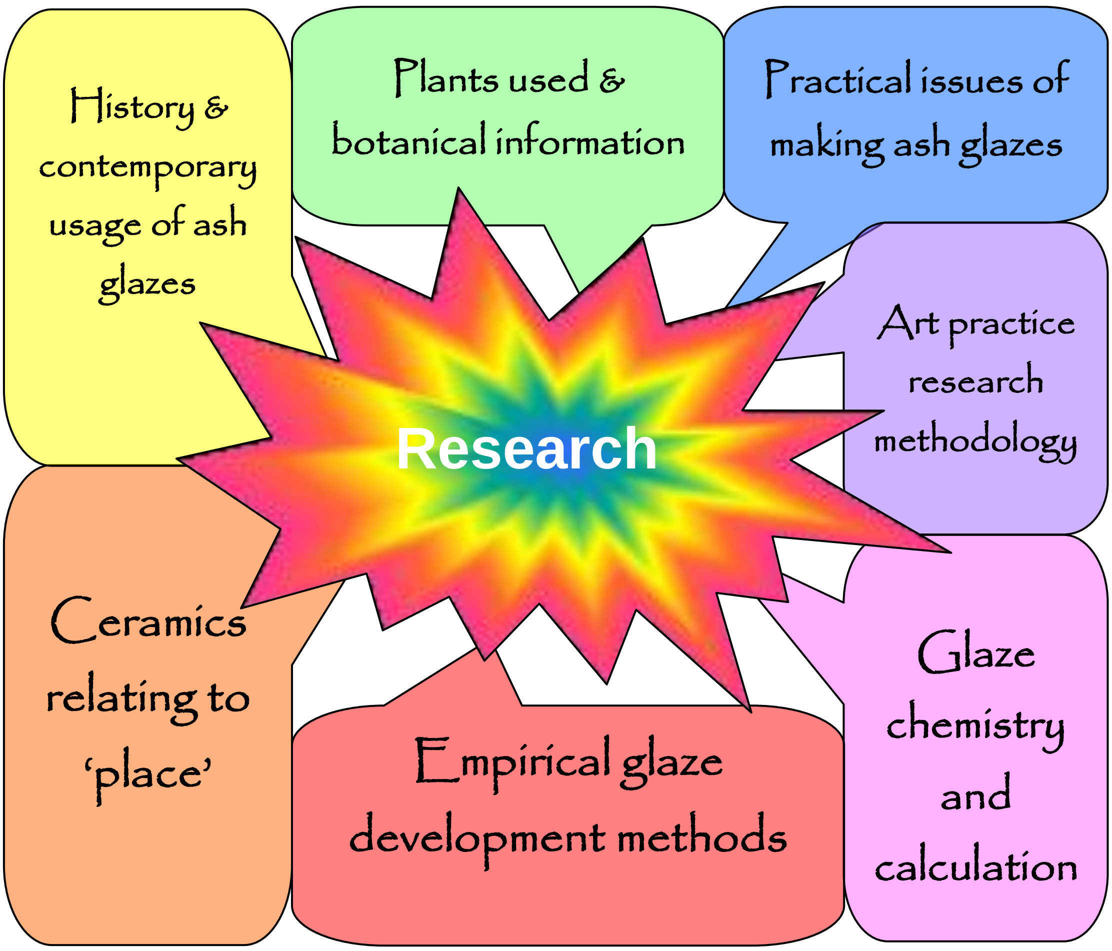


Figure 2:
Areas explored in the contextual review underpinning the research

Various types of literature were consulted, as well as gathering information from the study of actual objects in exhibitions and museums. Discussions with the case study subjects and visits to their studios also formed part of the contextual review. The diagram in Figure 3 below indicates all the different types of sources accessed and a full list of the references used is at the end of this document in the bibliographic references (p.225).

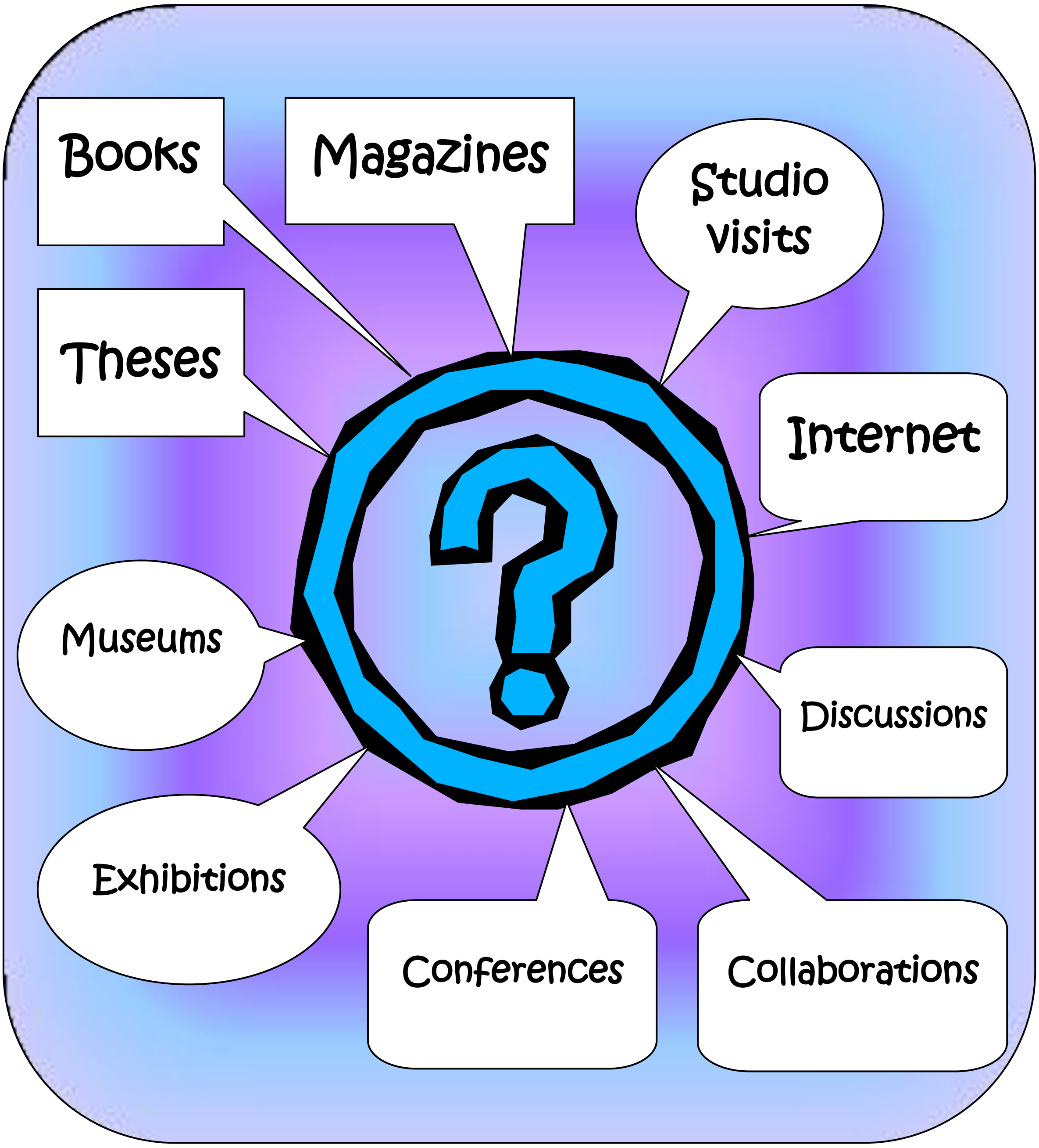


Figure 3:
The pool of sources consulted for the contextual review

In order to avoid a very lengthy and disjointed contextual review at this point in the thesis, aspects of the contextual study are reviewed at appropriate points throughout the thesis, where their relevance is more clearly apparent. This approach echoes the evolutionary nature of art practice research. This section therefore is just an outline review of the literature consulted and its content.

Only four books were found specifically on the subject of ash glazes (De Montmollin, 1997b, Rogers, 1991 & 2003 & Tichane, 1998).

- De Montmollin (1997b) covers the preparation, composition and testing of a wide variety of plant ashes from straw to lavender to wood. Firings are high temperature to 1280°C, preferably in reduction. The original French version of this book was used in this research but a translation has become available more recently.
- Rogers (1991) employs standard blending methods to test glazes containing wood and coal ashes, fired to a high temperature of 1280°C. He also covers the washing of ash in detail and surveys a range of potters, who have used ash glazes. Rogers (2003) is the second edition of the same book. The main text is virtually unchanged, however an updated and wider range of examples of contemporary ash glazed work is included.
- Tichane (1998) discusses a wide variety of ashes and acknowledges the use of washed and unwashed ash in glazes. Wet chemical analyses are given for many of the ashes, quoted from a 19th century text written in German, *Aschen Analysen* by E. Wolff (1880). A few X-ray analyses are also included. Most of the glaze tests carried out use wood ash and it is not made clear to what temperature they are fired, nor whether the firing was oxidised or reduced. In addition, Tichane devotes just four pages to low melting ash glazes, which he defines as Cone 8 (approximately 1260°C) and below.

All these texts then concentrate on the use of high temperature reduction firing and the glaze testing, except in De Montmollin, is predominantly of wood ash.

Several other references contain just a chapter or smaller section on the subject of ash. Notable examples include the Crafts Council (1986), describing Katharine Pleydell-Bouverie's life in ceramics. One chapter of this publication gives the detailed records Pleydell-Bouverie kept of her ash glaze recipes for both reduced and oxidised firings, the great majority of these, however, require high temperature firings. Leach (1962) contains short sections on wood ash and vegetable ashes and gives some analyses including rice straw, wheat husk and bracken ashes. He too describes the washing process for ash. Mellon & Foster (2007), a recent publication to which this research made a contribution, includes Mellon's ash glaze recipes using a wide range of plant ashes, again all fired to high temperatures of 1290-1300°C. The origins and early history of ash glazes are to be found in the comprehensive accounts of early Chinese glazes given by Wood (1999) and Sato (1981).

Quite a number of magazine articles were located and these revealed a more varied approach to ash glazing. Whilst many were still concerned with the traditional high temperature, reduction fired, wood ash glazes, there were also articles dealing with oxidation (Mellon 1998 & Stileman 2001) and an example using straw ash in low temperature glazes (Ehrenreich 1999).

The Internet proved to be a rich source of information and contacts and provided an enlightening, up to date insight into the current interest in ash glazes (*Clayart Archive* 2007). Responses to a message posted on this site came from practitioners around the world, with comments on ash from pecan shells, apple and willow wood, wheat straw and pampas grass. Contributions included several book recommendations, a Cone 6 (1222°C) recipe from Israel and an XRF analysis of willow ash from England, showing this ash to have a high lime content, typical of wood ash (See Appendix II, p.166). Contact with Phil Rogers was also initiated through this medium, resulting in the inclusion of a piece of my previous work in the second edition of his book (Rogers, 2003).

The only theses found on ash glazes were American MFA & MA theses; five titles were identified but only three were available (Azzaro, 1965, Johns, 1963 & Rockwell, 1951). Johns investigated nine wood and plant ashes, mainly unwashed, each used in nine glaze recipes. All the tests were reduction fired to Cone 9 (approximately 1280°C). Rockwell carried out preliminary tests using wood ashes, combining them with three other materials in quadraxial blends. He then went on to use washed corn cob ash, a waste material in plentiful supply, in triaxial and line blends. Seven of these glazes were selected for the final pots. Firings were to Cone 8 (approximately 1260°C), at which temperature many of the tests did not melt. Azzaro explored unwashed wood ash, both alone and in glaze recipes, using line blends and firing the tests to high temperature in reduction. He also had the wood ash analysed. All these American researchers evaluated their glazes in qualitative terms, Rockwell and Johns also including photographs of the outcomes.

In the UK, fourteen other art-practice theses were located and studied from a methodological point of view; of these eleven were in the ceramic field, some of which investigated glazes. Table 2 below gives an overview of these sources, ordered according to aspects of the focus of the research.

Table 2:
Overview of art practice research consulted

AUTHOR, DATE & AWARD	FOCUS OF RESEARCH& NOTES ON PRESENTATION	RESEARCH METHODS
Slade 2002 PhD	**Development of autoreductive glazes & discussion of colour theory against which to assess glaze results** Photos & close-ups of test tiles integrated into thesis	Glaze tests, including triaxial blends Small pots Reflection on tests in relation to colour theory, including subjective descriptions of colours
Mousa 1982 MPhil	**Tested the effects of 9 different glazes on the colours of 3 pink stains** **Firing atmospheres monitored closely**	Glaze test tiles Colorimeter to measure colours quantitatively Only 1 colour photo with qualitative description of colours
Meanly 1998 PhD	**Investigation of the philosophical, technical & aesthetic possibilities of salt glaze, using teapots as a model** **Examination of gases emitted from kiln** Photos of teapots in thesis Sketchbooks & logbooks presented Written in 1st person	Tests Compendium of teapots Sketchbooks of ideas Logbooks of firings Reflection on practice
Malins 1993 PhD	**Kiln design & modification for reduction lustre firings, safe to operate & with minimum environmental impact** **Kiln atmospheres & emissions monitored closely** **Devised method of assessing aesthetic qualities of glazes objectively**	2D & 3D glaze tests & vases Computer program used to formulate glaze recipes X-ray analysis of materials & glazes Interviews with contemporary practitioners Peer review using questionnaire

Contd. overleaf

Table 2 contd: Overview of art practice research consulted

AUTHOR, DATE & AWARD	FOCUS OF RESEARCH& NOTES ON PRESENTATION	RESEARCH METHODS
Petrie 1999 PhD	**Development of a safer ceramic transfer printing system using water based materials, both in studio and industrially** Thesis contains images within text	Tests and artworks Comparison with existing examples, produced by traditional methods Exhibition of artworks
Pengelly 1996 PhD	**Development of safe & environmentally sensitive printmaking practices** Relational database ‘A framework of safe practice’ on CD appended to thesis Text & visual documentation of workshop practice Photos of processes & artworks in thesis	Materials tests & artworks Participation in workshops Case studies of contemporary practitioners Questionnaire on current attitudes in education Exhibition of artworks as peer review
Aylieff 1984 MPhil	**Incorporation of other materials into clay bodies for making large scale unglazed sculptural ceramics** Thesis plus separately bound photographic record Description of practice written in 1st person	Tests & 3 large scale final pieces Tests evaluated in a table format against 6 predetermined criteria Reflection on practice Subjective descriptions of final pieces
Saied 1996 MPhil	**Investigated Sudanese clay bodies for ceramic manufacture** Photos incorporated into text	Firing, glazing & casting tests X-ray analysis of clays Reflection on tests led to next stage Properties (eg shrinkage)of clays measured quantitatively Colours also noted
Greenhill 1984 MPhil	**Use of local clay to make sculpture inspired by Northumbrian landscape** Maps, photos & slides appended to thesis Thesis all written in 1st person	Site-specific sculptures Reflection on inspiration & process Diary of pit firing Reflection on feelings about final sculptures
Hogarth 1998 PhD	**Study of the processes involved in a sculptor’s response to contemporary issues within the British landscape** Main body of thesis on CD Rom Photos & images from sketchbooks incorporated into accompanying text Written in 1st person throughout	7 site-specific sculptural projects Development of ideas via images & video with text explaining relevance of visual material Reflection on each project led to next Analysis using the 7 projects as case studies
Bunnell 1998 PhD	**Visualisation of designs on computer and integrated making methods for ceramics** Very long contextual review covering 9 areas/topics Thesis presented on CD in a database format	Tests & artworks Reflection in & on action Exhibiting as peer review Presentation at conferences

Contd. overleaf

Table 2 contd: Overview of art practice research consulted

AUTHOR, DATE & AWARD	FOCUS OF RESEARCH& NOTES ON PRESENTATION	RESEARCH METHODS
Marshall 1999 PhD	**Explored the use of a range of CAD/CAM technologies for ceramics in studio and industrial settings** **Also a study of the relationship between craft and technology**	A variety of final artefacts relating to architectural ceramics Case studies of practitioners using CAD/CAM Reflection-on-action Peer review
Wheeler 1996 PhD	**The role of architectural ceramics in contemporary site-specific art** **Examination of site-specific art from perspective of art practitioner** Images of drawings, making process & finished pieces within text 1st person used in analysis of own practice	4 collaborative site-specific art projects. Diary of work carried out Reflection on practice using the 4 projects as case studies Comparison to historical examples Comparison between case studies
Johnston 1997 PhD	**Investigated the innovative application of dichroic coated glass in architecture** Photos recording all tests & installations in appendix	Materials tests within a model setting Commissioned installations Case studies of 3 contemporary artists Reflection on tests & installations

Conclusions arising from the review of existing art practice research were:

- Very little research has been done on ash glazes
- Safety and environmental concern is a recurring theme in art practice
- Multiple methods are employed in most art practice based research
- Case studies of contemporary practitioners can provide useful detailed contextual information
- Comparison of outcomes to existing examples can be used in evaluation
- Exhibition of artworks and peer review often used to evaluate outcomes
- From a practitioner's point of view, images accompanied by qualitative descriptions are far more informative than numerical values when discussing surface qualities
- The use of the first person is preferable to the third person when discussing feelings about artworks and decisions made relating to them, whilst the passive voice is better for other parts of the research

1.3 Historical & contemporary context of ash glaze practice

This section gives a brief overview of the significant historical developments leading up to the knowledge of ash glazes and contemporary field we have today. This establishes the context within which this research has taken place and to which it has added new knowledge.

Down the centuries many ceramicists have successfully used plant ashes as a glaze ingredient and this practice continues today. There are many recipes available mostly using wood ash, though there are examples of other types such as rice husk or straw. In a recent publication, Wood (2005, p.7) reveals that some of the earliest examples of ash glazes were produced in the Middle East. These glazes melted at earthenware temperatures, the main flux being sodium oxide from the ashes of desert plants.

Archaeological evidence found at ancient kiln sites in China includes high-fired stoneware ceramics with hard, thin greenish wood ash glazes from an early Shang site dating from the Bronze Age nearly 3500 years ago (Wood, 1999, pp.17-18). In the early Bronze Age in China, kiln technology had advanced to a point where temperatures around 1200°C could be reached. Wood ash from the firing would then have produced a natural glaze on the pots and kiln walls. Observation of this phenomenon most probably led the Chinese potters to use wood ash for the world's first stoneware glazes. Examples of Shang glazes (c.1500 – 1050 BC) have been found where either wood ash alone, or wood ash and clay have been carefully applied to the pots by brushing, pouring or dipping. Far more examples exist from the later Bronze Age (1000 – 500 BC).

These wood ash and clay glazes were used almost unchanged for a period of about 2000 years from 1000 BC – 1000 AD (Wood, 1999, p.38) and include the well-known grey green Yue wares. From the 10th century AD limestone was used either with or instead of wood ash to provide calcia or lime (CaO) for these lime glazes, leading to a decline in the amount of wood ash used. Ash glazes have however continued to be used in China to a certain extent right up to the present day.

It was not until the ninth century AD that wood ash glazes were developed in Korea and Japan, influenced by imported Chinese wares. An important influence on pottery in Japan over many centuries has been the traditional tea ceremony, which involves the appreciation of simple natural beauty (Rhodes, 1959, pp.22&23). The subtle qualities of ash glazes were valued by this philosophy, their unpredictable effects being accepted as part of the making process, an approach that continues in Japan to the present day. One example of a contemporary ceramicist working in Japan is Jay Jago (*Jago Ceramics*, 2002). He uses rice ash in some of his glazes. Richard Batterham, who works in Britain, adopts a similar philosophy. In a conversation I had with him during the course of this research, Batterham expressed the opinion that the variation in ashes was an advantage, giving the glazes made from each batch a uniqueness that was to be valued.

Interest in ash glazes in Britain was kindled back in the early 20th century, with the advent of studio pottery, when ceramic artists, notably Bernard Leach, looked to the East for inspiration. Leach spent several years working in the Far East with the master potters, where he gained experience of ash glazes and the Japanese approach to the making of pottery (Cooper, 2003). When Leach returned to England in 1920, the Japanese potter, Shoji Hamada, joined him and both continued to work in the oriental tradition, including the use of ash glazes. Leach also taught and some of his pupils took a particular interest in ash glazes, especially Katharine Pleydell-Bouverie. Having spent a year with Leach, she returned home at the end of 1924 and set up the Cole Pottery in Mill Cottage, Coleshill. There she explored the possibilities of ashes from the many different species of trees and plants available from pruning and felling on the Coleshill estate. Writing to Leach in 1930 she explained the effects she aimed to create, *"…I want my pots to make people think, not of the Chinese, but of things like pebbles and shells and birds' eggs and stones over which moss grows."* (Crafts Council, 1986, p.7). Figure 4 (p.12) shows an example of just how successful she was in this aim. Pleydell-Bouverie kept notes of her recipes with descriptions of the results, both good and bad, and these are available in the literature (Crafts Council, 1986, p.59).

Figure 4:
Bowl by Katharine Pleydell-Bouverie with detail of blue crackle ash glaze. Diameter approximately 15cm (WA Ismay Collection)

[Photography: Carol Metcalfe]

According to Rhodes (1959, p.160), *" glazes made with ash have a distinctive quality and appearance, which is hard to reproduce with other materials"*. Many studio potters of the 20th century seem to have agreed and included ash glazes in their work. Today, in the early years of another new millennium, there are some notable examples of practitioners using ash glazing both in Britain and elsewhere. These include Phil Rogers, Lis Ehrenreich, Jim Robison, Mike Dodd, Eric James Mellon and Jim Malone. Selected contemporary ceramic practitioners are discussed in detail in the case studies in Chapter 6 (p.92).

Malone, speaking at the York Art Gallery in April 2006, acknowledged the influence of mediaeval earthenware jugs on his work. He commented that he uses ash glazes to achieve comparable surface qualities at stoneware temperatures.

Figure 5:
Ash glazed jug by Jim Malone, shown in *'Art of Throwing'* exhibition, Rufford Craft Centre, 2002. Height approximately 50cm.

[Photography: Carol Metcalfe]

Rogers is also influenced by Japanese ceramics and the Leach tradition. Ash glazes form an important part of his work (See Figure 6 below). Another contemporary example is Richard Bresnahan of Saint John's University, USA, who has used ash from various arable crops, including Navy beans (*Phaseolus vulgans*), another leguminous species (Saint John's Pottery, 1999).

Figure 6:
Pine ash glazed jar by Phil Rogers, Height 65cm

(Rogers, 1991, p.94)

Few ceramicists today have the facility to use large wood fired kilns, producing wood ash as a by-product of their firing. There is however still great interest worldwide in plant ash as a glaze material, as is demonstrated by messages to the *Clayart Archive* (2007) on the Internet. This ceramic discussion site devotes a specific section to ash glazes containing an archive of 800-900 messages stretching back over a period of 10 years. It is regularly updated with comments, requests for information and the subsequent replies, with some threads extending to tens of messages. See Appendix II (p.166) for the many responses generated by my message submitted at the outset of this research.

It was from this long and varied background that this research set out, ultimately adding a further aspect to the contemporary field. During the course of the research, an interest developed in the role of 'place' as inspiration for my ceramic artworks. Since this aspect of the context had no bearing at the outset, it is reviewed later in the thesis, in Section 7.7.2 (p.142), where it becomes relevant.

1.4 Issues leading to the rationale for this research

The chemical composition of a glaze recipe is, of course, crucial to its final appearance and to the ability to repeat that result. The ceramic practitioner making ash glazes faces a number of potential difficulties, many of which are due to the variable chemical composition of plant ashes. This section details these issues and discusses them in relation to the potential benefits of arable crop waste as a source of ash.

1.4.1 Supply

Ceramicists can obtain ash in a variety of ways, ranging from purchasing mixed wood ash from ceramic suppliers to collecting ash from their own fireplaces or being on hand to collect the remains of bonfires. Since plant ashes are variable in their composition, it is essential for the ceramicist to obtain a substantial supply of a particular ash to make it worthwhile taking the time to develop glaze recipes for it.

As can be seen in Figure 7, this issue is not a problem with arable crops as large areas are grown every year, providing a more than adequate supply for as long as the crop remains economically viable and continues to be produced.

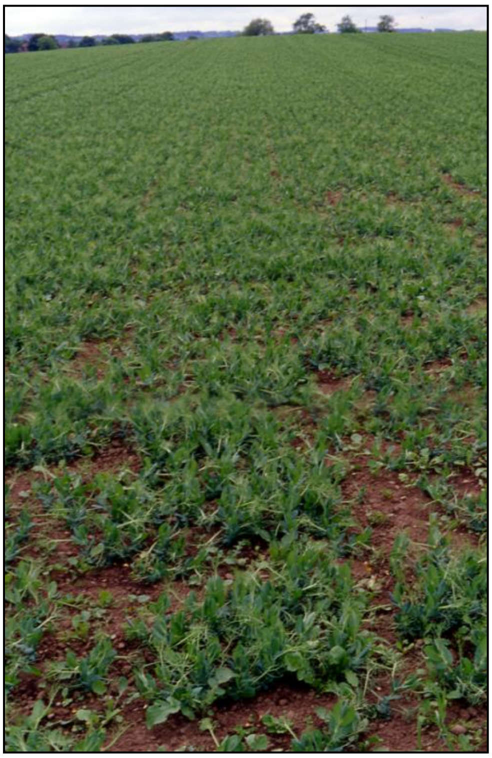


Figure 7:
A field of peas provides a substantial supply of ash from a single species

[Photography: Carol Metcalfe]

1.4.2 Plant Species

According to De Montmollin (1997b, pp.27-28), of the many factors affecting the composition of a plant ash, the species of plant is the most influential. It is important therefore to know what species the plant material is and preferable to avoid mixtures of species, where the proportion of each constituent would be impossible to determine. Arable crops are ideal in this respect, being monocultures of a selected species where weeds are virtually eliminated.

1.4.3 Part of Plant

Different parts of a plant will also yield ashes of widely differing compositions; for example, the trunk of a tree will differ from the small branches. Tichane (1998, p.26) illustrates this point with some analyses, one example being the level of potash present; 45.7% in ash from a tree trunk and only 8.1% in ash from its branches. Again this variation is minimised by the use of arable crop waste, since, for a given crop, it always comprises the same parts of the plant; in the case of the species investigated in this research, the dry stems, leaves and empty pods, as shown in Figure 8 below. Within agriculture, the term 'straw' is used generally to refer to this dry waste material left after the seeds from any crop, not only cereals, have been harvested.

Figure 8:
Rows of straw dropped back onto the field after seeds have been harvested
[Photography: Carol Metcalfe]

1.4.4 Season & Stage of Growth

The composition of ash from a particular plant also varies according to the stage of growth and season of the year at which it is collected (De Montmollin, 1997b, p.15). This factor is fixed for waste material from arable crops as the plants are harvested at the same stage of maturity and at approximately the same time each year.

1.4.5 Soil Type

Rogers, (1991, p.21), states that ash from plants of the same species can vary according to the soil type in which the plants have grown. De Montmollin (1997b, p.28), however, has found these differences to be minimal compared with differences between species. In the case of arable crops any differences are likely to be minimised as soils are regularly tested for acidity/alkalinity and nutrient levels. The correct balance for a particular crop is then achieved by appropriate applications of lime, fertilisers and trace elements so that its requirements are fully met.

1.4.6 Climate

Tichane (1998, p.26) suggests that climate is a further cause of variation in plants of the same species and thus the composition of the ashes derived from them. He gives, as an example, differences in the analyses of beech trees grown in lowland and alpine regions. The arable crops that are the focus of this research can only be successfully commercially grown within a relatively limited range of climatic conditions, though of course weather conditions from season to season can vary. Material gathered from successive years' harvests has been investigated to contribute data in respect of this issue and the analyses are discussed in Section 3.2.6 (p.50).

1.4.7 Ash Yield

Another factor to be considered is the amount of ash yielded by the burning of a certain quantity of plant material. This varies considerably from less than 0.5% for wood to over 7% for some types of straw (Tichane 1998, p.29-31). The Field bean straw burnt for this research yielded approximately 4%, quite a high yield, which is of course advantageous.

1.4.8 Environmental Concern

Research by Malins (1993), Bunnell (1998) and Petrie (1999) is indicative of the increasing concern about environmental issues affecting ceramic practice, over the last decade or so, with regard to kiln emissions and studio health and safety. The source of materials is also a possible cause for concern. The back cover of Tichane (1998) carries an illustration of the author in a woodland area with his chain saw. The caption reads: *"Author Robert Tichane with an ash tree about to be converted to an ash glaze".* This approach is not environmentally acceptable to me, nor is it likely to appeal to most ceramicists or their customers in today's climate of saving forests and recycling materials. The use of waste products from agriculture avoids the need to cut down trees or indeed any other plants solely for their ash.

Another environmental concern is that ceramic materials are often transported thousands of miles from their source. In addition substantial energy is also required to grind rock sources and to package products. The use of more local materials cuts these demands on resources, as Wood (2005, p.1) points out, *"The processing by potters of materials local to their workshops can therefore be an ecologically sound operation".*

1.4.9 Firing Temperature

Traditionally, ash glazes are fired to high stoneware temperatures, at least 1280°C, Cone 10 and often higher still, which is very costly. According to Malmgren, (2000, p.48), a fuel saving of 30% can be made by firing to Cone 6 instead of Cone 10. This research, in line with the general environmental concerns emerging today, seeks to save fuel resources by developing ash glazes for lower stoneware temperatures around 1240°C, Cone 7.

1.4.10 Kilns

Ash glazes have usually been fired in fuel burning kilns, for example gas kilns, in a reducing atmosphere. Often practitioners today live in areas where it is only appropriate to work with electric kilns and they therefore use oxidised firings. This research moves away from the traditional approach to explore what range of ash glazes can be produced using an electric kiln.

1.5 Aims and objectives

The issues discussed in Section 1.4 above show arable crop waste to be a useful and reliable source of ash, available in quantities viable for glaze development, responding to the situations experienced by today's ceramic practitioners. The recycling of local waste materials as a source of glaze ingredients, the fuel savings made by the use of lower temperature firings in oxidation and the subsequent improved kiln emissions all demonstrate an environmentally sensitive approach. The value of the investigation is thus established and the rationale identified.

1.5.1 Aims

This is a practical research project, carried out from my position as a ceramic practitioner, rather than a scientist or historian. Historical or scientific data have only been included when useful to support and inform my art practice.

As well as producing new ash glazes and using them to create artworks, the necessity of developing a model for the exploration of a new ash source was recognised from the outset. As my own experiences have proved, the economic viability and therefore availability of a certain crop can be changed suddenly by factors outside the control of both ceramicist and farmer.

Within this framework, the following aims were developed for this research:

- *Aim 1*
  To develop a range of new glazes, for lower stoneware temperature (1240°C, Cone 7) oxidised firings, using ash from arable crop waste as an environmentally sensitive ingredient.
- *Aim 2*
  To demonstrate and articulate the possible creative, practical and environmental benefits of the new glazes, for contemporary ceramic practitioners, principally through artworks.
- *Aim 3*
  To offer a model for investigating the potential of a new source of ash, as a glaze material.

1.5.2 Objectives

From the above aims a number of objectives were identified that needed to be met in order to achieve those aims. The research objectives are shown in Table 3 below, where their connection to the aims is also indicated. The methodology used to address these objectives is defined in the next section.

Table 3:
Objectives developed from each aim

Objectives	**Aim 1** Develop a range of new ash glazes for Cone 7 oxidation	**Aim 2** Demonstrate and articulate benefits of new glazes	**Aim 3** Offer model for investigating new ash
1. Identify the range of ash glazes in use in the contemporary field			
2. Identify the types of plant ashes that have already been used			
3. Compare the compositions of the new ashes under investigation to those of a range of ashes already in use			
4. Identify what other glaze ingredients are required			
5. Ascertain what glaze recipes could be used with the new ashes			
6. Explore what range of glazes can be produced from the new ashes in Cone 7 oxidised firings			
7. Explore how can these new glazes be used creatively in artworks			
8. Evaluate the significance and position of the new glazes within the contemporary field			
9. Identify a model for the exploration of a new source of ash			
10. Disseminate the outcomes of the research within the contemporary field			

1.6 The search for a methodology: Approaches taken to this research

1.6.1 Paradigms of inquiry

The following definition is taken from the *Concise Oxford Dictionary* (9th Edition, 1995):

Paradigm – an example or pattern especially one underlying a theory or methodology.

In the positivist paradigm of inquiry very specific research questions or hypotheses are stated at the outset, and then subjected to empirical testing under carefully controlled conditions. Scientific research is representative of this model. Whilst empirical testing is certainly used in this research project, no hypothesis is proposed, the research issues being more open. The intention was to discover what range of glazes could be produced using pea or bean ash rather than to demonstrate whether or not it was possible to make a particular type of ash glaze (e.g. a glossy transparent glaze).

This process of discovery, within a more natural setting, is a feature of the post-positivist paradigm. This paradigm recognises that reality is driven by natural laws that can only be incompletely understood (Gray & Malins, 2004, p. 20). It allows for the inclusion of qualitative methods of research such as the description of successful glaze qualities in aesthetic terms and comparisons between examples of glazes, that is to say, in terms naturally used by ceramic practitioners and meaningful to them.

There are also many aspects of the constructivist paradigm of inquiry that are relevant to art practice PhD research, since the practitioner is the researcher and is inextricably linked to the outcomes. Findings are therefore to an extent subjective, being located within the practice and the resulting artwork. Consensus can however be reached through discursive methods, drawing in others involved in the contemporary field. This combination of two or more opinions constitutes a form of ‘triangulation’ that can be employed to examine the outcomes from different perspectives (Gray & Malins, 2004, p.137). A wider evaluation of their significance is thus obtained. Within the constructivist paradigm it is accepted that multiple realities exist within the personal interpretations placed on findings. For example, the parameters for what constitutes a ‘good glaze’ will depend upon the individual practitioner, the style of work produced and its purpose – anything from tableware to sculpture. Gray & Malins (2004, p.21) define the multifaceted role of the practitioner/researcher. This research identifies with all the characteristics they list in the following ways:

- Participant in the creative process producing artworks
- Self-observer reflecting on and in own actions and seeking opinions of others involved in the field
- Observer of others in establishing the research context and gaining other perspectives
- Co-researcher, facilitator and research manager, working in collaboration with peers for certain aspects of the research

The artistic paradigm of inquiry adopted here, then, is flexible and eclectic. In order to respond, through art practice, to research objectives and problems arising within art practice, a combination of elements have been drawn from the existing, recognised and established positions.

1.6.2 Methodology and methods

In some of the literature consulted and referenced in this section, the terms methodology and method are, rather confusingly, used interchangeably. In the context of research, the methodology could be defined as the body of methods or ways by which the objectives are met and the aims of the research achieved.

The specific methods employed in each stage of this research and the reasons for selecting them are discussed in detail in the appropriate sections throughout the following chapters. Their significance is then more clearly and immediately apparent. This section is concerned mainly with identifying the overall methodology adopted, but gives in addition, an overview of the selected methods.

A frequent characteristic of artistic methodology is the use of multiple methods in what could be termed a ‘composite’ approach, made up of distinct elements. There are several completed PhD research projects where this strategy has been successfully employed. Marshall (1999) discusses his ‘multi-method’ methodology in great detail, citing a number of other examples of this approach; Malins (1993), Wheeler (1996), Pengelly (1996), Bunnell (1998).

Architectural ceramicist Eleanor Wheeler (1996, p.98) summarises her methodology thus: *"The research has been carried out using a multi-method approach which draws on aspects of established science, social science and historical approaches whilst seeking to formulate an appropriate 'artistic' method."* Her research involved the making of four commissioned site-specific ceramic features for public buildings. She then reflected on each project analysing all aspects, from funding to the making process to the responses to the final piece, before making comparisons between them.

A similar approach was taken by architectural glass artist, Laura Johnston (1997), who also produced site-specific commissions. In addition, she created and photographed small models to explore the new material being used and also carried out case studies of other contemporary glass artists to support her own art practice.

Petrie (1999), exploring new methods of transfer printing onto ceramics, worked both in a studio setting and with industry. He produced tests then used the new developments to create artworks for submission to selected exhibitions where the outcomes of the research could be integrated into the contemporary field. This research uses the exhibition of artworks in a similar way. Petrie also made a study of existing transfer printed pieces against which to evaluate the new process.

Malins (1993) and Bunnell (1998) both produced test tiles before going on to create 3 dimensional works, Malins applying successful glazes to a range of vase shapes, whilst Bunnell developed her own range of artworks. Both then used peer review to evaluate the outcomes. Bunnell also experimented with the format of the thesis, finally presenting the research in a type of database on CD. This was an innovative idea, but does however raise issues of having to have the correct software installed before being able to access the files, which especially over time, could be problematic. Bunnell identifies her methodology as 'naturalistic' since it takes place in the studio in the normal working environment of the researcher/practitioner.

Ceramicist, Richard Slade (2002) also stresses that his research is carried out in a 'natural' setting, using the standard equipment and glaze testing methods typical in studio ceramics, though carried out to a higher degree of accuracy than might be usual. He combined practical testing with theoretical study and explains one of the aims of the experiments as *"…determine through systematic practical experimentation whether the materials selected on the basis of the theoretical studies are actually effective as reducing agents"* (Slade, 2002, pp.26 & 52). A very similar approach is used in this research when selecting additional glaze ingredients and testing the glaze recipes developed for the new ashes.

Allison (1996, pp.9-22) identifies and describes several research methodologies. Those utilised in this research were:

- *Descriptive research*

  According to Allison (1996), a large proportion of all research is descriptive since a clear statement of *'what is'* is essential before any interpretation of the facts can take place. This activity of explaining relationships between the data gathered is also an integral part of descriptive research. In relation to this project, descriptive research of the literature and of existing examples of ash glazes is used in this chapter to establish the rationale and context. In addition, in Chapter 6 (p.92), case studies explore contemporary creative usage of ash glazes to identify the range of visual qualities sought by practitioners. This both further establishes the context for the new glazes developed and provides a useful framework for their assessment and evaluation. Descriptive research is also used in Chapter 3 (p.36), to compare the composition of the new ashes with others already in use, data having been gathered from analysis of materials.

- *Experimental research*

  Allison (1996) explains that the experimental approach, rather than identifying and describing *'what is'*, seeks to answer the question *'what if?'* A significant proportion of this research is devoted to answering the question *'What if bean and pea ashes are used as a glaze ingredient?'* and is therefore to some extent experimental. Typically experimental research divides the subjects into two groups. The experimental procedure is applied to one group whilst the other acts as a control. All other variable factors are kept strictly equal for both groups. The outcomes for the experimental group can then be compared with the control group and the effect of the new procedure evaluated. The 'control', against which the experimental bean and pea ash glaze test results are compared, is however supplied by existing ash glazes identified through the contextual study and case studies. The research design applied here is therefore not so tightly controlled as that in a contrived situation, where the researcher, can more closely monitor the variables. From the perspective of the ceramic artist however, it is more useful to assess the new glazes in a realistic environment rather than in isolation. They can then be positioned within the contemporary field, so as to assess the significance and possible application of the outcomes from a practical point of view. For similar reasons, the evaluation of the new glazes includes images and the descriptions are expressed in qualitative terms relating to their surface qualities rather than being quantified in any 'scientific' way. By contrast, Logan (2001) employed a colour pen to measure colour differences and a gloss meter to supply a numerical value for the fired surface quality, when evaluating the products of a new water based ceramic transfer printing process. The approach chosen for this research, using the sort of terminology found in existing glaze books such as *The Glaze Book* (Murfitt, 2002) and *The Potter's Book of Glaze Recipes* (Cooper, 2004), communicates in a more meaningful way with other ceramic practitioners, making the outcomes accessible to others in the field.

- *Practical research*.

  Allison identifies this as an area of research resulting in products, such as creative work in the arts, which constitute the main evidence of the research process. Both the process and the product are important, indeed he states that: *"It is principally the accessibility of the research process and methodologies adopted which distinguishes practical research from simply the output of creative or practical people, such as artists…".* Artworks exploring the creative usage of the new glazes constitute a significant part of the outcomes of this research. Reflection on this practical work assesses the significance of the outcomes when compared with existing examples of ash glazes and with ash glaze usage in contemporary practice. These products presented together with this thesis provide a transparency of methodology that would allow others to replicate much of the research.

1.6.3 An overview of the ‘composite’ methodology

To successfully address the research objectives identified in Section 1.5.2 (p.19), a range of methods was required. As mentioned above, the rationale for the specific methods employed is embedded throughout the thesis in the appropriate sections along with details of their application. Table 4 (p.26) provides an overview of the composite methodology adopted. The contribution each of the specific methods employed makes towards meeting the objectives, and thus achieving the aims of the research, is indicated. The methods used were:

- Contextual study
- Case studies
- Collaborations
- Analysis of ash compositions
- Empirical glaze testing
- Development of artworks
- Exhibition of artworks
- Reflection on art practice
- Publication of articles

The effectiveness of this approach is evaluated in the conclusions in Chapter 8 (p. 151).

Table 4:
Methods used to address each of the objectives.

Objectives	Contextual study	Case studies	Collaborations	Analysis of ash compositions	Empirical glaze testing	Development of artworks	Selected exhibitions	Reflection on art practice	Publication of articles
1. Identify the range of ash glazes in use in the contemporary field	■	■							
2. Identify the types of plant ashes that have already been used	■	■							
3. Compare the compositions of the new ashes under investigation to those of a range of ashes already in use		■		■					
4. Identify what other glaze ingredients are required	■	■	■	■					
5. Ascertain what glaze recipes could be used with the new ashes		■		■	■				
6. Explore what range of glazes can be produced from the new ashes in Cone 7 oxidised firings			■		■				
7. Explore how can these new glazes be used creatively in artworks		■	■			■			
8. Evaluate the significance and position of the new glazes within the contemporary field	■	■	■	■			■	■	
9. Identify a model for the exploration of a new source of ash	■	■	■	■	■	■	■	■	
10. Disseminate the outcomes of the research within the contemporary field			■				■		■

1.7 Summary and components of work constituting the research results

This introductory chapter has outlined the long history of ash glazes together with the contemporary field and my position within it, at the outset of the research. The current issues underpinning the rationale for the use of arable crop waste as a glaze ingredient have been identified and discussed, leading to the aims and objectives for the research. Examples of previous research and relevant literature have been consulted so as to identify an effective methodology for meeting these research aims and objectives.

The following chapters give details of the practice carried out, from the collection and preparation of the ash right through to reflection on the outcomes of the research and the conclusions reached. They also contain material from the contextual study and relate it to the art practice at each stage.

Using the methodology described in this chapter, the following components of work, constituting the research results, have been produced:

- A written thesis outlining the principles and describing the practical work undertaken
- A substantial body of glaze tests and creative artworks presented at examination, which are represented by images in the thesis.

2 Preparation of ash as a glaze material

This chapter gives an insight into the farming practices and procedures involved in growing the selected crops and how these influence the time frame for obtaining ash. There then follows a discussion of the collection and burning methods used and an explanation of the processes carried out to prepare the ash for use as a glaze material.

2.1 Collection of straw and ash

2.1.1 Growing crops

Peas and beans are leguminous plants, which have been grown since Neolithic times to provide protein for both human and animal consumption (Summerfield & Roberts 1985, pp.147, 148 & 200). Today they continue to be grown in many countries throughout the world. They are both annual crops, being sown and harvested within less than a year.

Figure 9:
Sowing pea and bean crops in spring
[Photography: Carol Metcalfe]

Before sowing soil tests are carried out on the land to establish the nutrient levels present and the level of acidity/alkalinity or pH of the soil. If necessary, lime is applied to achieve the appropriate neutral pH of 6.5-7.0. The ashes used for this research were obtained from crops grown in North Yorkshire, where the sowing times, weather permitting, are February/March for beans and March/April for peas (see Figure 9 above). Phosphate and potash fertilisers are applied to both crops in accordance with the results of the soil tests; ensuring sufficient nutrients are available to the plants. Selective herbicides are also applied to eliminate any weeds or volunteer cereal plants from previous cropping, which would compete with the legumes and contaminate the final product. The resulting monoculture is shown in Figure 10.

Figure 10:
Monoculture of bean plants
[Photography: Carol Metcalfe]

Figure 11:
Bean plants: in flower and with pods
[Photography: Carol Metcalfe]

Flowering takes place in June for the beans and late June/July for the peas, followed by the development of the seedpods (see Figure 11, p.29). At this stage, it is often necessary to apply a fungicide to the beans, as they are susceptible to the disease Chocolate Spot. Peas very occasionally require a fungicide if weather conditions are such that Downy Mildew becomes a problem. Aphids however are often a threat to developing pea pods and therefore an insecticide is sometimes applied. Farmers are required to keep detailed records of all pesticides applied to crops and this information is therefore available for each year's crop, should these chemicals be suspected of having an effect upon the analysis of the ash obtained.

In late August a desiccant is applied to the peas to kill off the plants and encourage even ripening of all the pods. The crop is harvested approximately two weeks later in September. Beans are left to mature naturally and are cut in late September. Both crops are harvested with a combine harvester, which separates the dry seeds from the pods and stems (see Figure 12 below). The seeds are collected in the machine, whilst the waste material is deposited back onto the field as straw rows. This straw can then be collected and burnt to produce ash for glaze material. It is otherwise disposed of by chopping and spreading over the field for reincorporating into the soil.

Figure 12:
Harvest: Dry bean pods and combine harvester cutting the pea crop
[Photography: Carol Metcalfe]

2.1.2 Burning waste material

Initially, straw was pushed into large heaps in the field and lit immediately after harvest. The fires burnt away and cooled very quickly, then the ash was collected with a dustpan and brush, taking care to avoid gathering any soil, as far as this was possible.

The disadvantages of this method were:

- The tendency for stones and soil to be pushed into the heaps along with the straw, making it difficult to avoid contamination of the ash.
- The need to carry out the burning and collection of ash immediately after harvesting, the timing of which was outside my control.
- The difficulty of collecting ash if the weather conditions happened to be windy.
- The bean straw tends to break up as it passes through the combine harvester, giving a very small straw row that proved impossible to push up into heaps.

An alternative method was therefore sought and arrangements made to have small bales of straw, as shown in Figure 13 below, made at harvest. These weigh approximately 20kg each and can easily be collected and stored under cover for burning when convenient.

Figure 13:
A small bale of straw

[Photography: Carol Metcalfe]

Bean straw from the harvest of 2000 was baled and subsequently burnt on a still dry day later in the autumn. A clean hard patch of open ground was selected for the bonfire. All the bales were gradually added to the fire, so that a deep layer of ash built up on a small area over a period of several hours, facilitating the collection of the ash, as shown in Figure 14 & Figure 15 below. This method therefore proved both more convenient and more efficient and has been used in subsequent harvests. In line with expectations indicated in Section 1.4.7 (p.16), a satisfactory yield of ash was thus obtained, containing very little charcoal or unburnt material. The ash yield for the bean straw was calculated as about 4% of the weight of straw burnt.

Figure 14:
Burning straw: Bonfire just lit and adding bales

[Photography: Carol Metcalfe]

Figure 15:
Cooled bonfire ready for collection of ash

[Photography: Carol Metcalfe]

© Carol Metcalfe

More recently, in the 2005 and 2006 harvests, it was possible to have big round bales made and moved under cover by a tractor. These are 120-150cm in diameter and weigh approximately 150-200kg, but once on site they can be rolled into position by hand and pushed over onto the flat side for burning, as shown in Figure 16 below. They can be burnt one at a time, yielding a useable amount of ash without the need to get close to the fire to add bales. It also proved possible to roll a further bale onto the embers of the first, building up a deeper layer of ash. As shown in Figure 17 below, standing the bales on the flat side prevented the layers of straw from opening out during burning and spreading the ash over a wider area. So long as machinery is available to handle these bales, this is a convenient method of collection and the burning process is considerably less arduous.

Figure 16:
Big round bales carried on site by the tractor can be rolled into position for burning
[Photography: Carol Metcalfe]

Figure 17:
Big round bales are burnt one at a time, standing on the flat side
[Photography: Carol Metcalfe]

2.2 Processing of ash

Despite careful burning and collection, the ash inevitably contains some debris, which needs to be removed to leave a fine powder suitable for incorporating into glaze mixtures. There are great differences of opinion between contemporary ceramicists as to whether it is advisable to wash the ash before using it as a glaze material. The arguments for and against washing ash are discussed in detail in Chapter 3 (p.36), where analysis of the ashes demonstrates unequivocally the effects of washing. Ash contains soluble alkalis, which, when mixed with water, make the glaze suspension very alkaline and therefore caustic with obvious dangers when handling. There is a possibility of glaze faults occurring due to soluble alkalis penetrating the clay body as it absorbs the water of the glaze, according to Rogers (1991, pp.36-37). Some ceramicists however, never wash ash and experience no such difficulties. One example is Eric James Mellon, who has worked with ash glazes for 40 years, and is the subject of one of the case studies in Chapter 6 (p.92). It should be noted that the soluble alkalis are strong fluxes so some of the useful components of the ash are lost through washing. This research therefore includes both washed and unwashed ash.

2.2.1 Dry Sieving process

Dry unwashed ash was gently passed first through a kitchen sieve, then through a 40-mesh sieve. As the ash is caustic a mask must be worn for this process. Care was taken to avoid, as far as possible, the loss of fine particles of ash, useful in the glaze.

2.2.2 Washing process

Washing of ash was carried out using the process shown in Rogers (1991, pp.37-40). A large container was half filled with ash, then filled up with water and mixed thoroughly. The ash was then allowed to settle and the debris and excess water poured carefully off. This procedure was repeated a few times, before sieving through a 40-mesh sieve.

The ash slurry was then poured into a cotton fabric 'hammock' to drain and dry, as shown in Figure 18. As the ash tends to settle out in layers during drying, the resulting dried mass needed to be broken up and thoroughly mixed before weighing out as a glaze ingredient.

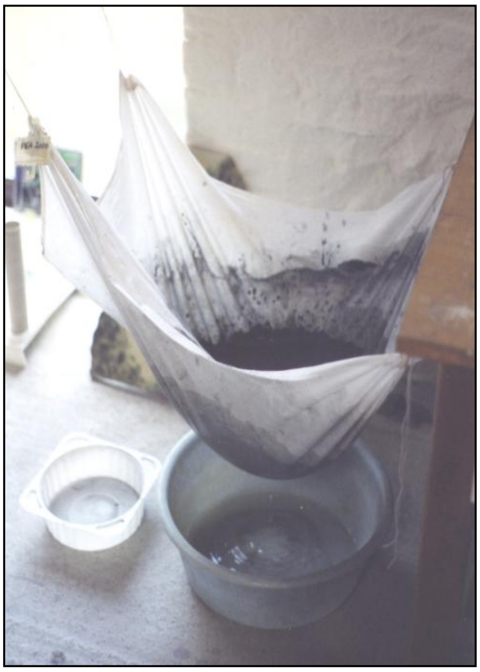


Figure 18:
Ash drying in cotton 'hammock'
[Photography: Carol Metcalfe]

2.3 Overview and clarification

This chapter has covered the processes involved in growing, collecting and preparing ash as a glaze material. Ashes, prepared as described above, were then ready to be used in glaze recipes, the exploration and development of which are the subjects of Chapters 3, 4 & 5.

For clarification, it should be noted that the ashes produced from the bean and pea straw are referred to in this thesis as 'bean ash' and 'pea ash'. These terms indicate ash from the waste material of bean and pea plants after harvest, not from the bean and pea seeds harvested. Similarly, when reference is subsequently made to types of tree ash, for example apple ash, in later chapters, this indicates ash from the wood of the tree not the fruit.

3 Comparing compositions of ashes to understand behaviour in glazes

This chapter explains the rationale for the use of analysis and the specific method used. The interpretation of the results is clarified, followed by a full discussion of the data. Using comparisons of ash compositions, a range of issues have been explored: the main constituents and profiles of ashes; the effects of washing ash; variations between harvest years and the theory put forward by another practitioner. Finally the significant factors revealed by the analyses, which informed and influenced the glaze testing, are assembled. The work described in this chapter thus meets Objective 3 and also makes a significant contribution towards meeting Objective 4, as identified in Chapter 1 (p.19).

3.1 Energy Dispersive X-ray (EDX) analysis

3.1.1 Rationale for the use of analysis

Having made the decision to explore the possibilities of ashes from the waste products of bean and pea crops, it was felt important to investigate the compositions of these new ashes. Only then could their characteristics be assessed to see how they would relate to known ash glazes. Informed empirical testing could then be carried out and a greater understanding of the results gained. Fortunately Eric James Mellon and Lis Ehrenreich, contemporary ceramicists, both subjects of the case studies in Chapter 6 (p.92), very kindly supplied a variety of ash samples for analysis. As a result, a substantial amount of data has been assembled, allowing comparison to be made across a wide range of ashes in contemporary use.

Through contact with the School of Computing & Technology at the University of Sunderland, it was possible to have numerous samples of ashes scanned using the Energy Dispersive X-Ray (EDX) system on the scanning electron microscope (SEM). This method produces a line graph with peaks indicating the elements present and can convert the area under the peaks into figures representing the relative concentrations of these elements. Unfortunately the lowest element in the Periodic Table that could be detected by the available equipment was sodium with an atomic weight of 23. Thus the lower elements, carbon, hydrogen and oxygen, and therefore carbonates and water, amongst others are not included in the analysis. However, since these parts of the ash are burnt off during the firing of a glaze, leaving the detected elements in the form of oxides, this is not so great a disadvantage as it first appears.

The figures given by the EDX analysis are a type of 'count' representing the percentage concentrations of each element present. They are not a percentage analysis of the weights of the oxides present, such as would be used in a glaze calculation process. The purpose of these analyses therefore is to compare one ash with another.

The EDX analysis method allows some very useful and interesting comparisons to be quickly and easily made between one ash and another or between washed and unwashed batches of a particular ash. This method has been used to great advantage to make comparisons between the new ashes being investigated here and those used by some other practitioners, effects of which are already known in glazes. The work reported here, based on comparisons of elemental constituents in a range of ashes, has lead to a greater understanding of the ashes' characters and thus an insight into their probable behaviour in glazes. The knowledge gained has facilitated well-informed practical testing to explore what would actually happen in the kiln. The value of this approach to the research has been confirmed when relationships between the analyses and firing behaviour have indeed been demonstrated in the subsequent tests and final pieces. It was anticipated that the evaluation of the subsequent test tiles would also be enriched by use of the EDX analyses, since it could thus be established that certain characteristics of the glazes were attributable to a higher or lower concentration of a particular element in the ash.

Since EDX analysis was available within the University, it was a financially viable proposition to carry out numerous tests. It would be equally possible to make comparisons using a different method of analysis that gives the percentages of the oxides present.

Malins (1993) employed EDX analysis in his research on lustre glazes. Using this method, he was able to establish that the proportions of elements present in the glazes varied with reduction temperature. Logan (2001) also opted to use EDX analysis in her research into a new water based ceramic transfer printing system in an attempt to understand the elemental changes taking place during firing of the transfers and account for the poor quality results obtained with certain colours.

3.1.2 Preparation of samples for EDX analysis

A small amount of ash is compressed to form a smooth disc 15mm in diameter and approximately 3mm thick, which is then scanned by the SEM. A beam of electrons strikes the sample, and then secondary electrons are emitted characteristic of the element that has been hit. The emitted electron beam output is analysed by the EDX facility of the microscope, to register the presence of certain elements and quantify the relative amounts of each one.

It is very important therefore that this tiny sample of ash is homogenous and representative of the ash supply as a whole. Quite a large quantity of ash needs to be sieved, first through a kitchen sieve, then through a 40-mesh sieve, before sampling, mixing well at each stage of the process. It is essential to wear a mask for this process. Even if the ash has been washed and sieved during the washing process, it must nevertheless still be sieved twice after drying to ensure that it is thoroughly mixed, as it tends to settle out in layers during the drying process.

The results from EDX analysis of samples prepared in this way have been very consistent both when several discs made from a particular ash supply have been scanned and when sample discs have been scanned more than once. This consistency proves the procedure followed to be a reliable method of examining ashes.

3.1.3 Interpreting EDX analysis

It is essential to understand how the percentages of concentration counts given by EDX analysis should be interpreted. Because of the different atomic weights of each element, figures can only be compared for the same element. For example, a figure of 20 for calcium in one ash and 10 for calcium in another ash indicates that the concentration of calcium in the first ash is twice that in the second one. It is however essential to remember that a result of 10 for calcium and 10 for silicon in an ash does not mean that there is the same percentage weight of these two elements present. It helps me to understand this if I think of a fruit bowl; if there were 10 cherries and 10 apples in the bowl, it would not indicate the same weight of each fruit present.

3.2 Discussion of results

A complete table of the EDX results can be found in Appendix IV (p.173). This includes bean, pea and linseed ashes from my own locality as well as the ashes supplied by Mellon and Ehrenreich, as mentioned above. None of the ashes tested have been washed unless specifically labelled as such.

As described in Chapter 2 (p.28), the pea and bean crops are both grown in a similar way and both are leguminous plants, which fix nitrogen in nodules on their roots. They might therefore have been expected to amass similar amounts of substances from the soil and consequently to have similar ash compositions. This did not however prove to be the case.

3.2.1 Main constituents of ash

Tests were carried out on a wide range of plant ashes including trees and bushes. All the samples contained a similar range of elements but in widely differing concentrations.

The main elemental constituents found were:

- Calcium
- Potassium
- Silicon
- Phosphorus

After firing these would be present as oxides, any carbonates or hydroxides having been burnt off, as mentioned previously.

All the samples also contained magnesium. The concentrations found varied from 0.6% of the count in oilseed rape and wheat straw to 5.5% in washed bean ash. Most of the samples also contained small amounts of:

- Sodium (less than 0.5% concentration)
- Iron (up to 1.5%)
- Aluminium (less than 2.5%)

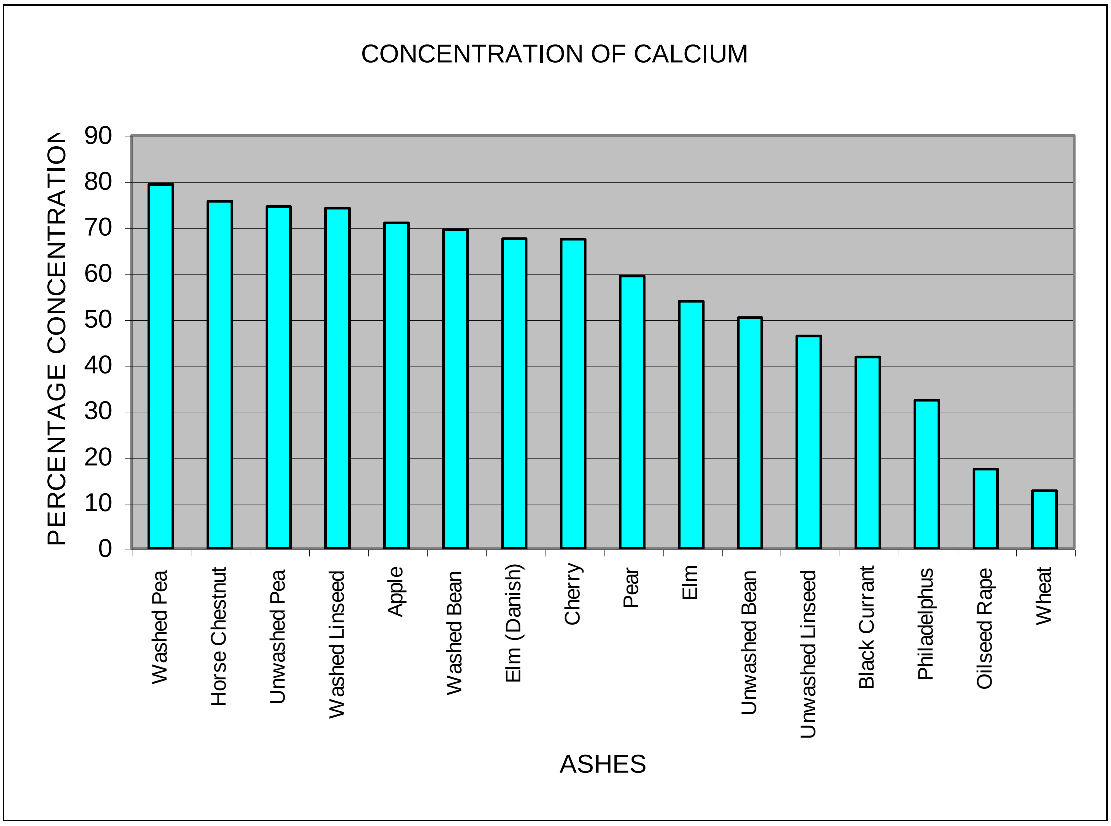
In general the chlorine content was low (0% - 4%) though just a few samples had significant amounts of 13% - 14%, for example oilseed rape straw. However since chlorine is volatile, this would burn off during firing and would not be present in the resulting glazes.

There would also be oxygen, hydrogen and carbon present, for example in the form of water, oxides, hydroxides and carbonates, but these being atoms of low atomic weight would not be detected by the EDX system used in this instance, as mentioned above. Again however, water and carbon dioxide would be driven off during firing, leaving the glaze oxides with which ceramicists are familiar, so need not be taken into account when considering the glaze forming qualities of an ash.

In the discussion that follows in the next subsections, only the main elements present are considered. The illustrative charts used were all developed from the data in Appendix IV (p.173).

3.2.2 The fluxes

Ash is usually used in glazes as a source of flux and indeed all the ashes tested contained significant amounts of calcium and some potassium. In Figure 19 (p.41), charts show the ashes in decreasing order of calcium concentration and potassium concentration respectively. From these charts it can be seen that bean and pea ashes differed widely from each other – an unexpected result given that they are of the same leguminous plant family. (See Appendix I, p.163, for information on plant families)



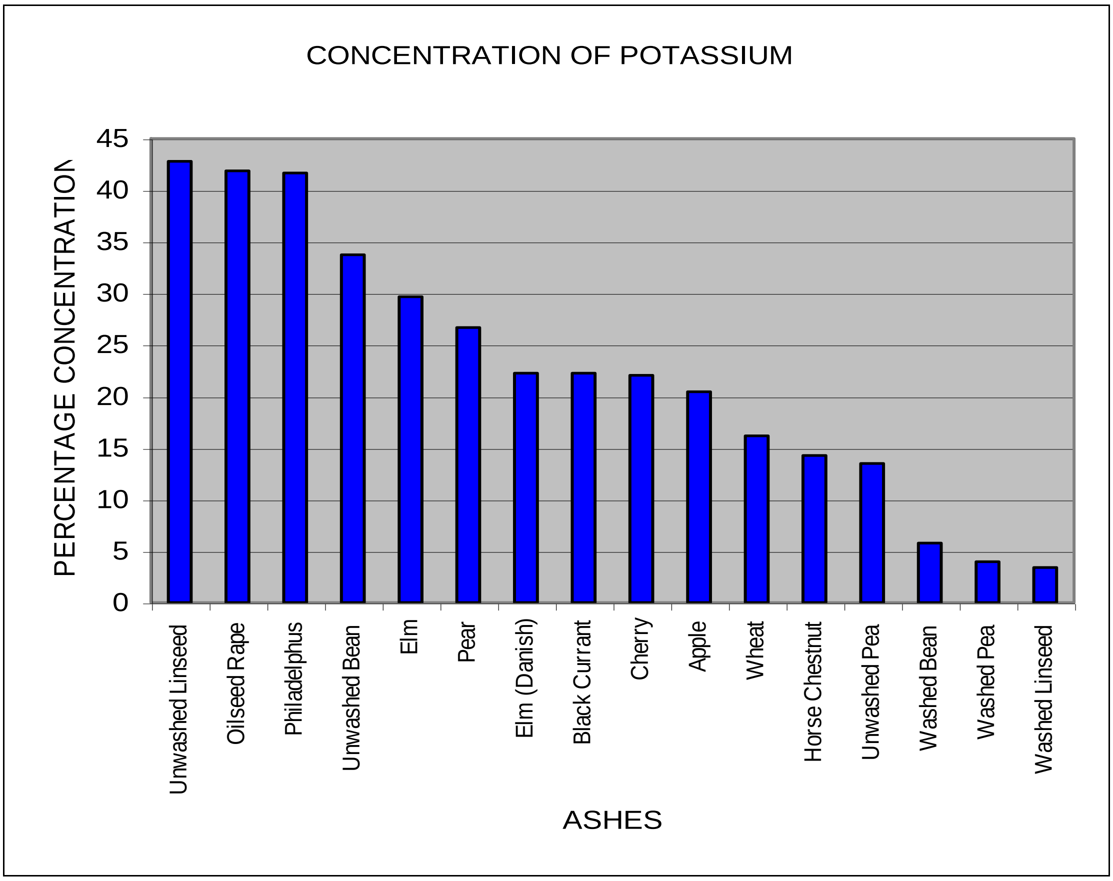


Figure 19:
Charts comparing calcium and potassium concentrations

The pea ash, both washed and unwashed, and the washed bean ash had levels of calcium similar to the wood ashes traditionally used in ash glazes, whilst the unwashed bean ash contained much less. Instead it had a high concentration of potassium, approaching that of the Philadelphus ash, used by Mellon, one of the case study subjects, in the stable glazes he applies over his oxide drawings (see Section 6.3.3, p.100). By contrast, the levels of potassium in the pea and washed bean ashes were very low. The pea ashes were also similar to the washed linseed ash that I have used previously, so it seemed likely that my existing recipes could be used.

Since a high calcium content gives glazes a tendency to run and form beaded textures, the pea ash could be expected to do this whilst the unwashed bean ash would be unlikely to do so. Figure 20 shows examples of the glaze tests subsequently carried out (see Section 5.2, p.72) in which the expected beaded effect did indeed occur in recipes with a high pea ash content.

Figure 20:
Glaze tests with high pea ash content demonstrating the expected beaded textures (Recipes UP3.1, 3.2 & 3.3 on Raku clay)

[Photography: David Williams]

3.2.3 Silicon & phosphorus

Figure 21 below shows that wheat straw, a cereal plant, is not so suitable as a fluxing material since its predominant element is silicon. Present in the form of silicon dioxide oxide, this is the glass forming substance silica, familiar to ceramicists. Such an ash would be more useful as an alternative material for the quartz or flint content of a glaze recipe.

In addition, Figure 21 shows that some of the ashes have quite high concentrations of phosphorus, which also acts as a glass forming substance and is valued for encouraging the formation of a bluish opalescent effect in some glazes.

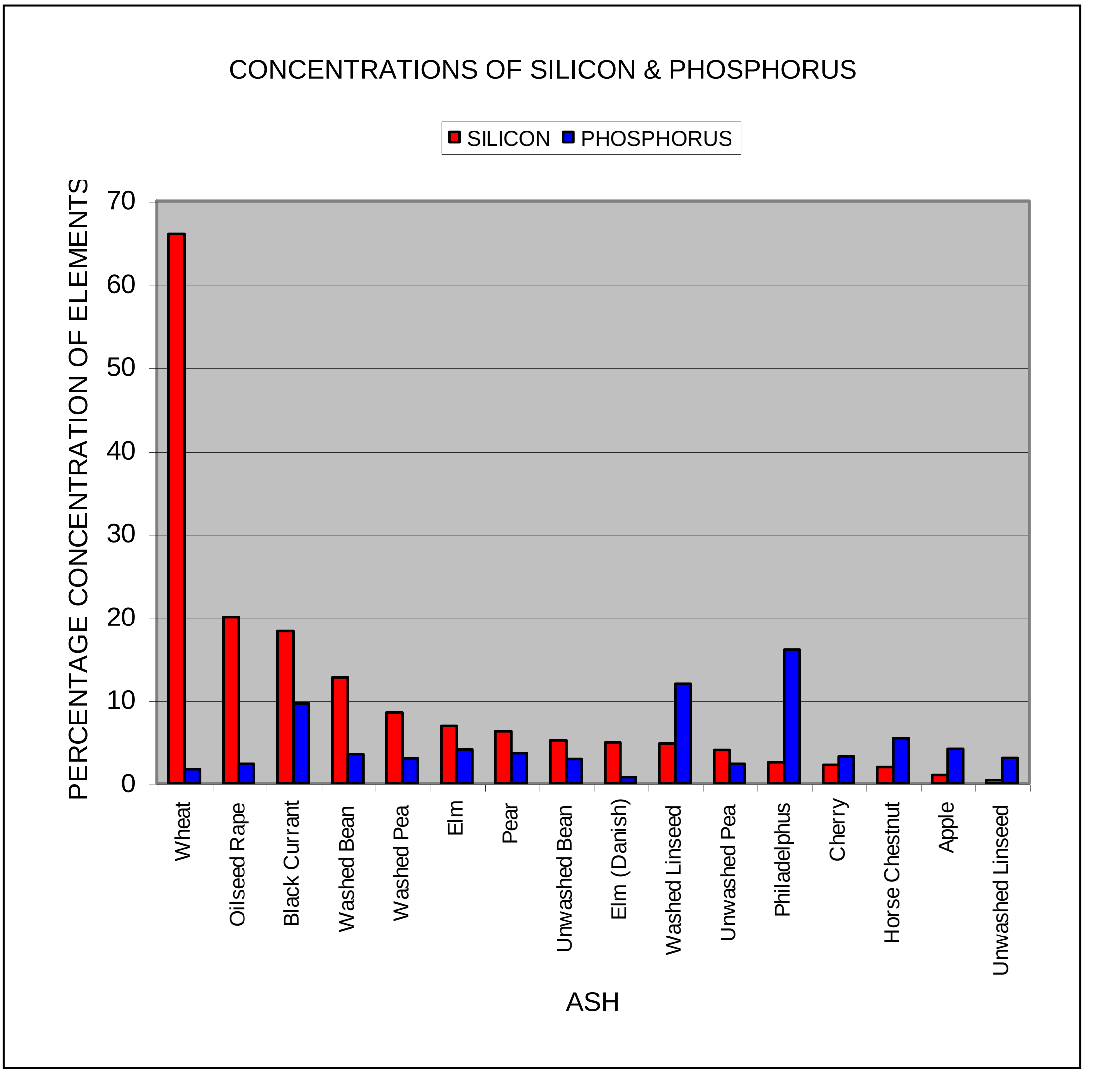


Figure 21:
Chart showing silicon & phosphorus concentrations

None of the bean or pea ashes contain high levels of silicon or phosphorus and therefore it can be concluded that they probably need further additions of silica in order to form a balanced glaze. Glazes do however react to an extent with the silica present in the clay body to which they are applied.

3.2.4 Comparison of ash profiles

By plotting the main constituents of a new ash on a line graph, its profile can be studied and compared to others, for example wood ashes traditionally used in ash glazes. For clarity the pea and bean ashes are profiled separately below.

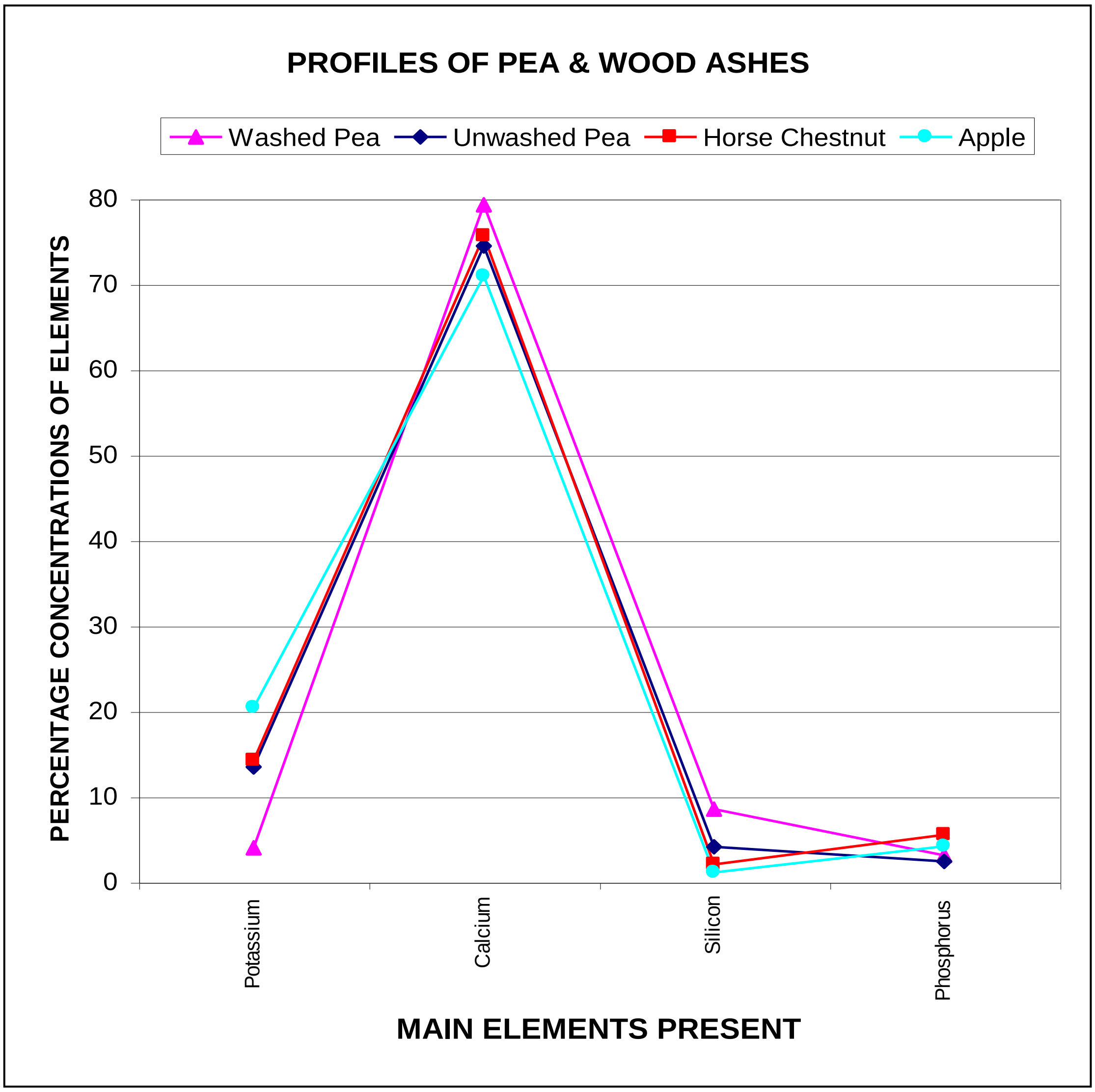


Figure 22:
Chart showing profiles of pea and wood ashes

Figure 22 shows the profiles of both washed and unwashed pea ash to be very similar to those of horse chestnut and apple wood ashes. Indeed, the horse chestnut and unwashed pea ash lines are almost identical. From this it can be concluded that pea ash might reasonably be expected to behave similarly to wood ash and therefore could be substituted in traditional recipes. This connection is discussed in the evaluation of the empirical tests in Chapter 5 (p.66). Also see Section 6.5 (p.106), where, in collaboration with case study subject Mike Dodd, pea ash has indeed been successfully used in one of his wood ash recipes.

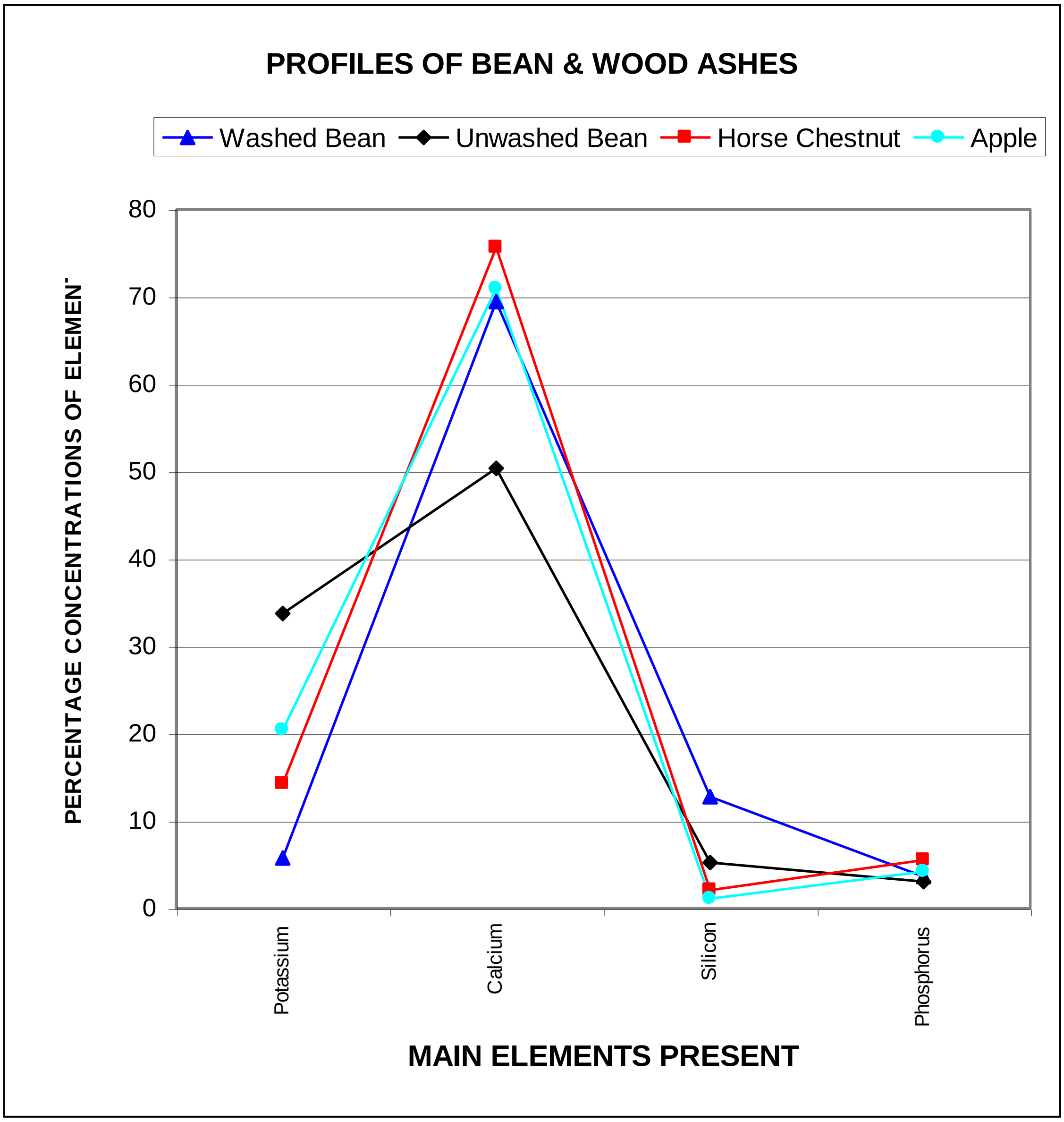


Figure 23:
Chart showing profiles of bean and wood ashes

The bean ash profiles are shown in Figure 23, again compared with horse chestnut and apple ashes. The washed bean ash line has similarities to the wood ashes, though the concentration of fluxes is slightly lower, whilst the level of silicon is rather higher. The unwashed bean ash however stands out on the graph as significantly different and can therefore be expected to give rise to glazes of a very different character, which has indeed proved to be the case.

3.2.5 The effects of washing ash

Ash contains soluble alkalis, which, when mixed with water, make the glaze suspension very alkaline and therefore caustic with obvious dangers when handling. The soluble alkalis are however strong fluxes and some of the useful components of the ash are therefore lost through washing.

As mentioned in Chapter 2 (p.34), opinions are polarised amongst practitioners as to whether or not ash needs to be washed before being used as a glaze ingredient. Opposing opinions are demonstrated within the case studies carried out for this research. Dodd is convinced that it is essential to wash ash otherwise glaze faults will occur, due to soluble alkalis penetrating the clay body as it absorbs the water of the glaze mix. Conversely, Mellon never washes ash and has never encountered any problems. In fact he is keen to retain all the soluble fluxes in order to keep the level of calcium as low as possible in glazes to be used over his oxide drawings, having found that high calcium levels cause the drawings to run (Mellon, 1976, 1977, 1980, 1998 & 2000a). Potassium is therefore a very valuable flux for producing a stable glaze.

Using figures from the EDX analysis, the effect of washing on the composition of ash can be evaluated. Three types of ash, bean, pea and linseed, have been tested both washed and unwashed. The chart in Figure 24 (p.47) shows the percentage concentrations of the main fluxes detected in the washed and unwashed ash samples and demonstrates just how dramatically washing alters the balance of the fluxes within the ash. The washing process hugely reduces the concentrations of potassium and consequently the percentages of calcium have risen. Potassium oxide is largely soluble in water and is therefore lost when the water is poured off the ashes during washing. This change in the balance of the fluxes present will significantly change the characteristics of the glazes produced. Before washing, the flux concentrations in the three ashes tested are very different from each other. After washing much of this variety is lost and all three are quite similar.

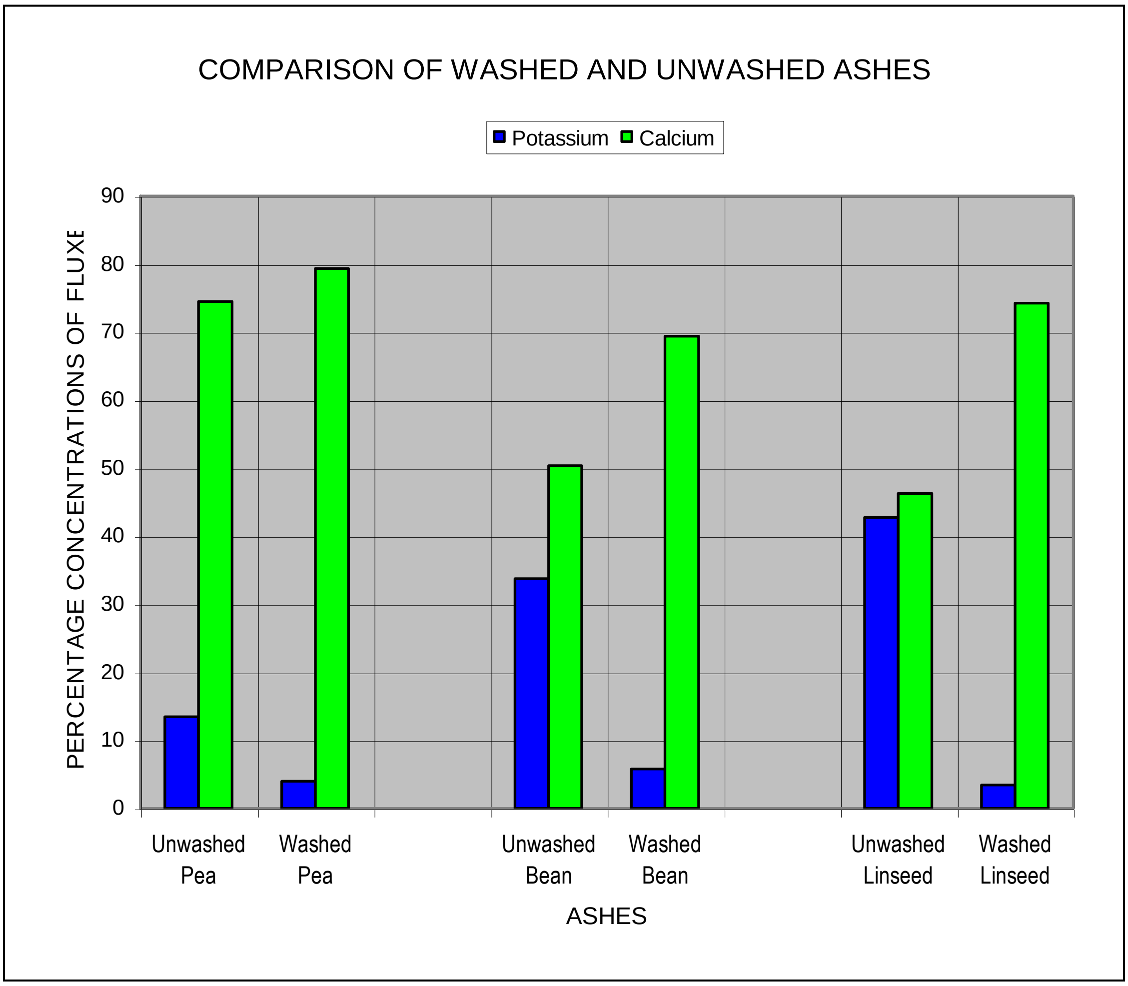


Figure 24:
Chart showing the effect of washing on the flux content of ash

Table 5 overleaf summarises all the arguments for and against washing ash; those gleaned from the contextual study, those from direct contact with the ceramicists Dodd and Mellon through the case studies, as well as findings from my own practice.

Table 5:
Summary of the arguments for and against washing ash

REASONS TO WASH ASH	REASONS NOT TO WASH ASH
▪ Unwashed ash contains soluble alkalis, which make the water in the glaze alkaline and therefore caustic to handle. Tests carried out in this research showed it to be pH 11 or more. Gloves should be worn.	▪ After 3 or 4 washings the ash was still very alkaline, testing at pH 10.5 – 11, so a great many washings would be needed to remove all the soluble alkalis. ▪ Repeated washing is very time consuming.
▪ Soluble alkalis penetrating the clay body in the water from the glaze could cause glaze faults when fired. Dodd has occasionally had glaze faults which he has attributed to insufficiently washed ash	▪ Mellon, who has worked with ash for 40 years, **never** washes ash and has encountered no subsequent glaze faults.
	▪ The soluble alkalis removed by washing are mainly potassium and sodium, which are strong fluxes, useful in glazes. Some of the fluxing power of the ash is therefore lost through washing. According to Rogers (1991, p.36) it can be as much as 25%

Continued overleaf

Table 5 contd.
Summary of the arguments for and against washing ash.

REASONS TO WASH ASH	REASONS NOT TO WASH ASH
▪ According to Rogers (1991, p.36) soluble alkalis in the glaze slop can cause problems if the glaze is to be kept for lengthy periods	▪ Mellon regularly keeps glazes containing unwashed ash in sealed containers for around 5 years, sometimes longer, with no problems ▪ In this experimental work, glazes have been kept for several months without difficulty
	▪ As shown in the chart in Figure 24, after washing, the compositions of the ashes are all quite similar. Much of the variety between them is lost when the soluble fluxes are washed out
▪ Sieving the ash mixed with water is safer as there is no dust.	▪ Sieving the dry ash proved easier than expected. When ash is sieved within a plastic box with the lid over as far as possible, very little dust was created. A mask was of course worn.

On consideration of the data provided by the EDX analysis and the arguments above, in particular the time taken to wash the ash, the loss of variety and the evidence of significant loss of fluxing power, the case for not washing the ash appears to be the stronger. I made the decision therefore that so long as no major problems subsequently developed, this research would concentrate on the unwashed ashes, supported by selective sampling only of washed ash.

3.2.6 Comparing harvests

Ashes are reputed to vary from season to season, which is another issue this research was able to investigate briefly. Samples of bean ash from each of the harvests from 1999 to 2002 were collected and analysed so that the composition of ash supplies from different years' harvests could be compared. Although these crops were not all from the same field, they were grown on the same farm within close proximity of each other. These tests were done in 2003 on a new SEM more sensitive to sodium, so cannot be compared with the previous data.   The resulting data can be found in Appendix IV (p.173).

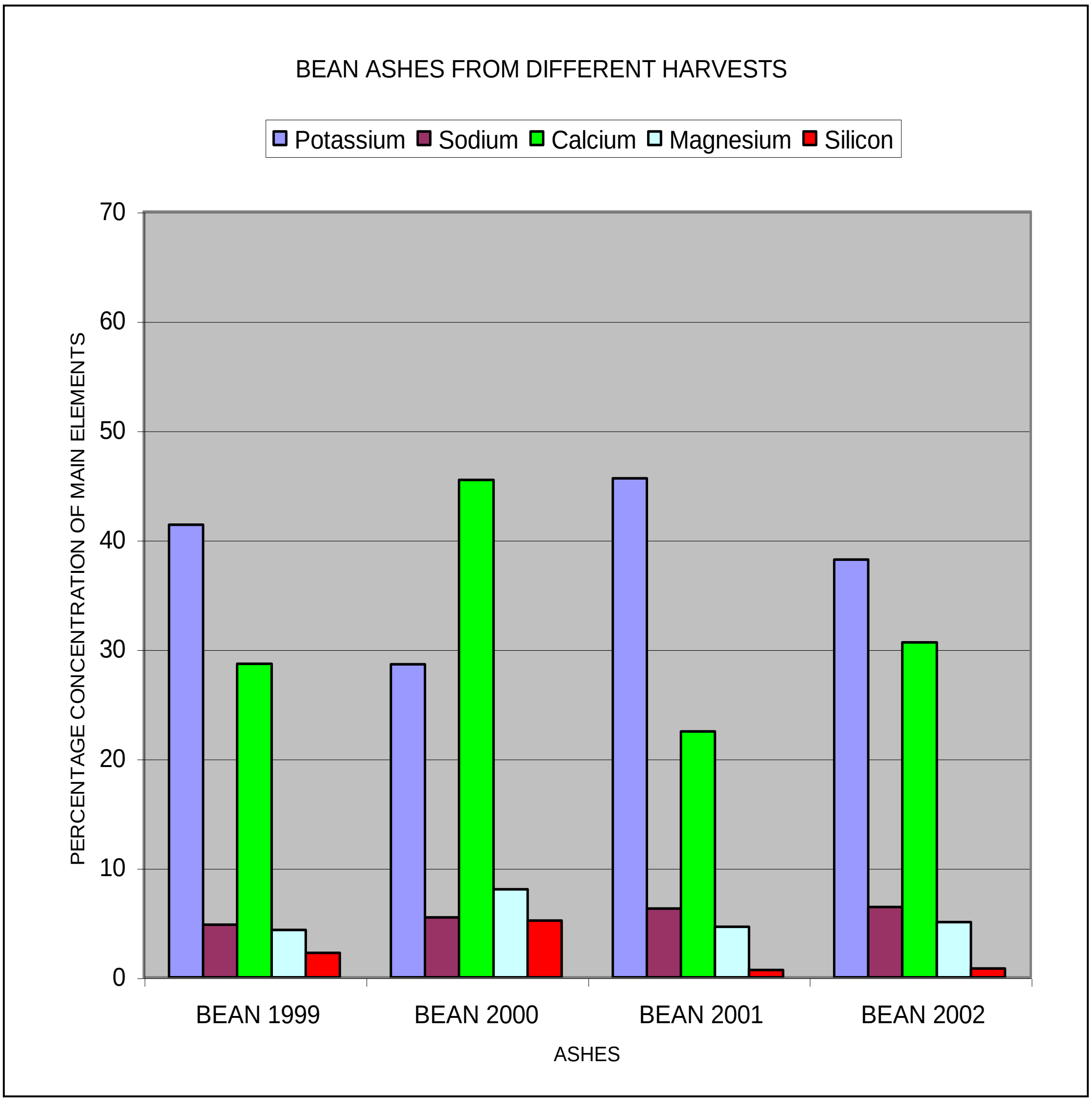


Figure 25:
Chart showing bean ashes from different harvests

Figure 25 shows the concentrations of the main elements present. There is indeed significant variation between the ashes from these four harvests, particularly in the levels of potassium and calcium. These differences are however better viewed within a wider context. Figure 26 shows them arranged in order of increasing potassium content, together with an example of wood ash, horse chestnut. Now it becomes clear that in comparison with this horse chestnut wood ash, all the bean ash samples have relatively high concentrations of potassium and relatively low calcium.

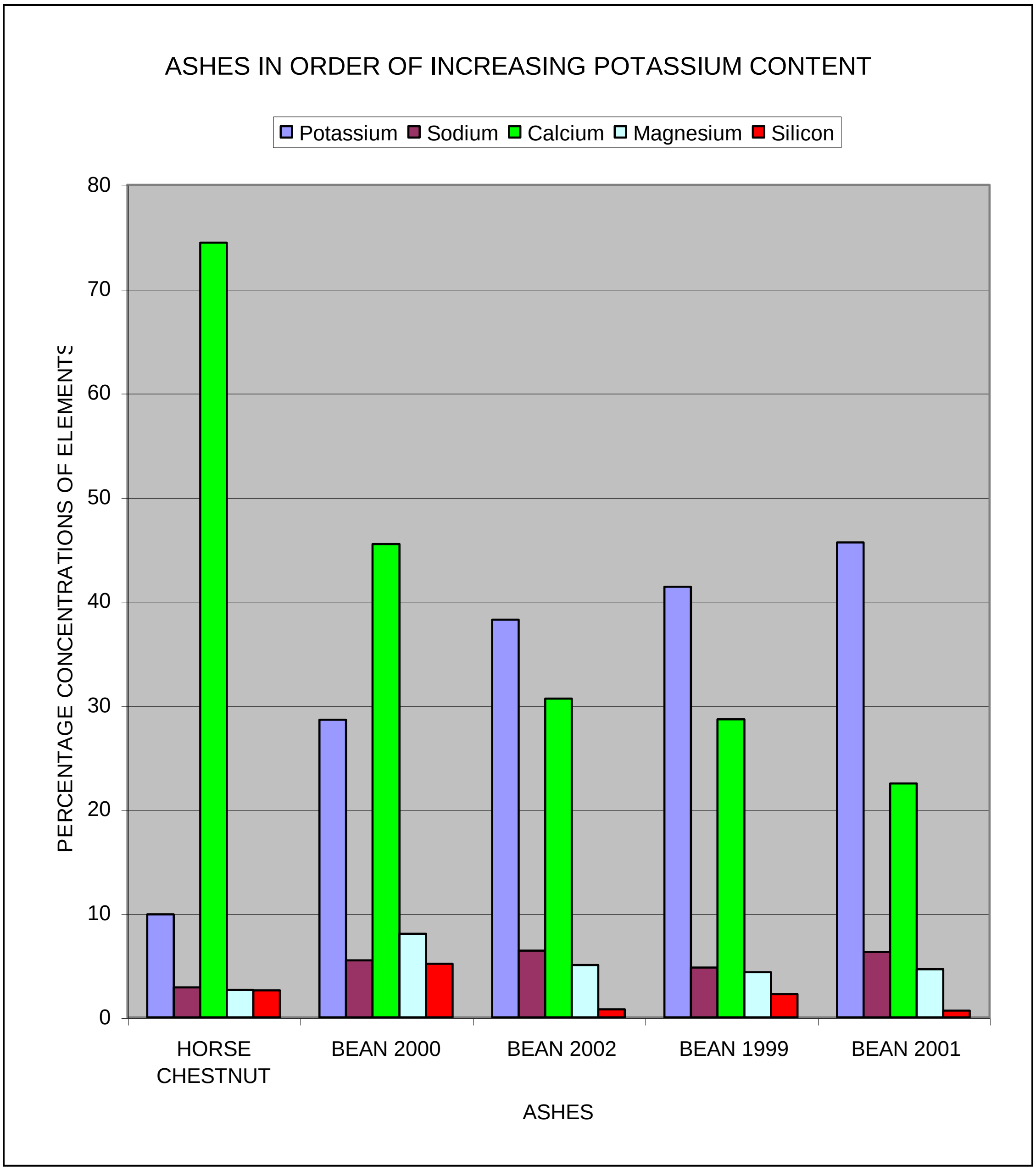


Figure 26:
Chart showing horse chestnut and bean ash analyses

Compared with the variation between species then, the variations between harvests seem less significant. They were nevertheless sufficient to influence glazes made from them. Small bowls made of Raku clay were glazed with 100% unwashed bean ash from each of the harvests, then fired in an electric kiln to 1240º C and soaked until Cone 7 was reached. Figure 27 shows them arranged in order of increasing potassium content and there is a distinct progression in the richness of colour produced.

Figure 27:
Bean ash test bowls arranged from Left to Right in increasing potassium content

Figure 28:
Undersides of the bowls in Figure 27

[Photography: Carol Metcalfe]

Figure 28 above and Figure 29 (p.53) show the undersides of the bowls, where the feet were not glazed but have developed a rusty 'halo' effect, which increases in intensity with increasing potassium content. This interesting characteristic of the bean ash is probably due to potassium dissolved in the water of the glaze being absorbed into the biscuit fired clay body or to volatilisation of potassium during firing.

Figure 29:
Underside of bowl showing 'halo' effect on unglazed feet
[Photography: Carol Metcalfe]

3.2.7 Testing a theory – Eric James Mellon's calcium theory

EDX analysis also enabled the evaluation of a theory put forward by Eric James Mellon. The diagram in Figure 30 overleaf is from Mellon (2000b, p.39), illustrating his theory that the calcium content of plant ashes varies according to the size of plant. Mellon's conclusion is based on observations made during the 40 years that he has used ash glazes. He had not had any of the ashes analysed prior to this research.

The chart in Figure 31 shows the level of calcium in a range of ashes relating to Mellon's diagram and indicates that this theory does hold good for the types of ash Mellon had used at the time. The bean ash also fits in with Mellon's theory; however, the pea ash appears to be an exception to the rule.

Mellon has expressed the opinion that he wasted many years trying to create stable glazes from various wood ashes, not realising that they were too high in calcium, a fact that would have been obvious had he had access to analyses of them. He has found the analysis results in this research very useful and interesting.

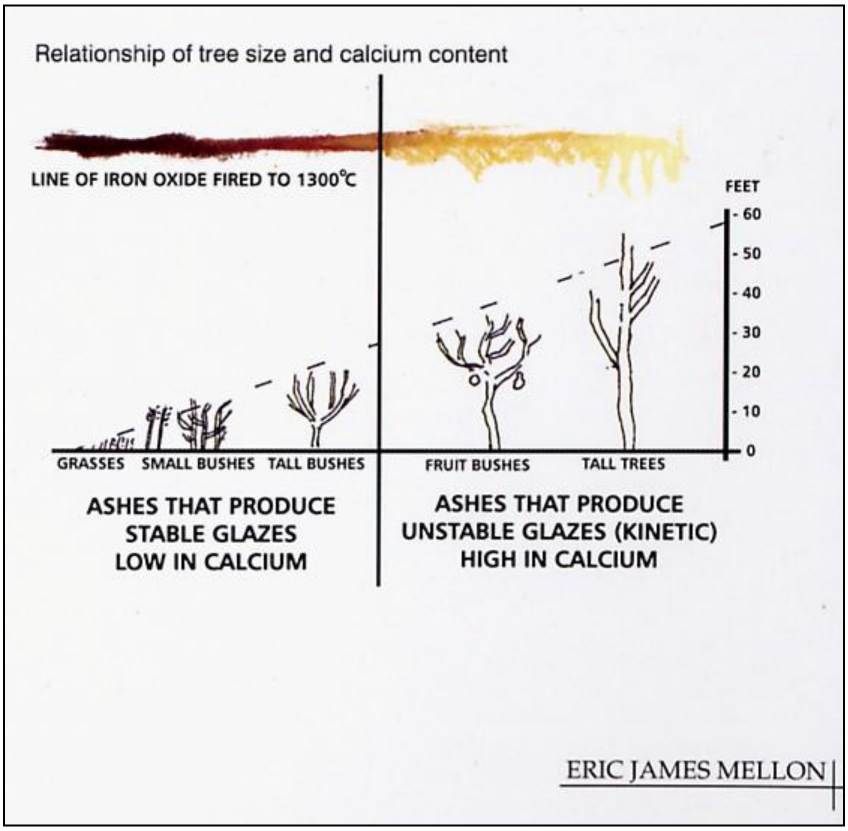


Figure 30:
Eric James Mellon's illustration of relationship between plant size and calcium content

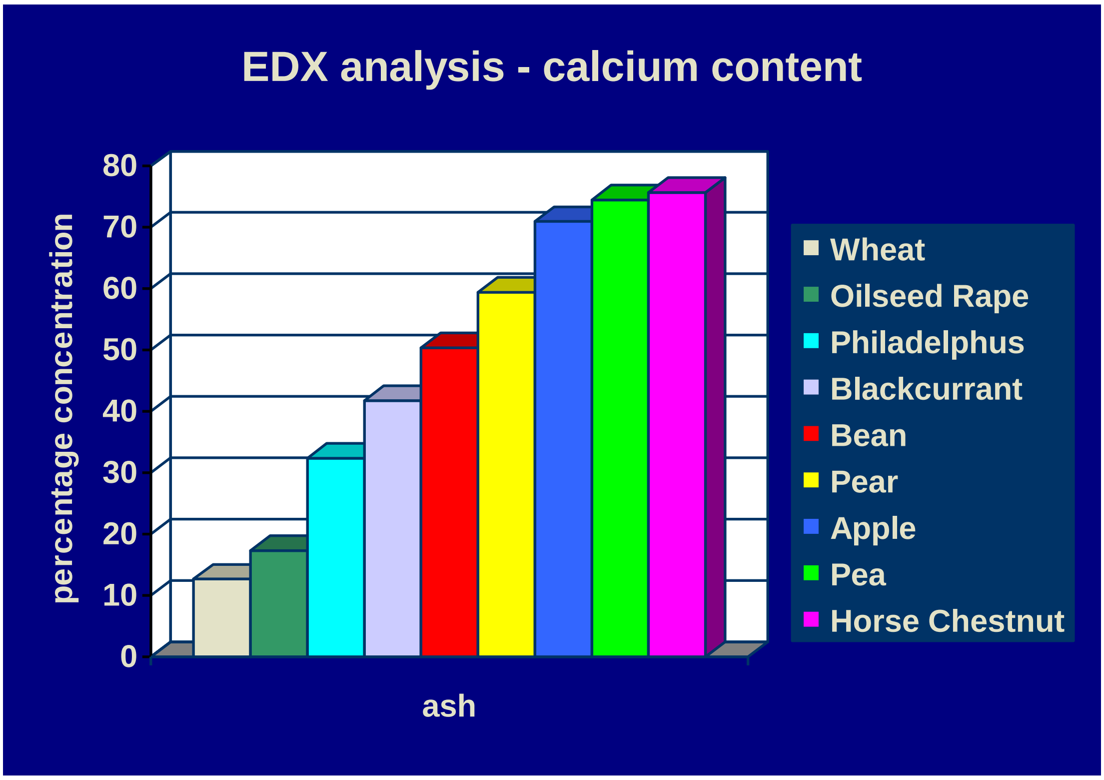


Figure 31:
Calcium content of a range of unwashed plant ashes, detected by EDX analysis

3.3 Significant factors revealed by the analyses

The analysis of a wide range of ashes revealed various factors significant to the research, which informed and influenced the glaze testing. The comparisons between the analyses showed the compositions of the new ashes to be located within the range represented by ashes already used in glazes. In the knowledge that the new ashes were indeed appropriate glaze ingredients, glaze testing could be carried out with confidence.

The comparisons between washed and unwashed ashes, highlighting the loss of variety caused by washing ash, were pivotal in the decision to focus the research mainly on the unwashed ashes. The analyses also showed the main constituents of all the new ashes to be fluxes, therefore indicating that additions of silica and alumina would be needed in the glaze tests.

The pea ash and washed bean ashes had profiles similar to tree ashes, especially with regard to the high calcium levels, notably in the washed pea ash. This indicated that these ashes were likely to produce similar glaze effects to those of wood ash glazes. Furthermore the knowledge of these high calcium levels raised the possibility of combining the ashes with further alkaline fluxes, provided by feldspars for example.

The understanding of the behaviour of the ashes in glazes was therefore greatly increased by the use of analysis and reference was made to the EDX results when examining the outcomes of the empirical testing. The analyses were shared with the ceramicists featured in the case studies in Chapter 6 (p.92) and were a useful reference during the subsequent collaborative project carried out with Mellon.

All the information revealed by the analyses was also disseminated, during the course of the research, by means of articles published in *Ceramic Review* (Metcalfe, 2003 & 2004). The effects of washing ash were included in the first article and the second one gave a more comprehensive account of all the comparisons made. Copies of these articles can be found in Appendix V (p.174). Presentations given at various events and detailed in Section 8.2.2 (p.153) were a further opportunity to share the findings and obtain feedback.

4 Glaze calculation to inform empirical testing

Glaze calculation is another possible approach to the development of new glaze recipes that has been used in this research to provide a starting point for empirical testing. There are a great many texts on the chemistry of glazes and the calculation of glaze recipes, some user-friendlier than others. In the development of the glaze recipes calculated in this chapter, extensive reference has been made to Cooper & Royle (1978), Currie (1986), De Monmollin (1997a&b) and Scott (1998). See Appendix III (p.172) for a list of the chemical symbols used below. This chapter concludes with the implications for the empirical testing drawn from the glaze recipe calculations

4.1 Calculation of unity formulae & formula weights for the new ashes

Conventionally the compositions of glazes and glaze materials are given in moles or molecular parts, expressed as 'unity' (or 'Seger') formulae. These have one component, for example the fluxes or the alumina, reduced to 1 and show the ratio between that and the other components present in molecular terms. This thesis follows the above convention.

The procedure for calculating the unity formula, clearly explained in Scott (1998, pp.82 & 83), requires quantitative analyses of the ashes in terms of percentage weights of oxides present. West X-Ray Solutions carried out these analyses, using x-ray fluorescence (XRF) analysis. Margaret West describes the procedure as follows:

> *1g ash was fused with 10g lithium tetraborate flux to form a 40mm diameter fused bead. The bead was analysed using a Philips PW2440 wavelength dispersive X-ray fluorescence spectrometer using the wide range oxide quantitative calibration as described in Giles et al., X-ray Spectrometry Vol 24: 205-218 (1995).*

Since the preparation procedure involves heating the ash to 1250º C, the water, carbonates and any other volatile substances in it are all burnt off and are therefore accounted for in the Loss on Ignition figure given. The oxides present in the analysis result then are those which will also be present in glazes made from the ash, when fired to a similar temperature (1240º C in this research).

The results of the XRF analyses are shown in Table 6 below:

ASH	Unwashed bean 1	Unwashed bean 2	Average unwashed bean	Washed bean	Unwashed pea	Washed pea
LOI	32.47	31.74	32.11	33.58	28.07	34.36
K_2O	13.10	14.05	13.58	2.70	6.16	2.09
Na_2O	2.12	1.88	2.00	0.37	0.37	0.03
CaO	24.21	24.15	24.18	28.52	32.77	32.07
MgO	6.03	5.89	5.96	6.64	5.31	5.14
ZnO	0.03	0.03	0.03	0.04	0.02	0.02
Fe_2O_3	0.71	0.75	0.73	0.90	1.01	0.96
Al_2O_3	1.70	1.69	1.70	2.12	2.59	2.28
SiO_2	16.66	16.55	16.61	21.96	20.92	20.27
P_2O_5	2.45	2.40	2.43	2.69	2.18	2.31
TiO_2	0.13	0.13	0.13	0.17	0.20	0.17
SO_3	0.17	0.53	0.35	0.07	0.18	0.10
Other	0.22	0.21	0.22	0.24	0.22	0.20
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

Table 6:
XRF analyses of pea and bean ash

These figures were used to calculate the flux unity formulae and formula weights needed in order to incorporate the new ashes in glaze calculations. The results of the calculations are summarised in Table 7 below. Table 8 (p.58) shows an example of the calculation method used and tables of all the calculations can be found in Appendix VI (p.182).

Oxides Ash	KNaO	CaO	MgO	Al_2O_3	SiO_2	Formula Weight
Unwashed Bean	0.23	0.57	0.20	0.02	0.37	132.4
Washed Bean	0.05	0.72	0.23	0.03	0.52	141.3
Unwashed Pea	0.09	0.74	0.17	0.03	0.44	127.0
Washed Pea	0.03	0.79	0.18	0.03	0.47	138.5

Table 7:
Summary of flux unity formulae and formula weights of new ashes

	CALCULATING THE FLUX UNITY FORMULA OF UNWASHED BEAN ASH													
	Oxides	K_2O	Na_2O	CaO	MgO	ZnO	Fe_2O_3	Al_2O_3	SiO_2	P_2O_5	TiO_2	Other	LOI	Total
	Ash (%s)xrf	13.58	2.00	24.18	5.96	0.03	0.73	1.70	16.61	2.43	0.13	0.57	32.11	100.03
	Molecular Weights of Oxides	94.1	62	56.1	40.3	81.4	160	102	60.1	142	79.9			
		Divide percentages by Molecular Weights to give Molecular Equivalent (or moles)												
*	Moles (supplied by 100g ash)	0.144	0.032	0.431	0.148	0.000	0.005	0.017	0.276	0.017	0.002			
	Total Fluxes	0.755												
		Divide Molecular Equivalents by Total Fluxes to bring fluxes to Unity (i.e. fluxes = 1)												
	Fluxes to Unity	0.191	0.043	0.571	0.196	0.000	0.006	0.022	0.366	0.023	0.002			
	Simplified Flux Unity Formula	0.23		0.57	0.20	0.00	0.01	0.02	0.37	0.02	0.00			
	Further Simplified	0.2		0.6	0.2	0.0	0.0	0.0	0.4	0.0	0.0			
	CALCULATING FORMULA WEIGHT OF THE ASH (see * above)													
	100g ash provides	0.755	moles of flux											
	therefore													
	Flux Unity Formula (i.e. 1 mole flux) is provided by 100g ash divided by						0.755							
						=	132.4							
			Molecular Weight of Flux Unity Formula =				132.4							

Table 8:
Calculation of flux unity formula and formula weight of unwashed bean ash

4.2 Limit formulae

Figures are available giving recommended balanced glaze compositions for a particular firing temperature. These are known as 'limit' formulae and are useful guidelines when devising glaze recipes. Table 9 below from Cooper & Royle (1978, p.91) shows those for the temperature range appropriate to this investigation. From these figures limits for a temperature of 1240°C were determined (shaded in the table) and used in the calculations carried out in Section 4.4 (p.61).

Oxides	KNaO	CaO	MgO	ZnO	Al_2O_3	B_2O_3	SiO_2
1200ºC	- 0.375	- 0.550	- 0.325	- 0.300	0.275 – 0.650	- 0.350	2.400 – 4.700
1225ºC	- 0.350	- 0.600	- 0.330	- 0.320	0.325 – 0.700	- 0.300	2.600 – 5.150
1240°C	- 0.335	- 0.630	- 0.333	- 0.332	0.355 – 0.730	- 0.270	2.840 – 5.510
1250ºC	- 0.325	- 0.650	- 0.335	- 0.340	0.375 – 0.750	- 0.250	3.000 – 5.750

Table 9:
Limit formulae (Cooper & Royle, 1978, p.91) and values determined for 1240°C (shaded)

It should be noted however that these limits are only a guideline and empirical testing should always be carried out. The following quotations make this point:

> *It must always be remembered, however, that the value of such limits is restricted to indicating fired effects of a glaze in a general way. Outside these limits it is possible to construct unusual and richly textured glazes which do not possess a 'balanced' formula. (Cooper & Royle 1978, p.91)*

> *The Seger formula should be considered a guide only, as most theoretical glazes do not react as expected and still require empirical testing to develop them fully. (Norsker & Danisch 1993, p.140)*

4.3 Eutectics

Eutectic compositions can also be used as a basis for glaze calculations. The phenomenon of eutectics is mentioned in many texts but is particularly well explained by Currie (1986, pp.84-91). Most of the oxides used in glazes have very high melting points, well beyond those reached in pottery kilns. When the oxides are mixed together however, the melting point of the mixture, perhaps rather surprisingly, is lower than that of either of the two constituents. There is an optimum ratio between any two components known as the ‘eutectic composition’, which gives the lowest melting point or ‘eutectic temperature’. The relationship between two oxides is not linear and some combinations lead to more than one mixture ratio with a significantly lower melting point. The situation is further complicated when three oxides are involved. Phase diagrams are used to express the results of these combinations and show several eutectic temperatures and compositions, surrounded by temperature contour lines.

The ceramicist can use these optimum ratios to develop glaze recipes with melting points suitable for pottery kilns. The Lime eutectic in a mixture of lime, silica and alumina is very relevant to a study of ash glazes since many ashes contain a high proportion of lime (CaO). There are two eutectic temperatures and compositions of interest. Expressed in moles or molecular parts, they are:

1170°C	CaO	0.35 Al_2O_3	2.48 SiO_2
1265°C	CaO	0.314 Al_2O_3	1.12 SiO_2

Finally it is useful to note that the more different oxides in a mixture, the lower the eutectic temperatures will be (Currie 1986, p.85). One example of this is the addition of potash to the above three oxides. The eutectic temperature is then lowered to 950°C with the eutectic composition:

950°C	0.94 K_2O	0.94 Al_2O_3	11.87 SiO_2
	0.06 CaO		
	1.00 Total flux		

4.4 Recipe calculations

When developing glaze recipes the following points were considered:

- Ash content of recipes was to be kept as high as possible so as to have maximum influence on glaze characteristics
- Ash itself is of a complex composition therefore recipes were kept as simple as possible using the minimum number of other ingredients
- Lower firing temperatures require less silica and alumina to 1 mole of flux
- Alumina : silica ratio for a transparent glaze is approx 1 : 10 and for a matt glaze 1 : 5 (Cooper & Royle 1978, p.91)
- Addition of 0.1 molecular part silica will increase melting point by approximately 20ºC (Norsker & Danisch 1993, p.140)
- Magnesium oxide may not be as active as a flux at the lower temperatures targeted in this research

4.4.1 Comparison of limit formulae to flux unity formulae of the new ashes

Having calculated flux unity formulae for the new ashes, the next step towards a glaze recipe was to compare the compositions of the ashes to the limit formulae to determine what needed to be added to the ash to create a balanced glaze. Table 10 below shows this process.

Oxides / Formulae	KNaO	CaO	MgO	Al_2O_3	SiO_2	Formula Weight
Limits at 1240°C	- 0.335	- 0.630	- 0.333	0.355 – 0.730	2.840 – 5.510	
Unwashed Bean	0.23	0.57	0.20	0.02	0.37	132.4
Washed Bean	0.05	0.72	0.23	0.03	0.52	141.3
Unwashed Pea	0.09	0.74	0.17	0.03	0.44	127.0
Washed Pea	0.03	0.79	0.18	0.03	0.47	138.5

Table 10:
Comparison between flux unity formulae of ashes and limit formula at 1240°C

The conclusions drawn from this comparison were:

- All the ashes except the unwashed bean ash have too much calcium oxide, so other fluxing materials need to be added to redress the balance, for example in the form of a feldspar
- All the ashes need the addition of a lot of alumina and silica, probably in the form of a clay and possibly flint for further silica
- Levels of magnesium oxide are well within limits

4.4.2 Calculating glaze recipes for the new ashes

Having identified appropriate materials to add to the ashes, glaze calculations were carried out for each ash. Table 12 (p.63) shows an example of a calculation for unwashed bean ash, based on the limit formulae. Since the pea ashes in particular have a high lime (CaO) content, calculations were also carried out using the Lime eutectic as a guide, to derive recipes approaching the lowest possible melting point. Table 13 (p.64) shows an example of this calculation using washed pea ash. All the recipes developed are given in Table 11 below and all the calculations are to be found in Appendix VII (p.188).

Ingredients / Recipe	Unwashed bean ash	Washed bean ash	Unwashed pea ash	Washed pea ash	Potash feldspar	China clay	Flint	Hyplas 71 ball clay
4 ingredients:								
I		39			21	17	23	
II			35		27	15	23	
III				35	36	10	19	
3 ingredients:								
IV	40					26	33	
V			43			28	29	
VI				44		28	28	
2 ingredients:								
VII	36							64

Table 11:
Calculated glaze recipes for the new ashes (in percentages weight)

CALCULATION OF UNWASHED BEAN ASH GLAZE RECIPE (Ash/ China clay/ Flint)										
The recipe for this calculation is based on the Limit formulae and the Unity formula of the ash. The ash supplies all the fluxes then china clay and flint supply the alumina and additional silica required										
			OXIDES	KNaO	CaO	MgO	Al_2O_3	SiO_2	WEIGHT	RECIPE: % WEIGHT
	LIMIT FORMULA			-0.335	-0.63	-0.333	0.355 – 0.730	2.840 – 5.510		
MATERIALS	MOLECULAR WEIGHT	X	MOLES REQD							
FORMULAE:										
Unwashed bean ash				0.234	0.571	0.196	0.022	0.366		
China clay							1.000	2.000		
Flint								1.000		
FLUX UNITY FORMULA OF RECIPE				**0.234**	**0.571**	**0.196**	**0.355**	**2.840**		
	TOTAL FLUXES			1.000						
INGREDIENTS:										
Unwashed bean ash	132.4	x	1.000	0.234	0.571	0.196	0.022	0.366	132.4	**40**
	Still needed			0.000	0.000	0.000	0.333	2.474		
China clay	258.2	x	0.333				0.333	0.666	86.0	**26**
	Still needed						0.000	1.808		
Flint	60.1	x	1.808					1.808	108.7	**33**
	Still needed							0.000		
Totals									327.0	**100**

Table 12:
Glaze calculation based on limit formulae

CALCULATION OF WASHED PEA ASH GLAZE RECIPE (Ash/ China clay/ Flint)										
The recipe for this calculation is based on the Lime eutectic, since the ash has a very high calcium content. The alumina and additional silica required are supplied by china clay and flint										
			OXIDES	KNaO	CaO	MgO	Al_2O_3	SiO_2	WEIGHT	RECIPE: % WEIGHT
	LIME EUTECTIC				1.000		0.350	2.480		
MATERIALS	MOLECULAR WEIGHT	X	MOLES REQD							
FORMULAE:										
Washed pea ash				0.031	0.792	0.177	0.031	0.467		
China clay							1.000	2.000		
Flint								1.000		
FLUX UNITY FORMULA OF RECIPE				0.031	0.792	0.177	0.350	2.480		
	TOTAL FLUXES			1.000						
INGREDIENTS:										
Washed pea ash	127	x	1	0.031	0.792	0.177	0.031	0.467	127.0	43.5
	Still needed			0.000	0.000	0.000	0.319	2.013		
China clay	258.2	x	0.319				0.319	0.638	82.4	28.2
	Still needed						0.000	1.375		
Flint	60.1	x	1.375					1.375	82.6	28.3
	Still needed							0.000		
Totals									292.0	100.0

Table 13:
Glaze calculation based on Lime eutectic

There is a range of specialist computer software programs available for carrying out glaze calculations, such as that used by Malins (1993), but their use and evaluation is outside the scope of this investigation.

4.5 Implications of the calculated glaze recipes

The calculations carried out in this chapter show the new ashes to have great potential as glaze ingredients. Using them in combination with just one, two or three other common glaze ingredients, it was possible to devise glaze recipes, containing at least 30% ash, for each one. In order to explore a wide range of glaze effects, these recipes were used as a starting point around which to base the empirical glaze testing blends. The calculated recipes demand glaze-testing methods for blending combining two, three and four ingredients. These, together with the glaze tests subsequently produced, are the subjects of the next chapter.

5 Empirical testing to develop new ash glazes

The empirical testing carried out in this research is detailed in this chapter. Firstly, methods of developing sets of empirical tests are reviewed. Recipes for the sets of tests carried out are then developed, based on the information gained from the analyses and calculations contained in Chapters 3 and 4. The rationale for the selection of the clay bodies is established. The development of the shape for the test tiles is then discussed, followed by details of the firing cycles used. The practicalities of mixing and applying the glazes are described and discussed. An evaluation of the testing methods used is given together with an assessment of the results of those tests. Finally, conclusions for this chapter are drawn, including the selection of glazes for the development of the artworks that are presented in Chapter 7 (p.122).

5.1 Glaze testing methods

Many texts offer a range of different methods of approaching the development of glaze tests, for example De Montmollin (1997a), Currie (1986), Scott (1988), Sutherland (1987). The following sections give an outline of several methods considered appropriate to the development of ash glazes and discuss the suitability of each one to the new ashes explored in this research. These methods would also be relevant to the further research in Section 8.6 (p.159).

5.1.1 Line blend

This method, mentioned in many of the references consulted, is simply a blend between two materials or recipes. The example in Figure 32 below, involving 11 tests, gives recipes with graduations of 10% by weight from 100% Material A to 100% Material B.

Figure 32:
Line blend

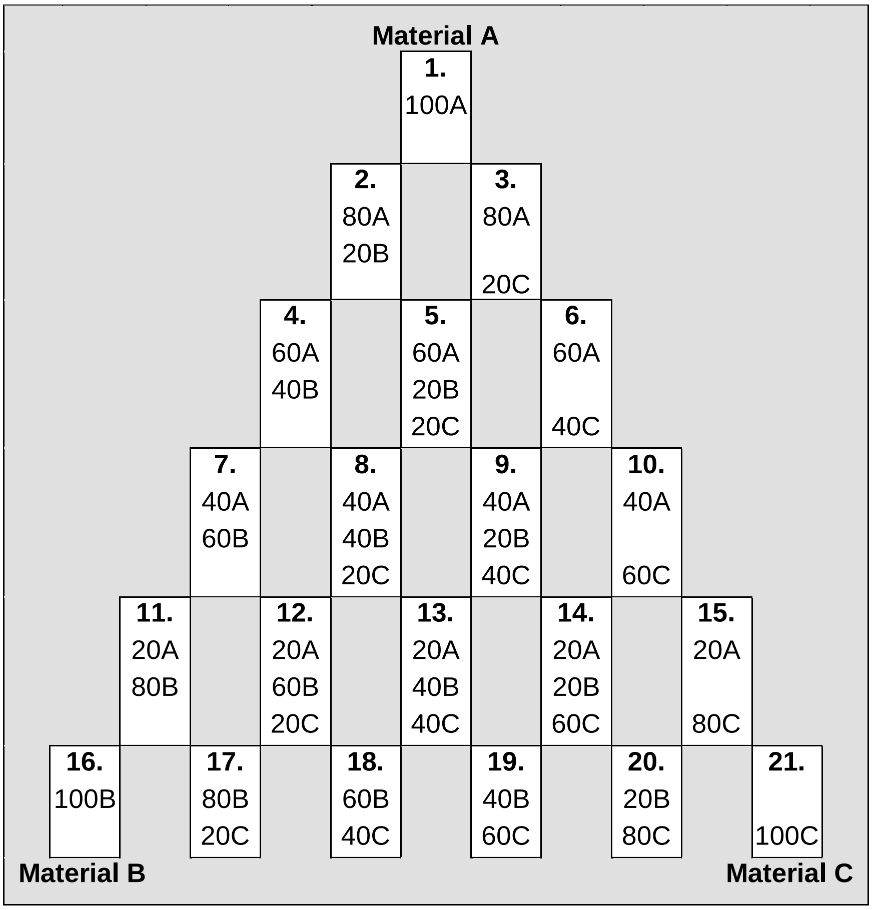
Material A										Material B
1.	**2.**	**3.**	**4.**	**5.**	**6.**	**7.**	**8.**	**9.**	**10.**	**11.**
100A	90A 10B	80A 20B	70A 30B	60A 40B	50A 50B	40A 60B	30A 70B	20A 80B	10A 90B	100B

The recipe calculations carried out and described in Section 4.4 (p.61) indicated that 'balanced' glaze recipes, as defined in Chapter 4, could be achieved by adding one further ingredient, ball clay, to the unwashed bean ash. The line blend could be used to explore the possibilities of this combination.

5.1.2 Triaxial blend

This is a widely used method, enabling three materials or recipes to be blended. The edges of the triangle are in effect line blends of just two of the materials, whilst the tests inside the triangle incorporate all three materials. The method is very clearly explained in Scott (1998, pp.139-141). The diagram in Figure 33 shows an example of a triaxial blend with graduations of 20% by weight between rows of tests.

Figure 33:
Triaxial blend



The analyses carried out in Chapter 3 and Chapter 4 indicated that the ashes were lacking in silica and alumina and the recipe calculations showed that these could be supplied by additions of two other materials, for example flint and china clay. The triaxial blend is a suitable method for this situation.

5.1.3 Tetrahedral blend

To explore a full range of possible mixtures of four materials or recipes, a tetrahedron of tests is needed as shown in Figure 34 and Figure 35 below (Sutherland 1987, pp. 42-45).

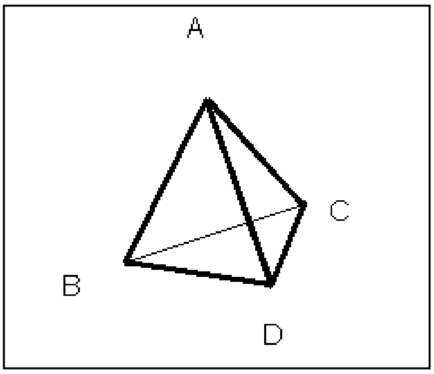
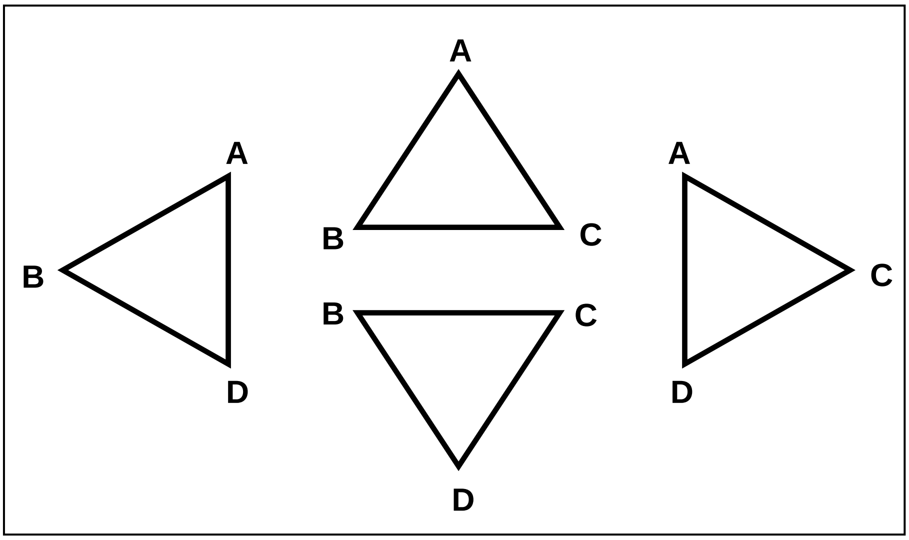


Figure 34:
Tetrahedron model for testing mixtures of four materials.

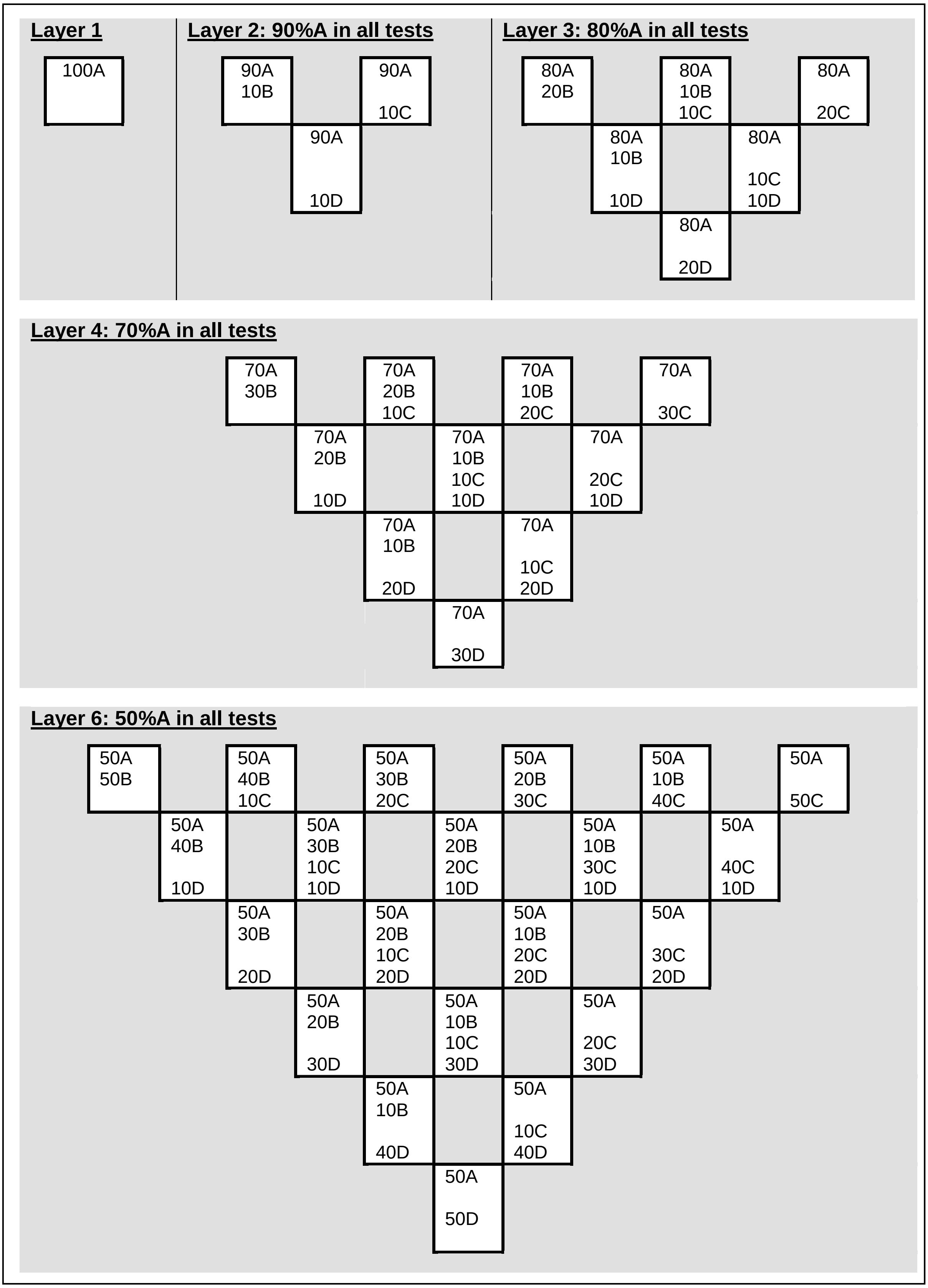
Each face of the tetrahedron is in fact a triaxial blend with line blends of two materials along the edges, surrounding blends of three materials on the faces.

Figure 35:
The four faces of the tetrahedron represented separately.



The tests within the tetrahedron contain all four materials. One way to visualise the layout and derive the recipe for each test is to consider each layer of the tetrahedron separately, starting with the apex at A which is 100% Material A. The diagrams in Figure 36 show some of the layers to illustrate this approach.

Figure 36:
Recipes from some layers of the tetrahedral blend.



In all, 11 layers are required to give graduations of 10% by weight between tests. Whilst this is a very comprehensive method it does involve a very large number of tests, 286 in all. However, only the 84 recipes from within the tetrahedron contain all four materials and of these only 35 contain at least 30% ash. One possible approach therefore, would be to carry out only these 35 tests. The calculations, detailed previously in Chapter 4, included recipes involving four ingredients, so this is a method that could be used to explore combinations of them.

5.1.4 Quadraxial blend

This method, again clearly explained in Scott (1998, p.144), also allows four materials or recipes to be blended. The mathematics of this blend however result in there being a maximum of 50% of any one material or recipe in each of the resulting tests, which is unfortunate as it limits the range of outcomes that can be explored. The layout of the 36 test recipes, given as percentages by weight of each of the four materials, A-D, is shown in the diagram in Figure 37.

Figure 37:
Quadraxial blend .

1. 50A 50B	**2.** 50A 40B 10D	**3.** 50A 30B 20D	**4.** 50A 20B 30D	**5.** 50A 10B 40D	**6.** 50A 50D
7. 40A 50B 10C	**8.** 40A 40B 10C 10D	**9.** 40A 30B 10C 20D	**10.** 40A 20B 10C 30D	**11.** 40A 10B 10C 40D	**12.** 40A 10C 50D
13. 30A 50B 20C	**14.** 30A 40B 20C 10D	**15.** 30A 30B 20C 20D	**16.** 30A 20B 20C 30D	**17.** 30A 10B 20C 40D	**18.** 30A 20C 50D
19. 20A 50B 30C	**20.** 20A 40B 30C 10D	**21.** 20A 30B 30C 20D	**22.** 20A 20B 30C 30D	**23.** 20A 10B 30C 40D	**24.** 20A 30C 50D
25. 10A 50B 40C	**26.** 10A 40B 40C 10D	**27.** 10A 30B 40C 20D	**28.** 10A 20B 40C 30D	**29.** 10A 10B 40C 40D	**30.** 10A 40C 50D
31. 50B 50C	**32.** 40B 50C 10D	**33.** 30B 50C 20D	**34.** 20B 50C 30D	**35.** 10B 50C 40D	**36.** 50C 50D

This model would also be suitable for exploring the combinations of ash with three other ingredients that were identified in the preceding chapters and involves fewer tests than the tetrahedral blend.

5.1.5 Blend varying silica and alumina

This approach involves having a fixed flux or mixture of fluxes, and then varying the amount of silica and alumina added to it. Currie (1986, p. 27) suggests a grid of 35 tests where:

- Material A is the flux(es) + china clay
- Material B is the flux(es) + china clay + silica
- Material C is the flux(es) alone
- Material D is the flux(es) + silica

The diagram in Figure 38 below shows how many parts by weight of each material are needed for each of the 35 tests.

Figure 38:
Recipes for varying silica and alumina content.

1. 24A	**2.** 18A 6B	**3.** 12A 12B	**4.** 6A 18B	**5.** 24B
6. 20A 4C	**7.** 15A 5B 3C 1D	**8.** 10A 10B 2C 2D	**9.** 5A 15B 1C 3D	**10.** 20B 4D
11. 16A 8C	**12.** 12A 4B 6C 2D	**13.** 8A 8B 4C 4D	**14.** 4A 12B 2C 6D	**15.** 16B 8D
16. 12A 12C	**17.** 9A 3B 9C 3D	**18.** 6A 6B 6C 6D	**19.** 3A 9B 3C 9D	**20.** 12B 12D
21. 8A 16C	**22.** 6A 2B 12C 4D	**23.** 4A 4B 8C 8D	**24.** 2A 6B 4C 12D	**25.** 8B 16D
26. 4A 20C	**27.** 3A 1B 15C 5D	**28.** 2A 2B 10C 10D	**29.** 1A 3B 5C 15D	**30.** 4B 20D
31. 24C	**32.** 18C 6D	**33.** 12C 12D	**34.** 6C 18D	**35.** 24D

De Montmollin (1997a, pp. 118-173) also uses the variation of silica and alumina against fixed flux in his stoneware glaze fusion diagrams. Since plant ashes contain a high proportion of fluxes and could therefore act as Material C, this method could be useful in the development of ash glazes.

5.2 Methods selected and recipes developed for the sets of tests

Three of the above testing methods were trialled. The line and triaxial blends were selected when combining one or two other ingredients with ash, as these had already proved useful methods in my previous work, mentioned in Section 1.1 (p.11), when developing linseed ash glazes. In addition, to explore recipes using three other ingredients with ash, the quadraxial blend was chosen since it involved fewer tests than the tetrahedron blend and would therefore be less time consuming. Since I had already had positive experiences of line and triaxial blends, it was decided to carry out a quadraxial blend for the first set of tests, using just one ash, as a pilot study. Washed pea ash happened to be the first type of ash ready for use and the calculated glaze recipes (p.62) indicated it to be an appropriate ash to combine with three other ingredients in this blend.

As mentioned in the previous chapters, it was decided that recipes should contain a minimum of approximately 30% ash so that this ingredient made a significant contribution to the characteristics of the glaze. Based around the conclusions reached from the analyses and the calculated recipes from Chapter 3 and Chapter 4, which indicated the use of up to three other glaze ingredients with the ashes, three sets of glaze tests in all were planned:

- *Set 1*
  Quadraxial blend combining ash with china clay, flint and potash feldspar
- *Set 2*
  Triaxial blend combining ash with china clay and flint
- *Set 3*
  Line blend combining ash with ball clay

Each glaze recipe is identified by the initials of the ash used, followed by the set number, then the test number.
Example: Glaze **UB2.4** is Test no.4 from Set 2 using unwashed bean ash.

5.2.1 Recipes for Set 1 – Quadraxial blend

A full set of 36 tests was carried out for one example of a quadraxial blend, as a pilot study. Test set 1 explored the combination of the following four materials:

Material A 100% washed pea ash (A)
Material B 30% washed pea ash (A) + 70% china clay (C)
Material C 30% washed pea ash (A) + 70% potash feldspar (P)
Material D 30% washed pea ash (A) + 70% flint (F)

As was previously mentioned, this blend method limits the recipe content of any one material to 50%; however, by introducing 30% ash with each of the other ingredients it was possible to achieve recipes ranging from 30-65% ash. The glaze recipes developed, given as percentages weight, are shown in Figure 39.

Figure 39:
Recipes used for quadraxial blend [ash (A)/ china clay (C)/ potash feldspar (P)/ flint (F)]

1. 65A 35C	**2.** 65A 28C 7F	**3.** 65A 21C 14F	**4.** 65A 14C 21F	**5.** 65A 7C 28F	**6.** 65A 35F
7. 58A 35C 7P	**8.** 58A 28C 7P 7F	**9.** 58A 21C 7P 14F	**10.** 58A 14C 7P 21F	**11.** 58A 7C 7P 28F	**12.** 58A 7P 35F
13. 51A 35C 14P	**14.** 51A 28C 14P 7F	**15.** 51A 21C 14P 14F	**16.** 51A 14C 14P 21F	**17.** 51A 7C 14P 28F	**18.** 51A 14P 35F
19. 44A 35C 21P	**20.** 44A 28C 21P 7F	**21.** 44A 21C 21P 14F	**22.** 44A 14C 21P 21F	**23.** 44A 7C 21P 28F	**24.** 44A 21P 35F
25. 37A 35C 28P	**26.** 37A 28C 28P 7F	**27.** 37A 21C 28P 14F	**28.** 37A 14C 28P 21F	**29.** 37A 7C 28P 28F	**30.** 37A 28P 35F
31. 30A 35C 35P	**32.** 30A 28C 35P 7F	**33.** 30A 21C 35P 14F	**34.** 30A 14C 35P 21F	**35.** 30A 7C 35P 28F	**36.** 30A 35P 35F

5.2.2 Recipes for Set 2 – Triaxial blend

Test set 2 explored the addition of china clay (C) and flint (F) to the ashes. The layout for this method and the recipes used are shown in the diagram in Figure 40. Note that the graduations between rows of recipes are not equal; instead they were adjusted to give more tests around the proportions indicated to be balanced glazes, by the calculations previously carried out in Chapter 4, Section 4.4.2 (p.62). This method allows for recipes with any ash content up to and including 100%.

Figure 40:
Recipes used for Set 2 – Triaxial blend [ash (A)/ china clay (C)/ flint (F)]

Recipes expressed in percentages by weight:

						1. 100A						
					2. 80A 20C		**3.** 80A 20F					
				4. 60A 40C		**5.** 60A 20C 20F		**6.** 60A 40F				
			7. 46A 54C		**8.** 46A 36C 18F		**9.** 46A 18C 36F		**10.** 46A 54F			
		11. 40A 60C		**12.** 40A 45C 15F		**13.** 40A 30C 30F		**14.** 40A 15C 45F		**15.** 40A 60F		
	16. 35A 65C		**17.** 35A 52C 13F		**18.** 35A 39C 26F		**19.** 35A 26C 39F		**20.** 35A 13C 52F		**21.** 35A 65F	
22. 28A 72C		**23.** 28A 60C 12F		**24.** 28A 48C 24F		**25.** 28A 36C 36F		**26.** 28A 24C 48F		**27.** 28A 12C 60F		**28.** 28A 72F

These recipes were carried out with both unwashed bean and unwashed pea ash, having decided to concentrate the research on the unwashed ashes, as discussed in Chapter 3.

5.2.3 Recipes for Set 3 – Line blend

Recipe calculations carried out in Chapter 4 indicated that balanced glaze recipes could be achieved adding just one other ingredient to ash. This led to the use of the line blend method for Test set 3, exploring combinations of ball clay (B) with the ashes in the proportions given in Figure 41 below. Again both unwashed bean and unwashed pea ashes were used.

Figure 41:
Recipes used for Set 3 – Line Blend [ash (A) / ball clay (B)]

Recipes expressed in percentages by weight:

1.	2.	3.	4.	5.	6.	7.	8.
100A	90A 10B	80A 20B	70A 30B	60A 40B	50A 50B	40A 60B	30A 70B

5.3 Selection of clays

The composition of the clay body has a significant effect on the appearance of the glaze applied to it, therefore a range of clays were used for the tests to explore the potential of the glazes more fully.

Factors considered when selecting the clays were:

- Firing temperature of the clay
- Iron content of clay
- Texture of clay
- Silica to Alumina ratio of clay
- Flux content of clay

Several clays of appropriate firing temperature were identified from the wide range offered by the supplier Potclays Ltd of Stoke on Trent. Prior to selecting which of these clays to use for the tests, calculations were made from data supplied by Potclays, to express the compositions in moles, in the same way as the glaze ingredients were expressed in Chapter 4 (p.56). For clays however the alumina is brought to unity rather than the fluxes. It is then much easier to compare them in terms of the ratios of silica to alumina to flux present and the iron content of the clays. The original data used and details of the calculations can be found in Appendix VIII (p.195). Table 14 (p.77) shows an overview of the information for the clay bodies considered. For the quadraxial blend, four clays were selected from these, as a pilot, to provide a wide variation in colour and texture, whilst limiting the other variables in composition as far as possible. They were:

- 1106 White St. Thomas
- 1117 Buff Stoneware
- 1113 Camberwell
- 1154 Raku

The same four clays were subsequently used for the other sets of tests.

5.4 Design of test tiles

The test tiles were designed to give a range of surfaces on which to trial the effects of the new glazes. As shown in Figure 42, the design incorporates:

- An angled surface to see if the glaze runs when fired
- An unglazed line across the angled surface to judge extent of any runs
- A horizontal area
- A textured area

Figure 42:
The test tile design used
[Photography: Carol Metcalfe]

(* indicates selected clay body) Clays (supplied by Potclays)	Colour	Firing Temp °C	Texture	Oxides (percentages in moles)						
				Fe_2O_3	Al_2O_3	SiO_2	CaO	MgO	K_2O	Na_2O
							Fluxes			
1145 White Stoneware	Off White	1200 – 1300	Smooth	0.015	1	4.1	0.14			
*1106 White St. Thomas	Off White Grey	1160 – 1300	Medium	0.020	1	3.3	0.12			
1120 Buff Body	Light Buff	1110 – 1285	Smooth	0.044	1	5.3	0.24			
*1117 Buff Stoneware	Buff Grey	1160 – 1290	Smooth	0.042	1	3.7	0.20			
*1113 Camberwell	Buff	1170 – 1300	Medium	0.046	1	3.4	0.14			
*1154 Raku	Brownish Buff	Over 900	Coarse	0.057	1	3.3	0.22			
1114 Craft Crank	Brown Buff	1170 – 1300	Coarse	0.070	1	4	0.15			

Table 14:
Selection of clays - Overview of data and ratios (expressed in moles)

See Appendix III (p.172) for a list of the chemical symbols used.

5.5 Firing procedure

All firings were carried out in a 6kW single-phase electric kiln with internal measurements of 45cm x 45cm x 45cm. An electronic programmer was used to control the firing schedules. In addition an Orton Cone 7 was included in each glaze firing and monitored visually through the spy hole during the soak period. When the cone had bent down to the position shown in Figure 43, the kiln was manually switched off and allowed to cool naturally with the bungs in for a period of 24 hours, until below 200°C.

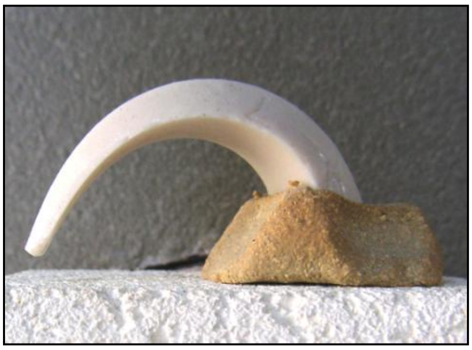


Figure 43:
Cone 7 after firing to 1240°C and soaking
[Photography: Carol Metcalfe]

5.5.1 Biscuit firing

Before application of the glazes, the test tiles were biscuit fired to 1000°C. The firing schedule was:

1st ramp 100°C/hour up to 600°C
2nd ramp 150°C/hour up to 1000°C
No soak

5.5.2 Glaze firing

The glazed tiles were then fired to 1240°C, Cone 7. This firing schedule was:

1st ramp 150°C/hour up to 600°C
2nd ramp 100°C/hour up to 1240°C
Soak approximately 30 minutes at 1240°C until Cone 7 reached

The kiln used however was not powerful enough to maintain the programmed rate of climb in the latter stages of the glaze firing, achieving only approximately 60°C/hour when approaching the top temperature. The firings therefore took a little longer than scheduled; however, since the soak period was monitored manually with a cone, the overall heat work done was controlled by adjustment of the soak time. The soak times required varied from 15 minutes to 1 hour.

5.6 Preparation and application of glazes

The glazes for Test set 1, using washed pea ash, and for Test sets 2 and 3, using unwashed bean ash, were prepared by accurately weighing out the ingredients for the recipe then mixing and sieving each glaze separately. This method proved to have certain difficulties:

- Since the amounts were small, it was important to leave as little as possible in the sieve. More water was used to wash the ingredients through, leading to some tests becoming too runny and therefore difficult to apply thickly enough to the test tiles.
- Both the accurate weighing out and the sieving were very time consuming.

It was therefore decided to use blending by volume to prepare Test sets 2 and 3 using unwashed pea ash. 150g of each ingredient were mixed with water and sieved then made up to a volume of 500ml with water. It is essential that the mix for each ingredient be made up to the same amount so that a certain volume of each mix contains the same dry weight for each of the ingredients.

Recipes can then be prepared by measuring out the amounts needed in millilitres, to a total of 100ml, using a large syringe and simply stirring them together, as the main batches have already been sieved. When tests are being measured in this way however, the basic ingredient mixes must be kept evenly blended and not allowed to settle out. It did not prove possible to achieve this for the ash or the flint, as these began to settle out immediately. An addition of 2% by weight of Bentonite, a very fine-particled clay, was therefore added to aid suspension. This small addition greatly improves the handling qualities of the mix, whilst having a negligible effect on the finished qualities of the glazes, especially since another form of clay was already being used in the recipes (Cooper & Royle, 1978). This method proved very successful, both saving a lot of time and leading to improved glaze application on the test tiles.

Glazes were applied to the biscuit fired test tiles in both single and double layers to give information on the effect of glaze thickness. The second layer was applied down the right hand side of the tile as soon as the first layer had adhered.

5.7 Evaluation of testing methods used

5.7.1 Quadraxial blend – Set 1

For this pilot blend, 36 tiles were made in each of the four selected clay bodies. The glaze recipes shown in Figure 39 (p.73) were then applied to them, so that each recipe was tested in combination with each of the clays. As mentioned above, this blending method has the limitation that recipes containing more than 65% ash cannot be investigated. As recipes with higher ash content than this, from the other sets of tests, subsequently provided interesting and useful glazes, this restriction represents a significant disadvantage.

Having carried out the tests, another difficulty was illustrated when comparing the test recipes and results with the glaze calculations from Section 4.4 (p.61) that initiated this blend. The 36 recipes developed do not cover the full range of combinations of the four materials, since there are three ways of arranging the materials around the square, as shown in Figure 44 below.

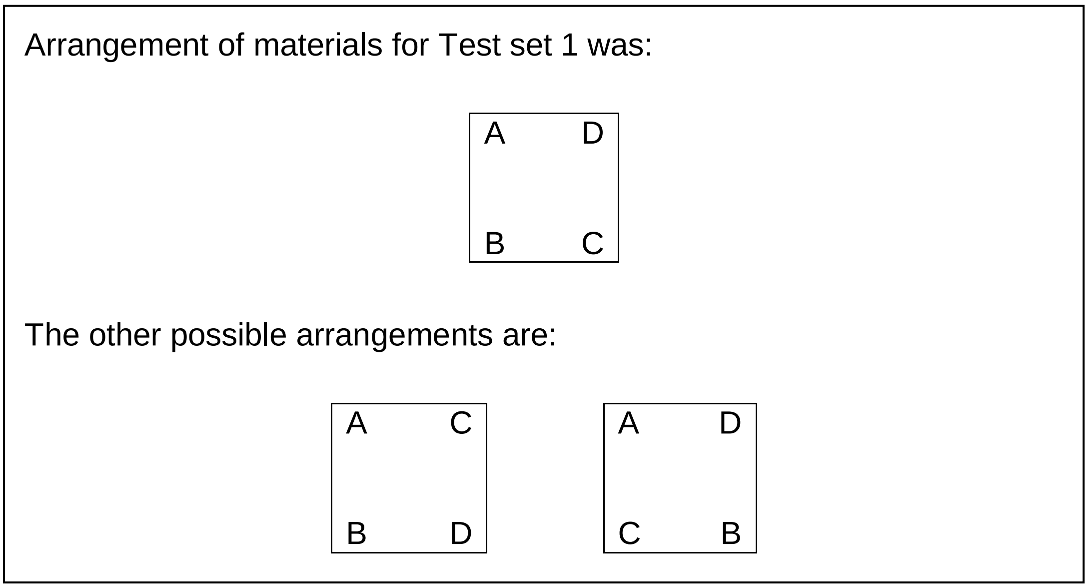


Figure 44:
Possible arrangements of materials for quadraxial blends

The different arrangements lead to different proportions of each material in the recipes across the blend. Some recipes are duplicated in the three arrangements, but even so in total 90 tiles, in each of the four clay bodies selected, are required to cover all possible combinations and still the recipes only have a maximum ash content of 65% (Sutherland, 1987).

Whilst the tiles in Test set 1 have provided some useful recipes, it was decided, in view of these disadvantages, not to pursue the quadraxial blend method. Had further recipes using feldspars been required, glaze calculations would have been carried out to investigate the possibility of using combinations of ash, feldspar and ball clay. A triaxial blend could then have been applied.

5.7.2 Triaxial blend – Set 2

Test set 2 explored the addition of china clay and flint to the ashes, the recipes from Figure 40 (p.74) being applied to tiles in each of the four different clay bodies being investigated. Sets of tests were produced using both unwashed bean and unwashed pea ashes, providing a wide range of resulting glazes, with recipes containing 28%-100% ash. The calculated recipes from Chapter 4, from which this blend was developed, are shown in Table 15 below.

	Unwashed bean ash recipe IV	Unwashed pea ash recipe V
Ash	40	43
China clay	26	28
Flint	33	29

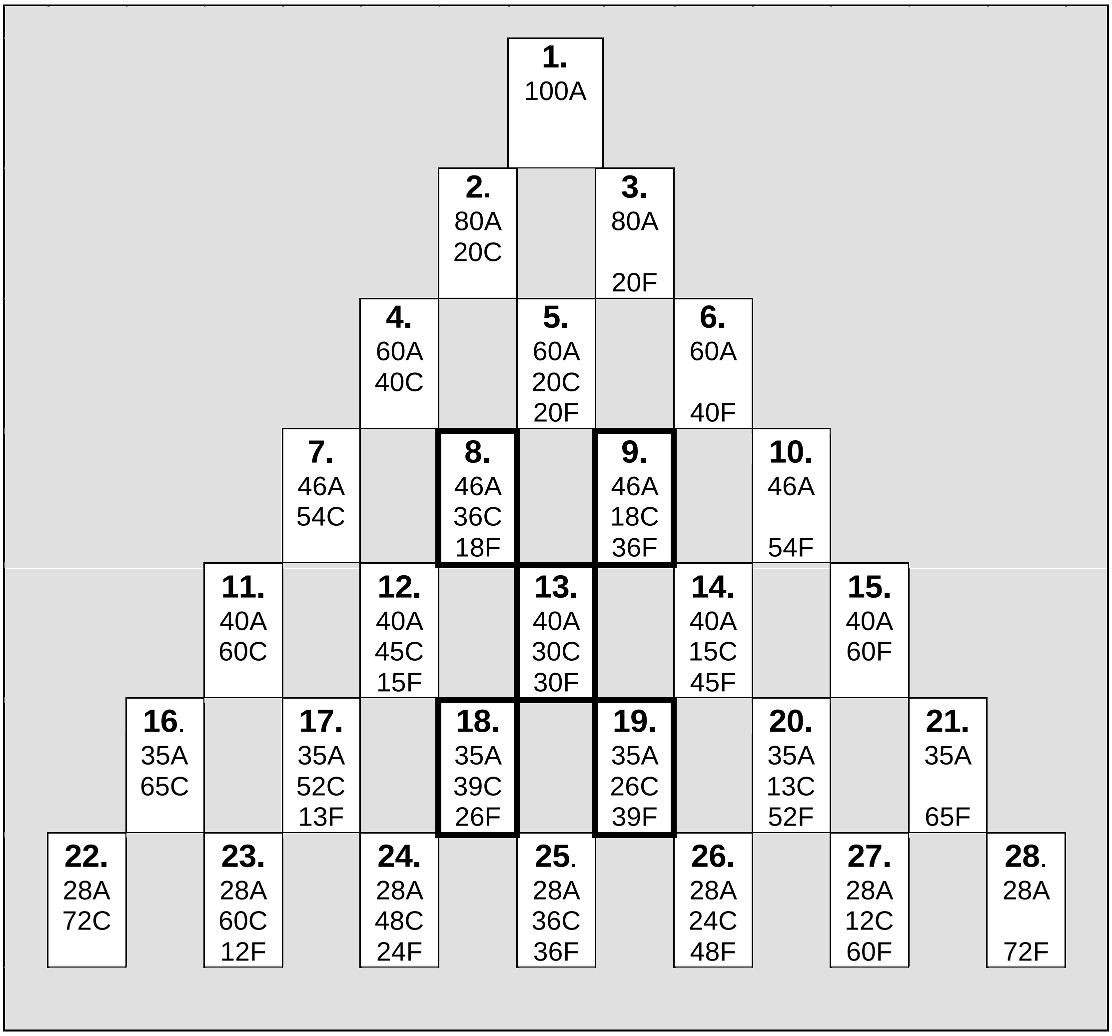
Table 15:
Calculated recipes from which Test set 2 was developed

The adjustments made to the graduations between rows of recipes in the triaxial blend allowed several tests to be carried out with recipes close to these calculated recipes. The resulting tests from this section of the blend are shown in Figure 45 and the test recipes are highlighted in Figure 46 (p.82) for comparison.

Figure 45:
Bean ash test tiles from Set 2 with recipes close to the calculated glaze recipe

[Photography: David Williams]

Figure 46:
Test set 2 with recipes close to calculated recipes highlighted



The layout of this method, allowing for recipes with any ash content up to and including 100%, coupled with the introduction of adjustments to the graduations between rows of tests, affords great versatility. The triaxial blend is therefore to be recommended.

5.7.3 Line blend – Set 3

Test set 3, exploring combinations of ball clay with the ashes, was also carried out using both unwashed bean and unwashed pea ashes and tiles in all four clay bodies. As can be seen from Figure 47 overleaf, the method provided wide ranging characteristics in the resulting glazes, some of which were subsequently selected for use in the artworks produced.

Figure 47:
Test set 3 – Line blend on Raku clay using unwashed pea ash
[Photography: David Williams]

Again the layout of this method allows for recipes with any ash content up to and including 100% and adjustments to the graduations between the tests could be introduced, if required, offering similar versatility to the triaxial blend. Equally, extra tests could be introduced within a specific range, making the line blend a simple but effective method of exploration, when combinations of only two ingredients are required.

5.8 Methods of assessing the test results

Various methods of assessing the results of the tests were devised and considered.

5.8.1 Descriptive approach

As a pilot for this approach, one triaxial set of tests was studied and an attempt made to describe each of the resulting glazes qualitatively in terms of colour and texture, plus any other particular visual features produced. The pilot example is shown in Figure 48 overleaf.

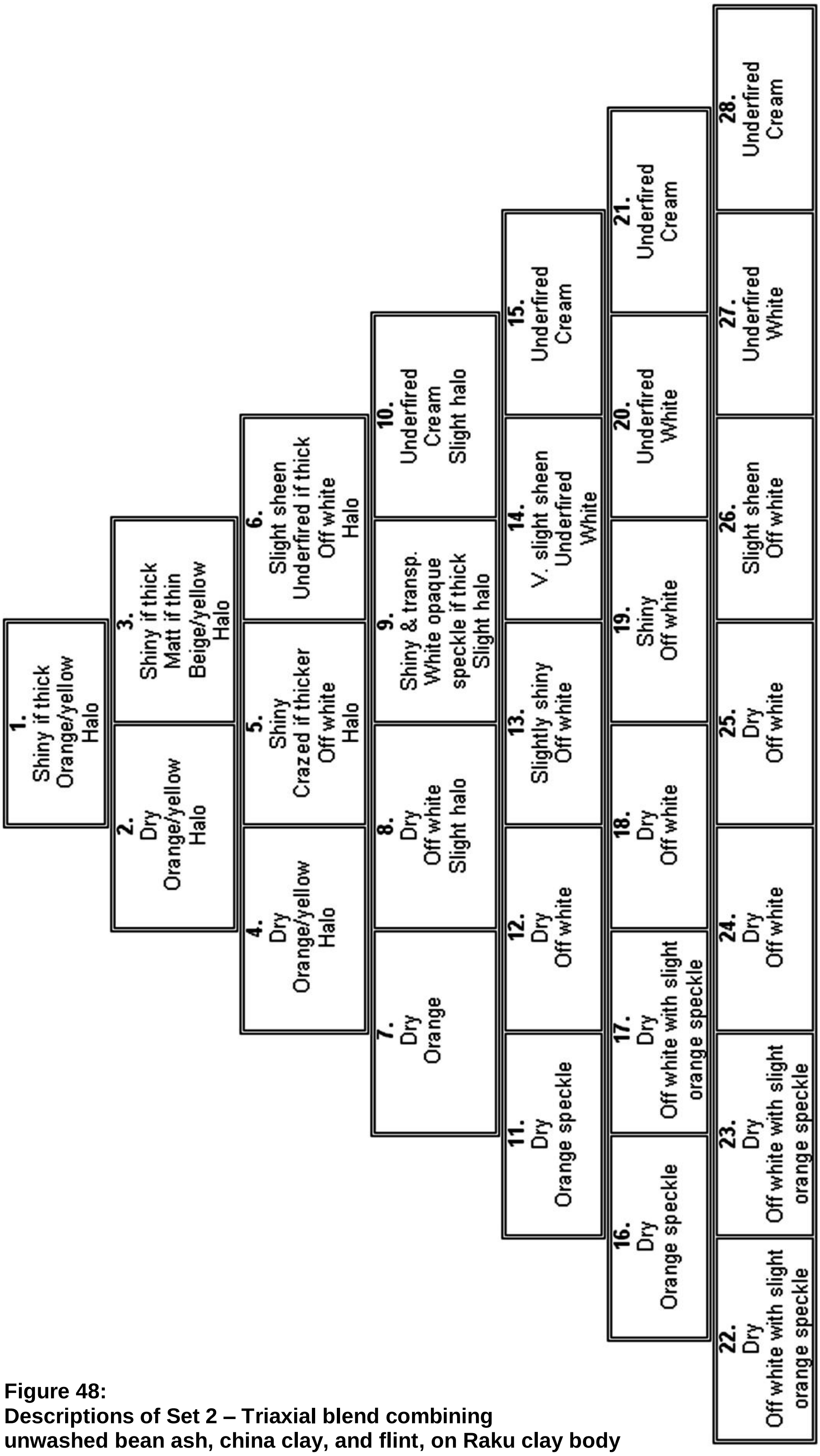
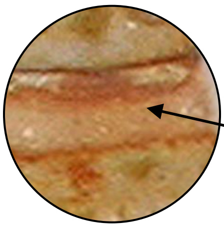


Figure 48:
Descriptions of Set 2 – Triaxial blend combining unwashed bean ash, china clay, and flint, on Raku clay body

A number of the tiles were under fired, the glaze not having melted at the firing temperature used. At higher temperatures these recipes might well produce useful glazes; however, it is outside the scope of this research to investigate this possibility, the aim being to develop glazes for the lower stoneware temperatures.

This descriptive approach to assessment would prove very time consuming were it to be extended to cover all 432 test tiles produced in the three sets. Furthermore, the descriptions could be misinterpreted, unless accompanied by images representative of the terms used, for example the ‘halo’ effect illustrated in Figure 49.



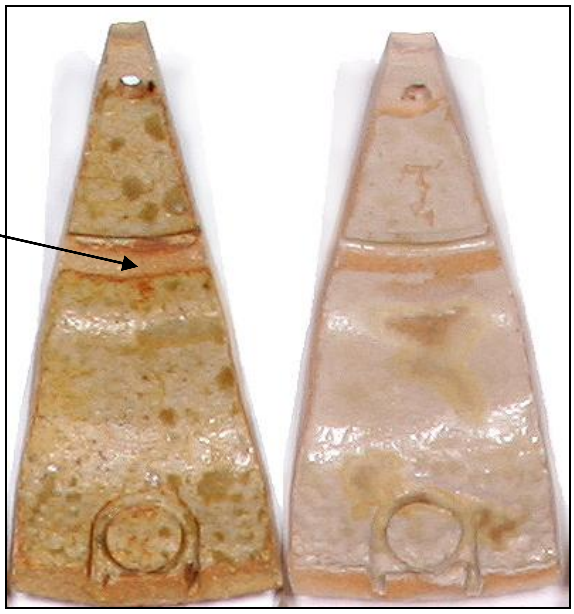


Figure 49:
Test recipes UP2.1 on Raku clay and UB2.1 on White St Thomas clay, illustrating the ‘halo’ effect giving brown colouration outside the glazed area on the edges of the tile and on the unglazed strip

It was decided therefore to pursue a comprehensively visual method of presenting the test results by means of good quality, high resolution, professional images, carefully lit to convey the maximum detail with regard to surface effect. Figure 50 overleaf shows an image of one set of tests and full-page images of all the sets are contained in Appendix IX (p.197). From these, the wide variety of surface qualities, obtained within the results, is immediately apparent. The images are also on the CD provided at the back of the thesis to enable interested parties to zoom in on a particular test for more detail.

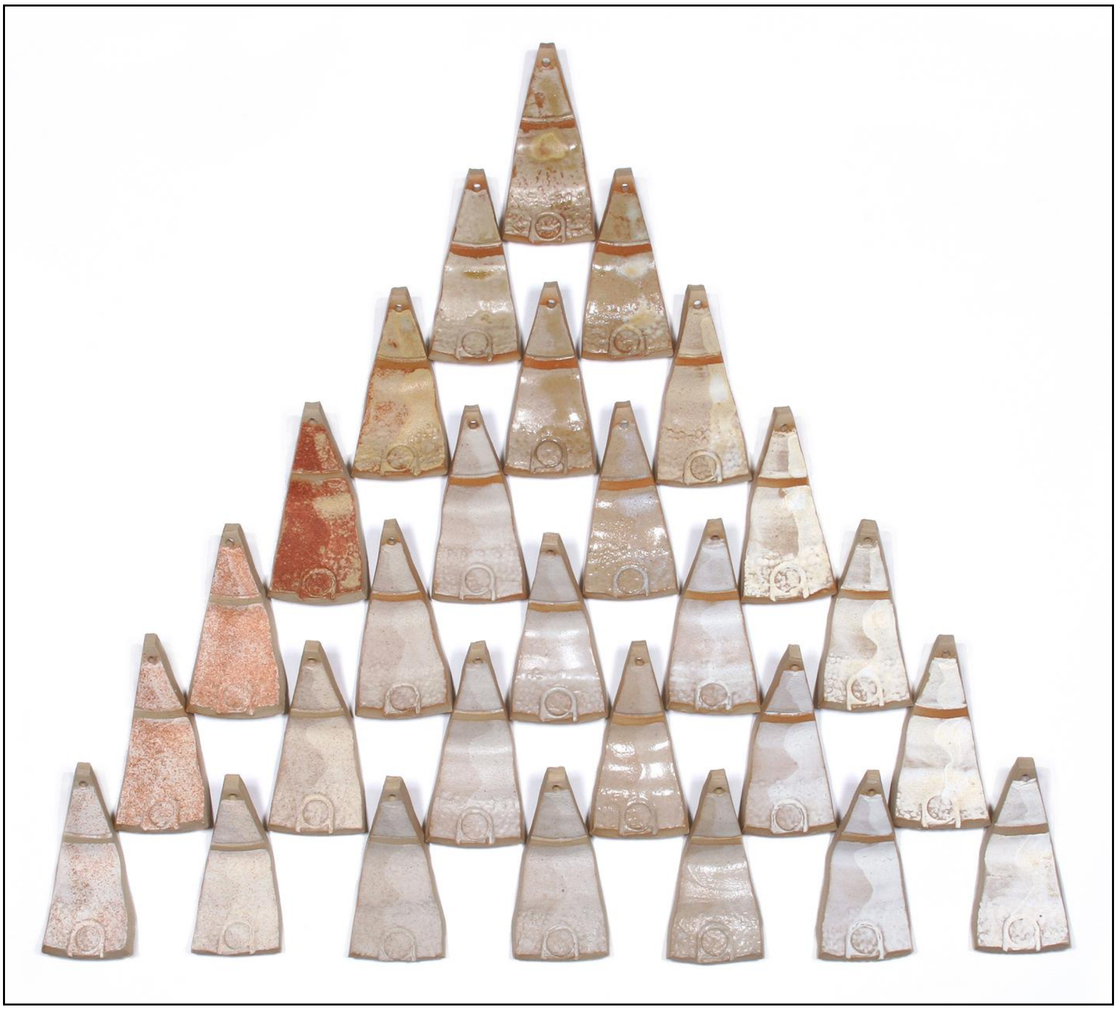


Figure 50:
Example of a triaxial blend of test tiles using unwashed bean ash on Smooth Buff stoneware clay body.

5.8.2 Art practice based approach

A more naturalistic approach to the assessment of the results, for the practising ceramic artist, is to focus on those test tiles within each set, which provide glazes appropriate for the production of artworks. Whilst this is a subjective process, it is more realistic and representative of studio practice and can be supported by seeking the opinions of other established artists. Consensus of opinion derived from such discursive methods is recognised within the constructivist paradigm of inquiry, as discussed in Section 1.6 (p.20). One of the subjects of the case studies, Dodd, examined the results of Test set 1, selecting glazes appropriate to his work, firstly from photographs, then from examination of the actual test tiles. This example of collaboration is discussed in Section 6.5 (p.106).

The selections made in Section 5.9.1 below are also the result of this personal practice-based approach to assessment. The process is cyclical in that the test tiles can be revisited and new selections made when new and different styles of artworks are developed, demanding different glaze effects.

5.9 Conclusions from the empirical testing

5.9.1 Glazes selected for development of artworks

A number of different characteristics of the new glazes produced were identified as being of possible use in my art practice.

- Richly coloured dry glazes
- Richly textured glazes
- Glazes with beaded texture
- Runny pooling glazes
- Glazes with the 'halo' effect
- Glazes with opalescent 'Chun' effects
- Shiny transparent glazes
- Satin semi opaque glazes
- Matt opaque glazes
- Shiny/satin opaque glazes

Glazes illustrating these qualities are shown in Figure 51 overleaf.

Table 16 (p.89) lists all the glazes, which were selected as having potential use in the development of artworks, also indicating the clay bodies for which each glaze is suitable. A catalogue of the recipes for all these glazes, together with images can be found in Appendix X (p.213).

Richly coloured dry glaze	Richly textured glaze	Glaze with beaded texture
		
UB2.4 on Raku	UB2.1/3.1 on Raku	UP3.2 on Raku
Runny pooling glaze with orange 'halo' effect	Opalescent 'Chun' effect	Shiny transparent glaze
		
UB2.5 on Smooth Buff	WP1.23 on Smooth Buff	WP1.22 on White St Thomas
Satin semi opaque glaze	Matt opaque glaze	Shiny/satin opaque glaze
		
UB2.13 on Camberwell	WP1.21 on Camberwell	WP1.36 on White St Thomas

Figure 51:
Selected test tiles indicating the characteristics identified in the new glazes

[Photography – David Williams]

© Carol Metcalfe

Table 16:
Glazes selected for possible development of artworks, with clay bodies on which they could be used indicated

GLAZE NO.S (* Indicates glaze illustrated in Figure 51)	**CLAY BODIES**			
	1106 White St. Thomas	**1117 Smooth Buff**	**1113 Camberwell**	**1154 Raku**
Richly coloured dry glazes:				
UB2.11	√	√	√	√
UB2.7	√	√	√	√
UP2.7			√	√
UP2.4				√
UB2.4			√	√
UB2.2		√	√	√
Richly textured glazes:				
UB3.2		√	√	√
UB2.1/3.1		√	√	√
Glazes with beaded texture:				
UP3.2				√
UP3.3				√
UP2.1/3.1			√	√
UP2.2	√	√	√	√
WP1.3	√	√	√	√
Runny pooling glazes:				
UB3.6	√	√	√	√
UB3.4		√	√	√
UP2.5	√	√	√	√
WP1.4	√	√	√	√
UP2.3		√	√	√
UB2.5	√	√	√	√
Glazes with 'chun' effect:				
WP1.5	√	√	√	√
WP1.17	√	√	√	
WP1.23	√	√	√	√
UB2.9	√	√	√	√
WP1.35	√	√	√	√

Contd. overleaf

Table 16 contd.
Glazes selected for possible development of artworks, with clay bodies on which they could be used indicated

GLAZE NO.S (***** Indicates glaze illustrated in Figure 51)	**CLAY BODIES**			
	1106 White St. Thomas	**1117 Smooth Buff**	**1113 Camberwell**	**1154 Raku**
Shiny transparent glazes:				
WP1.16	√	√	√	
WP1.28	√	√	√	√
WP1.22	√	√	√	√
UP2.9	√	√	√	√
WP1.34	√	√	√	√
Satin semi opaque glazes:				
UB2.19	√	√	√	√
UB2.13	√	√	√	√
UP3.7	√	√	√	√
UP2.13	√	√	√	√
UP2.19	√	√	√	√
UP3.8	√	√		
UB3.7	√			
WP1.9		√		
Matt opaque glazes:				
WP1.27	√	√	√	
UP3.6	√	√		
UP2.8		√		
UB2.8	√			
WP1.21	√	√	√	√
WP1.15		√		√
Shiny/satin opaque glaze:				
WP1.36	√	√	√	√

5.9.2 Concluding comments

Whilst the calculations carried out in Chapter 4 (p.56) provided several reliable recipes for new ash glazes, the application of blending methods described in this chapter has resulted in glazes with a far greater variety of surface qualities. The calculated recipes were however an excellent starting point for the blends, ensuring that the empirical testing would yield at least some useful outcomes. The wide variety of new glazes selected and their suitability for a range of clays, provided an inspirational input into my art practice for the next stage in the research, the development of new artworks, details of which are in Chapter 7 (p.122).

Meanwhile further input and support was gathered through the case studies profiling selected established artists, included in Chapter 6 (p.92). Undertaking these case studies gave an opportunity to share the test results, described in this chapter, within the field and to collaborate with some of the artists involved. The glaze testing carried out was also reported in an article published in *Ceramic Review* (Metcalfe, 2003), giving an opportunity to begin dissemination of the outcomes as they became available, within the wider field. A copy of this article can be found in Appendix V (p.174).

6 Case studies and collaborations to inform and help position the outcomes of this research

The case study method, as defined by Gray & Malins (2004, p.117), is used in this chapter. In Art & Design research, the 'case', the single instance or example of something, may be a practitioner. The study of each case is qualitative, intensive, in-depth and comprehensive, using several types of data, including images, to provide depth and breadth of evidence. Firstly, the rationale for the use of case studies and the collaborative projects stemming from them, is established. The approach taken to the case studies is then described, followed by the studies themselves. Next the approach to the collaborative work is outlined, followed by details of each collaborative project. The case studies are then summarised and finally the influences, drawn from this interaction with established contemporary practitioners, are identified.

6.1 Rationale for the case studies and collaborations

To assist in the positioning of the outcomes of this research, case studies have been carried out of internationally known contemporary ceramicists who use ash glazes. In order to represent a wide range of work and approach in the current field of ash glazing, four examples were selected; Mike Dodd, Lis Ehrenreich, Eric James Mellon and Jim Robison. These studies, detailed below, identify some of the diverse visual qualities and glaze properties sought and achieved by practitioners, thus providing a framework against which to compare the new glazes developed and assess their significance.

The case studies also examine the approaches used to develop ash glazes and explore the styles of work produced exploiting the different glaze effects achieved. This aspect of the studies informed some of the research processes employed, providing models of practice in both glaze testing and production of artworks. Architectural glass artist, Laura Johnson (1997, p.17), used case studies in a similar way and states in her practice led PhD thesis: - *"Each case provides insight into the working practice of the artists and their approach to the material."*

As a result of the contact made through the case studies, it has been possible to collaborate with some of the selected ceramicists. The significance of the new glaze materials and the recipes developed through this research was thus explored in relation to established practice. As well as informing some of the artworks I subsequently produced, this was an opportunity to begin dissemination of the findings and proved the research to be of interest within the contemporary field. Dodd for example has since used pea ash in some of the work he has exhibited, and Mellon has made extensive use of the bean ash. The collaborations are discussed in detail below.

6.2 The approach taken to the case studies

The ceramicists studied, all known for their use of ash glazes, were selected to represent the diversity to be found in the contemporary field. Styles of work, surface qualities, production methods and firing procedures range from high fired, dry glaze finishes to glossy, fluid glazes produced in lower temperature reduction firings in an electric kiln.

The development of an approach to the case studies began with an invitation to Mellon's home and studio in Summer 2001. During the visit, a variety of pieces were examined and photographs and slides taken of both the work and the ash production facilities, giving an insight into this ceramicist's practice. Many relevant and interesting points came out of this visit; however writing up the visit also raised further questions, which were addressed in the on-going correspondence that has developed with Mellon. For example, what other materials are used in the glazes? Ehrenreich was later to sum up the importance of this question, pointing out that it is not just an ash glaze she is producing, rather an ash, feldspar and borax glaze, all the ingredients contributing to the finished effect.

This first encounter formed the basis for the development of a list of questions for further studies. By initially addressing the same points with each participant, some structure was brought to the studies, allowing comparisons to be made and some parameters for contemporary ash glazed ceramics to be established. The approach developed therefore was to contact the selected ceramicists with an introduction explaining my PhD research and to put the list of questions to them. Visits were subsequently arranged to further discuss their work and to examine and photograph examples of it. The approach to Jim Robison differed slightly in that I was able to put questions to him and discuss the research whilst attending one of his courses.

The question list used was:

- How and when did you get started using ash in glazes?
- Why do you choose to use ash and what are the advantages of it over other materials for you or what special qualities do you feel it brings to your work?
- What particular qualities do you look for in the ash glazes?
- Where can examples of your work be seen?
- Do you use the ash washed or unwashed?
- What other materials do you use with the ash?
- Do you add any colouring oxides to your glazes?
- Do you use any oxides or slips under the glazes?
- What clay bodies do you use?
- What temperature/cone do you fire to and in what type of kiln?
- Are the firings reduced or oxidised?
- What types of ash do you use?
- Are you very careful about the species of plant used and do you find much variation from one batch to the next?
- Have you had any analyses done of the ashes you use?

Some of these questions, such as the washing of ash, are very important, whilst others were used to set the scene generally or simply to open the discussion. The information gained from these questions is discussed in the individual sections below, but one factor, common to all, was that none of the respondents had had the ashes used analysed. Any theories developed or conclusions drawn were based entirely on their own observations and experience, and were therefore to a certain extent conjecture. The analyses carried out in this research have provided a means of evaluating and expanding on these conclusions, especially in the collaboration with Mellon, as detailed in Section 6.6 (p.108).

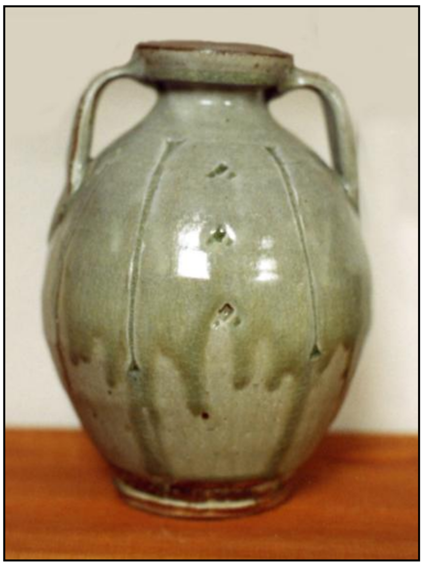
6.3 The case studies

6.3.1 Mike Dodd

British ceramicist Mike Dodd has had studios in various locations from Sussex to Cumbria to Somerset, where he now lives and works at Dove Studios near Glastonbury. Very early on in his career he developed an interest in using materials he could acquire locally, including ash, local clays and stones (Dodd, 2004, p.47). Dodd's work is functional, including platters, cheese dishes, jars with lids, jugs, coffee pots and bottles in a wide range of sizes. In style, it is influenced by Leach and the oriental tradition.

Figure 52:
Textured jar with lid by Mike Dodd, featuring fluid wood ash glaze. Height approximately 18cm.

[Photography: Carol Metcalfe]



Pots are thrown then decorated by various means to add line and texture - faceting, paddled textures, incised imagery. All these textural devices enhance the form of the pots and maximise the effects of Dodd's fluid ash glazes. (See Figure 52 & Figure 53)

Figure 53:
Jar by Mike Dodd with willow ash over mixed wood ash glaze. Height approximately 30cm

[Photography: Carol Metcalfe]

Various wood ashes are used, including hawthorn and willow from the surrounding area and mixed wood ash from Dodd's own stove, being careful to keep batches separate. He is particularly interested in any containing phosphorus, for example Corsican pine, which produces a bluish 'chun' effect, as shown in Figure 54. He always washes the ash thoroughly before use to avoid faults in the subsequent glazes. Other ingredients added to the ash are feldspars, clay and local stones. Recipes are kept quite simple and can be just a mixture of ash and a local stone, as can be seen in Table 17 (p.97).

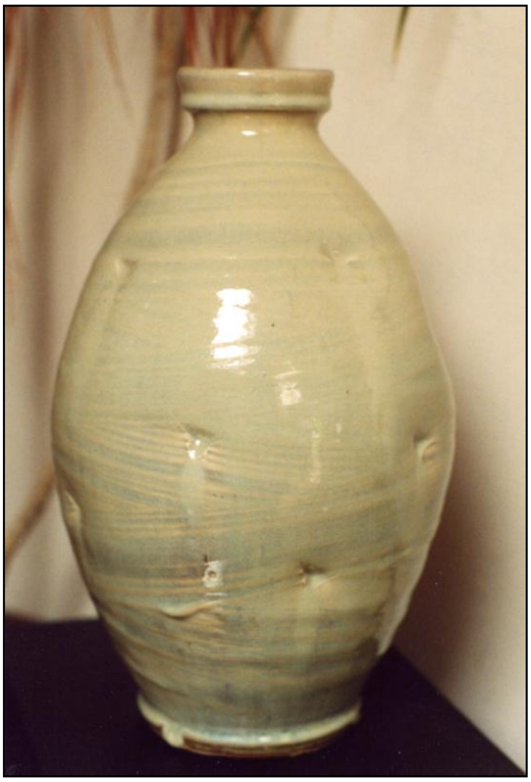


Figure 54:
Mike Dodd's Corsican pine ash glaze has a bluish tinge caused by phosphorus present in the ash

[Photography: Carol Metcalfe]

Either white slip (50:50 feldspar:china clay) or dark slips containing iron or manganese are applied under the glazes, sometimes after the pots have already been biscuit fired. The latter procedure causes a cracked effect in the slip layer and necessitates the immediate application of the glaze, as soon as the slip is no longer shiny, if it is to stick. Over the years, Dodd has used various fuel burning kilns to reduction fire his work to 1300°C (Cone 10) but currently fires mainly with oil. The reducing atmosphere can produce greenish glazes when small amounts of iron are present in the ashes used.

Recipe Ingredients	Simple recipe	Mixed wood ash I	Mixed wood ash II	Willow ash	Hawthorn ash
Ash	40	40	40	40	40
Local stone Eg Porphyry Granite Hornfels	60 		 20 20		
Potash feldspar		40		40	40
Local clay Eg Whitehaven yellow					10
Ball clay (HVAR or Hyplas)		20	16	20	10

Table 17:
Ash glaze recipes used by Mike Dodd

6.3.2 Lis Ehrenreich

Lis Ehrenreich is Danish and began using ash glazes whilst studying at the Jutland Academy of Fine Art, 1976-81. A visit was made to her studio in Arhus in 2003. Ehrenreich produces pots and plates using a local red earthenware clay body, which is quite open in texture.

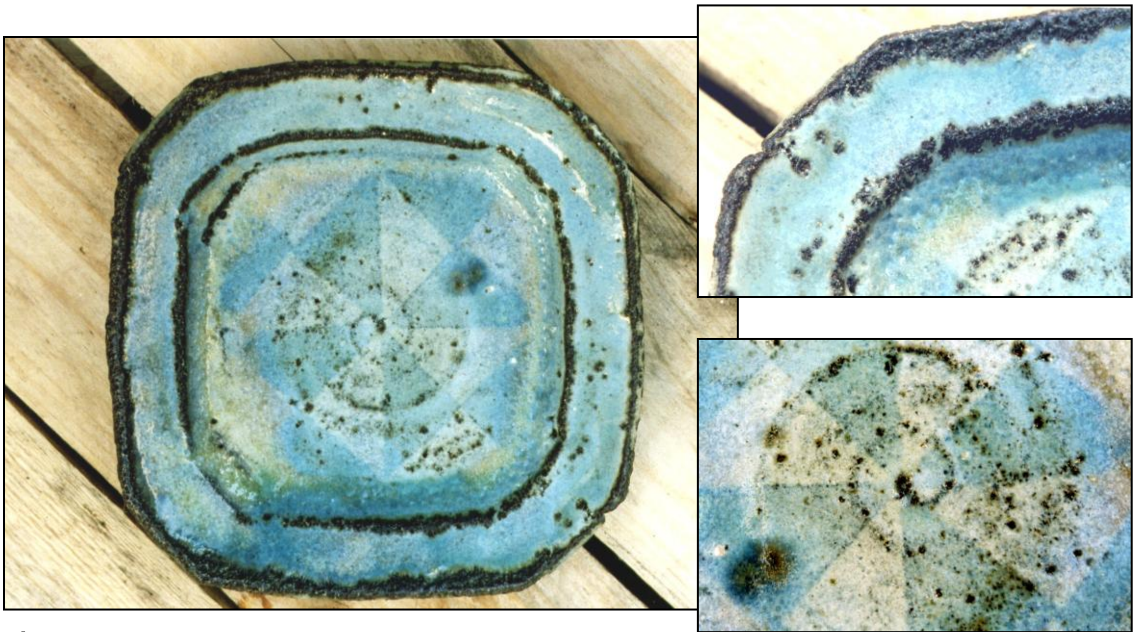


Figure 55:
Plate by Lis Ehrenreich approx. 20cm x 20cm with details of texture & slip decoration
[Photography: Carol Metcalfe]

The work is always decorated with a slip of ball clay and colouring oxides. Sometimes paper resists are used to apply geometric patterns in different coloured slips, as shown in the illustration in Figure 55 (p.97). Alternatively pots are textured the day after throwing using a plaster stamp on the outside whilst supporting the piece from the inside with the hand, as shown in the piece in Figure 56 below. Most of the work is thrown though some tiles are also made.

Ehrenreich uses various types of ash including wood ashes (elm and beech); cereal ash (wheat straw); and a broad-leaved plant (oilseed rape, a member of the Brassica plant family). She passes the ash through a 60-mesh sieve but never washes it, so all the constituents of the ash remain in the glaze mixture including any soluble fluxes. Additional ingredients of her glaze recipes are clay, feldspar and borax, the latter also a soluble flux material. Table 18 (p.99) gives two glaze recipes used by Ehrenreich. The glaze firing is to only 1180°C, which is much lower than most ash glazes. Fusion of the glaze at this temperature is made possible by the inclusion of borax in the glaze recipes. The firing is also unusual in that it takes place in an electric kiln, whilst achieving heavy reduction by introducing sticks of wood during the firing process.

Figure 56:
Pot with stamped texture by Lis Ehrenreich. Height approximately 40cm

[Photography: Carol Metcalfe]

Ingredients	Agnete glaze	Kolding glaze
Wheat straw ash	65	70
Rape straw ash	0	80
Beech ash	85	0
Feldspar	140	140
Borax	160	160
Red earthenware clay	0	60
Ball clay	60	0
Quartz	10	0

Table 18:
Ash glaze recipes used by Lis Ehrenreich

Glazes are applied immediately after mixing in order to achieve a shiny glaze with the crusty textures and holes, which are a feature of Ehrenreich's work (see Figure 55, p.97 & Figure 57 below). Interestingly she has noted that if her glaze is left to stand, it just results in a smooth shiny finish, the textured effects being lost.

Figure 57:
Textured pot by Lis Ehrenreich.
Diameter approximately 20cm

[Photography: Carol Metcalfe]

6.3.3 Eric James Mellon

Eric James Mellon defines two distinct types of ash glaze, which he uses for specific purposes in his work. These are:

- ‘Kinetic’ glazes containing wood ash, which are high in calcium oxide, giving runny glazes that cause decorative lines of oxides to break down and spread, as shown in the test pots in Figure 61 (p.102)
- Stable glazes containing bush ashes, high in potassium oxide, suitable for use over figurative drawings done in oxides, as shown in Figure 58.

Except for the tiles he produces, Mellon’s work is thrown using a variety of stoneware clays and porcelain to produce bowls, vases and bottles. (See Figure 58 below, also Figure 59 & Figure 60, p.101). He takes a fine art approach to the decoration, applying figurative drawings in oxides to the biscuit fired pieces before glazing. Every available area of the pot is decorated, as illustrated by the vase in Figure 58 and each piece is marked with the glaze used, the year and its own number.

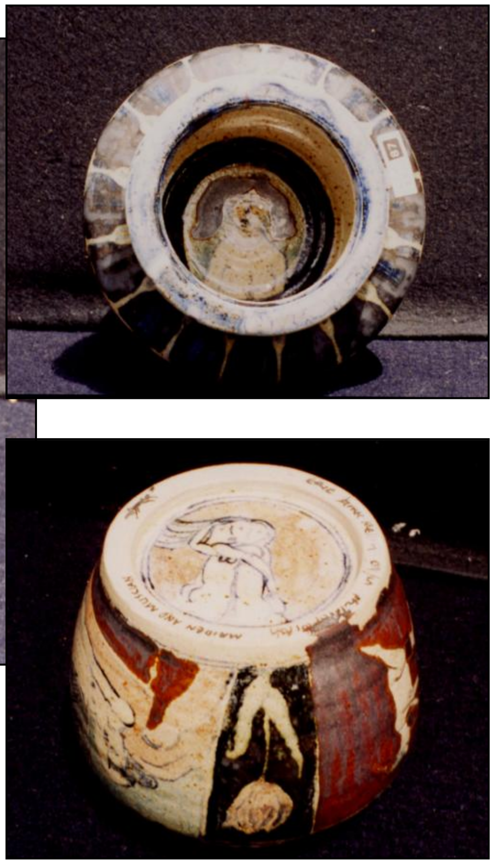


Figure 58:
Vase by Eric James Mellon from 2001, showing oxide drawings inside and underneath as well as on sides of piece. Height approximately 15cm

[Photography: Carol Metcalfe]

Mellon uses many different types of ash from trees, bushes and herbaceous plants, all unwashed so as to retain the potassium oxide flux he so values. Initially, almost 50 years ago, he took a traditional ash glaze recipe of 40 ash, 40 feldspar and 40 clay, choosing Cornwall Stone for the feldspar. He then substituted various other feldspathic materials but, to create successful glazes, found it necessary to make additions of silica to the recipes, in the form of flint. His method for calculating the amounts of silica required, developed with reference to Home (1952), is described in *Ceramic Review 65* (Mellon, 1980). Mellon's 'Series A' recipes result from these calculations. To explore the effect of more calcium, he then introduces calcium carbonate in the form of Whiting into the recipes, giving 'Series B'. Finally, an intermediate range of tests, 'Series C', is carried out using a 50:50 mixture of the A and B Series recipes. This approach results in a total of 12 recipes, which are given in Table 22 (p.111).

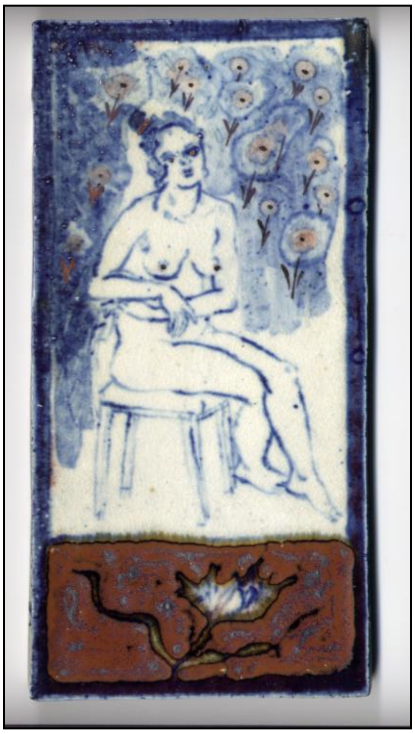


Figure 59:
Tile by Eric James Mellon decorated with figurative oxide drawings and glazed with elm ash (2002). 9x20cm

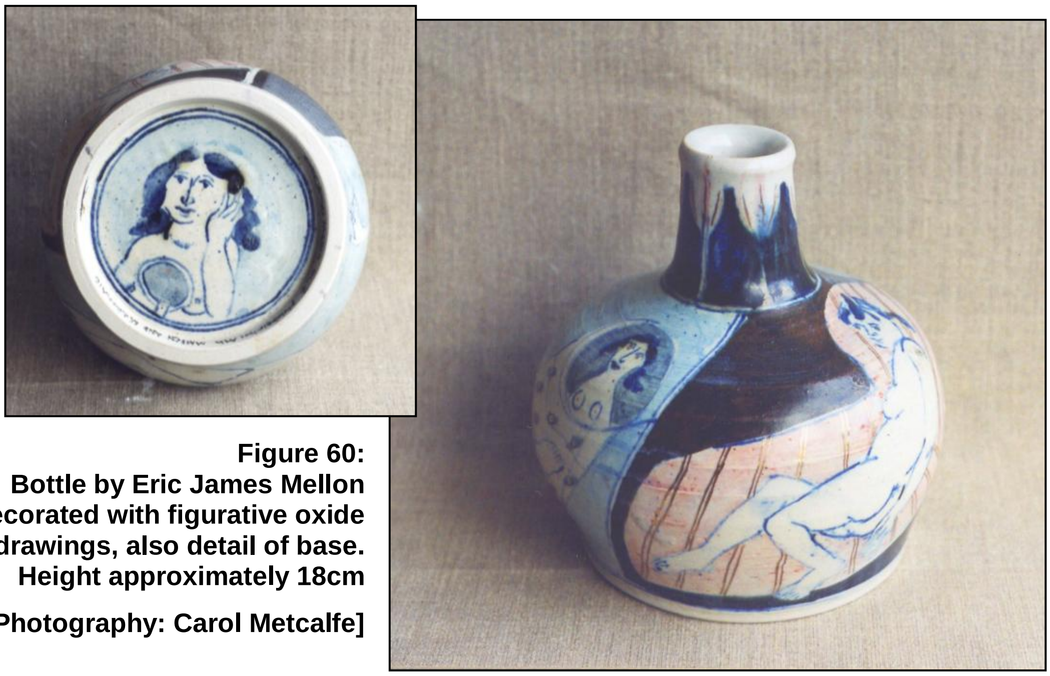


Figure 60:
Bottle by Eric James Mellon decorated with figurative oxide drawings, also detail of base. Height approximately 18cm

[Photography: Carol Metcalfe]

Originally firing took place in an electric kiln to 1300°C in oxidation. More recently a gas kiln has been used, again firing to 1300°C but with some reduction, which can affect the colours of the oxides and stains used in the drawings. Copper for example develops green in oxidation, red in reduction. The resulting colours also differ depending on the type of ash glaze applied over them, as can be seen in the test pots in Figure 61 below. Note also the subtle colour differences between the glazes on the rims of the test pots.

Figure 61:
Test pots using cherry, pear & beech ash glazes cause bands of copper, cobalt & iron oxides to collapse and run. The colours developed also differ.

[Photography: Carol Metcalfe]

6.3.4 Jim Robison

Jim Robison is an American ceramicist who has lived and worked in West Yorkshire for many years. His work ranges from large-scale sculptural pieces, assembled after firing (see Figure 62, p.103); to wall panels, comprised of tiles (see Figure 63); to individual pots and dishes, hand built with slabs or extrusions (See Figure 64 & Figure 65, p.104 and Figure 66, p.105). The large-scale pieces are made in sections with a top and base, enabling them to be slipped onto metal rods during assembly (Robison, 1997, p.24-25). The wall panel tiles have a hollow box structure with keyholes to fit onto a network of screws fixed into the wall (Robison, 1997, p.57-59).

Figure 62:
Installation by Jim Robison constructed in sections (Rufford Craft Centre 2006)
Height approximately 2.5m

[Photography: Carol Metcalfe]

Figure 63:
Wall panels depicting a flood at Holmfirth, with detail of textures

[Photography: Carol Metcalfe]

Inspiration comes from the landscapes, dry stone walls and quarries around Holmfirth, in which Robison's studio is situated. The textures are created using a wide variety of found objects and tools, including fabrics and kitchen utensils. Clay slabs are sometimes even pressed onto items *in situ*, for example the studio wall.

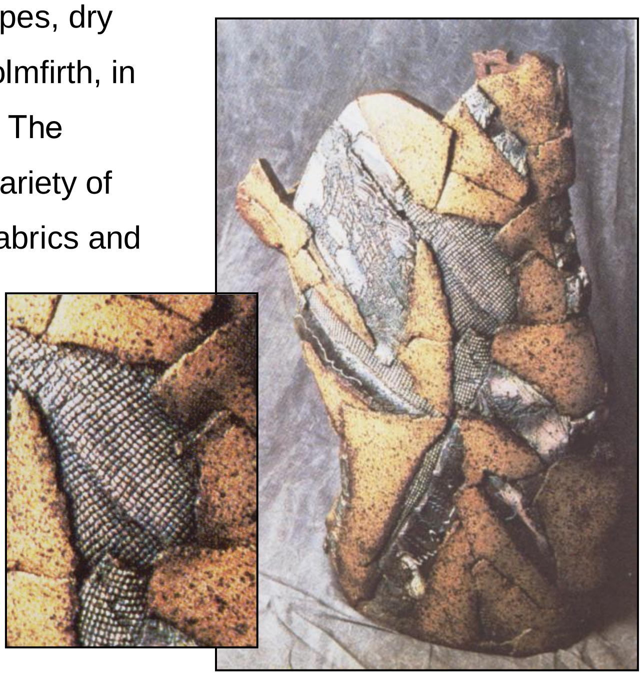


Figure 64:
Vase by Jim Robison, hand built of textured slabs, with detail of texture. Height approximately 100cm. (Minogue, 2001, p.47)

Figure 65:
Stages in making a slabbed vase

[Photography: Carol Metcalfe]

Whilst all the other case study subjects produce thrown work, Robison employs completely different techniques. His work is entirely hand built from slabs and extrusions, decorated with coloured slips and textures. Sometimes the clay is textured first, for example with rollers, and then slip is applied to highlight the texture. Sometimes decoration is drawn through the coating of slip, using one of the many found objects he has collected. In other cases slip is applied over open fabrics, laid onto the clay as a mask then removed to leave a negative pattern.

For large vases, the slabs are supported by sticks during construction, as can be seen in Figure 65 (p.104). When joining the slabs, the decoration is protected with cling film. Extruded sections are sometimes used to finish the rims of pots. Extruded pots are also decorated with coloured slips and are sometimes made from more than one section, as shown in Figure 66.

Figure 66: Stages in making an extruded pot and the finished pot

[Photography: Carol Metcalfe]

Robison began using ash because he thought, *"it would be fun and it was free"*. He has used various wood ashes. Initially, elm ash was available, which gave an attractive light colour. Later on, he used pine ash, which resulted in a very dark muddy glaze far less to his liking. Currently he is using apple ash from the prunings of an orchard in Belgium and has achieved a pale coloured glaze again. The same glaze recipe, given in Table 19 (p.106), has been used for all the different ashes. Robison is not interested in fluid ash glazes, but looks for dry glazes with rich colouring. The ash is prepared by washing just once to aid the sieving process. The ash glazes are applied in combination with other glazes, all sprayed in overlapping layers onto the coloured slip decoration. The glazes are passed through an 80-mesh sieve so as to be suitable for spraying. All pieces are once fired to 1280°C in reduction in a gas-fired kiln.

Ingredients	**Recipe**
Wood ash	20
China clay	18
Potash feldspar	5
Whiting	5
To this base recipe small additions of iron oxide or cobalt and copper oxides are added. For example 1% cobalt and 3% copper.	

Table 19:
Ash glaze recipe used by Robison (Rogers, 1991, p.120)

6.4 The approach to the collaborations

The idea of collaborative work grew out of the good rapport built up through the case studies. The first approach made was to ask two of the selected ceramicists, Dodd and Mellon, if they would be interested in trying out some of the new ashes and/or recipes in their work. The response was positive, so during visits made to their studios in 2003, I supplied washed pea ash and unwashed bean ash respectively. The decision as to which ash was likely to be of most interest to each participant was based on the results of the analyses and empirical testing combined with knowledge of their working practices gleaned from the case studies.

6.5 Collaboration with Mike Dodd

The results of the first series of glaze tests were discussed with Dodd. As a result, he tried out the washed pea ash in one of my recipes (Test II in Table 20 overleaf) and also in his own basic wood ash glaze recipe (Test I in Table 20 below), using his usual reduction firing procedure. He was able to successfully use pea ash as a substitute for wood ash, as was suggested by the EDX results in Section 3.2.4 (p.44). The glazes were applied over a white slip.

	Test I (Mike Dodd's recipe)	**Test II (My recipe WP1.22)**
Washed pea ash	40	44
Potash feldspar	40	21
Hyplas 71 ball clay	20	0
China clay	0	7
Flint	0	28
Resulting colour	Pale green	Pale blue green

Table 20:
Pea ash recipes used by Dodd

Figure 67:
Test bowls by Mike Dodd using Test I & Test II washed pea ash glazes over white slip.
Also undersides of bowls

[Photography: David Williams]

The test bowls produced by Dodd, using the glazes in Table 20, are shown in Figure 67 above. The very pale greenish and blue green colours developed are typical of reduction-fired glazes containing small amounts of iron, which the analyses showed to be present in the pea ash. Both glazes were considered successful and Dodd requested a larger supply of this ash so that he could add it to his range of work. He included the pea ash glazed vase shown in Figure 68 in his autobiography (Dodd, 2004 p.204). He also showed examples in his exhibition at Contemporary Ceramics, London in June 2005 and described them in the illustrated talk held in conjunction with it, acknowledging this research and the source of the ash. Pea ash glazes continued to feature in Dodd's work at *Potfest in the Park,* in 2006, including the example shown in Figure 69.

Figure 68:
Pea ash glazed small faceted vase by Mike Dodd, with biscuit slip decoration (Dodd, 2004, p.204)

Figure 69:
Pea ash glazed jar with lid, featuring incised decoration. Height approximately 14cm

[Photography: Carol Metcalfe]

6.6 Collaboration with Eric James Mellon

Eric James Mellon spent many years trying to develop stable ash glazes from tree ashes before coming to his conclusions on their high calcium content (see Section 3.2.7, p.53), something that would have been immediately obvious had he had the advantage of analyses. He has therefore been very interested in this research and the analyses carried out. An on-going exchange of ideas and information has developed, resulting in the collaborative glaze-testing project described below.

6.6.1 Collaborative glaze testing project

Initially Mellon tested the unwashed bean ash I supplied in some of his existing recipes, producing results he considered successful on small test pots fired to Cone 10, 1300º C in a neutral to slightly reducing atmosphere. Figure 70 below shows two pots, made in white stoneware and porcelain clays respectively, glazed with the recipes given in Table 21.

	Recipe I	Recipe II
Unwashed bean ash	4	4
Potash feldspar	0	4
Mixed feldspar	4	0
China clay	2.5	2.5
Ball clay	0.5	0.5
Flint	2.25	1

Table 21:
Bean ash recipes used by Mellon


Figure 70:
Test pots by Eric James Mellon using Recipes I & II respectively
[Photography: Carol Metcalfe]

Following the success of these initial experiments, both of which produced stable glazes over oxide drawings, more extensive testing was planned. In 2005, I participated in a collaborative glaze development project with Mellon, funded by Southern Arts, to explore further bean and pea ash glazes.

Test pots were prepared in three different clay bodies from Clayman of Chichester:

- PB103 ‘Really Good’ buff stoneware
- 1067 ‘Fine White’ stoneware
- 1086 ‘Imperial’ porcelain

Three types of oxide were applied to all the test pots:

- a band of 2:1 mixture of cobalt and copper oxides
- a band of red iron oxide
- a dot of copper oxide in the centre

Four feldspathic materials were used in the glaze recipes:

- Potash feldspar
- Mixed feldspar (Potash feldspar & soda feldspar)
- Soda feldspar
- Nepheline syenite

Mellon’s three series of glaze recipes are given in the table in Table 22 (p.111). His approach to the development of these glaze recipes was described in Section 6.3.3 (p.100). Tests using the full set of recipes were carried out using unwashed bean ash and a limited number of them repeated substituting unwashed pea ash. The latter are highlighted in Table 22 and were numbered 13A, 15A, 14B, and 16B respectively. Each recipe was applied to a set of three test pots, so as to be able to study the effect on each of the selected clay bodies. All the tests were fired in reduction in a gas kiln, offering an opportunity to explore another avenue in the potential of the new ashes, my own firings having been in the neutral atmosphere of an electric kiln. This collaborative project is included in a new book (Mellon & Foster, 2007), for which I was asked to provide charts of the ash analyses to accompany the outcomes. My own observations on the glaze tests are included below.

RECIPES	**Ash**	**Ball clay**	**China clay**	**Potash feldspar**	**Mixed feldspar**	**Soda feldspar**	**Nephtheline syenite**	**Flint**	**Whiting**
SERIES A									
1A/13A	**4**	**0.5**	**2.5**	**4**	**0**	**0**	**0**	**1**	**0**
2A	4	0.5	2.5	0	4	0	0	2.25	0
3A	4	0.5	2.5	0	0	4	0	3.5	0
4A/15A	**4**	**0.5**	**2.5**	**0**	**0**	**0**	**4**	**5**	**0**
SERIES B									
5B/14B	**4**	**3.5**	**0.25**	**2**	**0**	**0**	**0**	**0**	**2**
6B	4	3.5	0.25	0	2	0	0	0.5	2
7B	4	3.5	0.25	0	0	2	0	1.25	2
8B/16B	**4**	**3.5**	**0.25**	**0**	**0**	**0**	**2**	**2**	**2**
SERIES C									
9C	4	2	1.38	3	0	0	0	0.5	1
10C	4	2	1.38	0	3	0	0	1.38	1
11C	4	2	1.38	0	0	3	0	2.38	1
12C	4	2	1.38	0	0	0	3	3.5	1

Table 22:
Recipes used in the collaborative research
[1A–12C using Bean ash, 13A–16B using Pea ash]

As the feldspathic materials used in the recipes above are naturally occurring minerals, their compositions vary. Nevertheless figures from Obstler (2000) supply approximate analyses that can be compared with each other and with the XRF analysis of the bean and pea ashes, as shown in Table 23 (p.112).

This information was used when making the observations on the test results, which are described in the following sections.

	Oxides	Bean ash	Pea ash	Potash feldspar	Mixed feldspar (50:50 potash:soda)	Soda feldspar	Nepheline syenite
FLUXES	K_2O	13.58	6.16	10.3	7.4	4.5	4.8
	Na_2O	2.00	0.37	3.1	4.9	6.8	10.5
	CaO	24.18	32.77	0.4	1.0	1.5	0.4
	Al_2O_3	1.70	2.59	17.8	18.4	18.9	23.6
	SiO_2	16.61	20.92	67.5	67.8	68.0	60.2

Table 23:
Percentage weight analyses of ashes and feldspathic materials

6.6.2 Observations on bean ash tests

The recipes used for these tests (see Table 22, p.111) explore the reaction of unwashed bean ash in combination with the range of feldspathic materials, habitually used by Mellon. In the Series A test recipes, all the fluxes are supplied by the ash and feldspars. Potassium and calcium oxide are contributed by the bean ash; further potassium and calcium oxide, together with sodium oxide by the various feldspathic materials. The same amount of ash is present in each of the recipes so any differences noted in the finished glazes must be attributable to the feldspar chosen to combine with the ash. In general, this series of tests, pictured in Figure 71 (p.113), results in stable glazes, which do not cause the lines of oxides on the test pots to break down and run. There is however some movement of the iron oxide when applied to the buff stoneware clay body, which itself contains more iron than the other clays used.

Another difference noted is the level of reduction of the copper oxide spot in the centre of the test pots. In recipe 4A, where the bean ash is combined with a significant level of sodium oxide from the nepheline syenite, a distinct copper red results. This effect is particularly strong on the porcelain clay body. There is also variation in the colour response of the cobalt/copper oxide line in recipe

4A, where it develops a pinkish purple colour on the white stoneware body, again probably due to the reduction of the copper oxide content. Interestingly this change in colour is not seen when pea ash is combined with nepheline syenite in recipe 15A, where the line remains dark blue, as can be seen in Figure 74 (p.116).

Clay **Recipe**	**Buff stoneware**	**White stoneware**	**Porcelain**
1A (PF)			
2A (MF)			
3A (SF)			
4A (NS)			

Figure 71:
Series A bean ash tests

[Photography: BVR Print]

Clay Recipe	Buff stoneware	White stoneware	Porcelain
5B (PF)			
6B (MF)			
7B (SF)			
8B (NS)			

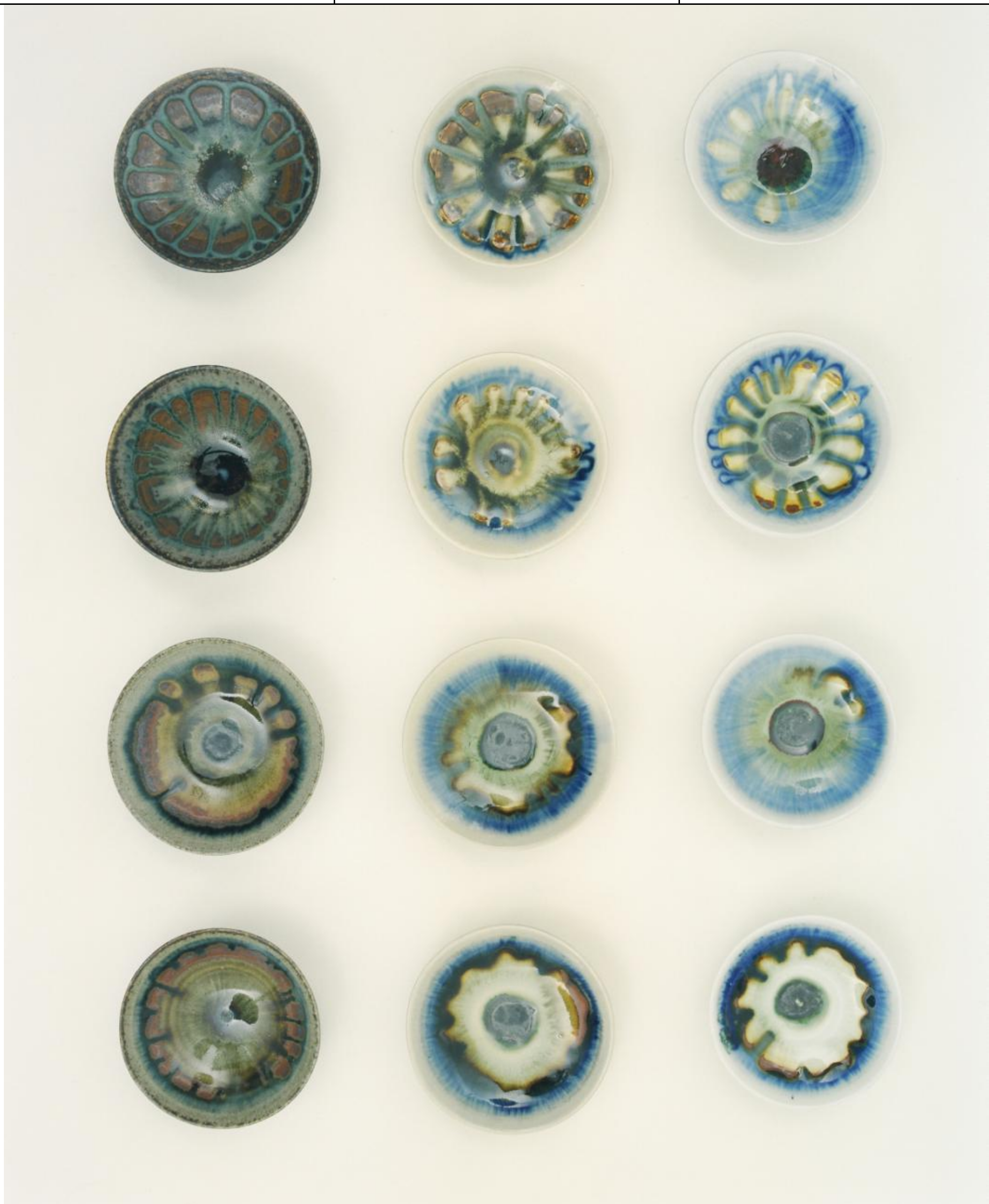


Figure 72:
Series B bean ash tests

[Photography: BVR Print]

In the recipes for the Series B bean ash tests, given in Table 22 (p.111), additional calcium oxide is present, provided by whiting. This causes all the glazes to become very fluid and run down, completely breaking up the oxide lines applied, as can be seen in Figure 72 above.

<table>
<tr><th>Clay

Recipe</th><th>Buff stoneware</th><th>White stoneware</th><th>Porcelain</th></tr>
<tr><td>9C (PF)</td><td colspan="3" rowspan="4"></td></tr>
<tr><td>10C (MF)</td></tr>
<tr><td>11C (SF)</td></tr>
<tr><td>12C (NS)</td></tr>
</table>

Figure 73:
Series C bean ash tests

[Photography: BVR Print]

In the Series C recipes, the intermediate range between Series A and Series B, the running of the glazes is most apparent on the porcelain tests, containing potash feldspar, whilst the recipes containing more sodium oxide have remained more stable (Figure 73 above).

6.6.3 Observations on pea ash tests

In addition to the bean ash tests, a limited number of recipes were repeated using pea ash, as shown in Figure 74 below. (See Table 22, p.111, for the recipes used).

Clay / Recipe	Buff stoneware	White stoneware	Porcelain
13A (PF)			
14B (PF)			
15A (NS)			
16B (NS)			

Figure 74:
Pea ash tests

[Photography: BVR Print]

The EDX analyses previously carried out and discussed in Chapter 3 (p.36), showed the pea ash to have very high levels of calcium, similar to some of the wood ashes tested. Mellon has found these wood ashes produce what he terms ‘kinetic’ glazes, fluid glazes under which lines of oxides collapse, resulting in runs of colour. The pea ash tests therefore were expected to follow this pattern, but the results proved otherwise.

In the Series A tests, 13A and 15A, there was only some spreading of the iron oxide, rather more so with the recipe containing potash feldspar than that with nepheline syenite. The cobalt oxide line remained stable, showing only the slightest movement in one test pot, the potash feldspar recipe, 13A, applied to a porcelain clay body.

In the Series B recipes, 14B and 16B, where yet more calcium was added in the form of whiting, the expected runs of colour did occur in the recipe containing potash feldspar, particularly on the porcelain body. Movement to a lesser extent was also seen in the nepheline syenite recipe, 16B, the buff stoneware test pot showing the least collapse of oxides.

Further study of the analyses of the ashes identified a difference in the magnesium content of the pea ash, when compared with ashes such as pear, apple and horse chestnut. (See graph in Figure 75, p.118). Whilst the magnesium content of all these ashes is small (no more than 2.6% concentration), the pea ash contains around twice as much as any of the wood ashes, as can be seen in the graph. This additional magnesium may account for the stabilising effect on the glaze, preventing the collapse of the colouring oxides applied under it. The available literature indicates that in certain recipes even the smallest amounts of magnesium oxide will stiffen the glaze surface (Obstler, 2000, p.198). It has also been observed that talc (magnesium silicate) prevents movement of the glaze and promotes mattness or buttery texture (Rogers, 1991, p. 47). Further research is required on the addition of magnesium to Mellon’s ‘kinetic’ wood ash glazes to fully establish the effect of small additions of this element in these recipes.

As shown in the graph in Figure 76 (p.119), there are also differences in some of the other elements present in low concentrations that could account for the unexpected results from the pea ash tests. The pea ash contains twice to three times the aluminium of any of the wood ashes, though all the readings are less than 1%, so it is questionable whether this element would have any effect. The pea ash also contains rather less phosphorus than the wood ashes. Again, further research is required to establish if additions of phosphorus to the pea ash would result in a kinetic glaze.

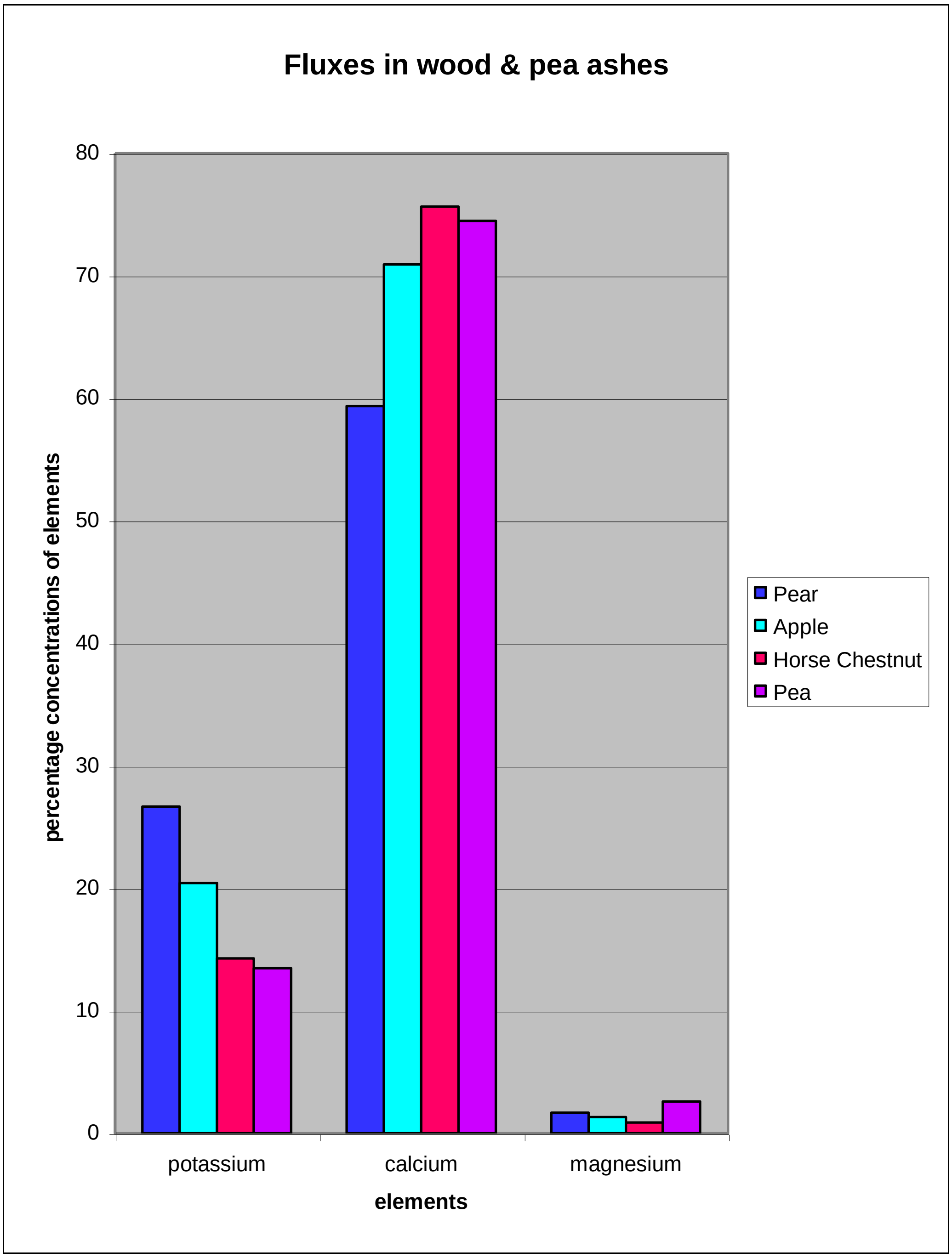


Figure 75:
Graph comparing flux content of wood & pea ashes

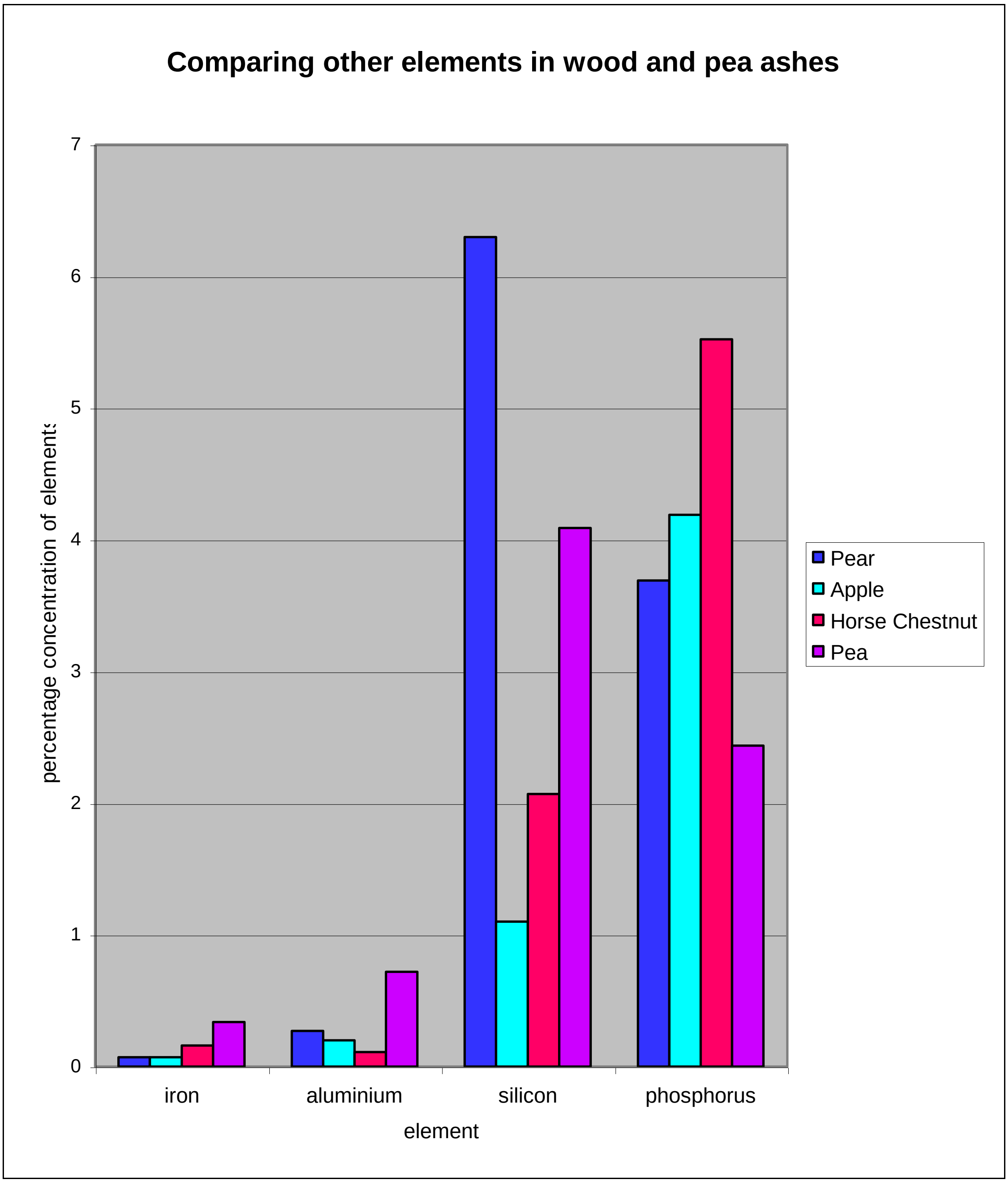


Figure 76:
Graph comparing other elements contained in wood & pea ashes

6.7 Overview of case studies

Table 24 (p.120) provides an overview of the information gathered in the case studies. It is used in the discussion in Section 7.8 (p.148) to help position the outcomes of this research in relation to contemporary practice, identifying where the new glazes are comparable and where new ground is covered.

Table 24:
Overview of information from case studies

	Mike Dodd	Lis Ehrenreich	Eric James Mellon	Jim Robison
Types of ash used	Mainly wood ashes	Beech, wheat, oilseed rape	Many trees, bushes and herbaceous plants	Various wood ashes
Ash washed	Yes thoroughly	No	No	Once
Other ingredients	Local stones & clays Ball clay Potash feldspar	Borax Feldspar Clay Quartz	Feldspars Clay Flint Whiting	Potash feldspar China clay Whiting
Oxides added to glazes	None	None	None	Iron Cobalt Copper
Glaze qualities	Gloss or satin transparent and fluid Also Chun	Glossy, transparent and fluid with crusty texture	2 types – fluid and stable Both gloss or satin & transparent	Dry & richly coloured
Style of work	Traditional functional ware of oriental influence, with textured decoration	Plates, jars and some tiles with geometric slip patterns	Bowls, vases, bottles & tiles decorated with figurative drawings	Sculptural vases, platters & installations Also wall pieces Slip & textured decoration
Production methods	Thrown	Thrown, sometimes altered Also tiles	Thrown Also tiles	Handbuilt from textured slabs & extrusions
Slips or oxides applied	White slip or dark iron or manganese slip	Coloured slip patterns	Figurative drawings in oxides & stains	Coloured slip patterns
Glaze application	Dipped & poured	Dipped & poured	Poured	Sprayed
Kiln type	Mainly oil fired	Electric	Formerly electric Now gas fired	Gas fired
Firing temperature	1300°C	1180°C	1300°C	1280°C
Firing type	Reduction	Heavy reduction	Oxidation & reduction	Once fired reduction

6.8 Overview of parallels & influences from interaction with contemporary practitioners

This research did not seek to reproduce previous artworks but has nevertheless found parallels with the case studies and been influenced in several ways by them and by the resulting collaborations. The factors identified were:

- Different opinions on washing ash made me question preparation methods
- Use of unwashed ash
- Handbuilding techniques using slabs
- Use of extruder to form some artworks
- Use of plate forms
- Use of textures from found objects
- Use of local materials
- Application of oxides under glazes
- Experimentation with oxide drawings
- Use of dry ash glazes in artworks
- Application of glazes in combination, dipped and poured
- Inspiration from landscape

These factors informed the development of the artworks, which is discussed in the next chapter.

7 Development of artworks to explore and demonstrate the creative potential of the new ash glazes

This chapter brings together the selected glazes from Chapter 5, the case studies and collaboration, detailed in Chapter 6, and relevant aspects of the contextual review. A variety of artworks have been developed to explore and demonstrate creative usage of successful glaze formulations. First, the rationale for developing artworks is established and the parameters governing their production outlined. An explanation is also given of the development of the forms and the emergent theme. The body of work is then presented through images and discussed. Details are given of the dissemination of the research outcomes, both within the field of studio ceramics and in the public domain. Reflection on the outcomes follows, including comments on personal practice and reference to related work by other artists. Finally, the new artworks are positioned within the contemporary field and conclusions drawn as to their significance. Overall the chapter addresses Objective 7 and makes a significant contribution towards Objectives 8 and 10 (see Section 1.5.2, p.19).

7.1 Rationale for the development of artworks

Alone, the glaze tests selected in Section 5.9.1 (p.87) are not sufficient to demonstrate the usefulness of the new glazes in studio practice. Only through the development of a range of forms can their creative potential be proved, revealing how the glazes behave in different situations and combinations. Furthermore, only by the production of artworks can the outcomes of the research be disseminated through exhibitions and galleries. Acceptance in the contemporary field can thus be judged and the opinion of a wider audience gauged.

The artworks developed are acknowledged as just one individual artist's response to the new glazes. They nevertheless give an insight and possible starting point for others, as well as providing a body of work for comparison with the case studies and other relevant practice. It should be noted that there was no intention to replicate the forms and glaze effects found in the work of other artists. The new work is however positioned by making comparisons with these existing examples.

7.2 Parameters for the development of artworks

As a ceramic artist, it was important that the pieces developed during this research formed part of my on-going practice and could continue beyond the research period. This requirement placed certain practical and logistical constraints on the designs:

- The work would be produced using only the facilities available in my own workshop, which include a slab roller and extruder
- I work alone, therefore pieces could not be too heavy
- The kiln size is 45cm x 45cm x 45cm
- Hand building techniques would be used in accordance with my established practice and interests

The creative potential of the new glazes was explored within these parameters.

7.3 The search for a form

Previously, I had always worked from visual material – photographs, drawings, rubbings, collages, found materials – gathered on a theme of interest. Glazes were then either identified or developed to provide the desired characteristics. In this research, the process was reversed, the new glazes being the starting point. This departure from my established way of working initially presented a great challenge.

In the first experiments, sharp cut edges and linear decoration were used for square bowls and plates. On reflection these seemed at odds with the organic qualities of many of the new glazes. Eventually, designs that complement the new glazes were achieved through the incorporation of torn edges or irregular edges, left as rolled out. Texture is also an important feature in all the pieces, as this gives greater scope for the glaze effects produced. Local found materials were used to create the textures and for other decoration, adding a further dimension. A theme gradually emerged and was then consciously developed, linking the pieces strongly with the location in which they were created and giving them 'a sense of place'.

7.4 The emergent theme – a sense of place

The artwork developed through this research and presented in the next section of this chapter continues the long tradition of ash glazing but with a strong connection to the place in which it was made. It is not so much about the place in a narrative sense but rather born out of its place of origin, the arable farm in North Yorkshire that is my home. This place is incorporated and embedded into the work in several ways both by means of observations made and actual materials sourced on the farm:

- Use of ash from crop waste in glazes
- Incorporation of waste dressed from the crops to create texture
- Use of found items for mark making
- Incorporation of actual items from the environment, again for texture
- Inclusion of remnants of collected plant material, that leave a trace of their structure in the fired clay
- Impressions of items taken *in situ*
- Inspiration from imagery, including man-made items present within the environment and altered by the elements, as shown in Figure 77 below

Thus the place of origin is an integral part of the artworks created. Of particular importance are the textures produced and the rich colours observed.

Figure 77:
Inspirational imagery ranges from plant forms to the textures and colours of rusting metalwork and the old bricks of the workshop wall

[Photography: Carol Metcalfe]

7.5 The artworks

A varied selection of artworks have been developed to explore the potential of the new glazes:

- Large square bowls
- Round bowls
- Small square plates
- *Squarish* plates and dishes
- *Patchwork* small textured dishes
- Extruded *Tall Pots*
- Lidded boxes
- *Patchwork* plates
- Figurative pieces

All the pieces were fired using the same procedures as for the tests, detailed in Section 5.5, (p.78), unless otherwise stated below.

Some of these exploratory pieces became fully resolved designs that were subsequently exhibited; others were not fully resolved but nevertheless contributed valid information as to how the new glazes could be used creatively. The initial evaluations voiced in this section are made from the point of view of the individual practising artist, reflecting during the making and development of the body of work. They are therefore entirely subjective. For a wider appreciation of the outcomes in a natural and realistic setting, pieces were submitted to galleries and exhibitions, as discussed in Sections 7.6 and 7.8, of this chapter (p.138 & p.148).

7.5.1 Large square bowls

The first form developed was a large square bowl approximately 43cm x 43cm, for which a plaster mould was produced. A series of three bowls using three different clay bodies were press moulded. There was an immediate connection with the locality in the decoration chosen for these pieces. Impressions were made in the soft clay, using oak twigs collected in the vicinity of the workshop. These textural effects were inspired by the patterns observed in the nearby woods, which are shown in Figure 78 below. The process further developed with the use of twigs themselves, adding further details and inspiring a motif created by imprinting the end of a large twig, shown in Figure 79 below.

Figure 78:
Nearby woods and the inspirational patterns observed in them
[Photography: Carol Metcalfe]

The most successful piece in the series was that made in Raku clay, in that it juxtaposes a combination of a dry orange bean ash glaze (UB2.4) and a pea ash glaze with beading effect (UP3.2). This piece, featuring the twig motif, also exploits the use of the 'halo' effect of the UB2.4 glaze, which adds to the rich colouring achieved, as shown in Figure 79 below.

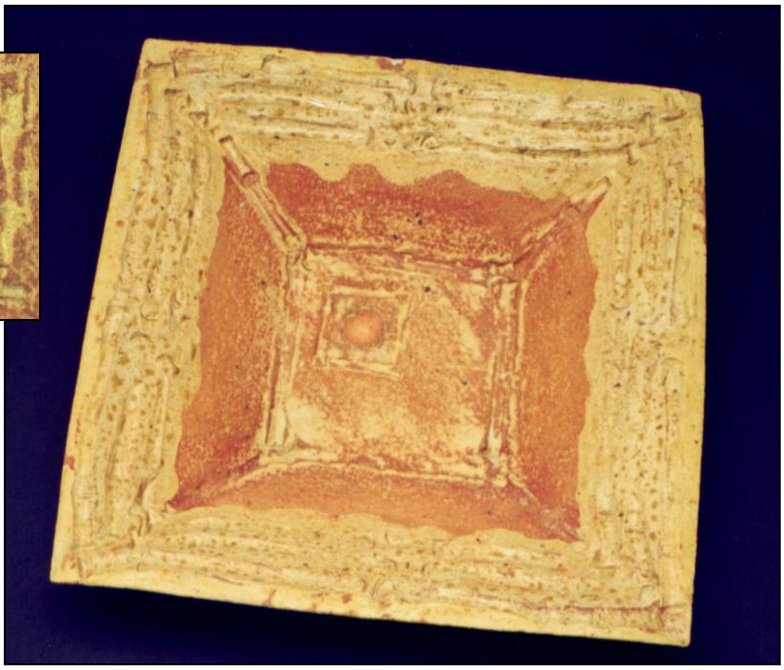


Figure 79:
Large square bowl in Raku clay with detail of 'halo' effect on twig motif
[Photography: Carol Metcalfe]

The Camberwell clay bowl features subtle glaze effects as shown in Figure 80 below. Here the glaze breaks over the texture produced by the impressions of the twigs, leading to variations in the colour produced from the single glaze (UB2.1) applied to it. The large square form did not prove suitable for the third type of clay used, Smooth Buff Stoneware, as it showed a tendency to slump and distort on firing.

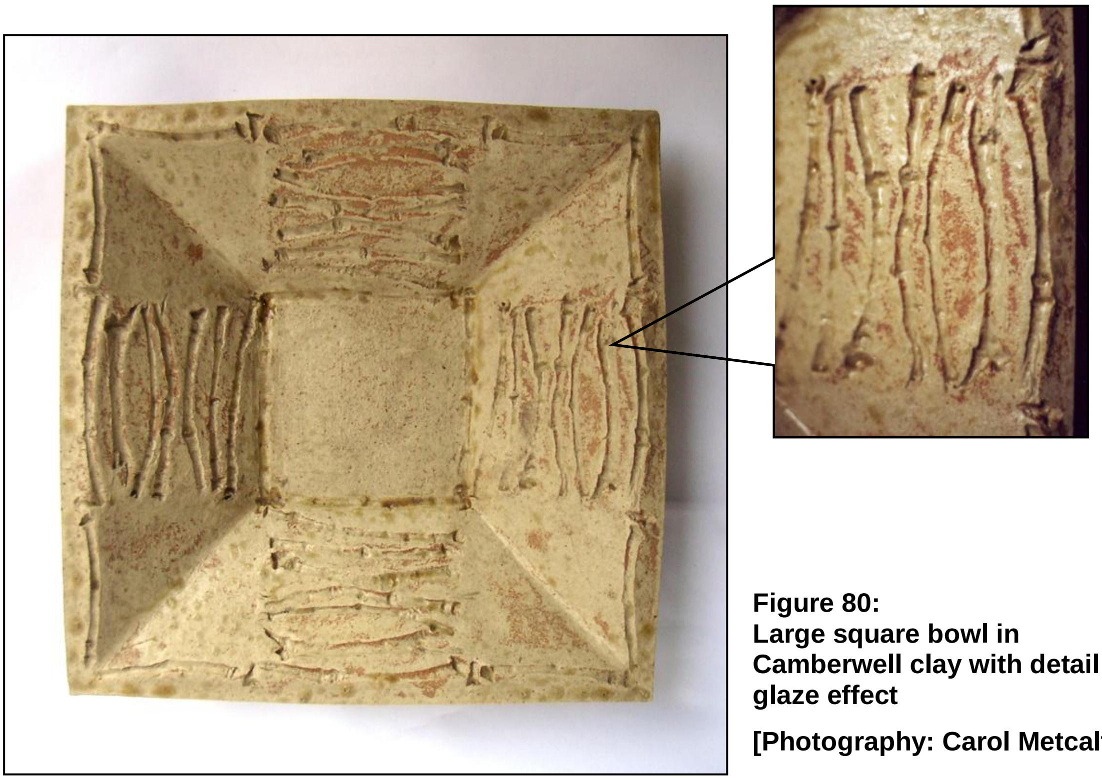


Figure 80:
Large square bowl in Camberwell clay with detail of glaze effect

[Photography: Carol Metcalfe]

Whilst the method of decoration used in the production of this series of bowls and the glaze effects achieved were successful, there were other practical difficulties. The manipulation of such large slabs into the mould was problematic, also the mould itself was very heavy and therefore was extremely difficult to move around. In view of the problems encountered, alternative smaller forms were sought.

7.5.2 Round bowls

A round bowl form in various depths, slumped into some existing plaster moulds of approximately 20cm diameter was explored. These pieces were decorated with impressions made with collages of found objects and waste materials. The edges were either left as rolled out or broken when leather hard to give an irregular rim. One bowl had torn sections of clay applied around the rim and feet were added to the deeper ones. These forms worked well especially those with feet, which lift the piece and add interest, creating interplay between it and the surface on which it stands, as shown in Figure 81 below.

Figure 81:
Adding feet to the piece creates an interesting interaction with the surface it stands on
[Photography: Carol Metcalfe]

Several round bowls were subsequently glazed with varying results. The piece with torn sections around the rim was the most interesting, providing two distinct areas on which to apply glazes, as seen in Figure 82 below. The same combination of dry and beaded glazes was used as in the large bowl in Figure 79 above. A seed head inspired the collage used to create texture in the centre of this round bowl. This technique of decoration is worthy of further exploration, as it allows the possibility of producing a repeatable effect and thus an element of control, on pieces where each form is individual.

Figure 82:
Round bowl in Raku clay with torn sections applied around rim
[Photography: Carol Metcalfe]

7.5.3 Small square plates

This exploration used smaller, more manageable slabs than the large square bowls. These were decorated with impressed textures from linocuts or fresh plant material, rolled into the surface. Rather than using a plaster mould, the slabs were shaped by being slumped into wooden frames. Whilst most of the pieces were made with straight cut edges, one was left as rolled out with irregular curves. This piece, shown in Figure 83 below, was made in Camberwell clay and decorated with a nettle plant, chosen as an extension of the concept of using waste materials from the farm, since it is a weed.

Contrasting glazes were selected, combining the dry rusty UB2.4 and the transparent UB2.9. Where the two overlap, a semi-opaque, whitish glaze effect results.

Figure 83:
***'Nettle Plate'* in Camberwell clay, incorporating irregular edges**
[Photography: Carol Metcalfe]

A selection of these plates was glazed but the results were very disappointing with the exception of the *Nettle Plate* with its irregular shaped edge and poured glazes. Reflecting on this series, I concluded that the sharp, square cut edges and linear lino cut design used in most of the pieces were at odds with the qualities of the new glazes and that more organic forms were needed. It was also decided to try some deeper frames for the slumping and to add feet as in the round bowls.

7.5.4 *Squarish* plates and dishes

Following on from the previous experimental form, a further square form was developed with irregular edges left as rolled. The Raku and Camberwell clays were chosen for this as they contain grog and respond well to this treatment, sometimes developing cracks along the edges of the slabs. The borders of these pieces were textured, leaving the centres smooth. Further examples of arable waste products, namely chaff and weed seeds dressed out of the crops, were rolled into the surface of the clay and found to be ideal for creating the textures. Experiments were also made in the shaping of the pieces, using deeper frames for the slumping and adding a variety of feet. In addition, a rectangular frame was used to develop a long version of this design.

Various combinations of glazes were used and different methods of application employed; dipping, pouring, and sponging. Some pieces had local clay, ochre or copper carbonate applied under the glazes, to add colour options. The local clay gives a yellowish brown and the ochre a deep reddish brown. These materials again formed a link to the place where they were collected. The copper carbonate was selected to provide green, appropriate to the plant material being incorporated in some of the decoration. As shown in Figure 84 below, some of these dishes provided interesting and encouraging results. Initially there was a minor problem of the forms sagging a little during the glaze firing. It was possible to allow for this by initially making them slightly deeper than required.

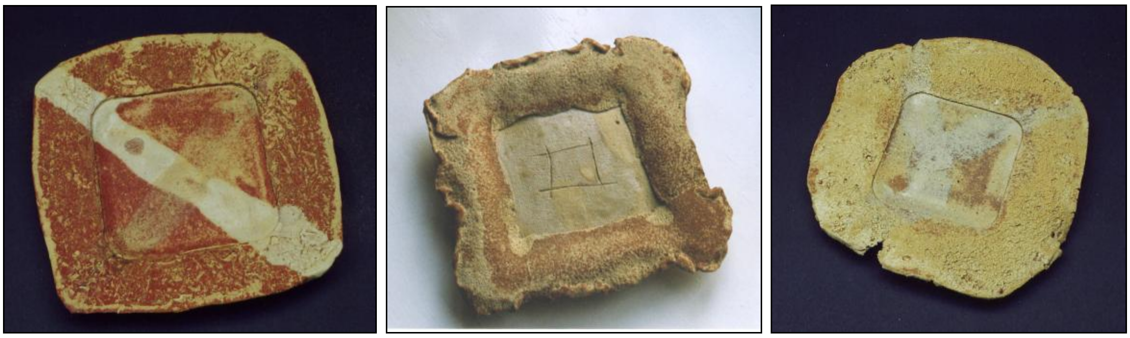


Figure 84:
A selection of *'Squarish'* pieces, textured with chaff, coffee grinds and weed seeds
[Photography: Carol Metcalfe]

These initial experiments with the *Squarish* form led to the production of the *Flow Series* and the *Plant Plates* (see Figure 85 & Figure 86, p.131). This form was also used for the figurative experiments described in Section 7.5.9 (p.135). The *Flow Series* of plates and dishes were decorated by pouring of ochre, local clay and the ash glazes, bringing a distinct element of chance into the finished result, though an approximate repetition is possible. The resulting flows are reminiscent of structures and patterns observed in stones and stone gateposts, weathered for many years and colonised by lichens.

The *Plant Plates* feature the imprint of an actual piece of plant material, collected on the farm, which is rolled into the surface of the soft clay when the plate is being formed. After biscuit firing and before glazing, ochre or oxide was painted into the texture created by the burnt out plant, to add a hint of colour and so highlight its structure. The example in Figure 86 was slumped into the rectangular frame, an extension of the original *Squarish* idea.

Figure 85:
'Flow Dish' **approximately 23cm x 23cm**

[Photography: Carol Metcalfe]

Figure 86:
'Plant Plate' **featuring Dock plant, approximately 25cm x 15cm**

[Photography: Carol Metcalfe]

7.5.5 *Patchwork* small textured dishes

These pieces were shaped in smaller wooden frames, the slabs having been assembled from torn and textured strips of clay, patched and rolled together. Again waste materials from the crops were used to create texture and feet were added made from extruded coils. Figure 87 (p.132) shows the feet and the effect they create. Again glazes with the 'halo' effects were employed and this can be seen colouring the feet even though no glaze was applied to them.

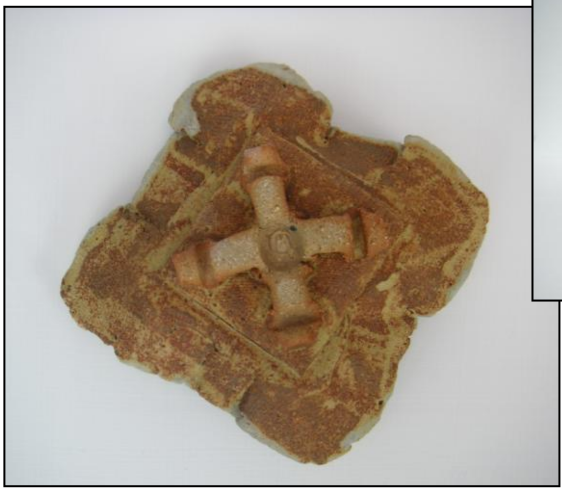



Figure 87:
The feet on the *'Patchwork'* dishes showing the effect they create

[Photography: Carol Metcalfe]

The encrusted textures bring to mind rusted and corroded metalwork and the richly coloured glazes chosen echo this. The bluish tinges seen on galvanised metal objects led to the application of copper carbonate under the glaze on some pieces. Figure 88 below shows the colour range in a selection of these dishes.

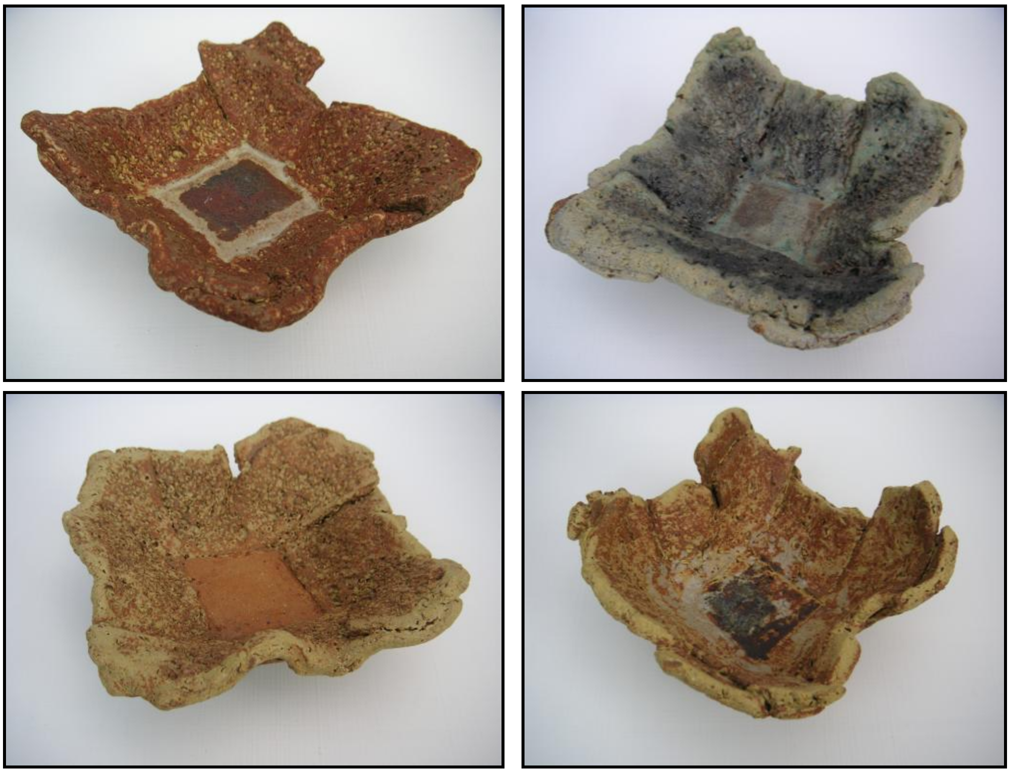


Figure 88:
A selection of *'Patchwork'* textured dishes, approximately 15cm x 15cm

[Photography: Carol Metcalfe]

7.5.6 Extruded *Tall Pots*

Both round and square extruded sections were considered for the development of a tall form to explore the use of the new glazes on vertical surfaces. The first potentially successful piece is shown in Figure 89 and incorporates a top section formed in the same way as the *Patchwork* dishes. Poured decoration was used on the sides using glaze UB2.1. The piece also had feet added to emphasise the tall form.

Figure 89:
***'Tall Form'*, extrusion with textured irregular top section. Height approximately 40cm**

[Photograph: Carol Metcalfe]

Reflecting on this piece, it was decided to develop the design to contain the torn edges within the top and side panels, keeping the top edge square to echo the base, in the next pieces produced. These squared off and bevelled edges were produced with a profile cut into the corner of a discarded credit card. This tool was drawn along the edges of the clay during the joining process, when adding the base and top to the extruded section. The *Tall Pots* series developed from this idea, including examples decorated and textured by several of the methods used for the plates and dishes described above. As shown in Figure 90 (p.134), some pieces also involved assembling sections of the extrusion to alter the sides of the pots before the top and base were added.

Figure 90:
Examples from the *'Tall Pots'* series

[Photography: Carol Metcalfe]

7.5.7 Lidded boxes

These forms were a direct development of the *Tall Pots*, exploring the incorporation of a lid. Only five pieces were produced, as it was not felt that the lid enhanced the design particularly.

Figure 91:
Lidded box developed from *'Tall Pots'*

[Photography: Carol Metcalfe]

7.5.8 *Patchwork* plates

The textures and colours used for these plates were the same as for the *Patchwork* dishes described in Section 7.5.5 above. The slabs were also assembled in the same way as for those dishes however the edges were then squared off and bevelled using the method developed for the base and top of the *Tall Pots*, described above. The texture and torn edges are thus confined to the surface of the plate within the controlled edge, creating a satisfying balance of control and serendipity. The coarse textured Raku clay was used so that the scraping of the edges also created a textured finish in keeping with the other surfaces of the piece. A variety of found materials; debris and small pebbles sieved out of the ash, weed seed and dressings from the crops were included to create the textured surfaces. The plates were formed in a shallow wooden frame and a variety of feet applied once they had dried just sufficiently to hold their shape.

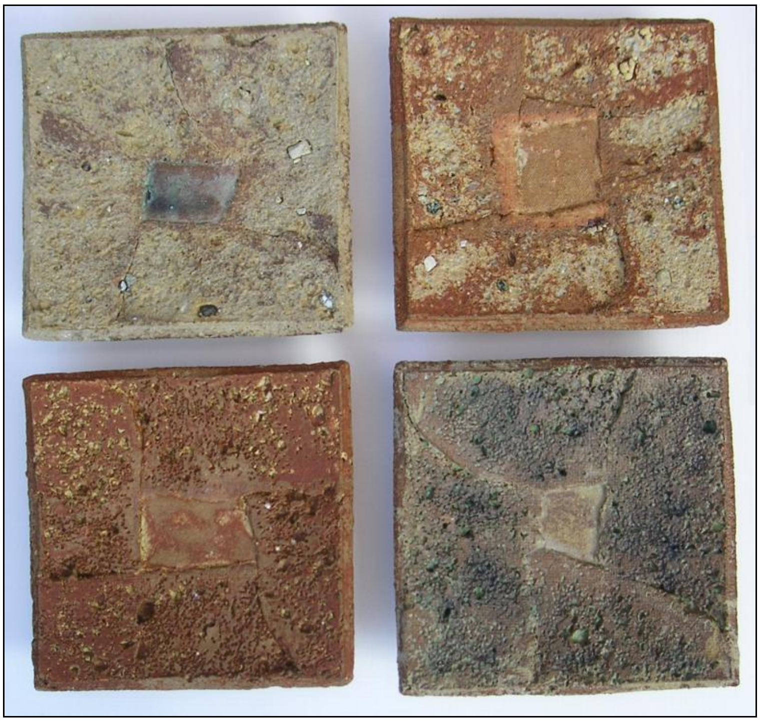


Figure 92:
***'Patchwork Plates'*, approximately 15cm x 15cm**
[Photography: Carol Metcalfe]

7.5.9 Figurative decoration – A new style of work

Whilst taking part in the collaborative project with Eric James Mellon, detailed in Section 6.6 (p.108), the opportunity arose to study Mellon's figurative approach to oxide drawings and then to experiment with decorating three of my *Squarish* forms, described in Section 7.5.4 (p.129), using this technique. The subject matter chosen was a wild flower that grows as a weed in the hedgerows on the farm. These three pieces had already been biscuit fired to 1000°C and, after decoration, were glazed with recipes selected from the new range just developed in the collaborative project. They were glaze fired in Mellon's gas fired kiln, following his reduction-firing schedule to the same temperature as the tests carried out during the collaboration. Figure 93 below shows one example made in Raku clay and decorated with a 2:1 mix of cobalt and copper oxides. This piece is included in Mellon and Foster (2007, p.136)

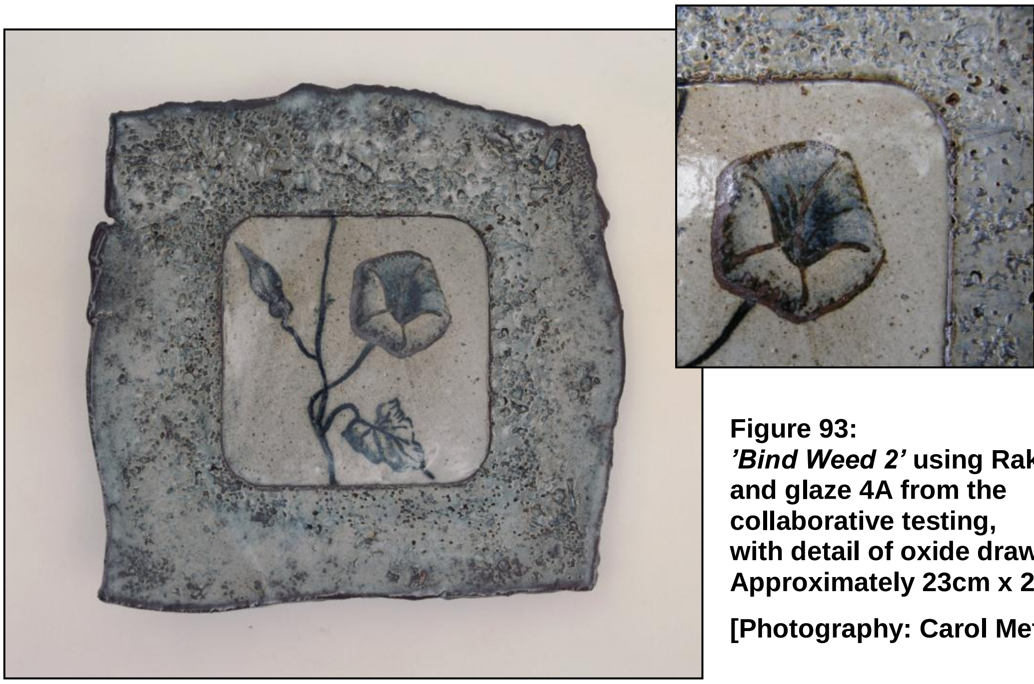


Figure 93:
***'Bind Weed 2'* using Raku clay and glaze 4A from the collaborative testing, with detail of oxide drawing. Approximately 23cm x 23cm**

[Photography: Carol Metcalfe]

This series of plates was later extended, using new glazes suitable for this style of work selected from the testing in Chapter 5, Section 5.9.1 (p.87), including:

- UB2.19
- UB2.9

7.6 Dissemination of the outcomes

The findings of this research have been disseminated by various means, detailed below. Some of the artworks developed have also been included in exhibitions or shown in galleries, thus bringing the outcomes of the research to the attention of others not only within the field but also in the public domain.

7.6.1 Collaboration with other ceramicists

Contact with the ceramicists selected for the case studies, described in Chapter 6 (p.92), gave the first opportunity to disseminate information gained from this research. The interest shown by these established artists gave rise to further sharing of information through collaborative work, detailed in the same chapter, which in turn influenced the artworks produced, in a cyclical process.

The collaborative project with Mellon and my involvement with his new book (Mellon & Foster, 2007) resulted in my being invited to speak about this research at the York book launch in June 2007. The poster for this event is shown in Figure 94 below and is based on the front cover of the book.

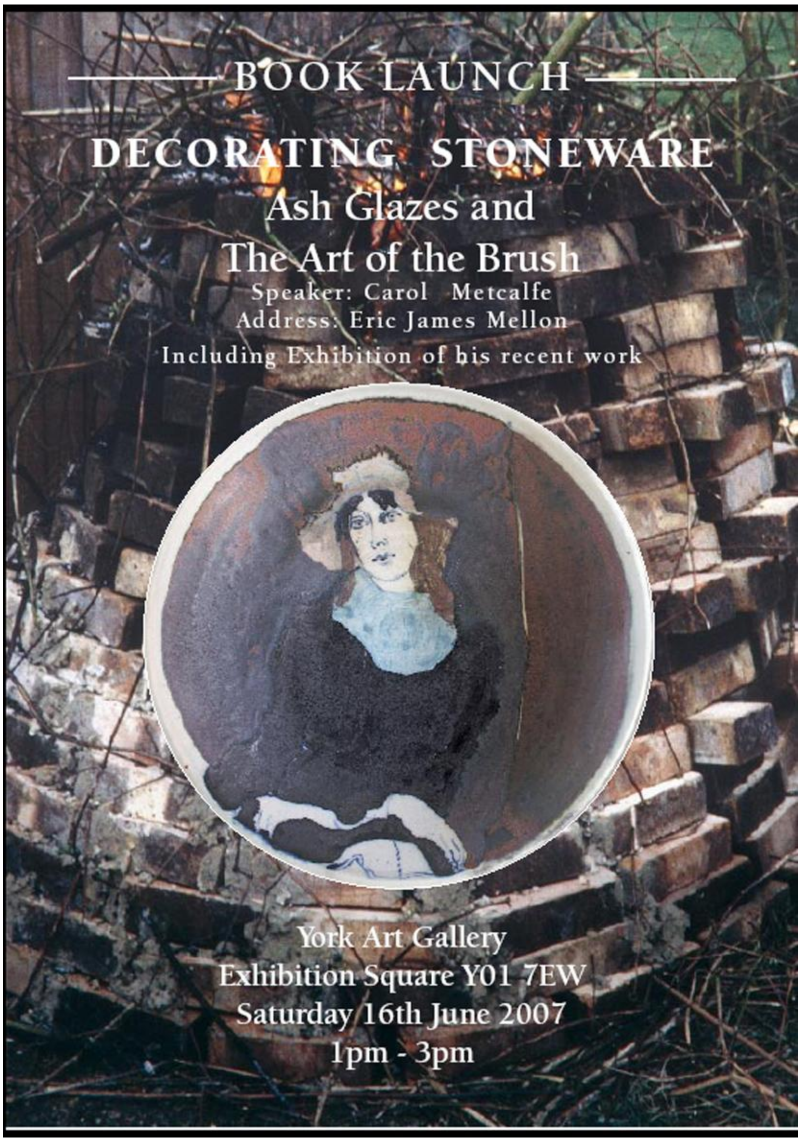


Figure 94:
Poster for the York launch of Mellon's new book

7.6.2 Articles and presentations

Articles based on the outcomes of this research and illustrated with images of the artworks developed, have been published in *Ceramic Review* (Metcalfe, 2003 & 2004), giving an opportunity to begin dissemination of the outcomes as they became available. Copies of these articles can be found in Appendix V (p.174). An image of one of the artworks was also chosen by *Ceramic Review* to illustrate an article about the *Northern Fire* exhibition at the Oxo Tower Gallery, London, described in Section 7.6.4, below (Berkowitz, 2005).

The artworks described in this chapter have been used to illustrate presentations given at various events, details of which are given in Section 8.2.2 (p.153). These events were an opportunity to introduce the work to a more academic, and in some cases international, audience.

7.6.3 Galleries

Galleries selling contemporary ceramics were approached with regard to showing the new artworks on a sale or return basis. The work was well received, resulting in various pieces being accepted. The Red House Gallery, Bedale, took a selection from the *Flow* series in 2005 (see Figure 95) and a range of the *Tall Pots* was in the Phoenix Gallery, Richmond in 2006. I have been invited to submit further work to both these outlets.

Figure 95:
Rectangular *'Flow'* dish sold through Red House Gallery.

[Photography: Carol Metcalfe]

In 2005, through the Northern Potters' Association, examples of the *Plant Plates* were included in an on-going sales cabinet display within the foyer of the Theatre Royal, York. A wider range of pieces was shown within a group exhibit in the foyer of the Arts Centre, Darlington (see Figure 96 below).

Figure 96:
New artworks on show in the foyer of the Arts Centre, Darlington

[Photography: Carol Metcalfe]

7.6.4 *Northern Fire* exhibition, Oxo Tower Gallery

Work has also been exhibited in the Oxo Tower Gallery, London, again in a group exhibition with the Northern Potters' Association, which gave an opportunity to disseminate the outcomes of the research to a much wider audience (see Figure 97).

Figure 97:
New artworks in the *'Northern Fire'* exhibition, Oxo Tower Gallery

[Photography: Carol Metcalfe]

Several images of the new artworks were selected from those submitted for the promotional materials and featured in the advertising for the event. These are indicated in Figure 98 below.

Figure 98:
Promotional material for the *'Northern Fire'* exhibition
(New artworks featured are circled)

There was also the opportunity to distribute information about the research in the form of an artist's statement displayed next to the work and a leaflet for visitors to take away. These items are included in Appendix XI (p.222).

7.6.5 Selected exhibitions

In 2006, some of the artworks were submitted for selected exhibitions, also through the Northern Potters' Association. The work was very well received, by the selectors, who included experienced ceramicists as well as representatives from the galleries. The great majority of pieces submitted were selected for inclusion in the exhibitions, resulting in *Tall Pots*, *Patchwork Plates, Patchwork Dishes* and some of the lidded boxes being shown in the *Freshly Fired Biscuit* exhibition at The Biscuit Factory, Newcastle and the *Servant of the Sun* exhibition at the Blandscliff Gallery, Scarborough (see Figure 99). Details of these exhibitions can be found in the promotional materials in Appendix XI (p.222). Shirley Sheppard, owner of the Blandscliff gallery requested further work for the 2007 season.

Figure 99:
New artworks exhibited at Blandscliff Gallery, Scarborough

[Photography: Carol Metcalfe]

7.7 Reflection on the body of work

In addition to the comments made on the individual pieces in Section 7.5 (p.125), the varied body of artwork, as a whole, has led to reflection in a number of directions and at different levels.

7.7.1 Implications of the outcomes for my art practice

On a personal note, I have found the production techniques developed during this research, in response to the new glazes produced, very rewarding. The combination of serendipity with a certain control gives each piece its individuality and I feel that this method of working has great potential for further design developments using the new glazes. The collage technique of decoration is also worthy of further exploration and will be assimilated into my art practice, as will the figurative style of decoration used in the *Bind Weed* plates. The emergence of a strong theme connecting the artwork to its place of origin is a valuable outcome that will no doubt continue to develop through future work. The research has thus strengthened and furthered my own art practice in directions that may well not have been explored otherwise and will continue to influence the development of my work.

7.7.2 Other practice relating to the theme of place

Reflection on the emerging theme of the artworks led to an examination of the role of places and landscape in the work of other ceramic artists. Many ceramicists use their artworks as a vehicle to record a visit, convey a message about the place or capture its essence or atmosphere. Forms and processes vary from figurative to the incorporation of actual materials from the environment and may also involve the use and extension of traditional ceramic techniques.

Figurative items like Sunderland lustre ware traditionally celebrated events or landmarks and promoted the industries of a particular place, as shown in Figure 100 (Shaw, 1973).

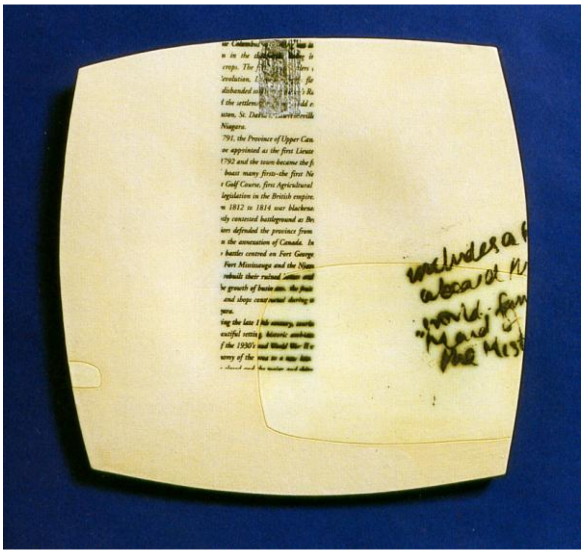
Figure 100:
Sunderland ware commemorating the building of the Cast Iron Bridge (Shaw, 1973, front cover)

In the contemporary field, Paul Scott uses the blue and white figurative style of the traditional Willow pattern but, in contrast to the original idyllic fantasy imagery, industrial landscapes are his subject matter as seen in Figure 101 below (Scott, 2001, p.147). In this way he comments on topical issues like nuclear power generation and the pollution it can cause. Scott also uses relief techniques to record images of buildings in clay, drawing and carving into the surface (Scott, 2001, p.131).

Figure 101:
***'Seascale' Pigeon* by Paul Scott, diameter 25cm (Scott, 2001, p.147)**

In 1998, Kevin Petrie produced transfer printed plates featuring sketches of places visited. The sketchbook theme is reinforced by means of *trompe l'oeil* effects, referencing a technique used in 18th century ware (Scott, 2001, pp.123 & 152). Figure 102 shows one of the pieces, on which the image of a length of masking tape appears to attach the sketch to the plate. This plate, which records a location visited in Paris, was also included in Petrie's PhD thesis (Petrie, 1999, p.72). The processes used were described in an article in *Ceramic Review* (Petrie, 2001).

Figure 102:
***'Springtime in Paris'* by Kevin Petrie**
(Scott, 2001, p.123)



Fiona Thompson, a fellow researcher at the University of Sunderland, also uses print, in the form of photo imaging, in her work, which relates to specific places with reference to tourism. Text is often incorporated into the prints.

Figure 103:
Screen-printed ceramic plate by Fiona Thompson, 2004

Jim Robison's response to the places and landscape surrounding his home in Yorkshire was described in the case study in Section 6.3.4 (p.102). Similarly Syl Macro of Stokoe House Gallery, Alston, depicts the surrounding landscapes of the North Pennines. Unlike Robison however, her technique is to use unglazed coloured clays to build the imagery, as shown in Figure 104 (p.144).

Figure 104:
Landscape tryptych by Syl Macro, shown at *Potfest in the Park* 2006
[Photography: Carol Metcalfe by kind permission of Syl Macro]

Genders (2002, pp.122-125) describes the work of Peter Lane whose simple vessel forms are airbrushed with colours that capture the atmospheric qualities of landscapes – mountains, skies and sunsets – as shown in Figure 105. In his work Lane tries to convey the feelings he has experienced when observing inspirational landscapes. Lane (1988, p.205) explains that although he makes vessels, function is peripheral, the primary purpose of the pieces being to express a visible statement of his feelings.

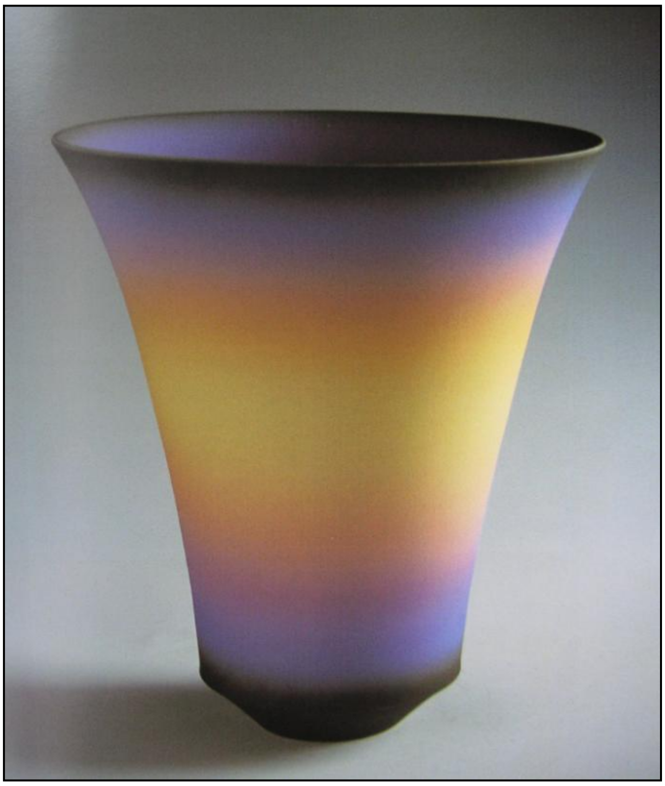


Figure 105:
Vessel by Peter Lane, inspired by sunset
(Genders, 2002, p.122-125)

Ashley (2006) describes the work of Andrew Palin, a relative newcomer to ceramics. Palin uses volcanic glazes on his vessels to represent characteristics from the landscape and textures found in the natural environment, capturing the essence of the place. He studies and documents the remnants of architectural forms as well as rock formations and coastal erosion, making detailed photographic records of sites visited, in locations ranging from Scotland to Jordan to Australia. For each of Palin's vessels there is a photographic counterpart, locating it in a specific place.

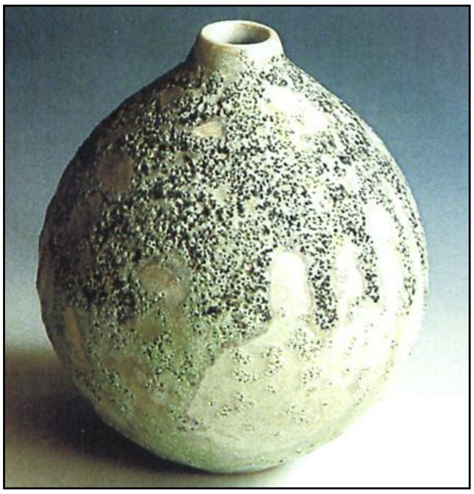


Figure 106:
***'Copper Bottle'* by Andrew Palin. 15cm x 12cm (Ashley, 2006, p.89)**

Lane (1988, pp. 204-205) describes the work of UK artist Tony Franks whose heavy vessel forms are used as a vehicle to investigate the relationship between geology, landscape and memory. Each piece refers to a specific location. Fragments of found materials, for example mosses, leaves, heather or ferns, are mixed with the clay and leave cavities when they burn out during firing. A further connection is made by the inclusion of crushed rocks from the site either as grog or colorant (see Figure 107 below). With the surface of the work, Franks attempts to capture the structure and geology of the place, as well as its climate, atmosphere and changing mood, through various processes from sandblasting to burnishing.

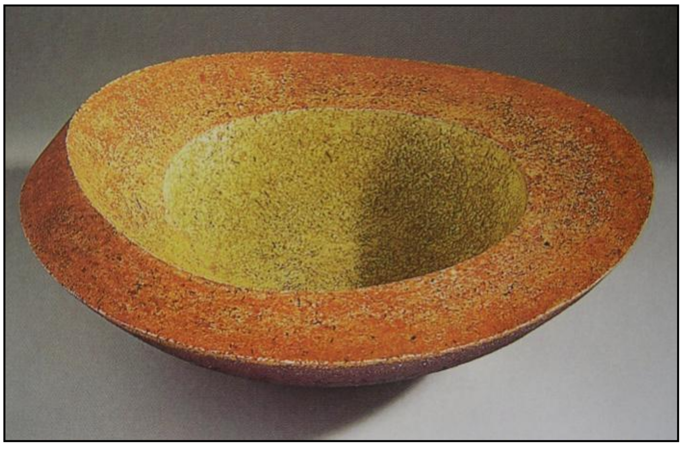


Figure 107:
***'Godfrey's Hill'*, bone china bowl by Tony Franks, diameter 53cm (Lane, 1988, p. 204)**

David Binns (2006) has recently been working on a planned research project exploring the use of aggregates in clay bodies. In the course of the research he has become interested in the idea of making pieces incorporating granular mineral material collected from a particular location thus *"giving each piece of work a sense of place or belonging"*. Pieces have been made using beach shingle from the east coast of England, grey granite from North Wales, and pink granite from Tasmania.

Figure 108: Group of 3 standing forms by David Binns, containing aggregates. Max. height 40cm (Binns, 2006, p.62)

US sculptor Barbara Sorensen references the figure and the landscape and how they relate to each other in her large-scale work (see Figure 109). Sometimes she embeds stones she has collected into the surface of the clay. These bubble and burst in the firing process, emulating volcanic activity (Mansfield, 2005, pp.125-127).

Figure 109: *'Capistrano',* installation by Barbara Sorensen in Colorado, with detail of texture (Mansfield, 2005, p.126)

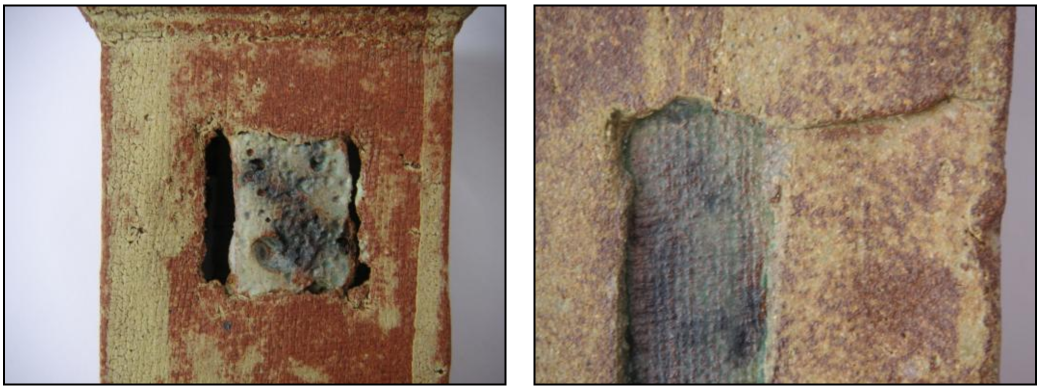
Renate Balda also makes the clay cracked and fissured by pressing small pieces of slate or tiny stones into the surface and mixing other materials into it. The value of chance is an essential element in her work. Balda's sculptures however relate to the landscape in a different way. She works with cylindrical forms that correspond to her idea of the course of life, but the sculpture is not complete until she finally places the pieces in the landscape, as shown in Figure 110 (Mansfield, 2005, p.188).

Figure 110:
'Columns in the Landscape'
by Renate Balda, tallest 2.1m
(Mansfield, 2005, p.188)

The responses to places found within the field of contemporary ceramics are many and varied; some relating closely to the artworks developed in this research, others where the approach is very different. The examples given here provide a framework, used in the next section of this chapter, when considering the position of the new artworks within the field. The concern with place has been an unforeseen but very welcome development to emerge from the research, illustrating the evolutionary nature of art practice research.

7.8 The position and significance of the artworks

In conclusion of this chapter, the position and significance of the artworks within the contemporary field of studio ceramics are considered. The position of the new artworks can be located in relation to relevant examples of practice, both within the field of existing ash glazing and around the theme of landscape and place. A framework for this is provided by the case studies, Dodd, Ehrenreich, Mellon and Robison, in Chapter 6 (p.92) and by the review of other artists' work in Section 7.7.2 of this chapter. The position of both the figurative and textural pieces have been considered demonstrating the wide range of new artworks explored.



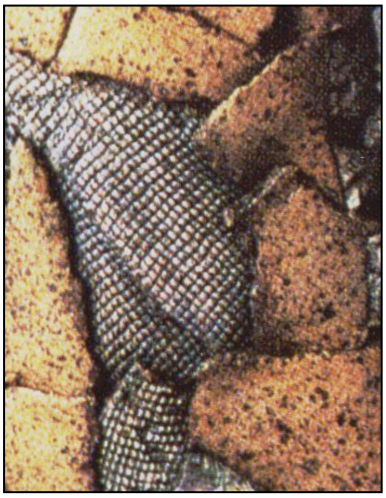


Figure 111:
Details of textures and richly coloured dry glazes on *'Tall Pots'* from this research (above) and a vase by Jim Robison (right)

[Photography: Carol Metcalfe]

The rugged style, textures and dry glazes of many of the new artworks echo features in Robison's work, as can be seen in Figure 111 above. His work however, is reduction fired, whilst an electric kiln was used in this research. Interestingly, rich colouring was still produced without reduction firing, an outcome that Robison himself found surprising when he examined one of the *Patchwork* dishes. The extruded and slab rolled production techniques used and the connection with place also find parallels with his approach.

The inclusion of found materials and plant material in the new artworks from this research compares with the work of Franks and Binns. Of particular significance, is the link forged between the artwork and the location where the materials have been collected, a factor in both these artists' work.

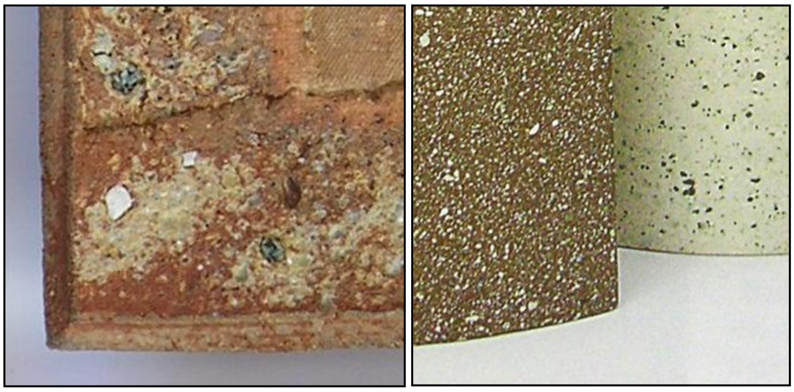


Figure 112:
Details of:
found materials included in the surface of *'Patchwork Plate'* from this research (left) & aggregates incorporated into David Binns' work, (Binns, 2006)(right)

[Photography: Carol Metcalfe]

By contrast, the range of new artworks also includes figurative pieces, using oxide drawings under transparent ash glazes, following principles advocated by Mellon, described in Section 6.3.3 (p.100). These drawn images also have something in common with the drawings Petrie produces, from which his transfer prints are produced. The shiny transparent glazes selected for use on the initial figurative pieces were developed in collaboration with Mellon (see Section 6.6, p.108). They have similar shiny transparent surface qualities to the ash glazes used by Ehrenreich over her coloured slip patterns (see Section 6.3.2, p.97). Her glazes however produce areas of volcanic texture not seen in the new glazes developed. The textures in the new artworks are within the clay itself. Figure 113 illustrates these observations.

Figure 113:
Details of: oxide drawing by Eric James Mellon (left), *'Bind Weed 2'* plate developed in this research (centre), coloured slip patterns by Lis Ehrenreich (right)

[Photography: Carol Metcalfe]

For a wider appreciation of the new artworks, the submission of work to galleries and exhibitions was used in order to access a realistic, and hopefully unbiased evaluation in a naturalistic situation. The selection of a wide range of the pieces by commercial galleries and exhibition selectors leaves no doubt that the qualities of the new glazes are acceptable within the contemporary field. It was decided not to adopt the approach of Malins (1993), who used a peer review survey with questionnaires to evaluate the outcomes of his research. This approach, comparing his new lustre glazes with examples produced by existing procedures, was acknowledged as problematic. The survey was very time-consuming for respondents, so a low number of totally completed questionnaires were received from some groups of participants. Marshall (1999) also used peer review to evaluate his artworks. He selected a group of respondents from the contemporary field, leading to a totally contrived situation. By contrast, the involvement of commercial galleries provided a real life setting for this research, where the artworks literally ‘took their place’ in the contemporary field. Furthermore, through the case studies and collaboration, established artists have shown considerable interest in the research as a whole, confirming its significance and value to others within the field.

8 Conclusions and areas for further research

This chapter brings together the conclusions of the research and relates them to each of the three aims identified at the outset. The implications for my own art practice are also evaluated and the contribution to knowledge stated. The identification and discussion of possible areas for further research are presented followed by the final remarks.

8.1 Conclusions relating to Aim 1

➤ To develop a range of new glazes, for lower stoneware temperature (1240°C, Cone 7) oxidised firings, using ash from arable crop waste as an environmentally sensitive ingredient.

8.1.1 A range of new glazes

This research set out to determine what glaze effects could be achieved using pea and bean ashes. The aim was to develop the widest possible range, rather than attempt to replicate particular existing ash glazes using the new sources of ash. An extensive catalogue of over forty new ash glazes has resulted, the recipes and full details of which are located in Appendix X (p.213). The new glazes display a wide variety of surface qualities from dry and textured to shiny and transparent to matt and opaque. The bean and pea ashes investigated proved to be versatile glaze materials.

8.1.2 Lower stoneware temperature oxidised firings

All the new glazes were produced in lower stoneware temperature, oxidised firings. The use of oxidised firings makes it possible to produce the new glazes in the electric kilns used by many ceramicists today. Furthermore, the use of lower firing temperatures than those traditionally used for ash glazes represents significant fuel savings whichever type of kiln is used (see Section 1.4, p.14).

8.1.3 Arable crop waste as an environmentally sensitive ingredient

The ashes used in this research were obtained from the waste material left after the harvest of arable crops. Such material is available locally and is therefore environmentally advantageous in terms of ‘carbon footprint’. Other materials that might perform the fluxing action provided by the ashes, for example feldspars, would have to be mined, milled and packaged then transported long distances from various parts of the world. This factor, combined with the fuel savings described in the previous section, give these new ash glazes clear environmental benefits.

8.2 Conclusions relating to Aim 2

- To demonstrate and articulate the possible creative, practical and environmental benefits of the new glazes, for contemporary ceramic practitioners, principally through artworks.

8.2.1 Demonstrating the possible benefits of the new glazes

The issues of concern surrounding ash glazes were identified in Section 1.4 (p.14), where the difficulties of obtaining a supply of ash were outlined. As demonstrated in Chapter 2 (p.28), the arable crops investigated have yielded plentiful, reliable and unadulterated supplies of ash that were easily prepared to provide a major ingredient of the new glaze recipes.   Furthermore, the supply is repeatable, to an extent, from year to year, as shown by the analyses in Section 3.2.6 (p.50).

The whole range of new glazes is nevertheless of little benefit to the contemporary ceramic practitioner unless these glazes can be shown to be of practical use in the studio. Artworks have been developed demonstrating the creative potential of several of the new glazes (See Section 7.5, p.125). These new artworks include shallow plates and dishes as well as taller pots and have allowed the behaviour of the glazes on both horizontal and vertical surfaces to be explored. They also offered the opportunity to employ a variety of methods of applying the glazes – pouring, dipping, brushing – and to investigate the outcomes when glazes were overlapped.

All the glaze tests and the artworks (with one exception described in Section 7.5.9, p.135) were produced in the electric kiln, proving the practicality of the oxidised firings. The environmental benefits the new glazes demonstrate have already been identified and discussed in relation to Aim 1 above.

8.2.2 Articulating the possible benefits of the new glazes

Dissemination of the research findings has been achieved through various channels during the research, as well as at its conclusion. Presentations about the research have been given at national and international conferences. These include *Atoms to Art* in 2006 and two events organised by The Society of Glass Technology, *New Researchers Forum on Glass* in 2002 and *Glass: The Art of Science*' in 2006, allowing an update on the progress of the investigation. Linked with the Society, a case study of the research appeared on the European Society of Glass Science and Technology website, accessing another medium by which to convey the findings to a worldwide audience (www.esg2006.co.uk/metcalfe.html).

During the course of the research, articles have also been published in *Ceramic Review* magazine, illustrated with images of the test tiles and new artworks and with charts produced from the ash analyses (Metcalfe 2002 & 2004). In this way information derived from the analyses and empirical testing has been articulated internationally to others in the field, as it became available.

Crucially, the new artworks developed have been exhibited in several galleries, indicating that they are of acceptable quality in the ‘real world’ of the contemporary field. Only through the development and presentation of a resolved body of artwork could access be gained to this professional evaluation of the outcomes. The results of the research have thus been made available to other ceramic practitioners and the background to the pieces communicated through artist’s statements displayed with the work (see Appendix XI, p.222).

The benefits of the new glazes and information gained from this investigation have also been shared through the collaborations with Mike Dodd and Eric James Mellon, as described in Chapter 6 (p.106). As a result, further creative possibilities have been demonstrated through the artworks produced by these ceramicists using the new ashes and glaze recipes. The outcomes of the collaborative glaze-testing project carried out with Mellon are included in a new book about his life’s work, published in May 2007 (Mellon & Foster, 2007). As I had contributed charts from the analyses in this research, to illustrate the book, I was invited to speak at the launch of the book in York. This offered a further excellent, if unforeseen, opportunity to articulate the benefits of the research findings. The interest shown by these established ceramicists is a measure of the value and benefits of this research for contemporary ceramic practitioners.

By disseminating the outcomes throughout the research period, feedback has been received from various different perspectives. The resulting ‘triangulation’, combining opinions on the outcomes, confirms the value of the research far more strongly than the views of a researcher alone could ever do. Figure 114 illustrates how the process applies to the outcomes of this research.

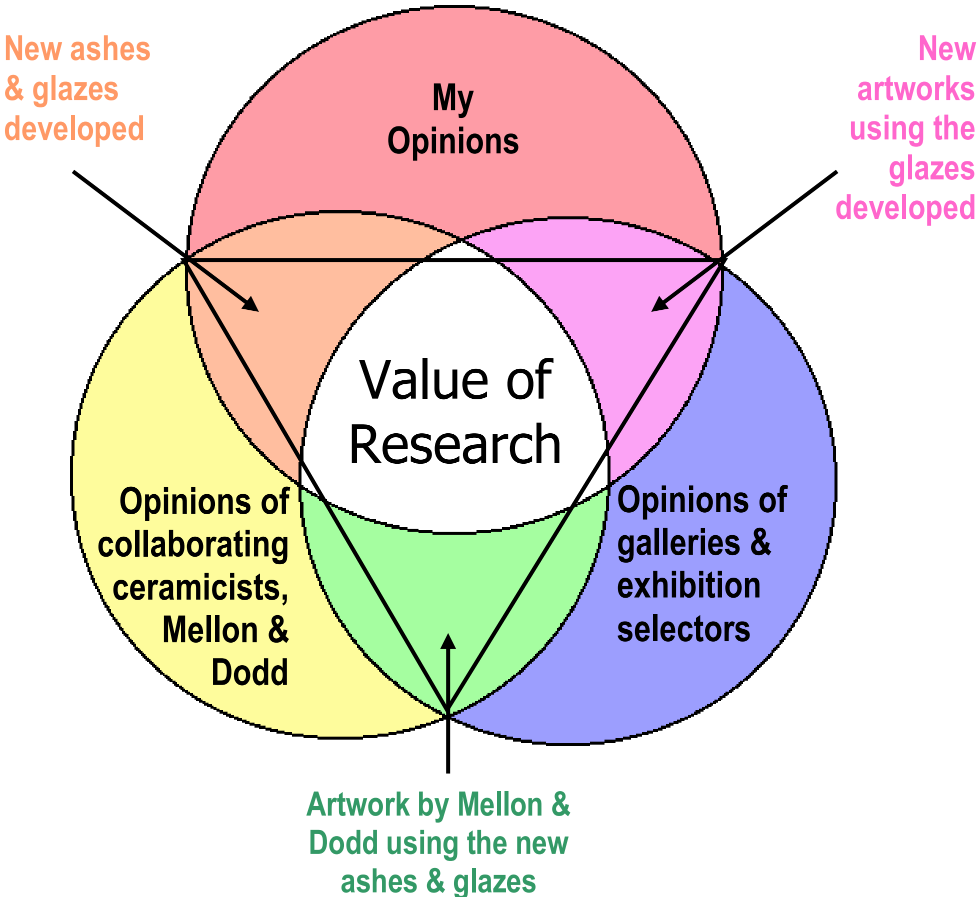


Figure 114:
Triangulation combines different perspectives on research outcomes, confirming the value of the research

This thesis forms a significant part of the dissemination of the research, articulating the outcomes in a permanently available publication. Due to the evolutionary nature of art practice research, the contextual review has been on-going not only in terms of keeping up to date but also in the breadth of the subject matter required. It was therefore decided to include the relevant information in each chapter and review it in context. This approach was possibly one of most controversial aspects of the methodology chosen. I have nevertheless found it to be very workable and dynamic, avoiding a long and disjointed contextual review of disparate subjects at the beginning of the thesis.

8.3 Conclusions relating to Aim 3

- To offer a model for investigating the potential of a new source of ash, as a glaze material.

The ever-changing availability of crops, discussed in the introductory paragraphs of this thesis (Section 1.1, p.2), identified the need for a model of practice applicable to any new source of ash. The methodology, which has evolved as a result of this practice-led investigation, provides transferable knowledge, relevant to other practitioners involved in ash glaze development in other locations and using other ashes. The following sections review the four stages of this model; ash analysis, glaze calculation, focussed empirical testing and development of artworks.

8.3.1 Value of ash analysis

The analyses undertaken have proved very useful in both the planning and evaluation of the subsequent empirical tests. The work reported in Chapter 3 (p.36), based on comparisons of elemental constituents in a range of ashes, has led to a greater understanding of the new ashes' probable behaviour in glazes. Qualitative analysis provides a profile of the new ash characteristics in comparison with other ash samples whose effects in glazes are already known and thus an insight into its probable performance as a glaze ingredient. The value of this approach to the research has been confirmed when relationships between the analyses and firing behaviour have indeed been demonstrated in the subsequent tests and final pieces. The high levels of calcium in pea ash and resulting beaded textures in glazes containing a high proportion of this ash provide one example. The evaluation of the subsequent test tiles has been enriched by use of the qualitative analyses, since it can thus be established that certain characteristics of the glazes are due to a higher or lower concentration of a particular element in the ash. Understanding of the behaviour of the ashes in glazes is therefore greatly increased by the use of analysis in conjunction with empirical testing.

The knowledge gained from the qualitative analysis has also facilitated well-informed practical testing to explore what would actually happen in the kiln, by indicating other appropriate glaze ingredients to combine with the ashes. Quantitative analysis was also used to provide detailed results in the form of percentages by weight of the oxides present in the ash, figures that are essential in order to carry out glaze recipe calculations, as in Chapter 4 (p.56).

8.3.2 Value of glaze recipe calculation

Glaze recipe calculations provided a strong starting point for the empirical testing, by identifying suitable ingredients to combine with the new ashes and precise recipes that would result in balanced glaze formulations. These calculated balanced glaze recipes located a focal point around which to concentrate the blends of empirical tests, thus informing and facilitating the next stage of the research (See Chapter 4, p.56).

8.3.3 Value of empirical testing

Whilst the balanced glaze recipes calculated in the previous stage of the research model virtually guarantee a successfully fused glaze test, the range of surface effects would have been severely limited had only these recipes been explored. The advantage of devising blends surrounding the calculated recipes is that the widest potential of the new ash is investigated, especially when the blended recipes are applied to a variety of clay bodies. Each set of tests is capable of yielding a number of glazes, appropriate to a range of wares from tableware to sculpture, from which a selection can be made. The tests can be revisited at any time and further selections made as necessary (see Chapter 5, p.66 and images in Appendix IX, p.197).

8.3.4 Role of artworks in the model of investigation

As the final stage in the model for investigating a new ash, the development of artworks explores the true potential of new glazes for one’s own practice. Through reflection both during the making of the pieces and after firing, the behaviour of the glazes when applied to a variety of forms can be assessed. The effects of overlapping glazes or their application over colouring oxides or slips can also be investigated. Furthermore, a resolved body of artwork gives access to evaluation of the new glazes by the contemporary field, in the natural setting of galleries and selected exhibitions. The process of integrating a new source of ash into one's art practice can thus be accomplished following the model presented here.

8.4 Conclusions relating to my art practice

In addition to the aims set out for the research there have been further outcomes on a personal level. The production of pleasing ash glazes in my electric kiln is of particular importance, allowing me to make use of this ingredient in my work. The wide range of glazes developed makes it possible to juxtapose contrasting surface qualities and colours in the artworks, a strategy I find rewarding. The production techniques developed during this research, the collage technique of decoration and the figurative style of decoration used in the *On the Wild Side* series of plates, for example *Bind Weed 2,* (pp.135 & 136), will also be assimilated into my art practice. I feel a strong affinity with the combination of serendipity and a certain control that gives each piece its individuality. These approaches have great potential for further design developments using the new glazes.

The emergence of a strong theme connecting the artwork to its place of origin represents a major new dimension in my art practice that will no doubt continue to develop through future work. The textures and colours provided by local found materials or inspired by observations of the place are of great importance in the artwork. My approach is thus located with those in the contemporary field whose work encapsulates a sense of place, as described in Section 7.7.2 (p.142), and offers a further example of this genre. Overall the research has strengthened and furthered my own art practice in directions that may well not have otherwise been explored and will continue to influence its development.

8.5 Original contribution to knowledge

The original contribution to knowledge made by this research comprises:

- A more environmentally sensitive approach to ash glazing
  (See Section 1.4, p.16)
- Extensive analyses of a range of tree, bush and plant ashes not documented elsewhere, enabling comparisons to be made between different ashes and between washed and unwashed ash
  (See Chapter 3, p.36 and Appendix IV, p.173)
- A dual approach to glaze development, adapting existing established models for blending, for example the triaxial blend, to devise glaze tests focused around recipes calculated for the new ashes
  (See Chapter 4, p.56 and Section 5.2, p.72)
- An evaluation of glaze testing methods, in relation to the development of ash glazes (See Section 5.7, p.80)
- An extensive catalogue of over forty new ash glaze recipes for lower temperature (1240°C, Cone 7) oxidised firing, providing a wide range of surface qualities and representing a substantial fuel saving
  (See Section 5.9, p.87 and Appendix X, p.213)
- New glazes and sources of widely available, sufficiently consistent ash, relevant to a variety of individual approaches, as exemplified by the work of the established ceramicists, who have incorporated them into their practice, further illustrating the creative potential offered
  (See Sections 6.5, p.106 & 6.6, p.108)
- The development and exhibition of a series of ceramic artworks demonstrating creative uses of several of the new ash glaze recipes
  (See Section 7.5, p.125)
- A further individual approach to the theme of ‘place’ within the contemporary field of studio ceramics
  (See Sections 7.4, p.124 & 7.8, p.148)
- A practical four-stage model of exploration for the many other ceramic practitioners interested in this subject to follow, in order to develop their own more economical and environmentally sensitive ash glazes
  (See Section 8.3, p.155)

8.6 Areas for further research

During the course of the research, several different areas for further research have emerged.

8.6.1 Further development of artworks

The range of artworks produced in this research and detailed in Chapter 7 (p.122) indicate opportunities for further developments. Both the theme of ‘place’ and some of the production techniques developed merit further investigation. More of the new glazes developed could also be utilised since, within the timescale of this investigation, it was only possible to develop a resolved body of artwork exploring some of the new glazes selected from Chapter 5 (p.87).

There is also scope for further exploring the application of these new lower temperature (1240°C, Cone 7) glazes over figurative oxide drawings, like those on the *Bind Weed 2 Plate* (Section 7.5.9, p.135). Thus the use of high temperature glazes could possibly be avoided, representing a substantial fuel saving as well as offering the environmental benefits previously identified in Section 8.1.3 (p.151).

8.6.2 Further glaze testing

There are many areas in which further tests would be likely to extend still further the range of possible pea and bean ash glazes. This research has focussed mainly on the unwashed ashes, therefore the recipes in Test sets 2 and 3 could be repeated using washed ashes.

Whilst the tiles in Test set 1, incorporating feldspar, provided some useful recipes, it was decided not to pursue the quadraxial blend method, in view of certain difficulties identified in Section 5.7.1 (p.80). Further recipes using a range of feldspars could be developed using glaze calculations to investigate possible combinations of ash, feldspar and ball clay. A triaxial blend could then be applied. Alternatively some of the other methods of blending four materials, described in Section 5.1 (p.66), could be employed.

This research aimed to develop glazes for the lower stoneware temperatures. As a result, a number of the test tiles produced were under fired, the glaze not having melted at this lower firing temperature. At higher temperatures these recipes might well produce useful glazes and this is another possible area for further research, though not so environmentally beneficial.

Some of the test results observed from the collaborative project described in Section 6.6 (p.108), in particular the qualities of the pea ash glazes, raise questions as to the properties of this ash. These observations suggest further avenues for investigation in order to identify the reasons for the features noted.

8.6.3 Addition of colour

Colouring oxides are not traditionally added to ash glazes. Nevertheless, during the course of my earlier studies I explored this possibility. One of the linseed ash glazes developed was selected as a base glaze to which several colouring oxides were added. The resulting collection of colour blends and effects is shown in Figure 115. Many of the new ash glazes developed in this research could be used as a base glaze for similar experiments.

Figure 115: Blends of colouring oxides added to linseed ash base glaze shown on central tile

[Photography: Carol Metcalfe]

8.6.4 New Crops

In the constantly changing environment of agriculture within the EU common agricultural policy and the world economy, the crops grown have to evolve too. For example, in the 2006 season, a new leguminous protein crop, lupins, began to be promoted, as shown in Figure 116 (p.161). Finding out if its ash produces glazes similar to the bean or pea ash will prove irresistible. Millet for a limited specialist market, whilst not widely grown, will be available in my immediate locality in the 2007 season, offering another possible source of ash to explore. Moves to encourage the production of crops for bio diesel will also influence the plant species grown, as will possible changes in climate. Waste materials available to explore as sources of glaze material will therefore change.

Figure 116:
A field of lupins provides a new potential source of ash for future glazes
[Photography: Carol Metcalfe]

8.7 Final remarks

The aims established for this research have been met and in some aspects exceeded, making a contribution to knowledge comprising various elements. The areas for further research that have emerged during the course of this investigation indicate that this is a dynamic area in the field of contemporary ceramics full of research potential. In this way, the tradition of ash glazing can continue developing into the future, this research having woven just a few more, hopefully interesting, strands into the rich tapestry of its 3500-year history.

Appendices

I Plant species used in ash glazes

In order to place the species selected for investigation in context with others mentioned in the literature, it was necessary to do a study of some botanical texts. Three books were sourced, which provided the necessary information on the classification of plants and plant families (Heywood 1978, Kilgour 1987, Roberts 1986). This research has however shown that the composition of ash varies widely from species to species, in a way that does not seem linked to the botanical information. In the case of woody plants (trees and shrubs), the composition also varies according to the type of material burnt, for example the proportion of bark or small branches. The botanical information has therefore proved not to be crucial to the development of the thesis so it has been placed here in an appendix.

Plants are classified according to structural features. The plant kingdom is divided into groups called ‘phyla’ ranging from algae and fungi to more complex, higher plants such as the Spermaphyta or seed plants. Each phylum is divided into ‘classes’ of plants. The classes are divided into ‘orders’, which are in turn divided into ‘families’. Within each family, individual plants have a ‘genus’ and ‘species’ name, for example Vicia faba (the field bean).

Most plants whose ash has been used for glazes are in the Phylum Spermaphyta. There are however exceptions and records exist of the use of bracken and fern ash, plants of the Phylum Pteridiophyta (Burton, 1906, pp.88-89 & p.113 and Leach, 1962, p.161). The Phylum Spermaphyta accounts for approximately 65% of plant species and includes all plants that form seeds. Figure 117 (p.164) shows just some of the hundreds of plant families and species it contains, including those chosen for this research. Table 25 (p.165) lists plant species identified in the contextual review as having been used in ash glazes.

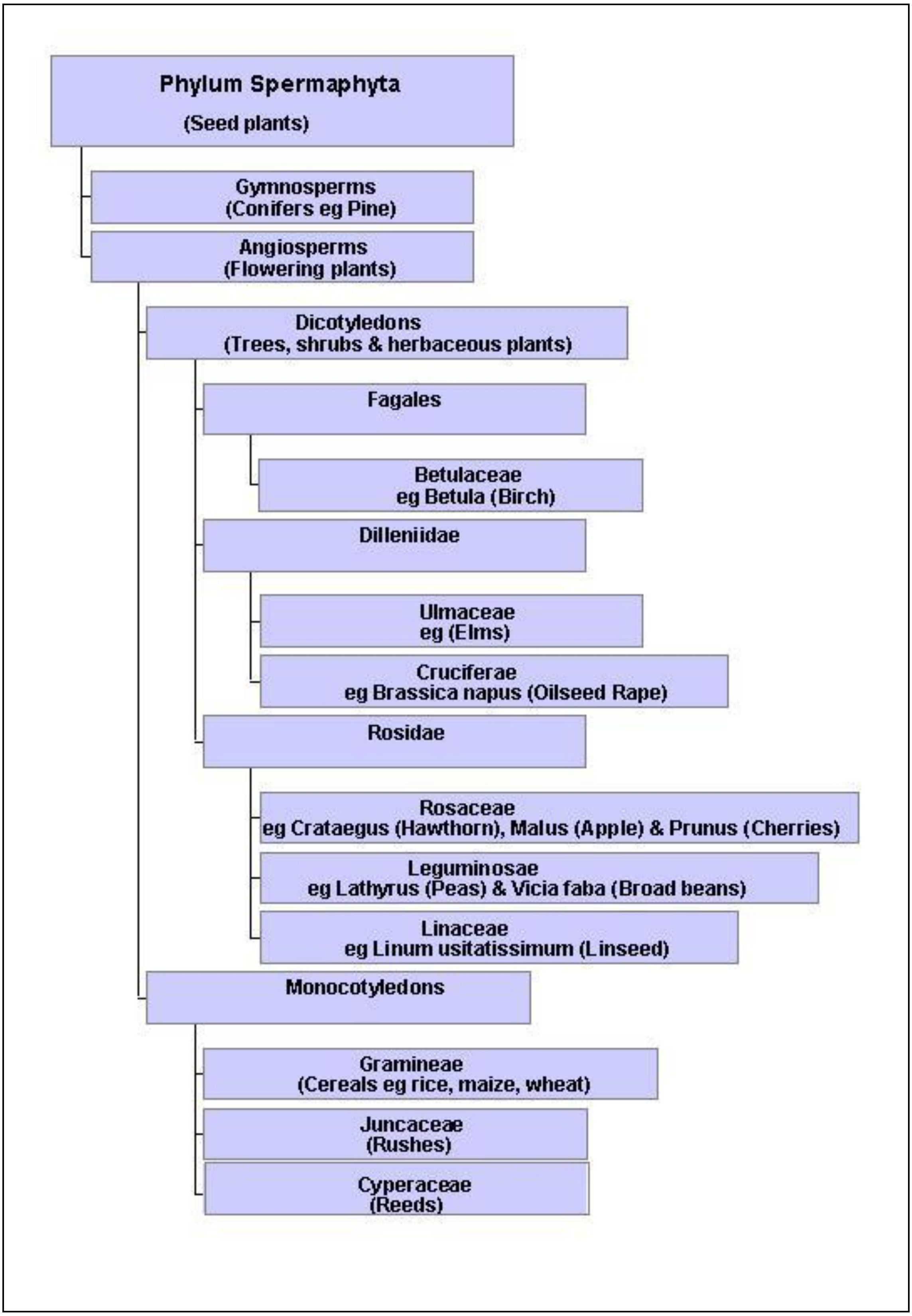


Figure 117:
Classification of plants in the Phylum Spermaphyta, showing just some of the hundreds of plant families and species

FAMILY	GENUS/SPECIES	COMMON NAME
Aceraceae	*Acer pseudoplatanum*	Sycamore
Betulaceae	*Betula*	Birch
Buxaceae	*Buxus*	Box
Compositae	*Helianthus annus*	Sunflower
Cruciferae	*Brassica napus*	Oilseed rape
Fagaceae	*Fagus*	Beech
Fagaceae	*Quercus*	Oak
Gramineae	*Zea mays*	Maize (corn cob)
Gramineae	*Oryza*	Rice
Gramineae	*Triticum*	Wheat
Grossulariaceae	*Ribes nigrum*	Blackcurrant
Hippccastanaceae	*Aesculus hippocastanum*	Horse chestnut
Labiatae	*Lavandula*	Lavender
Leguminosae	***Vicia faba***	**Field bean**
Leguminosae	*Trifolium repens*	Clover
Leguminosae	***Pisum sativum***	**Combining pea**
Leguminosae	*Phaseolus vulgaris*	Navy bean
Leguminosae	*Glycine max. vulgaris*	Soy bean
Linaceae	*Linum grandiflorum*	Linseed
Oleaceae	*Fagus*	Ash
Onagraceae	*Oenothera biennis*	Evening primrose
Philadelphaceae	*Philadelphus*	Philadelphus
Polygonaceae	*Fagopyrum esculentum*	Buckwheat
Pteridiophyta	*Pteridium aquilinum*	Bracken
Rosaceae	*Malus*	Apple
Rosaceae	*Crataegus*	Hawthorn
Rosaceae	*Prunus*	Plum and cherry
Rosaceae	*Pyrus communis*	Pear
Salicaceae	*Populus*	Poplar
Salicaceae	*Salix*	Willow
Ulmaceae	*Ulmus glabra*	Elm
Vitaceae	*Vitis vinifera*	Vine

Table 25:
Plant species identified as having been used in ash glazes, together with the species used in this research (shown in Bold)

II Clayart thread

The messages below are taken from the *Clayart Archive* (2007). They show my original message posted in the ash glazes section of the site and the responses received. As a result of the contact made with Phil Rogers, one of my linseed ash glazed pieces was included in the second edition of his *Ash Glazes* book (Rogers, 2003, p.29). Several respondents also emailed directly, rather than posting messages on the site. They were:

- John Christie <john@scotpotter.com>
- Mark <ASHPOTS@aol.com>
- Tom Buck <Tom.Buck@hwcn.org>
- Ivor Lewis <iandol@tell.net.au>
- Roger Korn <rkorn@europa.com>
- Barry R Geise <bgeise@netins.net>
- Roberta Miller <cn1919@coastalnet.com>

ash glaze research

updated sat 20 mar 04

Carol Metcalfe on fri 29 sep 00

Hi!

Having done some research into the use of linseed straw ash glazes as an undergraduate, I have just started a postgraduate research project on the use of arable waste in ash glazes. At the moment I am starting with the straw from peas and beans but any glazes using 'non-wood' ashes are of great interest to me. Does anyone have any information or comments they would like to share?

The complete results of my work and final thesis will eventually be published in some form or other.

Carol

Send postings to clayart@lsv.ceramics.org
> You may look at the archives for the list or change your subscription
> settings from http://www.ceramics.org/clayart/
> Moderator of the list is Mel Jacobson who may be reached at melpots@pclink.com.

Martin Howard on fri 29 sep 00

Carol, I recently had an analysis done of willow ash, burned in my wood burning stove in the pottery. The analysis was carried out by CERAM, Queens Road, Penkhull, Stoke on Trent, ST 7LQ, England. info@ceram.co.uk
http://www.ceram.co.uk
XRF Semiquantitative analysis
Silica 6.4
Titania .2
Alumina 1.9
Ferric Oxide 2.2
Lime 52
Magnesia 2.6
Potash w.w
Soda .1
Cupric Oxide .06
Manganic Oxide .06
Phosphorus Pentoxide 2.9
Sulphur trioxide .7
Strontia .2
Zinc Oxide .4
Zirconia .1
Loss on Ignition 27.90

Hope that helps your research. I would love to have the findings on Mares Tail, Hippurus vulgaris or Equisetum. It is reported to be the only herb with colloidal silica, so it should be useful for healing the ends of nerves. It should also be useful as another source of silica in glazes. I have a small supply snitched from hedgerows, which I will eventually test in glazes.

Martin Howard
Webb's Cottage Pottery
Woolpits Road, Great Saling
BRAINTREE, Essex CM7 5DZ
England
martin@webbscottage.co.uk

philrogers pottery on fri 29 sep 00

Carol,

Could you email me your address off line?
Thanks,

Phil.

Phil and Lynne Rogers,
Lower Cefn Faes,
RHAYADER.
Powys. LD6 5LT.
Tel/fax. (44) 01597 810875.
philrogers@ntlworld.com

Merrie Boerner on fri 29 sep 00

In my small Mississippi town, there is a place where people take their pecans to have them shelled by machine. Last Fall I took several garbage cans to the man and he filled them with the shell pieces. I made some ash out of some for a test.....just a basic ash glaze recipe. It was yellowish, and nice, but I only did this one test. The effects could have been the results of the sawdust/wood firing I tested it in and it would probably be different in another kiln.
When we fired with wood in the Hogchain Groundhog Kiln over New Year's Eve.....we shoveled the rest of the shells into the fire box (mainly cause it was fun). I do believe they helped make nice ash on our pots. Pecan shells are worth testing if you have them readily available.
Merrie

Hank Murrow on fri 29 sep 00

Dear Carol;

You can get a good idea of what an ash will contribute to a glaze by carefully regarding its function. Straw ash is pretty high in Si because its job is to hold up the seed. Rice husk ash is much the same, because its job is to protect the seed. Apple pulp, on the other hand, is high in fluxes and phosphorus because it concentrated the growth elements for fruiting. hard job = hard ash. Soft job = soft ash. just a rule of thumb to start with. Cheers, Hank in Eugene

Carolyn Nygren Curran on sat 30 sep 00

Sander's book on Japanese Pottery is another source of information on ash, too. And Robert Tichane has a book on ash glazes as well. cnc

Janet Kaiser on sat 30 sep 00

Carol

You might like to look at pages 40-1 in Ceramic Review No. 183, May/June 2000. The article is "Colour in Ash Glaze" by Eric James Mellon and includes a neat illustration of "ashes that produce stable glazes low in calcium" (grasses, small and tall bushes 0 to 25 feet) and "ashes that produce unstable glazes (kinetic) high in calcium" including fruit and tall trees 25 to 60 feet high.

Good luck with your work!

Janet Kaiser
The Chapel of Art . Capel Celfyddyd
HOME OF THE INTERNATIONAL POTTERS' PATH
Criccieth LL52 0EA, GB-Wales Tel: (01766) 523570
E-mail: postbox@the-coa.org.uk
WEBSITE: http://www.the-coa.org.uk

Janet Kaiser on sun 1 oct 00

He is not blowing his own trumpet, so I will be so bold... Our very own Phil Rogers published an excellent book on this very subject. It is now a classic around the globe. A "must read" text for anyone interested in ash glazes and interesting enough for everyone else to at least look through...

Come on Phil... Give them the ISBN and the details!!

Janet Kaiser - who lent her copy to someone, never to be seen again)-:

The Chapel of Art . Capel Celfyddyd
HOME OF THE INTERNATIONAL POTTERS' PATH
Criccieth LL52 0EA, GB-Wales Tel: (01766) 523570
E-mail: postbox@the-coa.org.uk
WEBSITE: http://www.the-coa.org.uk

philrogers pottery on sun 1 oct 00

Thank you Janet. Unfortunately or fortunately depending on your point of view the reprint of the book is almost out of print although I think Axner still has some in stock and A&C Black have a few left in the U.K. The ISBN No.is 0-7136-3440-5.

I am currently working on a new updated edition which should be available in 2002.

Janet, your cheque is in the post!!
Phil.

Phil and Lynne Rogers,
Lower Cefn Faes,
RHAYADER.
Powys. LD6 5LT.
Tel/fax. (44) 01597 810875.
philrogers@ntlworld.com

Teresa Speakman on mon 2 oct 00

Dear Phil,
I had been wondering if philrogers pottery was the same Phil Rogers, the author of the Ash Glazes book that I studied last spring. I am grateful that Ohio University-Lancaster has it in their library, although I must admit that it was at my house for Spring Quarter! I am grateful to be able to thank you for such a wonderfully inspiring account of wood ash glazes.

I was able to experiment with apple ash and wheat-straw/pampass-grass ash at ^9-10, but presently have no access to high firings. Someone asked about lower fired ash glazes, and I didn't notice any responses, but maybe I missed it. Does anyone have suggestions for mid-range temps for ash glazes or is there a necessity for higher heat.

The last firing I did at school was in a falling down, 20+ year old sprung arch kiln, that could barely be reduced, with a particularly uneven fast firing. The resulting ash glazes resulted in a beautiful bloated lava texture which I love. I had read that this was a fault , but certainly only in the eyes of the beholder!

I am going to experiment with lower fired ash glazes regardless of response, but any input is appreciated.

Thanks again, Peace- Teresa in Ohio

philrogers pottery on tue 3 oct 00

Hello Teresa,

I have not done a lot with lower temperature ash glazes. I fire to Cone 11. For me at least, there is a quality in the glaze at the higher temperature that isn't there at the lower temperatures largely due to glaze body interaction. However, Katharine Pleydell Bouverie achieved many beautiful glazes at around 1200C by adding small amounts of Alkaline frit to the batch. If you look in 'Ash Glazes' I think there is a recipe that might give you a clue to the kind of quantity but around 5% may be a good place to start. At the lower temperature you could try adding a small quantity of salt to the glaze (a couple of teaspoonfuls per 5 gallon bucket) The salt in combination with present solubles does go some way in achieving a body/glaze interaction but it is not as good as the real thing.

Hope that helps,

Phil.

Phil and Lynne Rogers,
Lower Cefn Faes,
RHAYADER.
Powys. LD6 5LT.
Tel/fax. (44) 01597 810875.
philrogers@ntlworld.com

Carol Metcalfe on thu 12 oct 00

Hello again!

First of all, many, many thanks to everyone who replied to my posting. As a beginner at email and the Internet, I am quite amazed at how many messages I've had and so quickly!

I now realise, I should perhaps have mentioned in my original message that I live in North Yorkshire, ENGLAND. This means some of your suggestions are definitely NOT available to me, but if anyone else tries them out, I would still love to hear about the results.

To pick up on the lower temperature debate, my linseed experiments were fired to Cone 8, 1260 C in oxidation. Cone 11 is beyond the limits of my electric kiln and lower temperatures in general would be better for the elements. So, I am watching with interest and will perhaps be able to take part of my research project in this direction as well.

Thanks again,
Carol

Earl Krueger on thu 5 feb 04

Might be of interest to ash glazers.

A PDF document produced by State of Illinois entitled;
"Utilization of Illinois Fly Ash in Manufacturing of Ceramic Tiles"

Discusses various aspects of ash in glazes.

http://www.icci.org/01final/01mishulovich.pdf

Earl K...
Bothell, WA, USA

Carol Metcalfe on fri 19 mar 04

-----Original Message-----
From: Clayart [mailto:CLAYART@LSV.CERAMICS.ORG] On Behalf Of Carol Metcalfe
Sent: Friday, March 19, 2004 12:44 PM
To: CLAYART@LSV.CERAMICS.ORG
Subject: ash glaze research

Just a note to let everyone know that my ash glaze research continues at the University of Sunderland but my email address has changed to carol.metcalfe@tesco.net . Some of the first tests I did were covered in an article I had in Ceramic Review last summer together with examples of plates using the glazes. I am currently exploring the differences between ashes from different growing seasons of arable crops. All my glazes are fired in the electric kiln to Cone 7, 1240C.

Would love to hear from anyone doing similar work.

Carol M

Ababi Sharon on fri 19 mar 04

I want to offer you the following test based on the high CaO in the ash: ABABI'S RED ASH
,,,

Cone 6 1222 deg.C. - =09
,,,

common ash 50.00
Kaolin CC31 15.00
Quartz 20.00
Wollastonite 15.00
Tin Oxide 7.00
Chrome Oxide 0.35
,,,
This is a matte glaze of course you can change it. I apply it very thick Out of different ashes you might have different reds. You can see it here:
http://members4.clubphoto.com/ababi306910/981929/
The last side
Ababi Sharon
Glaze wizard
Kibbutz Shoval Israel
ababisha@shoval.org.il
http://ababi.active.co.il
http://www.matrix2000.co.nz/Matrix%20Demo/Ababi.htm
A fast link Ceramics forum in Hebrew:
http://www.botzpottery.co.il/kishurim.html=20

III Chemical symbols

Element	Symbol
Aluminium	**Al**
Calcium	**Ca**
Carbon	**C**
Chlorine	**Cl**
Copper	**Cu**
Hydrogen	**H**
Iron	**Fe**
Magnesium	**Mg**
Manganese	**Mn**
Nitrogen	**N**
Oxygen	**O**
Phosphorus	**P**
Potassium	**K**
Silicon	**Si**
Sodium	**Na**
Sulphur	**S**
Titanium	**Ti**
Zinc	**Zn**

IV EDX Results

ANALYSIS RESULTS USING EDX

These results are percentage concentrations of the elements detected and take no account of the oxides present nor any substances lost during firing.

ASH	K	Na	Ca	Mg	Fe	Al	Si	P	S	Cl	Total
Apple	20.42	0.09	70.93	1.30	0.07	0.20	1.10	4.19	0.81	0.88	100
Black Currant	22.23	0.00	41.73	1.43	1.58	2.43	18.31	9.62	2.31	0.37	100
Cherry	21.88	0.44	67.44	1.46	0.13	1.40	2.37	3.12	0.90	0.87	100
Cherry (2nd test)	22.19	0.32	67.34	1.10	0.16	1.55	2.28	3.52	0.88	0.66	100
Cherry-Average	22.04	0.38	67.39	1.28	0.15	1.48	2.33	3.32	0.89	0.77	100
Elm	29.66	0.17	53.93	1.86	0.34	0.60	6.96	4.15	1.13	1.20	100
Elm (Danish)	22.23	0.16	67.48	0.68	0.36	1.77	5.00	0.86	0.87	0.59	100
Horse Chestnut	14.26	0.12	75.65	0.86	0.16	0.11	2.07	5.52	1.00	0.25	100
Oilseed Rape 1	42.30	0.01	17.13	0.61	0.30	0.58	19.35	2.44	3.38	13.90	100
Oilseed Rape 2	41.40	0.09	17.43	0.67	0.22	0.88	20.81	2.47	3.10	12.94	100
Oilseed Rape-Average	41.85	0.05	17.28	0.64	0.26	0.73	20.08	2.46	3.24	13.42	100
Pear	26.66	0.00	59.39	1.66	0.07	0.27	6.30	3.69	0.87	1.08	100
Philadelphus	41.89	0.00	32.28	2.79	0.32	0.62	2.51	16.01	2.80	0.78	100
Philadelphus (2nd test)	41.45	0.15	32.42	2.78	0.31	0.68	2.77	16.12	2.28	1.02	100
Philadelphus-Average	41.67	0.08	32.35	2.79	0.32	0.65	2.64	16.07	2.54	0.90	100
Unwashed Bean 1	33.16	0.29	51.59	3.10	0.34	0.62	5.34	2.69	0.97	1.89	100
Unwashed Bean 2	34.32	0.32	49.12	3.15	0.46	0.86	5.12	3.35	1.16	2.15	100
Unwashed Bean-Standard	33.76	0.40	49.72	2.94	0.54	1.06	5.54	3.03	1.01	2.00	100
Unwashed Bean-Standard 2	33.11	0.35	50.32	2.69	0.48	0.69	5.92	3.11	1.17	2.15	100
Unwashed Bean-Average	33.59	0.34	50.19	2.97	0.46	0.81	5.48	3.05	1.08	2.05	100
Unwashed Linseed	42.8	0.22	46.31	1.88	0.38	0.00	0.43	3.14	0.94	3.93	100
Unwashed Pea	13.77	0.00	74.34	2.48	0.41	0.84	4.04	2.36	0.76	1.00	100
Unwashed Pea (2nd test)	13.17	0.06	74.60	2.75	0.27	0.60	4.14	2.51	0.72	1.18	100
Unwashed Pea-Average	13.47	0.03	74.47	2.62	0.34	0.72	4.09	2.44	0.74	1.09	100
Washed Bean	5.97	0.04	68.50	5.56	1.06	1.38	13.10	3.81	0.08	0.50	100
Washed Bean (2nd test)	5.58	0.11	70.37	5.38	1.10	1.59	12.43	3.38	0.23	0.00	100
Washed Bean-Average	5.78	0.08	69.44	5.47	1.08	1.49	12.77	3.60	0.16	0.25	100
Washed Linseed	3.42	0.09	74.23	3.58	0.70	0.92	4.85	11.99	0.26	0.00	100
Washed Pea	4.15	0.00	78.91	2.95	0.65	1.48	8.57	3.23	0.10	0.00	100
Washed Pea 2	3.82	0.10	79.72	2.60	0.58	1.26	8.52	2.95	0.45	0.00	100
Washed Pea-Average	3.99	0.05	79.32	2.78	0.62	1.37	8.55	3.09	0.28	0.00	100
Wheat 1	16.54	0.08	12.84	0.66	0.38	0.62	65.24	1.80	1.07	0.78	100
Wheat 2	15.83	0.04	12.42	0.60	0.43	0.47	66.88	1.74	0.83	0.76	100
Wheat-Average	16.19	0.06	12.63	0.63	0.41	0.55	66.06	1.77	0.95	0.77	100

ANALYSIS RESULTS USING EDX ON NEW SEM

ASH	K	Na	Ca	Mg	Fe	Al	Si	P	S	Cl	Total
HORSE CHESTNUT	9.9	2.9	74.5	2.6		1.1	2.6	5.1	1.4	0.6	100
BEAN 1999	41.4	4.8	28.7	4.3			2.2	2.4	1.3	15.0	100
BEAN 2000	28.6	5.5	45.5	8.0	1.0	0.9	5.2	2.2	1.2	1.6	100
BEAN 2001	45.6	6.3	22.5	4.6		0.8	0.7	0.9	1.5	17.2	100
BEAN 2002	38.2	6.4	30.6	5.0	0.9	0.6	0.8	2.7	1.1	13.5	100

V Copies of articles published in *Ceramic Review*

Ash Glaze Research

GLAZE – CAROL METCALFE shares the results of extensive tests to examine arable crop waste ashes.

PHOTOGRAPHY – CAROL METCALFE

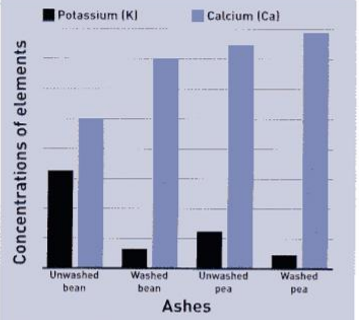


Figure 1: EDX analysis of washed and unwashed ashes

	Unwashed bean straw ash	Unwashed pea straw ash		Unwashed bean straw ash	Unwashed pea straw ash
LOI	32.47	28.07	SiO_2	16.66	20.92
K_2O	13.10	6.16	P_2O_5	2.45	2.18
Na_2O	2.12	0.37	TiO_2	0.13	0.20
CaO	24.21	32.77	SO_3	0.17	0.18
MgO	6.03	5.31	Mn_3O_4	0.08	0.09
ZnO	0.03	0.02	SrO, BaO, Cr_2O_3	0.14	0.12
Fe_2O_3	0.71	1.01			
Al_2O_3	1.70	2.59			

Figure 2: XRF percentage weight analysis of ashes

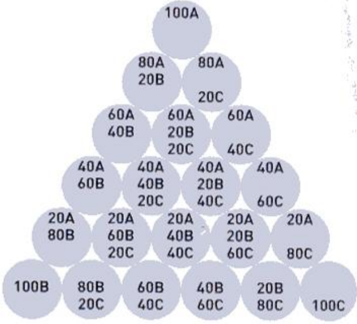


Figure 3: Standard triaxial blend, figures expressed in percentages

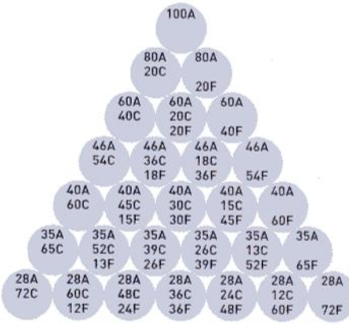


Figure 4: Adapted triaxial blend: ash (A), china clay (C), flint (F)

I first became aware of the use of wood ash as a glaze ingredient a few years ago, whilst studying for my BA (Hons) Arts and Design at the University of Sunderland. I was fascinated by the idea that an everyday substance such as ash could be transformed, simply by the application of heat. The Chinese were the first to discover ash glazes about 3,500 years ago. They went on to develop simple but beautiful glazes, using the waste product from their wood-fired kilns.

Inspired, I started to investigate the use of ashes from waste materials available in my environment – an arable farm in North Yorkshire. My research has now become an art practice-led PhD project, again at the University of Sunderland, the title of which is: *New Ash Glazes from Arable Crop Waste: Exploring the use of straw from Pisum sativum (the Combining pea) and of Vicia faba (the Field bean).*

MATERIAL ANALYSIS

After the combine harvester has cut the pea and bean crops and collected the dry seeds from them, the waste plant material is left in rows in the fields. At first I just pushed this straw into heaps and had bonfires immediately in the fields, collecting the ash with a dustpan and brush when it had cooled. The success of this process was very reliant on weather conditions, especially the wind, so I now have the straw made into bales weighing about 20kg. These I store in an outbuilding, burning a few at a time on suitable days.

Having obtained a supply of ash, I had to decide whether or not to wash it. Opinion among ceramists is strongly divided so I decided to compare the compositions of washed and unwashed samples before coming to a conclusion. I was able to have qualitative Energy Dispersive X-ray (EDX) Analysis carried out at the University of Sunderland and I am indebted to the staff there who carried out these tests for me. The results showed the washing process to have the greatest effect on the main fluxes present: calcium and potassium. Their concentrations are shown in Figure 1.

From these analyses I could see that a great deal of valuable potassium was being lost. I also noted that after washing, the compositions of the two ashes were quite similar to each other, whilst before washing their proportions of potassium and calcium differed greatly. On the basis of this information I have chosen to explore unwashed ash to give me the greatest variety of results. This means that the ashes must be sieved dry, firstly through a kitchen flour sieve then through a 40s mesh sieve. A mask must be worn for this process.

My approach to glaze development combines glaze calculation and empirical testing. Using X-ray Fluorescence (XRF) analysis provided by West X-ray Solutions, I obtained figures for the percentages of oxides in the ashes. See Figure 2 for the results. These were compared to known Limit Formulae for balanced glazes (See *Glazes for the Studio Potter*, Cooper and Royle, 1978 p.91 for a list of Limit Formulae). From this information I was able to calculate recipes for each ash. For example:

Bean ash	39.4
China clay	25.2
Flint	35.4

TRIAXIAL BLENDS

I am not, however, only interested in balanced glazes, giving smooth or shiny surfaces. I also want to know the result of recipes with higher percentages of ash. I therefore decided to use a triaxial blend of ash, china clay and flint. The usual triaxial blend, very clearly described in CR200, moves in steps of 10% or 20% from 100% to 0% for each ingredient (Figure 3). I made some adjustments to these steps to give more tests around the calculated recipes I

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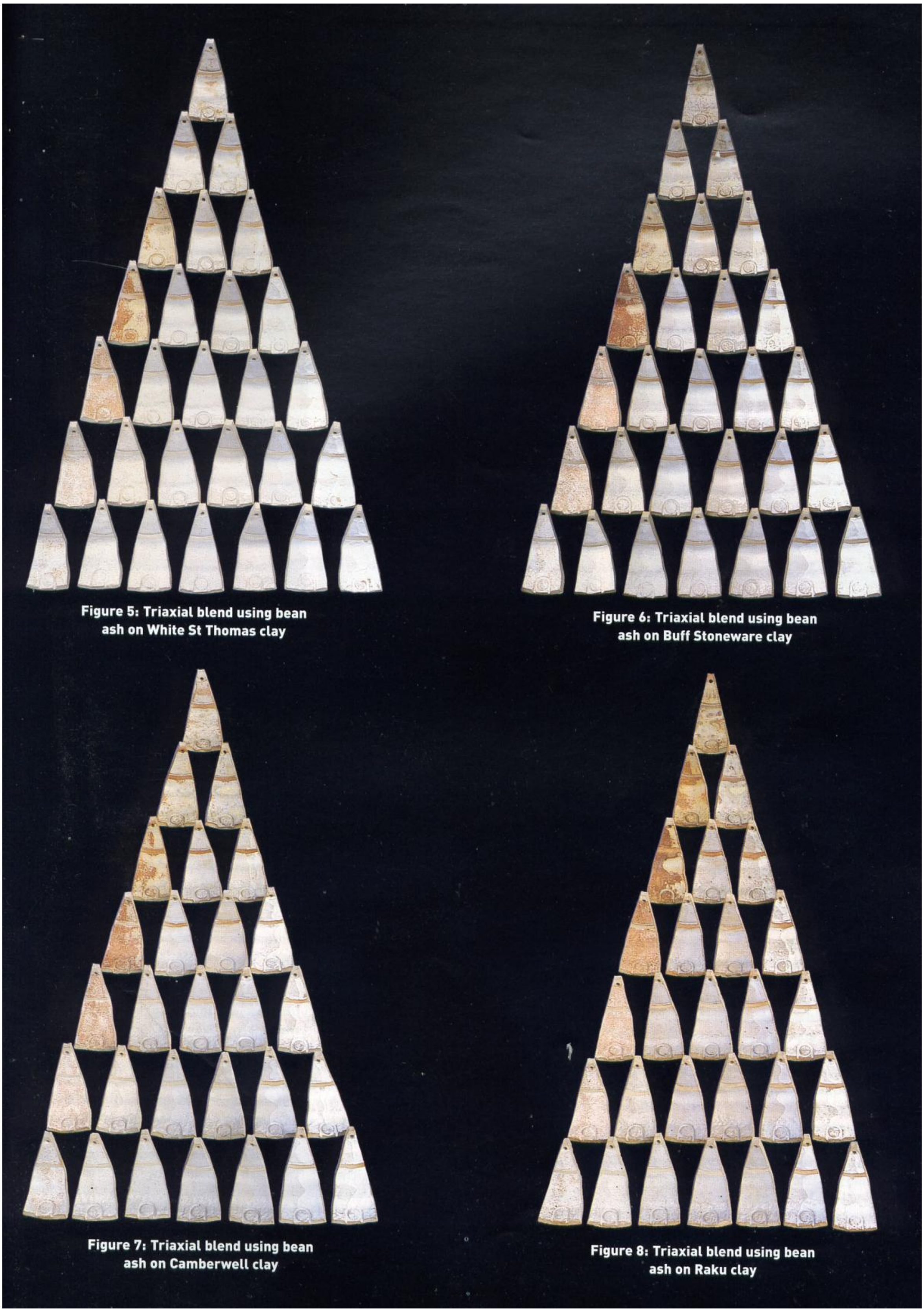

Figure 5: Triaxial blend using bean ash on White St Thomas clay

Figure 6: Triaxial blend using bean ash on Buff Stoneware clay

Figure 7: Triaxial blend using bean ash on Camberwell clay

Figure 8: Triaxial blend using bean ash on Raku clay

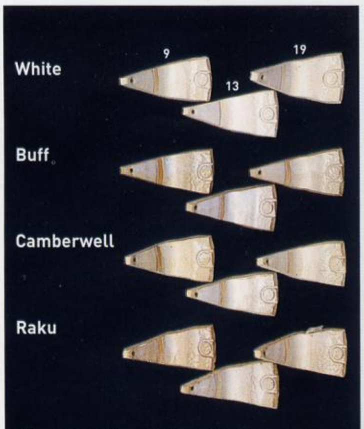

Figure 9: Tiles 9, 13 and 19 from the bean ash triaxials

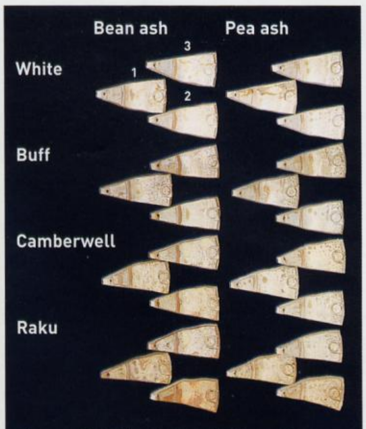

Figure 10: Tiles 1, 2 and 3 from the bean and pea ash triaxials

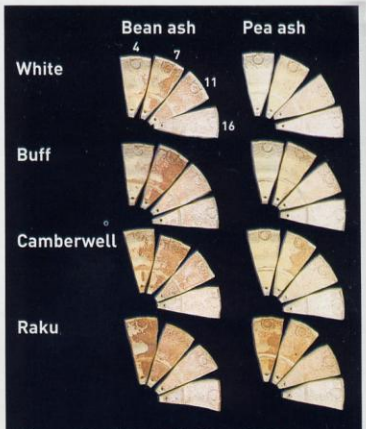

Figure 11: Tiles 4, 7, 11 and 16 from the bean and pea ash triaxials

Figure 12: Tile 1 from the bean (left) and pea (right) ash triaxials on raku clay

Figure 13: *Chaff* plate, Ø23cm

Figure 14: *Nettle* plate, Ø20cm

had devised. Also, since I am investigating ash glazes, I decided on a minimum ash content of around 30% in the test recipes. The adapted triaxial is shown in Figure 4.

The clay body onto which the glazes are applied has an enormous effect on the finished glaze, so I have selected four different clays (all from Potclays) for my research. These are:

- **White St Thomas**
  low iron content, medium texture,
- **Buff Stoneware**
  medium iron content, smooth texture,
- **Camberwell Buff**
  medium iron content, medium texture,
- **Raku**
  higher iron content, coarse texture.

Each of the 28 recipes in the triaxial blend was applied to test tiles in each of the four clays, making a total of 112 tiles for each ash tested. The tiles were fired in my electric kiln to Cone 7 at 1240°C. The results of blends using bean ash are shown in Figures 5, 6, 7 and 8. (Note: triaxial tiles are numbered 1–28 from apex, left to right.) The same triaxial blend was also carried out using pea ash.

Tiles 9, 13 and 19 (Figure 9) are close to the calculated recipes and so result in smooth and shiny glazes, transparent where thin and slightly opaque where thicker.

The triaxial blend has also yielded some interesting textures and colours in recipes with a high ash content, tiles 1, 2 and 3 shown in Figure 10. Raku clay body gives the strongest colour responses, especially with bean ash, while White St Thomas clay gives the least interesting results. Pea ash has a tendency to form a beaded texture, which is typical of glazes high in calcium or lime and the analysis of the pea ash shows this to be the case here.

All the tests with high levels of bean ash show a reddish brown colouration outside the area of glaze application at the top and on the unglazed stripe across the tiles. This 'halo' effect is minimal in the pea ash tests (Figure 12). A comparison of the analyses shows the bean ash to have much higher levels of potassium than the pea ash. Since potassium is a soluble alkali, it is likely that this flux is travelling with the glaze water into surrounding areas of the absorbent biscuited tiles during glaze application and that this is causing the halo effect observed.

The ash and china clay mixtures, tiles 4, 7, 11 and 16, shown in Figure 11, produce dry glazes with interesting colour responses. Again the bean ash recipes have richer colours than the equivalent pea ash recipes and the raku clay has given a stronger response than any of the other clays tested. Some of these glazes are very sensitive to the thickness of application so it is important that the tests explore this quality. The right side of each tile has had two layers of glaze applied and shows a yellowish colour compared to the oranges on the left sides where the glaze is single thickness.

Having developed a range of glaze effects from my two arable ashes, the next step was to design appropriate ceramic forms with which to successfully combine them. Texture is important in my work and I am currently exploring a variety of plates (Figures 13 and 14), on which the patterns are created using further waste products, including weed seeds and chaff dressed out of the arable crops. The colour variations on the rim of the *Chaff* plate result from different thicknesses of bean ash Recipe 4: orange where the glaze was thinly applied; creamy yellow where it was thicker, in the textures and around the edge of the plate. The test tile for this recipe indicated this effect should be expected. Indeed the test tiles have proved a very reliable insight into how the glazes will develop on a larger piece of work.

These triaxial blends show that arable waste materials are a good alternative to wood ash and, whilst they represent only the first stages of my research project, my work is already benefiting greatly. CR

West X-ray Solutions, 405 Whirlowdale Road, Sheffield, S11 9NF. Tel: 0114 2490517.

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Ash Glaze Research 2

TECHNICAL/GLAZE – Continuing her investigations into plant ashes, CAROL METCALFE reports on her latest findings.

PHOTOGRAPHY – CAROL METCALFE

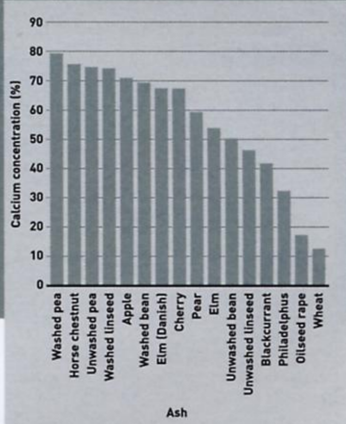

Figure 1: Decreasing calcium concentration

Down the centuries many ceramists have successfully used plant ashes as a glaze ingredient, a practice that continues today. Recipes often incorporate wood ash, though there are examples of other types, such as rice husk or straw. When deciding to explore the possibilities of ashes from the waste products of bean and pea crops grown on the farm where I live, as outlined in CR202, I felt it was important to investigate their compositions. Only then could I see how they would relate to known ash glazes.

The ability to compare the new ash supplies, both washed and unwashed, with those already in use has been invaluable in providing an understanding of their likely behaviour in glazes and thus with a starting point for practical tests, and this article outlines in detail the analyses involved.

My research is being carried out as an art-practice led PhD at the University of Sunderland, where I have access to Energy Dispersive X-ray (EDX) analysis on the Scanning Electron Microscope (SEM) in the School of Computing and Technology.

PREPARING SAMPLES FOR EDX ANALYSIS

A small amount of ash is compressed to form a smooth disc 1.5cm in diameter and about 3mm thick, which is then scanned by the SEM. A beam of electrons strikes the sample which results in the emission of secondary electrons, characteristic of the element that has been hit. The emitted electron beam output is analysed by the EDX facility of the microscope to register the presence of certain elements and quantify the relative amounts of each. It is important, therefore, that this tiny sample of ash is homogenous and representative of the ash supply as a whole. Quite a large quantity of ash needs to be sieved before sampling, first through a kitchen sieve, then mixed well before a second sieving through a 40 mesh sieve. It is essential to wear a mask for this process.

Even if the ash has been washed and sieved it must nevertheless still be sieved twice after drying to ensure that it is thoroughly mixed, as it tends to settle out in layers whilst drying.

The results from EDX analysis of samples prepared in this way have been very consistent, both when sample discs have been scanned more than once, and where several discs have been made from a particular ash supply. The method has therefore proved reliable.

UNDERSTANDING EDX ANALYSIS

It needs to be understood at the outset that the figures given by the EDX analysis are a type of 'count' representing the percentage concentrations of each element present. They are not a percentage analysis of the weights of the oxides present, such as would be used in a glaze calculation process. The purpose of these analyses therefore is to compare one ash with another.

For example, a percentage concentration of 20 for calcium in two different ashes indicates the same relative calcium content in each of them. Similarly, a figure of 20 for calcium in one ash and 10 for calcium in another indicates that the concentration of calcium in the first ash is twice that in the second one.

However it is essential to remember that a result of 10 for calcium and 10 for silicon in an ash does not mean that there is the same percentage weight of these two elements present. It helps me to understand this if I think of a fruit bowl; if I counted 10 cherries and 10 apples in the bowl, it would not indicate the same weight of each fruit.

Once understood, the EDX analysis method allows some very useful comparisons to be made between one ash and another or between the washed and unwashed versions of an ash.

RESULTS

The pea and bean crops on which my research focuses are both harvested dry in the autumn. Both are leguminous plants, which fix nitrogen in nodules on their roots. Since they belong to the same plant family and are grown in a similar way, I had expected them to amass similar amounts of substances from the soil and to therefore have similar ash compositions. The results were surprising.

Tests were carried out on a wide range of plant ashes including trees and bushes. All the samples contain a similar range of elements but in widely differing concentrations. The main elemental constituents found are:

- Calcium
- Potassium
- Silicon
- Phosphorus

All are present as oxides.

The samples also contain magnesium, the concentrations found varying from 0.6% of the count in oilseed rape and wheat straw to 5.5% in washed bean ash. Most of the samples also contain small amounts of:

- Sodium (less than 0.5% concentration)
- Iron (up to 1.5%)
- Aluminium (less than 2.5%)
- Chlorine

In general the chlorine content is low (0-4%) though a few samples have significant amounts of around 13-14%, for example oilseed rape straw. However since chlorine is volatile this would burn off during firing and would not be present in the resulting glazes.

There will also be oxygen, hydrogen and carbon present, for example in the form of water, oxides, hydroxides and carbonates, but these are small atoms that are not detected by the EDX system used. Again, however, water and carbon dioxide would be driven off during firing, leaving the glaze oxides with which we are familiar, so these elements need not be taken into account when considering the glaze-forming qualities of an ash.

In the data and discussion that follows, only the main elements present are considered. Please note also that all ashes are unwashed unless otherwise stated.

THE FLUXES

Ash is usually used in glazes as a source of flux and indeed all the ashes tested contain significant amounts of calcium and some potassium. Figure 1 shows the ashes in decreasing order of calcium concentration whilst Figure 2 shows decreasing potassium content. To my great surprise bean and

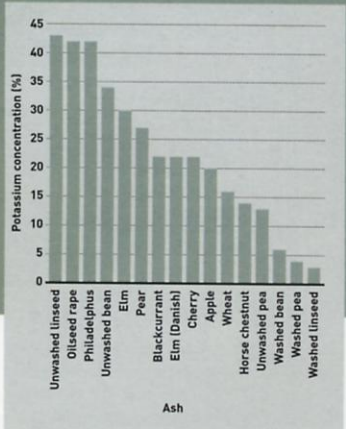

Figure 2: Decreasing potassium concentration

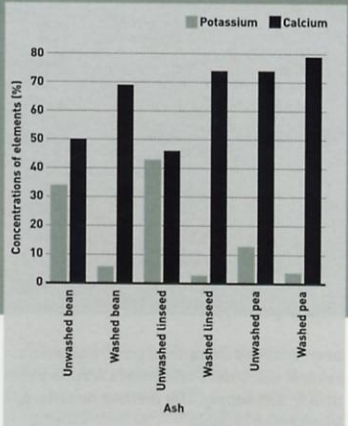

Figure 3: The effect of washing ash

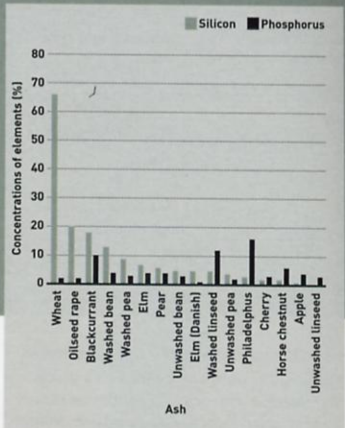

Figure 5: Concentrations of silicon and phosphorus

pea ashes differ widely from each other. The pea ash, both washed and unwashed, has levels of calcium similar to the wood ash from horse chestnut, whilst the unwashed bean ash contains much less. Instead it has a high concentration of potassium.

Since a high calcium content gives glazes a tendency to run and form beaded textures, the pea ash could be expected to do this whilst the bean ash is less likely to do so.

THE EFFECT OF WASHING

Three types of ash – bean, pea and linseed – were tested both washed and unwashed and it is clear that the washing process has a marked effect on their potassium content. Potassium oxide is largely soluble in water and is therefore lost when the water is poured off the ashes during washing. Figure 3 shows just how dramatically washing alters the balance of the fluxes within the ash. Before washing, the three ashes are very different. After washing, much of this variety is lost and the flux concentrations in all three are quite similar.

Some ceramists find potassium to be a valuable flux in their glazes. Eric James Mellon, for example, uses blackcurrant and philadelphus ashes in the glazes he puts over his oxide drawings. He has found that high calcium levels cause the drawings to run. Potassium is therefore an essential flux in producing a stable glaze. For this reason he never washes ash.

Mellon has tested some of my bean ash in one of his own recipes [1] and found it to be successful over oxide brushwork. Figure 4 shows his porcelain test pot, which was fired to cone 10, 1300°C in a neutral to slightly reducing atmosphere. The recipe is:

Bean ash	4
Potash feldspar	4
Ball clay	0.5
China clay	2.5
Flint	1

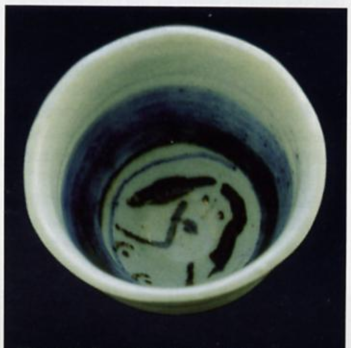

Figure 4: Porcelain test pot by Eric James Mellon using bean ash over oxide drawing

SILICON AND PHOSPHORUS

Figure 5 shows that wheat straw, a cereal plant, is not so suitable as a fluxing material since its predominant element is silicon. This will be present as the glass-forming substance silicon dioxide or silica. Such an ash would be more useful as an alternative material for the quartz or silica content of a glaze recipe.

Figure 5 also shows that some of the ashes have quite high concentrations of phosphorus, which also acts as a glass-forming substance and is valued for encouraging the formation of a bluish opalescent effect in some glazes.

Bean and pea ashes do not contain high levels of silicon or phosphorus and will therefore probably need further additions of silica in order to form a balanced glaze.

THE PROFILE OF AN ASH

By plotting the main constituents of an ash on a line graph, its profile can be studied and compared to others. Figure 6 shows the profile of pea ash, both washed and unwashed, to be very similar to those of horse chestnut and apple wood ashes. Indeed the horse chestnut and unwashed pea ash lines are almost identical. From this it can be concluded that pea ash will behave similarly to wood ash.

The bean ash profiles are shown in Figure 7, again compared with horse chestnut and apple ashes. The washed bean ash line has similarities to the wood ashes, though the concentration of fluxes is slightly lower, whilst the level of silicon is rather higher. The unwashed bean ash, however, stands out on the graph as significantly different and can therefore be expected to give rise to glazes of a very different character.

COMPARING HARVESTS

A further aspect of my research involves comparing the composition of ash supplies from different years' harvests. Ashes have a reputation for being variable from season to season, so to investigate this possibility, samples of bean ash from the 1999-2002 harvests were tested using EDX analysis.

Figure 8 shows the concentrations of the main elements present, ordered by increasing levels of potassium. There is significant variation between these four batches of ash, particularly in the levels of potassium and calcium. Compared, however, with an example of a wood ash, in this case horse chestnut, it becomes clear that all the bean ash samples have relatively high concentrations of potassium and relatively low calcium.

The differences between these batches of bean ash are nevertheless sufficient to alter glazes made from them. Small bowls made from raku clay were glazed with 100% unwashed bean ash from each of the harvests then fired in my electric kiln to 1240°C and soaked until cone 7 was reached. Figure 9 shows them arranged in order of increasing potassium content and there is a distinct progression in the richness of colour produced. Figure 10 shows the undersides of the bowls where the feet were not glazed but

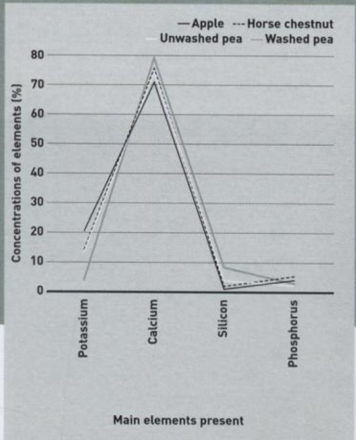

Figure 6: Profiles of pea and wood ashes

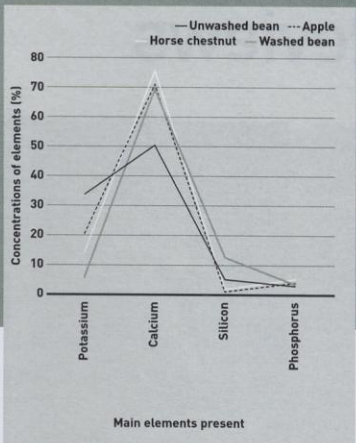

Figure 7: Profiles of bean and wood ashes

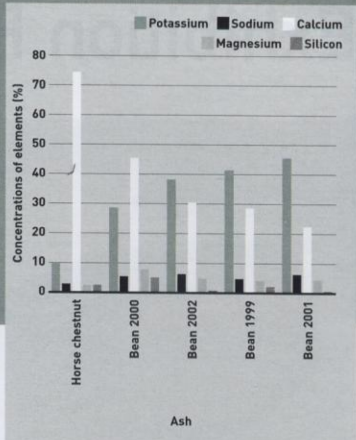

Figure 8: Different harvests of bean ashes ordered by increasing potassium

Figure 9: Bowls in raku clay with 100% bean ash glazes from different harvests, arranged in order of increasing potassium content

Figure 10: Undersides of bowls in Figure 9 showing increasing 'halo' effect with increasing potassium content

have developed a rusty 'halo' effect, which increases in intensity with increasing potassium content. This interesting characteristic of the bean ash is probably due to potassium dissolved in the water of the glaze being absorbed into the biscuit fired clay body.

THE VALUE OF ASH ANALYSIS

The work reported here, based on comparisons of elemental constituents in a range of ashes, has lead to a greater understanding of the ashes' probable behaviour in glazes. The knowledge gained has enabled me to progress with well-informed practical testing to explore what would actually happen in the kiln. The value of this approach is confirmed every time the relationship between the analyses and firing behaviour is demonstrated in the subsequent tests and final pieces. **CR**

[1] See CR42, 43, 65, 172 and 183 for Eric James Mellon's articles about his glazes

I am indebted to my supervisor, Dr Collin Gill, and the university staff who carried out the analyses for me. Thanks also go to Eric James Mellon and Lis Ehrenreich for generously supplying samples of the ashes they use in their glazes.

London Calling

EXHIBITION – MAGGIE ANGUS BERKOWITZ looks forward to the Northern Potters' forthcoming show in London.

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Why should the Northern Potters Association (NPA), a mixed assortment of potters and ceramic artists from the north of England, be coming together to organise an expensive and time-consuming project with no assured outcome other than a line on future CVs that mentions London? Would it not be better to exhibit instead in Newcastle or Sheffield, Leeds or Liverpool? Well, yes and no, and most of us have exhibited in such venues and even further afield, but London is just, well, central. Automatically, almost, the answer is it is a bigger market. But does that mean more sales? For me, at least, buyers are people who know my work or know me, or (a big surprise) are Japanese. Maybe we all hope for wider exposure, dreams of fame and discovery.

Traditionally, centuries-old potters' markets in England were local events, within reach by horse and cart or on the routes of the travelling people who themselves were known as potters. Industrialisation changed the way potters worked, slowly edging out artisan workshops and small-scale potteries in favour of more large-scale factory-based production. For as long as inkbottles and bread pancheons were used and needed, local potters survived, able to meet the demands of the market, some continuing in production until the middle of the last century. A few were rescued by the craft revival but increasingly looked to metropolitan sales and/or promotion. Industrialisation changed the distribution system too in this country just as it has done around the world. In Japan, with no wheeled transport anyway, there was a different system to be disrupted. Are cooking pots still carried by dugout canoe from Malawi to Tanzania as I saw years ago, I wonder? Our craft history in England is not the only one – and it is still being made in an increasingly international context. So London becomes local, maybe? A stepping-stone to a wider world? So some of us hope.

Of eighty exhibitions named in Tanya Harrod's splendid history, *The Crafts in Britain in the 20th Century* (Yale University Press) only six are outside London, and three of those are outside Britain, a fact that might have something to do with our turning to London. Behind the pivotal exhibitions listed, and behind all the organisations such as the Crafts Council, *The Crafts in Britain* does describe the co-operative, self-help efforts of many potters. This exhibition means organising ourselves rather than being organised. We have a tradition of co-operation. Since 1977, when a group of us met in a dungeon-like crypt below the sumptuous galleries of Bowes Museum and voted to start the NPA, we have set up our own exhibitions in many different venues. We have also been glad of help from other organisations and galleries.

NPA member Carol Metcalfe says, 'the exhibitors are a diverse group with varied backgrounds. Some are recent graduates, others have worked in ceramics for decades, some are part-time whilst for others potting is a full-time business. Most, if not all, have exhibited before, but not necessarily in London. Despite our diversity, however, we are all bound together in this group venture, and without

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exception we hope that it will help us connect with the south. The work to be exhibited is as varied as its creators, and ranges from smoke-fired to stoneware, from functional to sculptural, from tiny vessels to architectural installations, and is produced in as many different ways – a reminder of just how wide a scope there is in our craft.'

Since the foundation of the NPA there have been many local guilds and exhibiting societies, some with influence, some with excellent local reputations. But a good exhibition in Manchester attracts little attention in Newcastle, while, usually, a show in Sheffield is of little interest to Liverpool. A critical mass of attention is not reached until London takes notice, and reputation reflects back on the regions. Not that we expect to take the city by storm, but we will have braved the windmill. Maybe we might break the record. We do not

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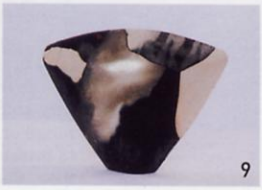
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have a long history, have few documents, fewer minutes, although we do have an excellent newsletter. The NPA has been an available vehicle, one to be hopped into and driven by whoever was so inclined (so long as a sufficient number of passengers agreed to go along and paid their fare). Since our inaugural workshop at Coxwold Pottery, York, we have gone toward whatever direction, gallery or conference fitted the moment – and now seems a good time for some of us to revisit the capital, and present our faces to a wider world. We look forward to doing so together. **CR**

Thanks to Carol Metcalfe for collating the images for this feature.

Northern Fire, Oxo Tower Gallery, London, October 6-24. Website www.northern-potters.org.uk

1: Mandy Long – Paperclay figure, 1250°C, concrete base, H30cm ▌2: Ian Marsh – *Pipe Extrusions*, smooth textured crank, 1260°C reduced, gas kiln, H max. 60cm ▌3: Maggie Angus Berkowitz – Part of the hydrotherapy pool tiling at Chapel Allerton Hospital, Leeds ▌4: John Rivers – Two stoneware teapots, H approx. 20cm ▌5: Fiona Mazza – Raku vessel, coiled, raku fired 950°C, H28cm ▌6: Babs Taylor – Raku fired bowl, white clay body, white crackle and copper matt glazes, fired to 1000°C in a home-made raku kiln, Ø24cm ▌7: Barbara Wood – Three bottles, coiled and burnished porcelain and T material, bisqued to 1000°C then smoke fired, H max. 39cm▌8: Penelope Withers – *Freeform Bottles*, thrown stoneware, H max. 69cm ▌9: Helen Plaxton – Handbuilt, reconstructed 'shoulder' form, smoke and saggar-fired, H15cm ▌10: Stephanie Black – Vessel, stoneware, 1220°C oxidisation, H approx. 30cm ▌11: Carol Metcalfe – *Squarish Poured Plate*, raku clay, bean ash glazes, 1240°C electric kiln, W approx. 23cm.

VI Flux unity formula and formula weight calculations

The tables on the following pages show the calculations for the flux unity formulae and formulae weights, given in Table 7 (p.57), and used in the recipe calculations in Appendix VII (p.188). For a list of chemical symbols see Appendix III (p.172)

	CALCULATING THE FLUX UNITY FORMULA OF UNWASHED BEAN ASH													
	Oxides	K_2O	Na_2O	CaO	MgO	ZnO	Fe_2O_3	Al_2O_3	SiO_2	P_2O_5	TiO_2	Other	LOI	Total
	Ash (%s)xrf	13.58	2.00	24.18	5.96	0.03	0.73	1.70	16.61	2.43	0.13	0.57	32.11	100.03
	Molecular Weights of Oxides	94.1	62	56.1	40.3	81.4	160	102	60.1	142	79.9			
		Divide percentages by Molecular Weights to give Molecular Equivalent (or moles)												
*	Moles (supplied by 100g ash)	0.144	0.032	0.431	0.148	0.000	0.005	0.017	0.276	0.017	0.002			
	Total Fluxes	0.755												
		Divide Molecular Equivalents by Total Fluxes to bring fluxes to Unity (i.e. fluxes = 1)												
	Fluxes to Unity	0.191	0.043	0.571	0.196	0.000	0.006	0.022	0.366	0.023	0.002			
	Simplified Flux Unity Formula	0.23		0.57	0.20	0.00	0.01	0.02	0.37	0.02	0.00			
	Further Simplified	0.2		0.6	0.2	0.0	0.0	0.0	0.4	0.0	0.0			
	CALCULATING FORMULA WEIGHT OF THE ASH (see * above)													
	100g ash provides	0.755	moles of flux											
	therefore													
	Flux Unity Formula (i.e. 1 mole flux) is provided by 100g ash divided by						0.755							
						=	132.4							
			Molecular Weight of Flux Unity Formula =				132.4							

Table 26:
Calculation of flux unity formula & formula weight of unwashed bean ash

	CALCULATING THE FLUX UNITY FORMULA OF WASHED BEAN ASH													
	Oxides	**K_2O**	**Na_2O**	**CaO**	**MgO**	**ZnO**	**Fe_2O_3**	**Al_2O_3**	**SiO_2**	**P_2O_5**	**TiO_2**	**Other**	**LOI**	**Total**
	Ash (%s)xrf	2.70	0.37	28.52	6.64	0.04	0.90	2.12	21.96	2.69	0.17	0.31	33.58	100.00
	Molecular Weights of Oxides	94.1	62	56.1	40.3	81.4	160	102	60.1	142	79.9			
		Divide percentages by Molecular Weights to give Molecular Equivalent (or moles)												
*	***Moles (supplied by 100g ash)**	0.029	0.006	0.508	0.165	0.000	0.006	0.021	0.365	0.019	0.002			
	Total Fluxes		0.708											
		Divide Molecular Equivalents by Total Fluxes to bring fluxes to Unity (i.e. fluxes = 1)												
	Fluxes to Unity	0.041	0.008	0.718	0.233	0.001	0.008	0.029	0.516	0.027	0.003			
	Simplified Flux Unity Formula	0.05		0.72	0.23	0.00	0.01	0.03	0.52	0.03	0.00			
	Further Simplified	0.0		0.7	0.2	0.0	0.0	0.0	0.5	0.0	0.0			
	CALCULATING FORMULA WEIGHT OF THE ASH (see * above)													
	100g ash provides	0.708	**moles of flux**											
	therefore													
	Flux Unity Formula (i.e. 1 mole flux) is provided by 100g ash divided by						0.708							
						=	141.3							
			Formula Weight of Flux Unity Formula =				141.3							

Table 27:
Calculation of flux unity formula & formula weight of washed bean ash

	CALCULATING THE FLUX UNITY FORMULA OF UNWASHED PEA ASH													
	Oxides	K_2O	Na_2O	CaO	MgO	ZnO	Fe_2O_3	Al_2O_3	SiO_2	P_2O_5	TiO_2	Other	LOI	Total
	Ash (%s)xrf	6.16	0.37	32.77	5.31	0.02	1.01	2.59	20.92	2.18	0.20	0.40	28.07	100.00
	Molecular Weights of Oxides	94.1	62	56.1	40.3	81.4	160	102	60.1	142	79.9			
		Divide percentages by Molecular Weights to give Molecular Equivalent (or moles)												
*	*Moles (supplied by 100g ash)	0.065	0.006	0.584	0.132	0.000	0.006	0.025	0.348	0.015	0.003			
	Total Fluxes		0.787											
		Divide Molecular Equivalents by Total Fluxes to bring fluxes to Unity (i.e. fluxes = 1)												
	Fluxes to Unity	0.083	0.008	0.742	0.167	0.000	0.008	0.032	0.442	0.019	0.003			
	Simplified Flux Unity Formula	0.09		0.74	0.17	0.00	0.01	0.03	0.44	0.02	0.00			
	Further Simplified	0.1		0.7	0.2	0.0	0.0	0.0	0.4	0.0	0.0			
	CALCULATING FORMULA WEIGHT OF THE ASH (see * above)													
	100g ash provides	0.787	moles of flux											
	therefore													
	Flux Unity Formula (i.e. 1 mole flux) is provided by 100g ash divided by						0.787							
						=	127.0							
			Formula Weight of Flux Unity Formula =				127.0							

Table 28:
Calculation of flux unity formula & formula weight of unwashed pea ash

	CALCULATING THE FLUX UNITY FORMULA OF WASHED PEA ASH													
	Oxides	K_2O	Na_2O	CaO	MgO	ZnO	Fe_2O_3	Al_2O_3	SiO_2	P_2O_5	TiO_2	Other	LOI	Total
	Ash (%s)xrf	2.09	0.03	32.07	5.14	0.02	0.96	2.28	20.27	2.31	0.17	0.30	34.36	100.00
	Molecular Weights of Oxides	94.1	62	56.1	40.3	81.4	160	102	60.1	142	79.9			
		Divide percentages by Molecular Weights to give Molecular Equivalent (or moles)												
*	*Moles (supplied by 100g ash)	0.022	0.000	0.572	0.128	0.000	0.006	0.022	0.337	0.016	0.002			
	Total Fluxes	0.722												
		Divide Molecular Equivalents by Total Fluxes to bring fluxes to Unity (i.e. fluxes = 1)												
	Fluxes to Unity	0.031	0.001	0.792	0.177	0.000	0.008	0.031	0.467	0.023	0.003			
	Simplified Flux Unity Formula	0.03		0.79	0.18	0.00	0.01	0.03	0.47	0.02	0.00			
	Further Simplified	0.0		0.8	0.2	0.0	0.0	0.0	0.5	0.0	0.0			
	CALCULATING FORMULA WEIGHT OF THE ASH (see * above)													
	100g ash provides	0.722	moles of flux											
	therefore													
	Flux Unity Formula (i.e. 1 mole flux) is provided by 100g ash divided by						0.722							
						=	138.5							
			Formula Weight of Flux Unity Formula =				138.5							

Table 29:
Calculation of flux unity formula & formula weight of washed pea ash

CALCULATING THE UNITY FORMULA OF GHS Hyplas 71 Ball Clay (see Scott, pp. 82-83)										
Calculated from analysis provided by GHS										
Oxides	K_2O	Na_2O	CaO	MgO	Fe_2O_3	Al_2O_3	SiO_2	Other	LOI	Total
GHS Hyplas 71 Ball Clay (% wt)	1.9	0.4	0.1	0.4	0.9	20.0	69.0	1.8	5.4	99.9
Molecular Weights of Oxides	94.1	62	56.1	40.3	160	102	60.1			
	Divide percentages by Molecular Weights to give Molecular Equivalent (or moles)									
*Moles (supplied by 100g ash)	0.020	0.006	0.002	0.010	0.006	0.196	1.148			
Total Fluxes	0.038									
	Divide Molecular Equivalents by Alumina to bring to Unity (i.e. alumina = 1)									
Alumina to Unity	0.103	0.033	0.009	0.051	0.029	1.000	5.855			
Simplified Flux Unity Formula	0.14		0.01	0.05	0.03	1.00	5.86			
CALCULATING MOLECULAR WEIGHT OF THE CLAY (see * above)										
100g clay provides	0.196	moles of alumina								
therefore										
Unity Formula (i.e.1 mole alumina) is provided by 100g ash divided by						0.196				
					=	510.0				
		Molecular Weight of Unity Formula =				510				

Table 30:
Calculation of unity formula & formula weight of Hyplas 71 ball clay

VII Calculation of new glaze recipes

The tables below show the calculations for the glaze recipes, given in Table 11 (p.62), which use the flux unity formulae and formulae weights given in Table 7 (p.57). The chemical symbols used can be found in Appendix III (p.172)

CALCULATION OF WASHED BEAN ASH GLAZE RECIPE (Ash/ Potash feldspar/ China clay/ Flint)

The recipe for this calculation is based on the Limit formulae and the Unity formula of the ash. The ash and feldspar supply the fluxes then china clay and flint supply the additional alumina and silica required

			OXIDES	KNaO	CaO	MgO	Al_2O_3	SiO_2	WEIGHT	RECIPE: % WEIGHT
	LIMIT FORMULA			-0.335	-0.630	-0.333	0.355 – 0.730	2.840 – 5.510		
MATERIALS	MOLECULAR WEIGHT	X	MOLES REQD							
FORMULAE:										
Washed bean ash				0.049	0.718	0.233	0.029	0.516		
Potash feldspar (Scott, 1998, p.180)				1.000	0.000	0.000	1.000	6.000		
China clay							1.000	2.000		
Flint								1.000		
FLUX UNITY FORMULA OF RECIPE				**0.166**	**0.630**	**0.204**	**0.355**	**2.840**		
			TOTAL FLUXES	1.000						
INGREDIENTS:										
Washed bean ash	141.3	x	0.877	0.043	0.630	0.204	0.025	0.453	123.9	**39**
			Still needed	0.123	0.000	0.000	0.330	2.387		
Potash feldspar	556.8	x	0.123	0.123	0.000	0.000	0.123	0.738	68.5	**21**
			Still needed	0.000	0.000	0.000	0.207	1.649		
China clay	258.2	x	0.207				0.207	0.414	53.4	**17**
			Still needed				0.000	1.235		
Flint	60.1	x	1.235					1.235	74.2	**23**
			Still needed					0.000		
Totals									320.1	**100**

Table 31:
Recipe calculation for Recipe I

CALCULATION OF UNWASHED PEA ASH GLAZE RECIPE (Ash/ Potash feldspar/ China clay/ Flint)										
The recipe for this calculation is based on the Limit formulae and the Unity formula of the ash. The ash and feldspar supply the fluxes then china clay and flint supply the additional alumina and silica required										
			OXIDES	KNaO	CaO	MgO	Al_2O_3	SiO_2	WEIGHT	RECIPE: % WEIGHT
	LIMIT FORMULA			-0.335	-0.630	-0.333	0.355 – 0.730	2.840 – 5.510		
MATERIALS	MOLECULAR WEIGHT	X	MOLES REQD							
FORMULAE:										
Unwashed pea ash				0.091	0.742	0.167	0.032	0.442		
Potash feldspar (Scott, 1998, p.180)				1.000	0.000	0.000	1.000	6.000		
China clay							1.000	2.000		
Flint								1.000		
FLUX UNITY FORMULA OF RECIPE				**0.228**	**0.630**	**0.142**	**0.355**	**2.845**		
			TOTAL FLUXES	1.000						
INGREDIENTS:										
Unwashed pea ash	127	x	0.849	0.077	0.630	0.142	0.027	0.375	107.8	**35**
			Still needed	0.151	0.000	0.000	0.328	2.470		
Potash feldspar	556.8	x	0.151	0.151	0.000	0.000	0.151	0.906	84.1	**27**
			Still needed	0.000	0.000	0.000	0.177	1.564		
China clay	258.2	x	0.177				0.177	0.354	45.7	**15**
			Still needed				0.000	1.210		
Flint	60.1	x	1.210					1.210	72.7	**23**
			Still needed					0.000		
Totals									310.3	**100**

Table 32:
Recipe calculation for Recipe II

CALCULATION OF WASHED PEA ASH GLAZE RECIPE (Ash/ Potash feldspar/ China clay/ Flint)										
The recipe for this calculation is based on the Limit formulae and the Unity formula of the ash. The ash and feldspar supply the fluxes then china clay and flint supply the additional alumina and silica required										
			OXIDES	KNaO	CaO	MgO	Al_2O_3	SiO_2	WEIGHT	RECIPE: % WEIGHT
	LIMIT FORMULA			-0.335	-0.630	-0.333	0.355 – 0.730	2.840 – 5.510		
MATERIALS	MOLECULAR WEIGHT	X	MOLES REQD							
FORMULAE:										
Washed pea ash				0.032	0.792	0.177	0.031	0.467		
Potash feldspar (Scott, 1998, p.180)				1.000	0.000	0.000	1.000	6.000		
China clay							1.000	2.000		
Flint								1.000		
FLUX UNITY FORMULA OF RECIPE				**0.229**	**0.630**	**0.141**	**0.355**	**2.847**		
			TOTAL FLUXES	1.000						
INGREDIENTS:										
Washed pea ash	138.5	x	0.795	0.025	0.630	0.141	0.025	0.371	110.1	**35**
			Still needed	0.204	0.000	0.000	0.330	2.476		
Potash feldspar	556.8	x	0.204	0.204	0.000	0.000	0.204	1.224	113.6	**36**
			Still needed	0.000	0.000	0.000	0.126	1.252		
China clay	258.2	x	0.126				0.126	0.252	32.5	**10**
			Still needed				0.000	1.000		
Flint	60.1	x	1.000					1.000	60.1	**19**
			Still needed					0.000		
Totals									316.3	**100**

Table 33:
Recipe calculation for Recipe III

CALCULATION OF UNWASHED BEAN ASH GLAZE RECIPE (Ash/ China clay/ Flint)										
The recipe for this calculation is based on the Limit formulae and the Unity formula of the ash. The ash supplies all the fluxes then china clay and flint supply the alumina and additional silica required										
			OXIDES	KNaO	CaO	MgO	Al_2O_3	SiO_2	WEIGHT	RECIPE: % WEIGHT
	LIMIT FORMULA			-0.335	-0.63	-0.333	0.355 – 0.730	2.840 – 5.510		
MATERIALS	MOLECULAR WEIGHT	X	MOLES REQD							
FORMULAE:										
Unwashed bean ash				0.234	0.571	0.196	0.022	0.366		
China clay							1.000	2.000		
Flint								1.000		
FLUX UNITY FORMULA OF RECIPE				**0.234**	**0.571**	**0.196**	**0.355**	**2.840**		
	TOTAL FLUXES			1.000						
INGREDIENTS:										
Unwashed bean ash	132.4	x	1.000	0.234	0.571	0.196	0.022	0.366	132.4	**40**
	Still needed			0.000	0.000	0.000	0.333	2.474		
China clay	258.2	x	0.333				0.333	0.666	86.0	**26**
	Still needed						0.000	1.808		
Flint	60.1	x	1.808					1.808	108.7	**33**
	Still needed							0.000		
Totals									327.0	**100**

Table 34:
Recipe calculation for Recipe IV

CALCULATION OF UNWASHED PEA ASH GLAZE RECIPE (Ash/ China clay/ Flint)

The recipe for this calculation is based on the Lime eutectic, since the ash has a high calcium content. The alumina and additional silica required are supplied by china clay and flint

			OXIDES	KNaO	CaO	MgO	Al_2O_3	SiO_2	WEIGHT	RECIPE: % WEIGHT
			LIME EUTECTIC		1.000		0.350	2.480		
MATERIALS	MOLECULAR WEIGHT	X	MOLES REQD							
FORMULAE:										
Unwashed pea ash				0.091	0.742	0.167	0.032	0.442		
China clay							1.000	2.000		
Flint								1.000		
FLUX UNITY FORMULA OF RECIPE				0.091	0.742	0.167	0.350	2.480		
			TOTAL FLUXES	1.000						
INGREDIENTS:										
Unwashed pea ash	127	x	1	0.091	0.742	0.167	0.032	0.442	127.0	43.3
			Still needed	0.000	0.000	0.000	0.318	2.038		
China clay	258.2	x	0.318				0.318	0.636	82.1	28.0
			Still needed				0.000	1.402		
Flint	60.1	x	1.402					1.402	84.3	28.7
			Still needed					0.000		
Totals									293.4	100.0

Table 35:
Recipe calculation for Recipe V

CALCULATION OF WASHED PEA ASH GLAZE RECIPE (Ash/ China clay/ Flint)										
The recipe for this calculation is based on the Lime eutectic, since the ash has a very high calcium content. The alumina and additional silica required are supplied by china clay and flint										
			OXIDES	KNaO	CaO	MgO	Al_2O_3	SiO_2	WEIGHT	RECIPE: % WEIGHT
	LIME EUTECTIC				1.000		0.350	2.480		
MATERIALS	MOLECULAR WEIGHT	X	MOLES REQD							
FORMULAE:										
Washed pea ash				0.031	0.792	0.177	0.031	0.467		
China clay							1.000	2.000		
Flint								1.000		
FLUX UNITY FORMULA OF RECIPE				0.031	0.792	0.177	0.350	2.480		
	TOTAL FLUXES			1.000						
INGREDIENTS:										
Washed pea ash	127	x	1	0.031	0.792	0.177	0.031	0.467	127.0	43.5
	Still needed			0.000	0.000	0.000	0.319	2.013		
China clay	258.2	x	0.319				0.319	0.638	82.4	28.2
	Still needed						0.000	1.375		
Flint	60.1	x	1.375					1.375	82.6	28.3
	Still needed							0.000		
Totals									292.0	100.0

Table 36:
Recipe calculation for Recipe VI

CALCULATION OF UNWASHED BEAN ASH GLAZE RECIPE (Ash/Ball clay)										
The recipe for this calculation is based on the Limit formulae and the Unity formula of the ash using Hyplas 71 ball clay to supply the alumina and additional silica required										
			OXIDES	KNaO	CaO	MgO	Al_2O_3	SiO_2	WEIGHT	RECIPE: % WEIGHT
	LIMIT FORMULA			-0.335	-0.63	-0.333	0.355 – 0.730	2.840 – 5.510		
MATERIALS	MOLECULAR WEIGHT	X	MOLES REQD							
UNITY FORMULAE										
Hyplas 71 ball clay				0.136	0.009	0.051	1.000	5.855		
Unwashed bean ash				0.234	0.571	0.196	0.022	0.366		
FLUX UNITY FORMULA OF RECIPE				0.272	0.526	0.201	0.448	2.841		
			TOTAL FLUXES	1.000						
INGREDIENTS										
Hyplas 71 ball clay	510	x	0.428	0.058	0.004	0.022	0.428	2.506	218.28	64
			Still needed	0.214	0.523	0.179	0.020	0.335		
Unwashed bean ash	132.4	x	0.916	0.214	0.523	0.179	0.020	0.335	121.3	36
			Still needed	0.000	0.000	0.000	0.000	0.000		
Totals									339.6	100

Table 37:
Recipe calculation for Recipe VII

VIII Selection of clay bodies

When selecting clay bodies for this research, the data shown in Table 38 below, supplied by Potclays Ltd, was used to calculate the alumina unity formulae shown in Table 39 (p.196). The procedure followed was that shown in Table 30 (p.187), used to calculate the unity formula of Hyplas 71 ball clay.

Oxides (percentages) Clays	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_2O	Texture
1153 Industrial Crank	60.60	0.90	26.50	2.80	0.40	0.30	1.20	0.80	Coarse
1114 Craft Crank	61.30	0.90	26.30	2.80	0.40	0.30	1.40	0.60	Coarse
1154 Raku	55.00	1.00	28.60	2.50	0.60	0.90	2.30	0.20	Coarse
1102 Oxid St Thomas	62.30	0.90	23.80	2.20	0.50	0.50	1.20	0.60	Medium
1113 Camberwell	59.00	0.80	29.10	2.00	0.30	0.40	1.40	0.60	Medium
1117 Buff Stoneware	58.20	1.30	26.60	1.80	0.20	0.90	2.20	0.10	Smooth
1120 Buff Body	65.20	1.20	20.80	1.50	0.70	0.30	1.80	0.70	Smooth
1109 Flecked Stoneware	62.40	1.40	24.40	1.30	0.30	0.30	1.80	0.60	Medium
1106 White St. Thomas	58.00	0.90	30.00	1.00	0.30	0.30	1.20	0.60	Medium
1145 White Stoneware	63.20	1.00	26.20	0.70	0.15	0.30	1.60	0.50	Smooth

Table 38:
Analyses of a range of stoneware clays, expressed as percentages by weight of oxides

(Data supplied by Potclays Ltd)

Oxides (percentages) Molecular weights Clays (supplied by Potclays)	SiO_2 60.1	TiO_2 80	Al_2O_3 102	Fe_2O_3 160	CaO 56.1	MgO 40.3	K_2O 94.1	Na_2O 62	Temp	Colour	Texture
1145 White Stoneware	63.20	1.00	26.20	0.70	0.15	0.30	1.60	0.50	1200 -1300	Off White	Smooth
Molecular equivalent	1.05	0.013	0.257	0.004	0.003	0.007	0.017	0.008			
Alumina Unity	4.09	0.050	1.000	0.015	0.012	0.027	0.066	0.031			
Ratios	**4.1**		**1**	**0.015**	**0.14**						
1106 White St. Thomas	58.00	0.90	30.00	1.00	0.30	0.30	1.20	0.60	1160 -1300	Off White Grey	Medium
Molecular equivalent	0.97	0.011	0.294	0.006	0.005	0.007	0.013	0.010			
Alumina Unity	3.28	0.037	1.000	0.020	0.017	0.024	0.044	0.034			
Ratios	**3.3**		**1**	**0.020**	**0.12**						
1120 Buff Body	65.20	1.20	20.80	1.50	0.70	0.30	1.80	0.70	1110 -1285	Light Buff	Smooth
Molecular equivalent	1.08	0.015	0.204	0.009	0.012	0.007	0.019	0.011			
Alumina Unity	5.29	0.074	1.000	0.044	0.059	0.034	0.093	0.054			
Ratios	**5.3**		**1**	**0.044**	**0.24**						
1117 Buff Stoneware	58.20	1.30	26.60	1.80	0.20	0.90	2.20	0.10	1160 -1290	Buff Grey	Smooth
Molecular equivalent	0.97	0.016	0.261	0.011	0.004	0.022	0.023	0.002			
Alumina Unity	3.72	0.061	1.000	0.042	0.015	0.084	0.088	0.008			
Ratios	**3.7**		**1**	**0.042**	**0.20**						
1113 Camberwell	59.00	0.80	29.10	2.00	0.30	0.40	1.40	0.60	1170 -1300	Buff	Medium
Molecular equivalent	0.98	0.010	0.285	0.013	0.005	0.010	.0.015	0.010			
Alumina Unity	3.44	0.035	1.000	0.046	0.018	0.035	0.053	0.035			
Ratios	**3.4**		**1**	**0.046**	**0.14**						
1114 Craft Crank	61.30	0.90	26.30	2.80	0.40	0.30	1.40	0.60	1170 -1300	Brown Buff	Coarse
Molecular equivalent	1.02	0.010	0.258	0.018	0.007	0.007	0.015	0.010			
Alumina Unity	3.95	0.040	1.000	0.070	0.027	0.027	0.058	0.039			
Ratios	**4**		**1**	**0.070**	**0.15**						
1154 Raku	55.00	1.00	28.60	2.50	0.60	0.90	2.30	0.20	Over 900	Brownish Buff	Coarse
Molecular equivalent	0.92	0.013	0.280	0.016	0.011	0.022	0.024	0.003			
Alumina Unity	3.28	0.046	1.000	0.057	0.039	0.079	0.086	0.011			
Ratios	**3.3**		**1**	**0.057**	**0.22**						

Table 39:
Unity formulae of clay bodies

IX Images of glaze tests

Test set 1:

Recipes used for Set 1 [ash (A)/ china clay (C)/ potash feldspar (P)/ flint (F)]

Recipes expressed in percentages by weight:

1. 65A 35C	**2.** 65A 28C 7F	**3.** 65A 21C 14F	**4.** 65A 14C 21F	**5.** 65A 7C 28F	**6.** 65A 35F
7. 58A 35C 7P	**8.** 58A 28C 7P 7F	**9.** 58A 21C 7P 14F	**10.** 58A 14C 7P 21F	**11.** 58A 7C 7P 28F	**12.** 58A 7P 35F
13. 51A 35C 14P	**14.** 51A 28C 14P 7F	**15.** 51A 21C 14P 14F	**16.** 51A 14C 14P 21F	**17.** 51A 7C 14P 28F	**18.** 51A 14P 35F
19. 44A 35C 21P	**20.** 44A 28C 21P 7F	**21.** 44A 21C 21P 14F	**22.** 44A 14C 21P 21F	**23.** 44A 7C 21P 28F	**24.** 44A 21P 35F
25. 37A 35C 28P	**26.** 37A 28C 28P 7F	**27.** 37A 21C 28P 14F	**28.** 37A 14C 28P 21F	**29.** 37A 7C 28P 28F	**30.** 37A 28P 35F
31. 30A 35C 35P	**32.** 30A 28C 35P 7F	**33.** 30A 21C 35P 14F	**34.** 30A 14C 35P 21F	**35.** 30A 7C 35P 28F	**36.** 30A 35P 35F

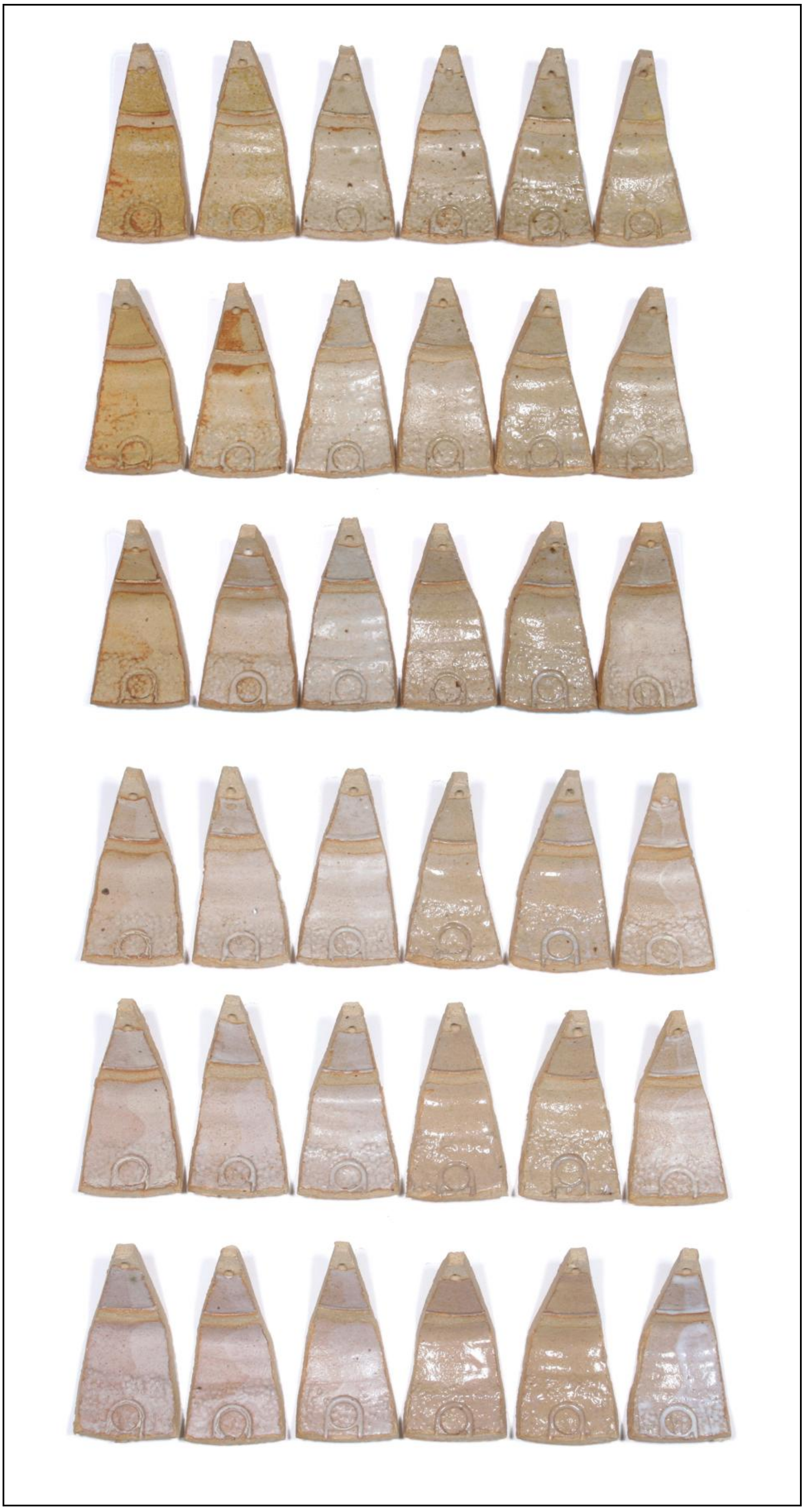


Figure 118:
Test set 1: Washed pea ash recipes WP1.1 – WP1.36 on Raku clay

[Photography: David Williams]

Figure 119:
Test set 1: Washed pea ash recipes WP1.1 – WP1.36 on Smooth Buff clay
[Photography: David Williams]

Figure 120:
Test set 1: Washed pea ash recipes WP1.1 – WP1.36 on Camberwell clay
[Photography: David Williams]

Figure 121:
Test set 1: Washed pea ash recipes WP1.1 – WP1.36 on White St Thomas clay
[Photography: David Williams]

Test set 2:

Recipes used for Set 2 – Triaxial blend [ash (A)/ china clay (C)/ flint (F)]

Recipes expressed in percentages by weight:

1.	100A		
2.	80A	20C	
3.	80A		20F
4.	60A	40C	
5.	60A	20C	20F
6.	60A		40F
7.	46A	54C	
8.	46A	36C	18F
9.	46A	18C	36F
10.	46A		54F
11.	40A	60C	
12.	40A	45C	15F
13.	40A	30C	30F
14.	40A	15C	45F
15.	40A	60F	
16.	35A	65C	
17.	35A	52C	13F
18.	35A	39C	26F
19.	35A	26C	39F
20.	35A	13C	52F
21.	35A		65F
22.	28A	72C	
23.	28A	60C	12F
24.	28A	48C	24F
25.	28A	36C	36F
26.	28A	24C	48F
27.	28A	12C	60F
28.	28A		72F

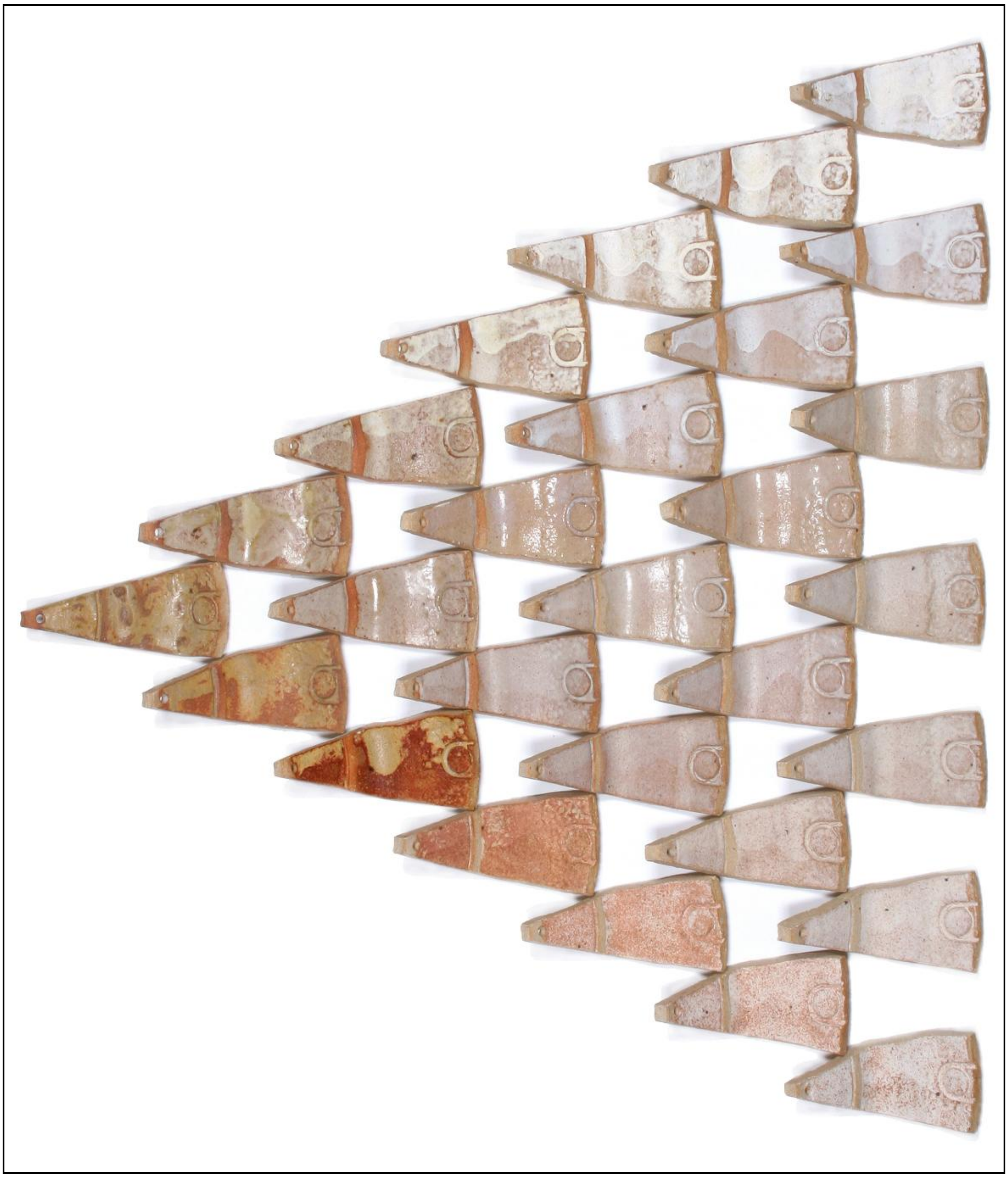


Figure 122:
Test set 2: Unwashed bean ash recipes UB2.1 – UB2.28 on Raku clay

[Photography: David Williams]

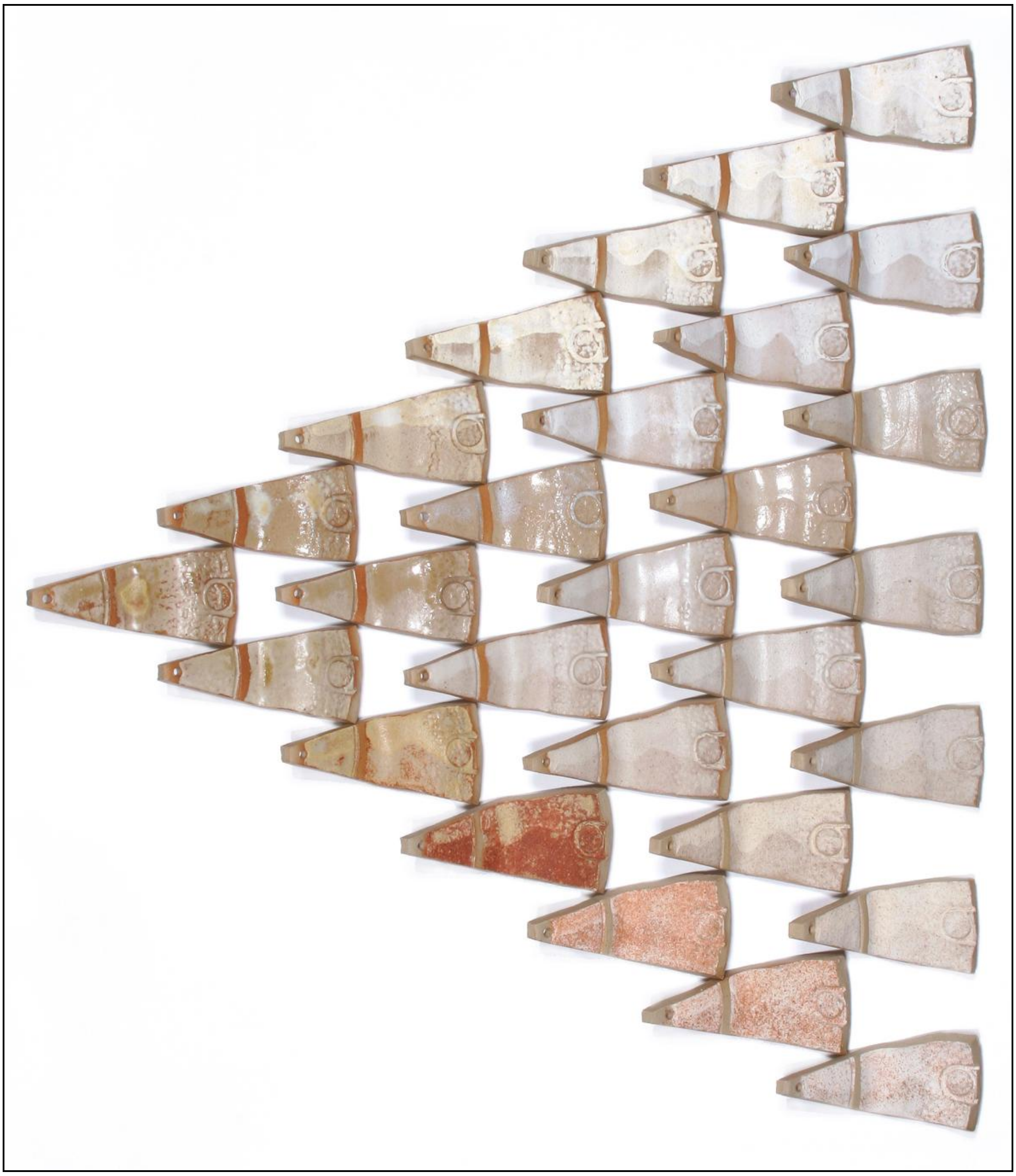


Figure 123:
Test set 2: Unwashed bean ash recipes UB2.1 – UB2.28 on Smooth Buff clay
[Photography: David Williams]

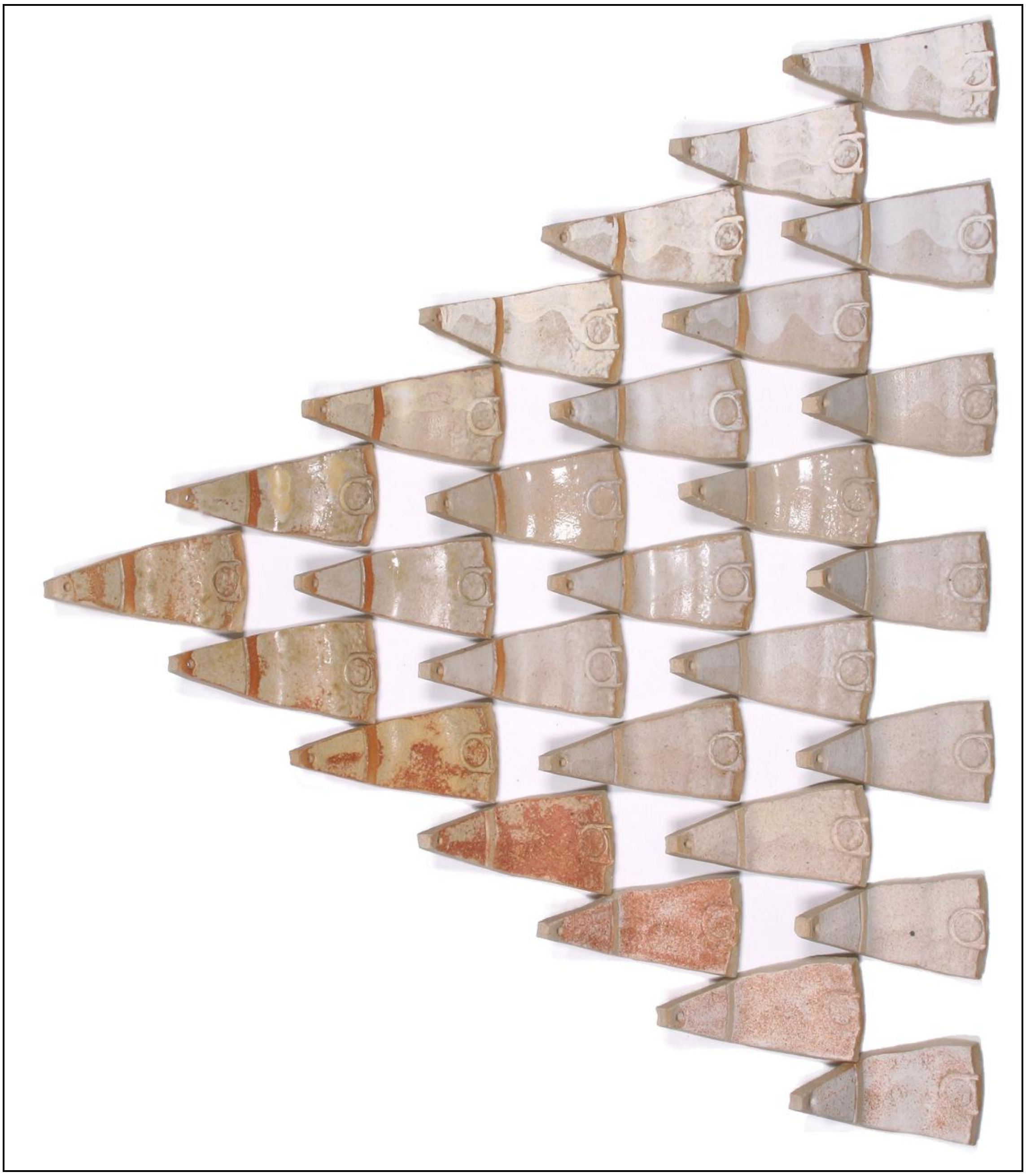


Figure 124:
Test set 2: Unwashed bean ash recipes UB2.1 – UB2.28 on Camberwell clay

[Photography: David Williams]

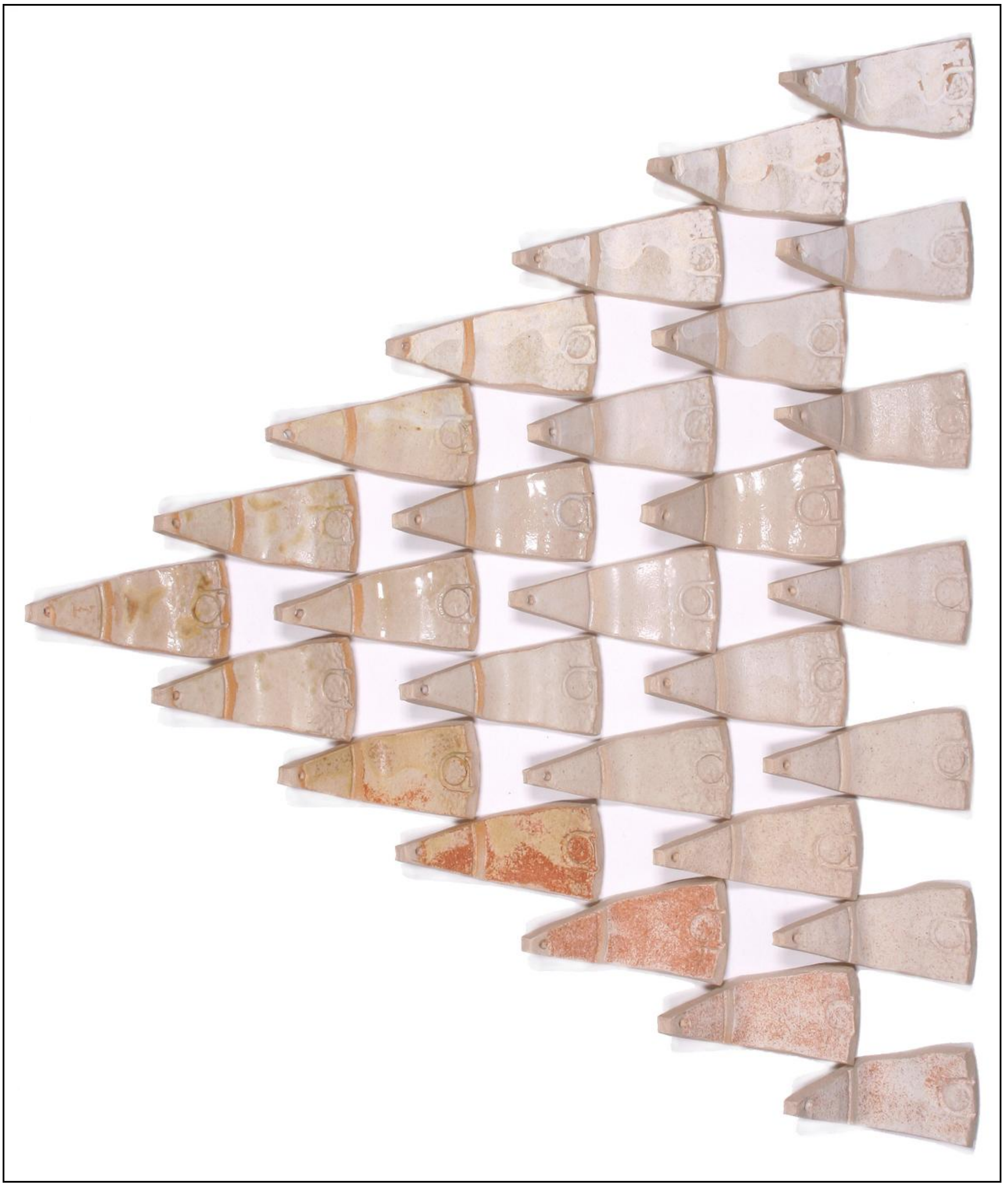


Figure 125:
Test set 2: Unwashed bean ash recipes UB2.1 – UB2.28 on White St Thomas clay

[Photography: David Williams]

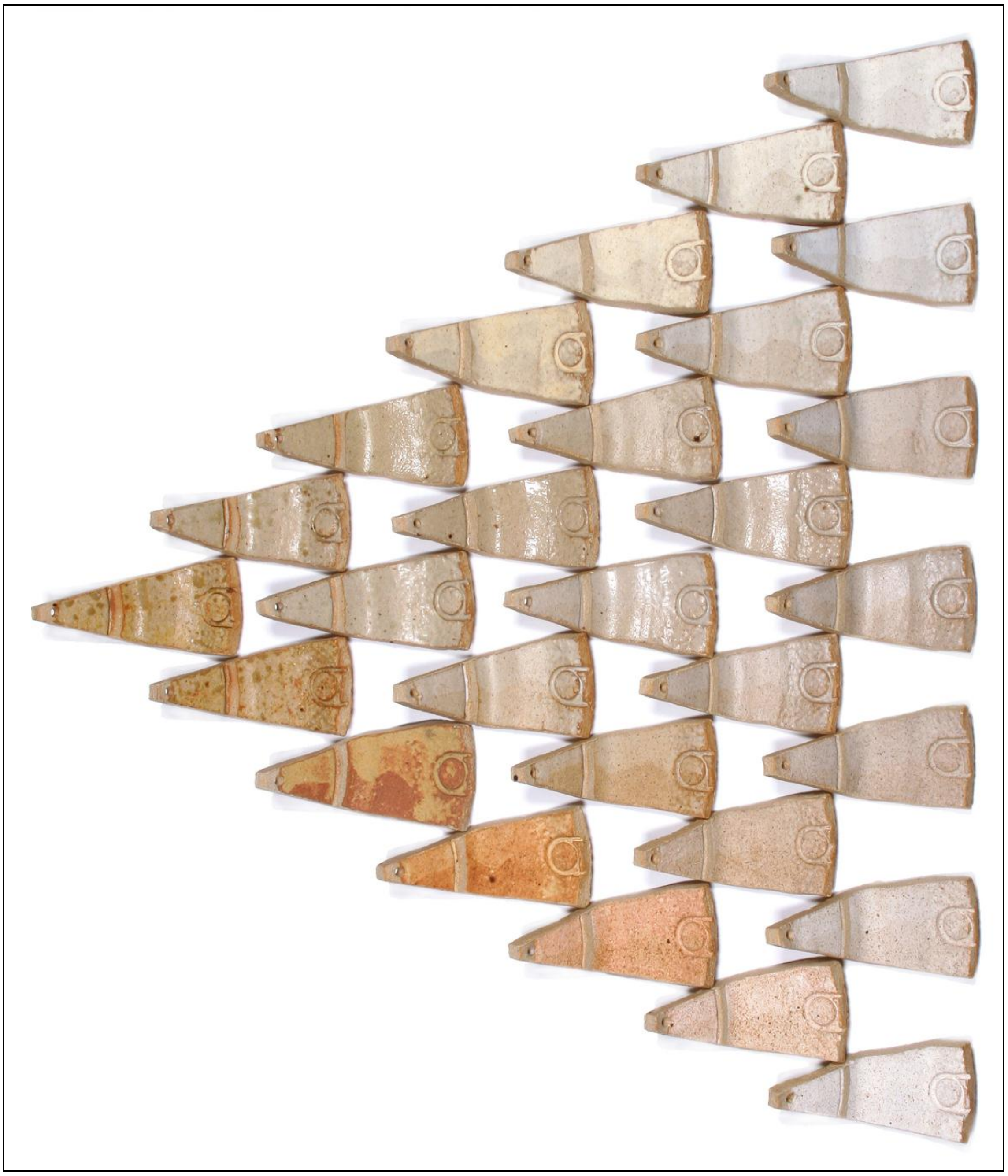


Figure 126:
Test set 2: Unwashed pea ash recipes UP2.1 – UP2.28 on Raku clay

[Photography: David Williams]

Figure 127:
Test set 2: Unwashed pea ash recipes UP2.1 – UP2.28 on Smooth Buff clay
[Photography: Carol Metcalfe]

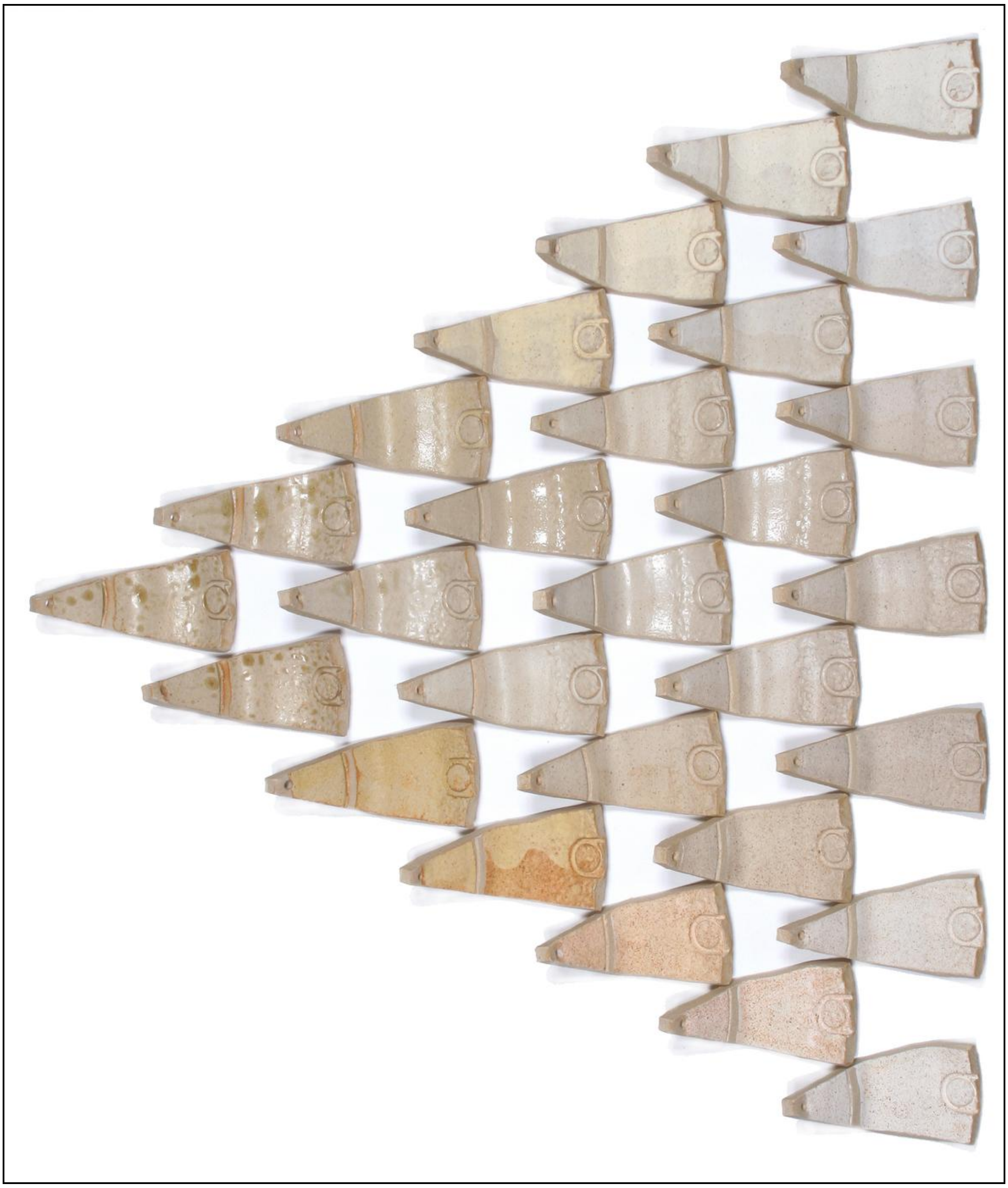


Figure 128:
Test set 2: Unwashed pea ash recipes UP2.1 – UP2.28 on Camberwell clay

[Photography: David Williams]

Figure 129:
Test set 2: Unwashed pea ash recipes UP2.1 – UP2.28 on White St Thomas clay

[Photography: David Williams]

Test set 3:

Recipes used for Set 3 – Line Blend [ash (A) / ball clay (B)]

Recipes expressed in percentages by weight:

1.	2.	3.	4.	5.	6.	7.	8.
100A	90A	80A	70A	60A	50A	40A	30A
	10B	20B	30B	40B	50B	60B	70B

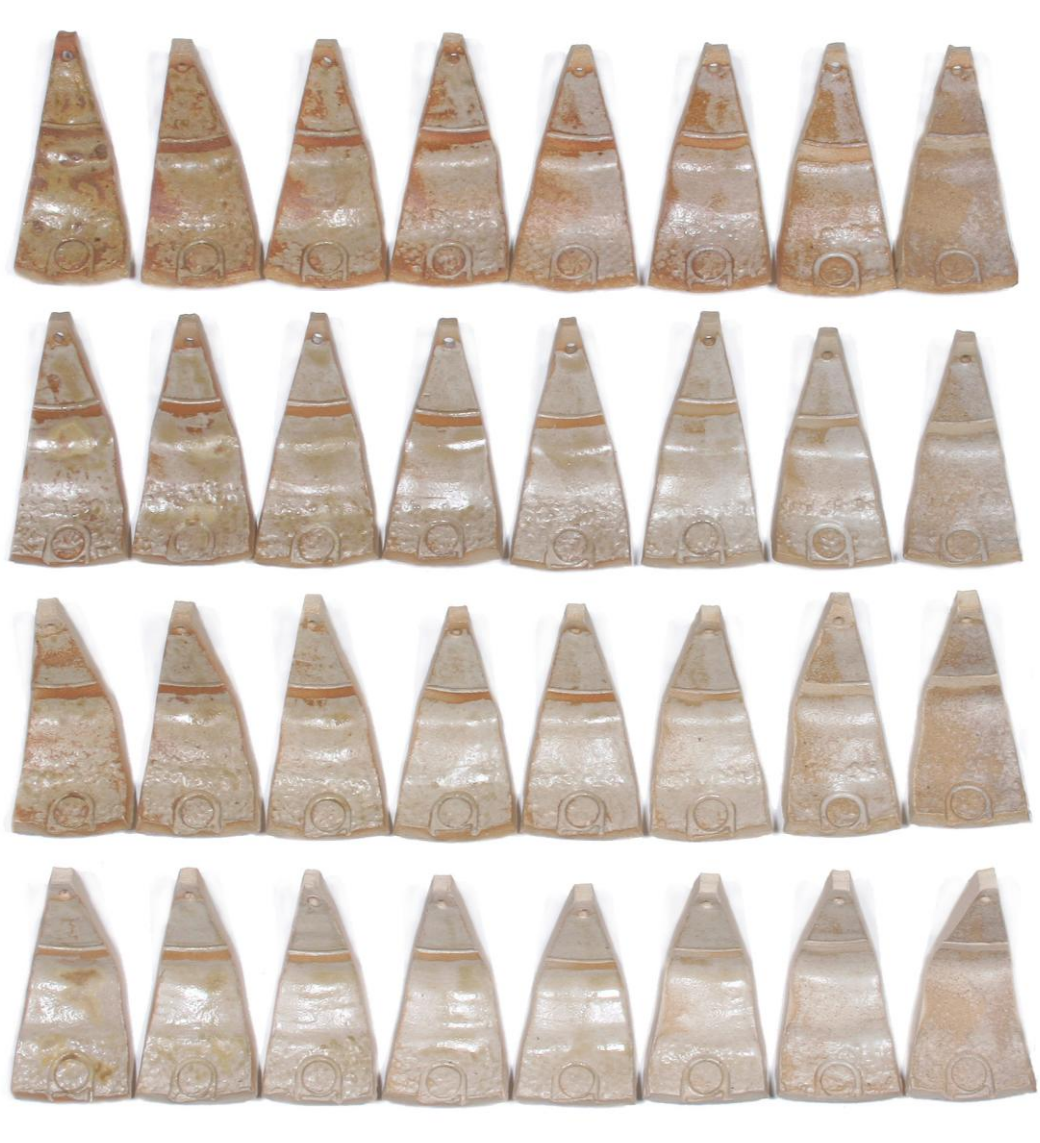
<table>
<tr><th>Recipe</th><th>UB3.1</th><th>UB3.2</th><th>UB3.3</th><th>UB3.4</th><th>UB3.5</th><th>UB3.6</th><th>UB3.7</th><th>UB3.8</th></tr>
<tr><td>RAKU</td><td colspan="8" rowspan="4"></td></tr>
<tr><td>SMOOTH BUFF</td></tr>
<tr><td>CAMBERWELL</td></tr>
<tr><td>WHITE</td></tr>
</table>

Figure 130:
Test set 3: Unwashed bean ash recipes UB3.1 – UB3.8

[Photography: David Williams]

<table>
<tr><th>Recipe</th><th>UP3.1</th><th>UP3.2</th><th>UP3.3</th><th>UP3.4</th><th>UP3.5</th><th>UP3.6</th><th>UP3.7</th><th>UP3.8</th></tr>
<tr><td>RAKU</td><td colspan="8" rowspan="4"></td></tr>
<tr><td>SMOOTH BUFF</td></tr>
<tr><td>CAMBERWELL</td></tr>
<tr><td>WHITE</td></tr>
</table>

Figure 131:
Test set 3: Unwashed pea ash recipes UP3.1 – UP3.8

[Photography: David Williams]

X Catalogue of new glaze recipes

RECIPE NUMBER	INGREDIENTS					CLAY BODIES			
	ASH	CHINA CLAY	FLINT	POTASH FELDSPAR	HYPLAS 71 BALL CLAY	RAKU	SMOOTH BUFF	CAMBERWELL	WHITE ST THOMAS
WASHED PEA ASH GLAZES:									
WP1.3	65	21	14						
WP1.4	65	14	21						
WP1.5	65	7	28						
WP1.9	58	21	14	7					
WP1.15	51	21	14	14					

RECIPE NUMBER	INGREDIENTS					CLAY BODIES			
	ASH	CHINA CLAY	FLINT	POTASH FELDSPAR	HYPLAS 71 BALL CLAY	RAKU	SMOOTH BUFF	CAMBERWELL	WHITE ST THOMAS
WASHED PEA ASH GLAZES:									
WP1.16	51	14	21	14					
WP1.17	51	7	28	14					
WP1.21	44	21	14	21					
WP1.22	44	14	21	21					
WP1.23	44	7	28	21					

RECIPE NUMBER	INGREDIENTS					CLAY BODIES			
	ASH	CHINA CLAY	FLINT	POTASH FELDSPAR	HYPLAS 71 BALL CLAY	RAKU	SMOOTH BUFF	CAMBERWELL	WHITE ST THOMAS
WASHED PEA ASH GLAZES:									
WP1.27	37	21	14	28					
WP1.28	37	14	21	28					
WP1.34	30	14	21	35					
WP1.35	30	7	28	35					
WP1.36	30		35	35					

RECIPE NUMBER	INGREDIENTS					CLAY BODIES			
	ASH	CHINA CLAY	FLINT	POTASH FELDSPAR	HYPLAS 71 BALL CLAY	RAKU	SMOOTH BUFF	CAMBERWELL	WHITE ST THOMAS
UNWASHED PEA ASH GLAZES:									
UP2.1	See UP3.1 below								
UP2.2	80	20							
UP2.3	80		20						
UP2.4	60	40							
UP2.5	60	20	20						
UP2.7	46	54							

RECIPE NUMBER	INGREDIENTS					CLAY BODIES			
	ASH	CHINA CLAY	FLINT	POTASH FELDSPAR	HYPLAS 71 BALL CLAY	RAKU	SMOOTH BUFF	CAMBERWELL	WHITE ST THOMAS
UNWASHED PEA ASH GLAZES:									
UP2.8	46	36	18						
UP2.9	46	18	36						
UP2.13	40	30	30						
UP2.19	35	26	39						
UP2.1 **UP3.1**	100								

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RECIPE NUMBER	INGREDIENTS					CLAY BODIES			
	ASH	CHINA CLAY	FLINT	POTASH FELDSPAR	HYPLAS 71 BALL CLAY	RAKU	SMOOTH BUFF	CAMBERWELL	WHITE ST THOMAS
UNWASHED PEA ASH GLAZES:									
UP3.2	90				10				
UP3.3	80				20				
UP3.6	50				50				
UP3.7	40				60				
UP3.8	30				70				

RECIPE NUMBER	INGREDIENTS					CLAY BODIES			
	ASH	CHINA CLAY	FLINT	POTASH FELDSPAR	HYPLAS 71 BALL CLAY	RAKU	SMOOTH BUFF	CAMBERWELL	WHITE ST THOMAS
UNWASHED BEAN ASH GLAZES:									
UB2.1	See UB3.1 below								
UB2.2	80	20							
UB2.4	60	40							
UB2.5	60	20	20						
UB2.7	46	54							
UB2.8	46	36	18						

RECIPE NUMBER	INGREDIENTS					CLAY BODIES			
	ASH	CHINA CLAY	FLINT	POTASH FELDSPAR	HYPLAS 71 BALL CLAY	RAKU	SMOOTH BUFF	CAMBERWELL	WHITE ST THOMAS
UNWASHED BEAN ASH GLAZES:									
UB2.9	46	18	36						
UB2.11	40	60							
UB2.13	40	30	30						
UB2.19	35	26	39						
UB2.1 **UB3.1**	100								

RECIPE NUMBER	INGREDIENTS					CLAY BODIES			
	ASH	CHINA CLAY	FLINT	POTASH FELDSPAR	HYPLAS 71 BALL CLAY	RAKU	SMOOTH BUFF	CAMBERWELL	WHITE ST THOMAS
UNWASHED BEAN ASH GLAZES:									
UB3.2	90				10				
UB3.4	70				30				
UB3.6	50				50				
UB3.7	40				60				

XI Artist's statements and promotional material

CAROL METCALFE

My current work results from the PhD research project I am engaged in at the University of Sunderland, exploring the use of arable crop waste in ash glazes. The forms are inspired by a study of nature's effects on man-made objects in the landscape - erosion, corrosion, and colonisation. The textured surfaces are also produced using locally found materials, giving the work a strong sense of place.

Carol Metcalfe

Growing Glazes

My current work results from the PhD research project I am engaged in at the University of Sunderland, exploring ash glazes from arable crop waste, produced on the farm where I live. I have developed a whole range of glazes from field bean and pea crops; some glossy and transparent, others dry with rich colouring.

The forms are inspired by a study of nature's effects on man-made objects in the landscape - erosion, corrosion, and colonisation. These processes produce visual effects, which I incorporate into my designs.

The textured surfaces are also produced using waste products from the farm. Weeds or weed seed and chaff, dressed out of the harvested crops, are rolled into the surface of soft clay. Further surface decoration makes use of other natural, locally found materials, such as clay slips and iron-bearing silts, poured or painted onto the piece. Thus the work has a strong sense of place.

Firing takes place in an electric kiln to relatively low stoneware temperatures.

Contact details:

Figure 132:
Artist's statement and promotional information leaflet from *'Northern Fire'* exhibition, Oxo Tower Gallery, 2005

Freshly Fired Biscuit

An Exhibition by Northern Potters

The Northern Potters Association was formed in September 1977 to promote ceramics in the north of England. The group is committed to encouraging all those who have a passion for clay, glaze and kilns and to creating opportunities for the exchange of information on materials, techniques, fellowship, and a sense of community. Membership is open to all, professionals, students, amateurs, hobbyists, educationalists or purely an interest in ceramics. They run an extensive programme of selected and thematic exhibitions throughout this large geographical region, encompassing both rural and urban environments.

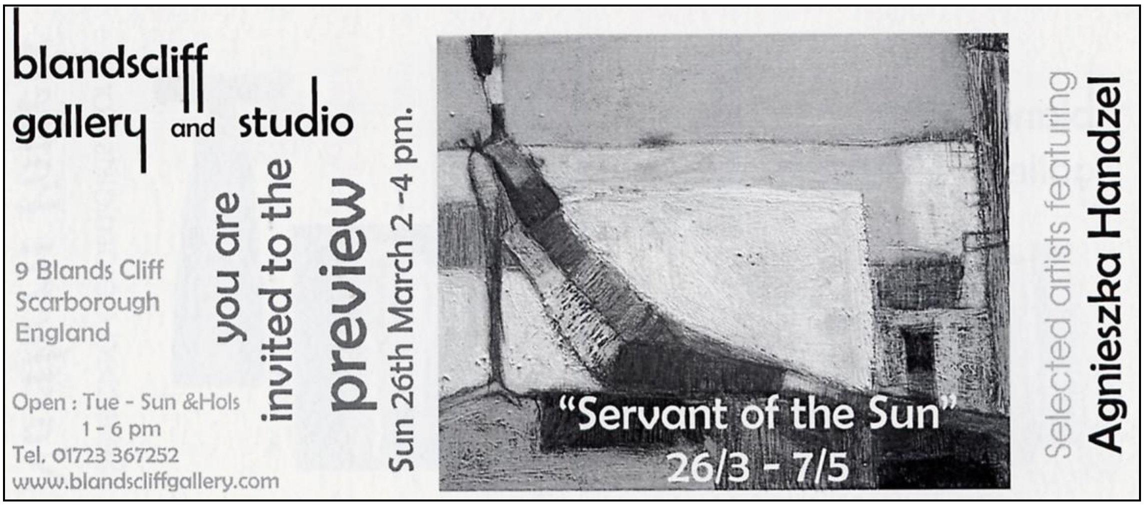
We are very pleased to see such an exciting range of potters at The Biscuit Factory. This is a unique chance to admire the diversity and skill of some of our best local ceramicists.

BRIAN HOLLAND | Three ceramic figures

DENNIS KILGALLON | Proud Detail

JILL FORD | Lily Jar with White Stopper

Figure 133:
Promotion of *'Freshly Fired Biscuit'* exhibition in The Biscuit Factory's *'Fresh Magazine'* Spring/Summer 2006



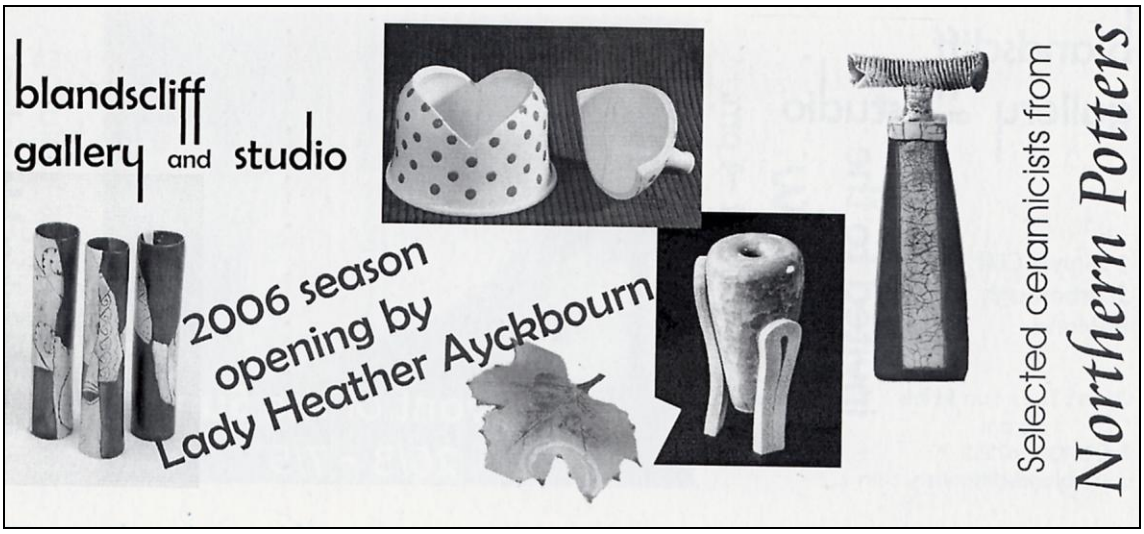


Figure 134:
Preview invitation for *'Servant of the Sun'* exhibition, 2006

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