

**Appendix 1:**

**An Examination of the Broadfield House Collection of Walter  
using a Radiation monitor.**



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## **APPENDIX 1.**

### **An Examination of the Broadfield House Collection of Walter using a Radiation Monitor.**

#### **Introduction.**

The following images in this appendix have been taken directly from the photographs that make up the accompanying catalogue to the 2006-07 Amalric Walter Exhibition at Broadfield House Glass Museum, Kingswinford, West Midlands (Cummings, 2006). A private collection of 161 pieces of Walter's glasswork formed the basis of the exhibition, which is held in trust by the museum. I have been fortunate to have had unrestricted access to the collection and my examination of the works has informed much of the research undertaken in this PhD study.

I have placed the images in the same order as the original Broadfield House catalogue with its corresponding number attached to it. The discussions in Books I and II refer to this catalogue of images. Where pieces of the collection are shown as images or discussed in the text they are indicated in the form of 'Cat. No. 48' (for instance). They can be referred to directly in the following set of images.

The information contained in this appendix has two direct uses. The first is as a referencing system for discussion within the main body of the thesis about individual works. The second is as an illustration to the discussion in Book II about the radiation content within each piece.

The photographs have been duplicated and placed in two columns. The images in the left column show the pieces as they were published in the Broadfield House catalogue. The images in the right-hand column indicate the areas of radiation from my examination of the collection.

## **The examination.**

Following the examination of the *Small Square Covered Box* (Cat. No. 86.b) in Book II, Chapter 5 and the discussion of the subsequent results with Dr Hamilton I decided I that an examination of the rest of the Broadfield House's Walter collection with a Geiger counter was necessary. This would determine if there were any other pieces that may exhibit levels of radiation similar to it. The Broadfield House collection of Walter was at that time at The National Glass Centre in Sunderland where it was being exhibited. I made my examination on the 14th March 2008.

A series 900 mini monitor Geiger counter was used. This records Counts Per Second (CPS). The 'background' measurement reading is usually around 2 CPS on the counter. This is considered in scientific terms to be a 'normal' level, and is what the general public can expect from everyday life. Anything twice that reading, i.e. 4 CPS, would indicate a noticeable level of radioactive material present (e.g. uranium).

The Geiger counter was on loan from Jane McLaughlin Assistant Radiation Protection Advisor, Health and Safety dept, Charles Stewart House, 9-16 Chambers Street, Edinburgh. When I returned the monitor to her at Edinburgh University's Radiation Advisory Unit it was explained that each monitor varies slightly in its readings and is dependent on how it is set. This may cause the CPS levels to read slightly higher or lower than they actually are in reality, but, nevertheless, the percentage differences between each piece would be the same and conclusions easily drawn.

My assistant in the examination was Tim Jago-Smith, a student at the time on the glass course at the University of Sunderland, recorded the level of CPS.

## **Methodology.**

A general examination of each piece was made with the head of the Geiger counter and the CPS observed. The head was then placed approximately 1cm away from the glass on areas that had showed significant levels of radiation, and held there for up to 10 seconds. Other points on each object were treated in the same manner and the readings recorded to show contrasting, or lower readings, using the same time scale of 10 seconds. This is not the recommended method of testing for radiation readings in glass as suggested to me by Robert Brill of Corning. He suggested placing the counter alongside the piece, and waiting for a longer period (up to 2 minutes) before recording the data, and then testing again another 4 times in the same area. The 5 results would then be added together and then divided by 5 to obtain the mean result. Due to the restricted time access placed on me at the National Glass Centre (the objects were still on public display) this was not a test I could do for each piece. Two hours had been allowed for the examination, so the tests for 161 pieces had to be relatively quick.

Occasionally there were fluctuations in readings where the needle on the monitor's dial kept vacillating between numbers. For instance, the needle would hover between 4 and 5 CPS and then would, move up to 15 CPS, before falling back again.

Cat. No.71a was an example of this. In those cases I have recorded the phenomenon.

While showing some anomalies such as the example above the, records do give a good indicator of what levels of radiation emitted from each pieces of glass. More importantly, they show in what colours radioactive material is to be found. The collected data has yielded remarkable information. This is discussed below.

The results of the CPS readings are collated below. The data is also attached to an image of each piece in the next section. Lassoed areas indicating where and how much radiation was emitted have been placed over each image together with points of reference. An identical, but clean image is placed next for comparison.

## Catalogue Number (Cat. Nos) and CPS Readings.

1. a) Nib tidy with grasshopper: .....CPS: 5  
b) Covered box with moth: CPS: 2; Yellow on lid knob: CPS: 7-8.  
c) Dish with bee: .....CPS: 0.5.
2. Leaf with Cockchafer: .....CPS 2.
3. Scarab paperweight: .....CPS 2-3.
4. Oval dish with goose: .....CPS 1.
5. Rectangular point of sale nameplate: .....CPS 0.75.
6. Detail of chameleon dish: see No.48.
7. Frog dish: .....CPS2.
8. Frog dish: .....CPS 1-2.
9. Dish with Duck: .....CPS 1.
10. Duck paperweight: .....CPS: 1.
11. Dish with green lizard: .....CPS 30-40.
12. Dish with green lizard: pale areas: CPS 3-4; orange-brown areas: CPS 30.
13. Dish with stag beetle: .....CPS 1.
14. Pen tidy with stag beetle: .....CPS 1.
15. Dish with crab: .....CPS 0.5.
16. a) Two entwined lizards: .....CPS: 1.25.  
b) Single green lizard: blue base: CPS 1.5; lizard: CPS: 3-4  
c) Chameleon: chameleon snout: CPS 9-10; ochre base: CPS: 9;  
chameleon body: .....CPS 8.
17. Dish and prawns: .....CPS 0.5.
18. Dish with green lizard: yellow areas on dish: .....CPS 9-10;  
ochre areas (including blue lizard): .....CPS 35 – 40.
19. Large frog paperweight: .....CPS 2.
20. Flat dish with butterfly: .....CPS 0.5.
21. Dish with hermit crab: yellow-ochre crab shell: CPS 4-6;  
blue-yellow dish: .....CPS 2.5 - 3 .
22. a) Red stag beetle paperweight: .....CPS 0.5.  
b) Brown stag beetle paperweight: .....CPS <1.
23. Lidded bowl with wood boring beetles: Yellow finial: CPS 20 - 23;  
beetles, lid and bowl: .....CPS 2 -6.

24. Chameleon dish: ochre interior and orange edge of dish: CPS 70;  
pale yellow areas of interior and edge: CPS 15; chameleon: CPS 7.
25. Tortoise paperweight: Olive green base: CPS <1; red markings on shell of  
tortoise: .....CPS 7.
26. Dish with two stag beetles: interior of dish at top end (dark red):  
CPS 20; paler end (with signature): CPS 3 – 4; beetles: CPS 4 – 5.
27. Large crab dish: crab shell and legs CPS 7; pale areas of dish: CPS 2.5.
28. a) Beetle dish: opaque colour, beetle: CPS 30; pale lip: ...CPS 2 - 3  
b) Lobster dish: yellow areas and lip: CPS 7; interior of dish: CPS 10;  
crayfish and immediate surrounding area: .....CPS 10-13.
29. Covered box with moths: whole box including yellow flowers and  
moths: .....CPS 1.
30. Oval dish with crab: crab shell: CPS 3-4; main part of dish through to the pale  
olive green ends: .....CPS 4-5.
31. Inkwell and pen tray: yellow interior of dish: .....CPS 10 – 15;  
pale yellow end: CPS 6; nut inkwell: .....CPS 8.
32. Dish with red crab: crabshell and legs: CPS 1.5; seaweed: CPS 20.
33. Dish with brown and yellow crab: crab's shell: CPS 2; dish: CPS 1.
34. Mouse dish: .....CPS 1.
35. Mouse dish: .....CPS 0.75 – 1.25.
36. a) Frog on Tortoise paperweight: .....CPS 1.  
b) Frog paperweight: .....CPS 0.5.  
c) Frog dish: CPS 3; lily pad: CPS 4; rest of yellow dish: CPS 9-10.
37. Large cockatoo: CPS 1; maize cob: .....CPS 20.
38. Mouse group with carved ivory mouse: End of base CPS 5-6;  
yellow areas: CPS 10; mouse group 1-2.
39. Ermine: .....CPS 1.
40. a) Sea-lion paperweight: .....CPS 0.5  
b) Squirrel paperweight: .....CPS 1.
41. a) White owl dish: .....CPS 0.5.  
b) Brown owl dish: .....CPS 1.
42. a) Brown mouse paperweight: .....CPS 1.5.  
b) White mouse paperweight: .....CPS 1.5.  
c) Two pale brown mice paperweight: .....CPS 1.

43. Box with two compartments with beetle finials: beetle bodies: CPS <5; pale yellow lids and base CPS2 – 4.
44. Inkwell with snail finial: .....CPS 1 – 2.
45. Dish with grasshoppers: .....CPS 1.
46. a) Round dish with lizard: .....CPS 6 – 7.  
 b) Tricorn dish with lizard: lizard and yellow areas: CPS 30-35;  
 brown lip on dish: .....CPS 50-70.
47. Green lizard on leaf: .....CPS 10.
48. Chameleon dish: yellow base and body of dish: CPS 15-20; emerald green area in dish base: CPS 7; chameleon: .....CPS 3.
49. Chameleon dish: yellow areas of dish: CPS 4-5; chameleon: CPS1.5.
50. Cockatoo dish: interior of dish: CPS 10; paler yellow areas and edge: CPS 5;  
 cockatoo: .....CPS 2.
51. Pheasant: .....CPS 2.
52. Kingfisher hollow light fitting: .....CPS 4.
53. a) Blue paperweight: .....CPS 1.  
 b) Turquoise paperweight: .....CPS 1.
54. Fledgling paperweight: .....CPS 1.
55. Fox: .....CPS 1.
56. a) Lioness paperweight: .....CPS 3.  
 b) Rabbit paperweight: .....CPS 2<.  
 c) Kitten paperweight: .....CPS 20.
57. Cat's head: CPS 1.5; base .....CPS 2.
58. a) Moth paperweight: Grey base and the wings of moth: CPS 15; red-brown body of the moth: .....CPS 10-12 .  
 b) Moth paperweight: .....CPS 2-3.
59. Oval crab dish: Interior of the dish CPS 15; crab CPS 0; blue end CPS 0.
60. Chameleon dish: .....CPS 1.
61. a) Round moth dish: Yellow lip and base of dish CPS 10;  
 moth and ochre areas: .....CPS 17-18.  
 b) Triangular moth dish: Yellow lip CPS 5-6; ochre and moth CPS 22.  
 c) Boat shape moth dish: Yellow interior of dish: CPS 10;  
 moths at both ends: .....CPS 25.
62. a) Triangular dish with bee: .....CPS 0.5.

- b) Leaf dish with wasp: .....CPS 8.5 – 9.
- 63.a) Pin dish: yellow base and lip CPS 5; crab: .....CPS10-12.
- b) Brown crab paperweight: .....CPS >2 .
- c) Yellow crab paperweight: .....CPS 3.
- d) Green crab paperweight: .....CPS 3-4.
- 64. Dish with green lizard CPS 7; yellow in base CPS 6-7; ochre lip CPS10-15
- 65. Dish with flying fish: .....CPS 1.5.
- 66. Hexagonal dish with flying fish: yellow CPS 2-4; blue: .....CPS 2.
- 67. a) Small dish with red fish: .....CPS 0.75.
- b) Small dish with shoal of fish: .....CPS 0.5.
- 68. Dish with sea horse: .....CPS 1.5.
- 69. a) Oval dish with yellow tortoise: Dish CPS 1; tortoise shell CPS 7.
- b) Oblong dish with yellow moth: .....CPS 1.
- c) Spade shape dish with moth: .....CPS 1.
- 70. Rectangular dish with moths: Base and interior of dish CPS 0.0;  
    blue lip CPS 0.0; moths: .....CPS 0.0.
- 71. a) Triangular dish with wood boring beetles: ochre lip: CPS 25;  
    dish interior: .....CPS 4-5-15.
- b) Oval dish with beetles: Ochre lip CPS 10-15; dish interior CPS 5-6.
- 72. Dish with fish breaking through wave: .....CPS 0.5.
- 73. a) Green bird paperweight: .....CPS 1.
- b) Yellow bird paperweight: .....CPS 2-3.
- 74. Guinea pig: CPS 4-5; opaque edge on base: .....CPS 5.
- 75. Fennec fox: .....CPS 1.
- 76. a) Snail paperweight: base CPS 7; snail shell: .....CPS 8.
- b) Dish with snail: Yellow base CPS 3; snail shell: .....CPS 4.
- c) Hermit crab paperweight: Base CPS 3; shell: .....CPS 6.
- 77. a) Red lobster paperweight with green base: .....CPS < 0.5.
- b) Two mussels paperweight: .....CPS 0.75 – 1.
- c) Red lobster paperweight with yellow base: Lobster: CPS 1.5;  
        olive green end: .....CPS 10<.
- 78. Snail on grape vine paperweight: base CPS 2-3; snail: .....CPS 5.
- 79. Dish with cicada: .....CPS 35.
- 80. Dish with shell: Dish CPS 0; shell: .....CPS 4.

81. Dish with Butterfly: Butterfly and dish CPS 2-3; yellow flowers CPS 15.
82. Three ring and stud trays: a): .....CPS 1.  
     b): .....CPS 0.5.  
     c) Blue dish CPS 1; wings on moth CPS 5.
83. Covered bowl with bees and honeycomb: Bowl CPS 10; lid CPS 7-10.
84. Covered box with berries: .....CPS 2.
85. Covered box with rose hips and snail finial: Box and lid CPS 0;  
     snail and ochre areas in rim: ..... CPS 4
86. Three covered boxes: a) lid CPS 25; box: .....CPS 10.  
     b) Box and lid: CPS 4-5; red berries: CPS 5<.  
     c): .....CPS 7 -8 -10.
87. a) Covered bowl with bee: blue lid CPS 2-3; yellow finial (flowers and bee) on lid  
     CPS 5.5; yellow florets on box side: .....CPS 6.
- 87 b) Dish with wasps: .....CPS 0.75.
- 88.a) Inkwell with cicada and ant finial: .....CPS 1-2.  
     b) Paperweight with cicada: .....CPS 1.5.
- 89.a) Covered box with grasshopper finial: .....CPS 2.  
     b) Inkwell with bees and cherries: .....CPS >2.
90. Inkwell and pen tray: Pale yellow end: CPS 2; silver spider inkwell: CPS 10.
91. Detail of no.90: (CPS as above).
92. Pair of fox bookends: .....CPS 3-5 (both pieces).
93. Pair of squirrel bookends: .....CPS 0.5 (both pieces).
94. Large hollow duck light fitting: .....CPS 2.
95. Pair of fish bookends: .....CPS 0.5 (both pieces).
96. Hollow dove light fitting: .....CPS < 0.5.
97. Hollow pelican light fitting: Body of bird CPS 0.5; beak CPS 8.
98. a) Fish Paperweight: .....CPS 2.  
     b) Hollow fish light fitting: .....CPS < 2.
99. a) Solid fish: .....CPS 0.5.  
     b) Fish ornament: .....CPS 1.
100. a) Dove ashtray: .....CPS < 1.  
     b) Dove paperweight: .....CPS < 1.
101. Panther: .....CPS 1.
102. Duck paperweight: .....CPS 0.5.

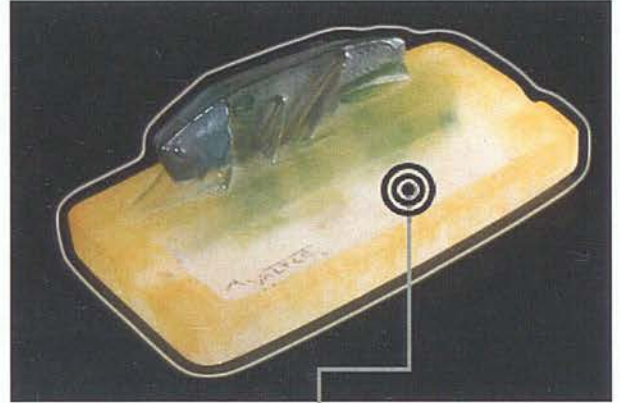
103. Hexagonal dragon fly plate: .....CPS < 0.75.
104. a) Tray with beetles: yellow interior of dish: .....CPS 6;  
       brown edges and lips: .....CPS 13-14.
- b). Ashtray with salamanders: Yellow interior of dish: CPS 5-8;  
       ochre rim: .....CPS 50.
105. a) Parakeet: CPS < 0.5; yellow flowers: .....CPS 5.  
       b) Kingfisher: .....CPS < 0.5.
106. Oval dish with fish: Dish CPS 2: fish: .....CPS 11-12.
107. Oval dish with frog: Dish CPS 1-5: frog: .....CPS 11-12.
108. Small covered pot with cat finial: Cat finial CPS 1-2; ochre colour: CPS 4
109. Dish with beetles: .....CPS 0.5>.
110. a) Small dish with bee: .....CPS 1.  
       b) Paperweight with green lizard: .....CPS 1.5.
111. Traingular Chameleon dish: .....CPS >3.
112. Rectangular dish with snails and flowers: .....CPS1.
113. Hexagonal flat dish with crab: .....CPS 2 - 5.5.
114. Triangular dish with shells and seaweed: Dish CPS5; yellow shells: CPS 10.
115. Dish with angelfish: Dish CPS 25-35; red snout of fish: CPS 30 – 50 – 65.
116. Dish with snail: Dish CPS 4-5: snail: .....CPS 8-10-12.
117. Hexagonal dish with dragonfly: .....CPS 0.5 - 0.75.
118. Point of sale nameplate: .....CPS 0.5.

# Appendix 1

## Geiger Counter Readings

Catalogue Number:

1.a Nib tidy with grasshopper;  
CPS: 5



1.b Covered box with moth;  
Body: CPS 2, yellow on lid knob: CPS 7-8



1.c Dish with bee;  
CPS 0.5



CPS 0.5

2. Leaf with Cockchafer;  
CPS 2



CPS 2

3. Scarab paperweight;  
CPS 2-3



CPS 2-3

4. Oval dish with goose;  
CPS 1



CPS 1

5. Rectangular point of sale nameplate;  
CPS 0.75



CPS 0.75

6. Detail of chameleon dish; see entry No.48



7. Frog dish;  
CPS 2



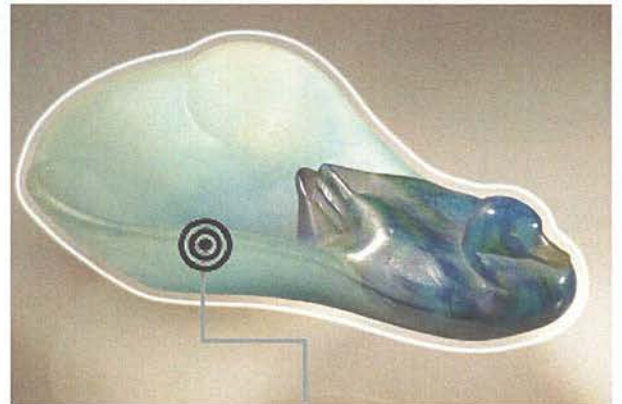
CPS 2

8. Frog dish;  
CPS 1-2



CPS 1-2

9. Dish with Duck;  
CPS 1



CPS 1

10. Duck paperweight;  
CPS 1



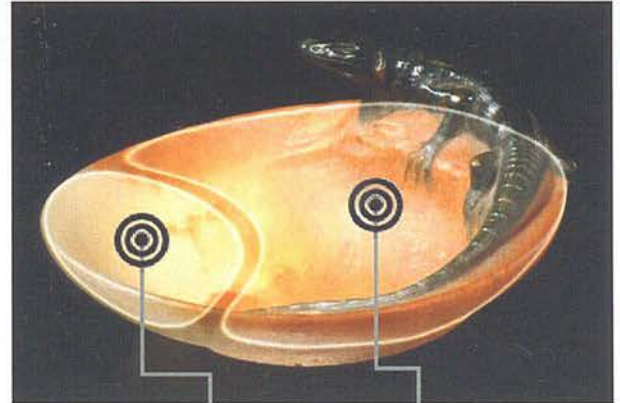
CPS 1

11. Dish with green lizard;  
CPS 30-40



CPS 30-40

12. Dish with green lizard;  
Pale areas: CPS 3-4, orange-brown areas: CPS 30



CPS 3-4

CPS 30

13. Dish with stag beetle;  
CPS 1



CPS 1

14. Pen tidy with stag beetle;  
CPS 1



CPS 1

15. Dish with crab;  
CPS 0.5



CPS 0.5

16. a) Two entwined lizards;  
CPS 1.25



CPS 1.25

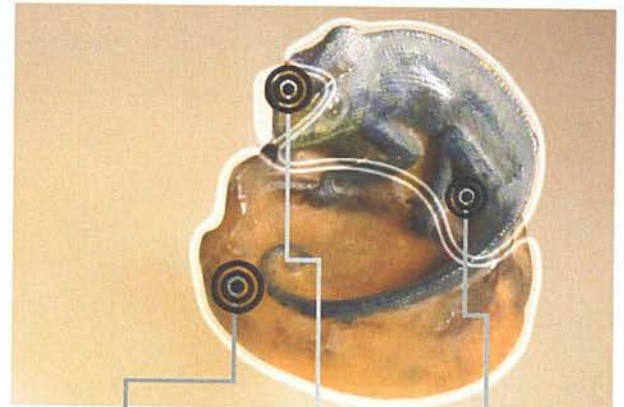
16. b) Single green lizard;  
Blue base: CPS 1.5 lizard: CPS 3-4



CPS 1.5

CPS 3-4

16. c) Chameleon;  
Chameleon snout: CPS 9-10 ochre base: CPS 9 chameleon body: CPS 8

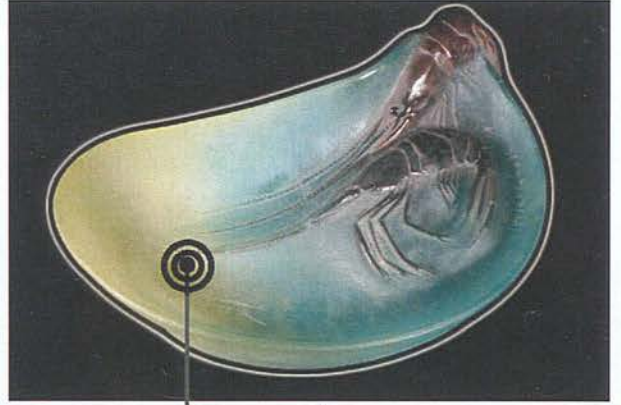


CPS 9

CPS 9-10

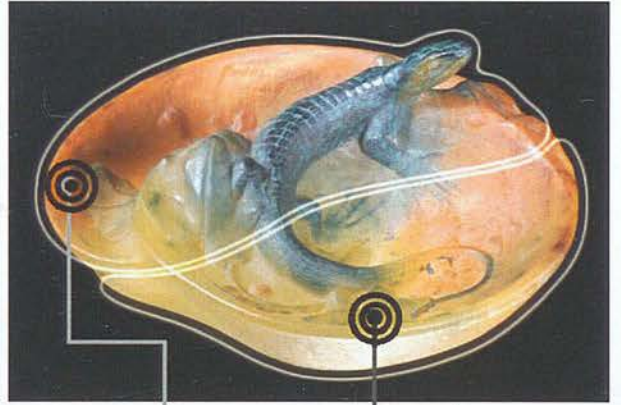
CPS 8

17. Dish and prawns;  
CPS 0.5



CPS 0.5

18. Dish with green lizard; Yellow areas on dish: CPS 9-10  
Ochre areas (including blue lizard): CPS 35-40



CPS 35-40

CPS 9-10

19. Large frog paperweight;  
CPS 2



CPS 2

20. Flat dish with butterfly;  
CPS 0.5



CPS 0.5

21. Dish with hermit crab;  
Yellow-ochre crab shell: CPS 4-6    blue-yellow dish: CPS 2.5 - 3



CPS 4-6

CPS 2.5-3

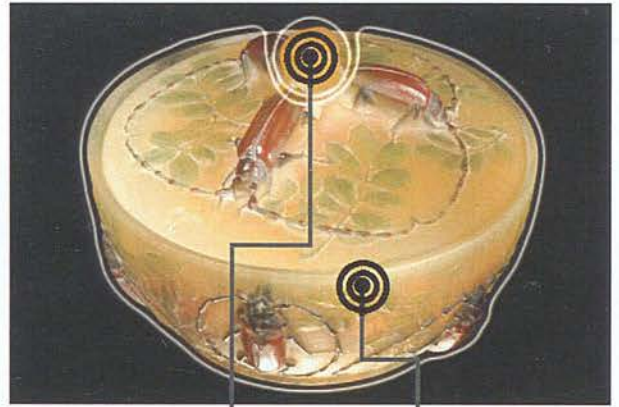
22. a) Red stag beetle paperweight; CPS 0.5  
b) Brown stag beetle paperweight; CPS <1



CPS 0.5

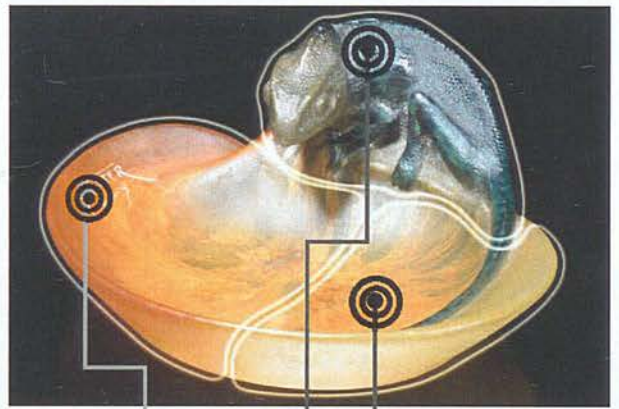
CPS <1

23. Lidded bowl with wood boring beetles;  
 Yellow finial: CPS 20-23    beetles, lid and bowl: CPS 2-6



CPS 20-23    CPS 2-6

24. Chameleon dish; Ochre interior and orange edge of dish: CPS 70  
 pale yellow areas of interior and edge: CPS 15    chameleon: CPS 7



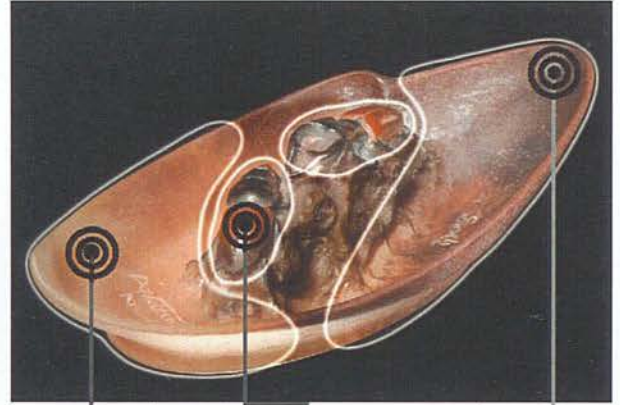
CPS 70    CPS 7    CPS 15

25. Tortoise paperweight;  
 Olive green base: CPS <1    red markings on shell of tortoise: CPS 7



CPS <1    CPS 7

26. Dish with two stag beetles; Interior of dish at top end (dark red): CPS 20  
 paler end (with signature): CPS 3-4      beetles: CPS 4-5



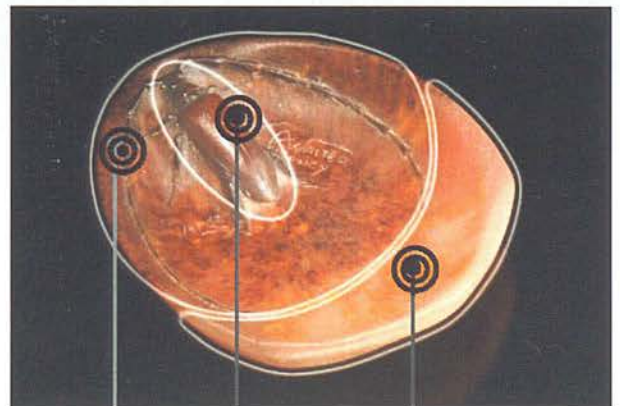
CPS 3-4      CPS 4-5      CPS 20

27. Large crab dish;  
 Crab shell and legs CPS 7      pale areas of dish: CPS 2.5



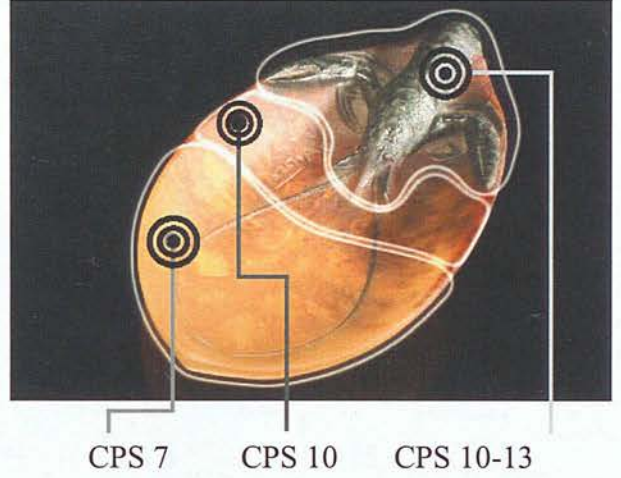
CPS 2.5      CPS 7

28. a) Beetle dish:  
 Opaque colour, beetle: CPS 30      pale lip: CPS 2-3



CPS 30      CPS 2-3

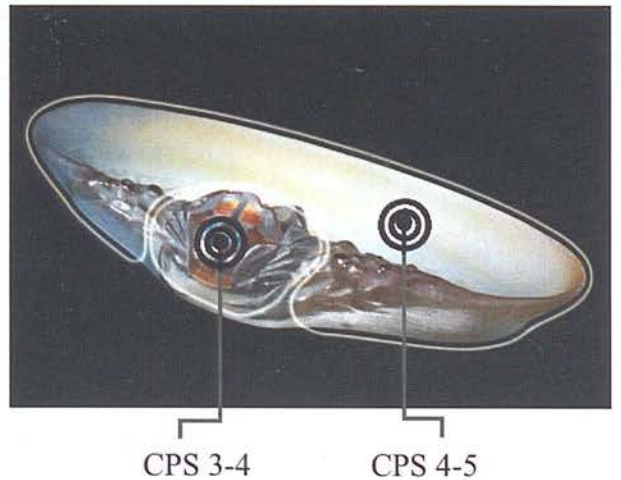
28. b) Lobster dish; Yellow areas and lip: CPS 7 interior of dish: CPS 10  
 crayfish and immediate surrounding area: CPS 10-13



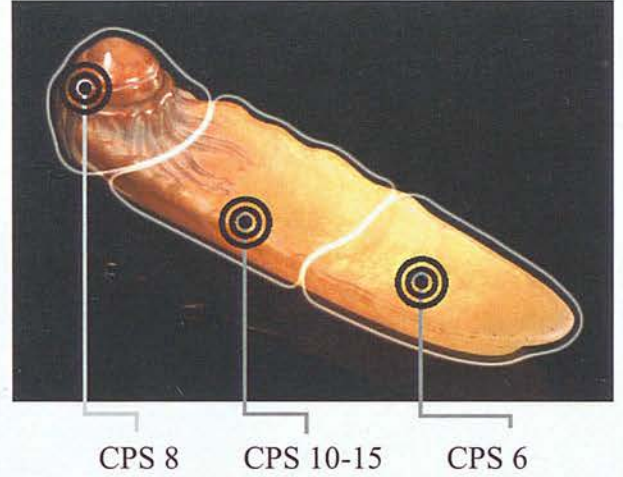
29. Covered box with moths;  
 Whole box including yellow flowers and moths: CPS 1



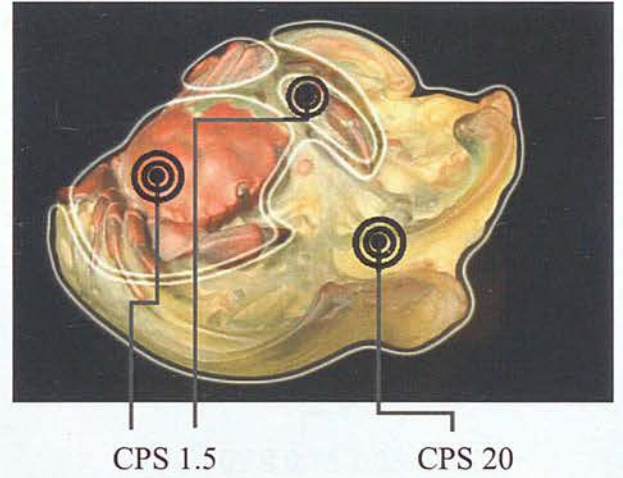
30. Oval dish with crab; Crab shell: CPS 3-4  
 main part of dish through to the pale olive green ends: CPS 4-5



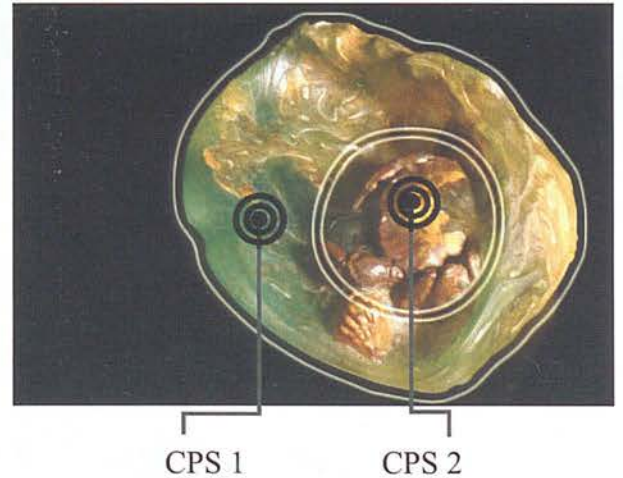
31. Inkwell and pen tray; Yellow interior of dish: CPS 10-15  
 pale yellow end: CPS 6 nut inkwell: CPS 8



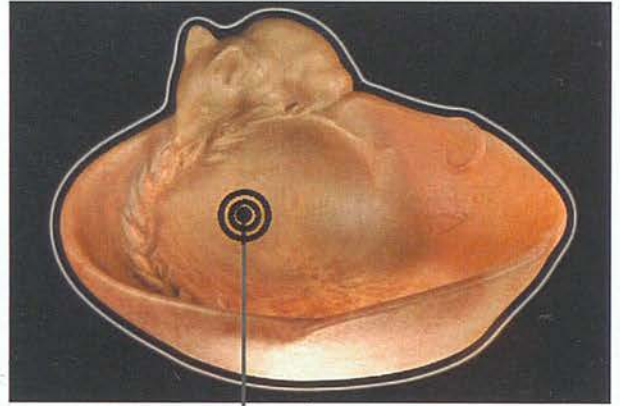
32. Dish with red crab;  
 Crab shell and legs: CPS 1.5 seaweed: CPS 20



33. Dish with brown and yellow crab;  
 Crab's shell: CPS 2 dish: CPS 1



34. Mouse dish;  
CPS 1



CPS 1

35. Mouse dish;  
CPS 0.75-1.25



CPS 0.75-1.25

36. a) Frog on Tortoise paperweight;  
CPS 1



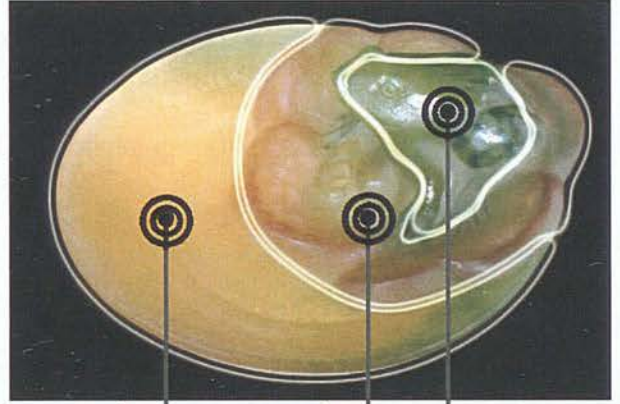
CPS 1

36. b) Frog paperweight;  
CPS 0.5



CPS 0.5

c) Frog dish;  
Frog: CPS 3    lily pad: CPS 4    rest of yellow dish: CPS 9-10



CPS 9-10

CPS 4

CPS 3

37. Large cockatoo;  
Main body: CPS 1    maize cob: CPS 20



CPS 1

CPS 20

38. Mouse group with carved ivory mouse;  
End of base: CPS 5-6    yellow areas: CPS 10    mouse group: CPS 1-2



CPS 5-6

CPS 10

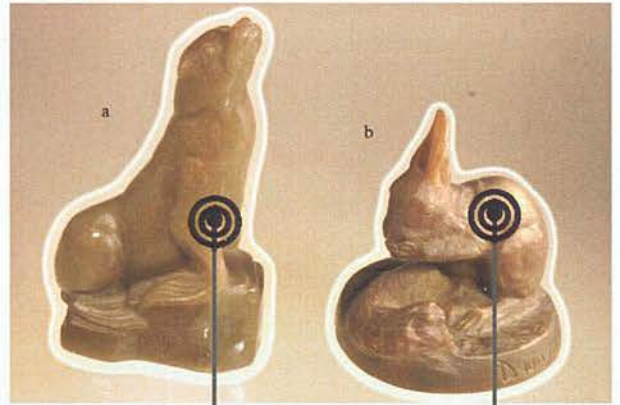
CPS 1-2

39. Ermine;  
CPS 1



CPS 1

40. a) Sea-lion paperweight; CPS 0.5  
b) Squirrel paperweight; CPS 1



CPS 0.5

CPS 1

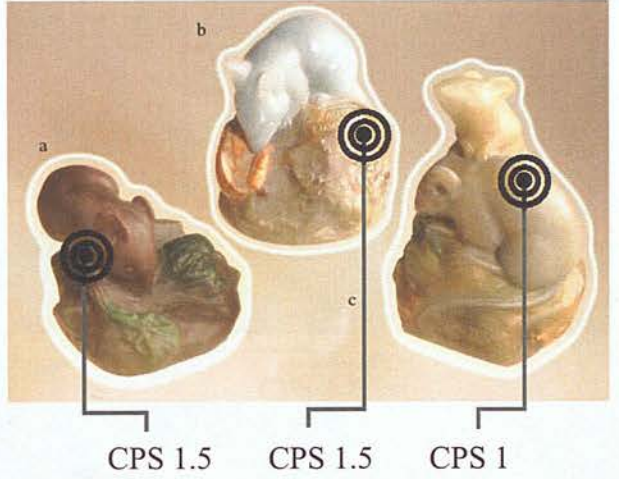
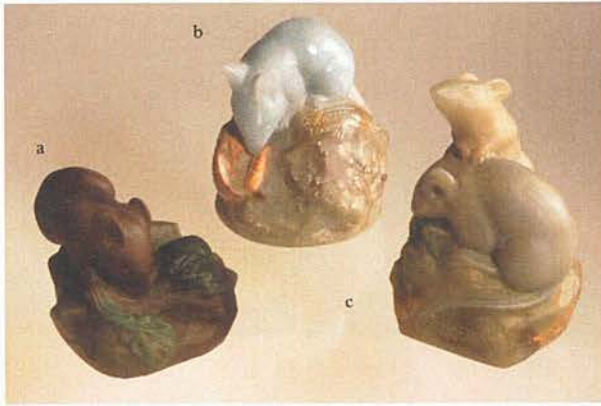
41. a) White owl dish; CPS 0.5  
b) Brown owl dish; CPS 1



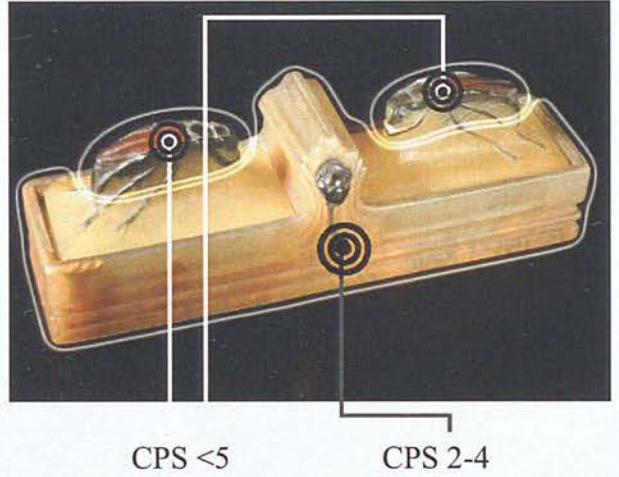
CPS 0.5

CPS 1

42. a) Brown mouse paperweight; CPS 1.5  
 b) White mouse paperweight; CPS 1.5  
 c) Two pale brown mice paperweight; CPS 1



43. Box with tow compartments with beetle finials;  
 Beetle bodies: CPS <5      pale yellow lids and base: CPS 2-4

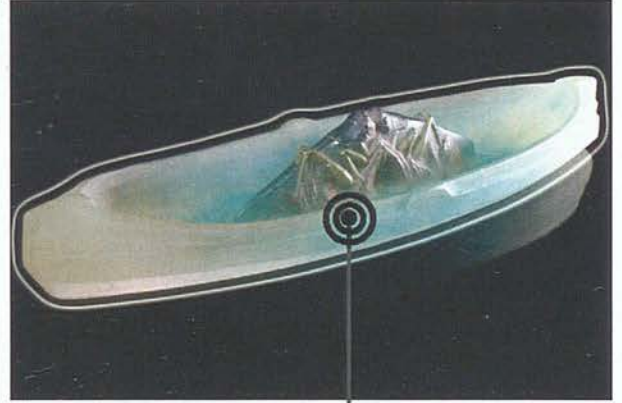


44. Inkwell with snail finial;  
CPS: 1-2



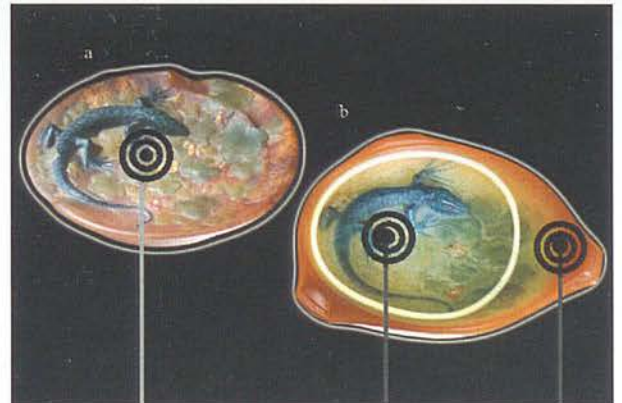
CPS 1-2

45. Dish with grasshoppers;  
CPS 1



CPS 1

46. a) Round dish with lizard; CPS 6 – 7  
b) Tricorn dish with lizard; Lizard and yellow areas: CPS 30-35  
brown lip on dish: CPS 50-70

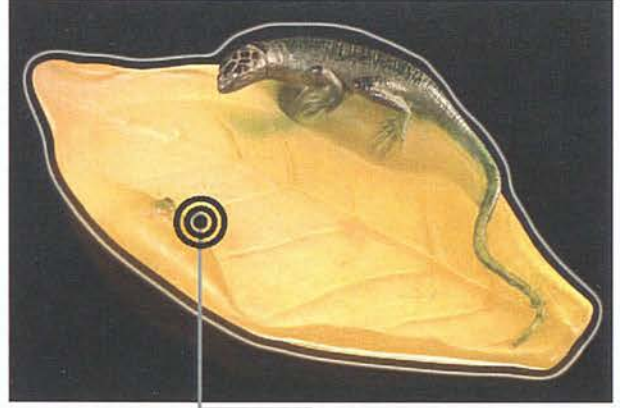


CPS 6-7

CPS 30-35

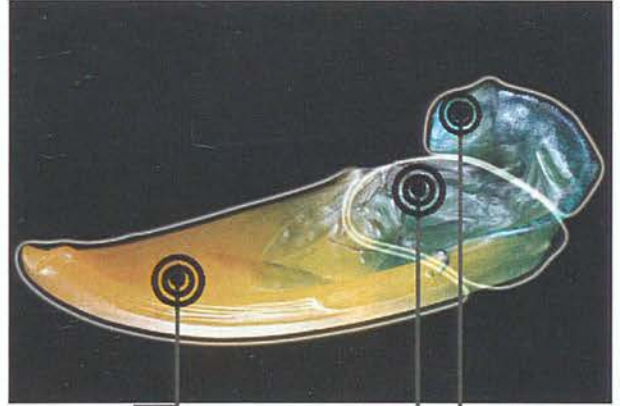
CPS 50-70

47. Green lizard on leaf;  
CPS 10



CPS 10

48. Chameleon dish; Yellow base and body of dish: CPS 15-20  
emerald green area in dish base: CPS 7    chameleon: CPS 3

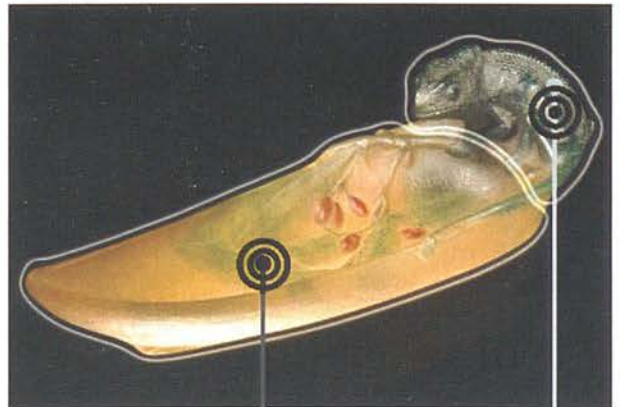


CPS 15-20

CPS 7

CPS 3

49. Chameleon dish;  
Yellow areas of dish: CPS 4-5    chameleon: CPS 1.5

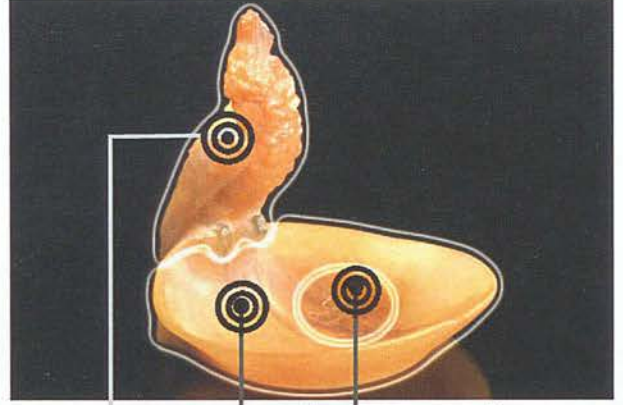


CPS 4-5

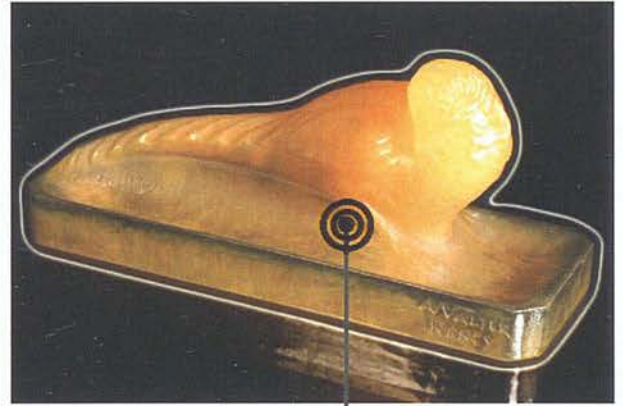
CPS 1.5

50. Cockatoo dish; Interior of dish: CPS 10  
paler yellow areas and edge: CPS 5

cockatoo: CPS 2



51. Pheasant;  
CPS 2

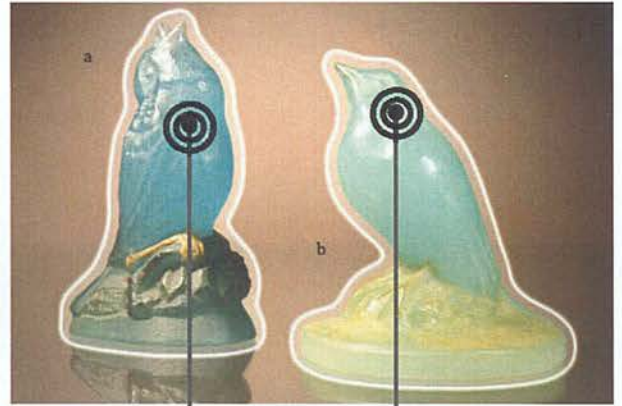


52. Kingfisher hollow light fitting;  
CPS 4



CPS 4

53. a) Blue paperweight; CPS 1  
b) Turquoise paperweight; CPS 1



CPS 1

CPS 1

54. Fledgling paperweight;  
CPS 1



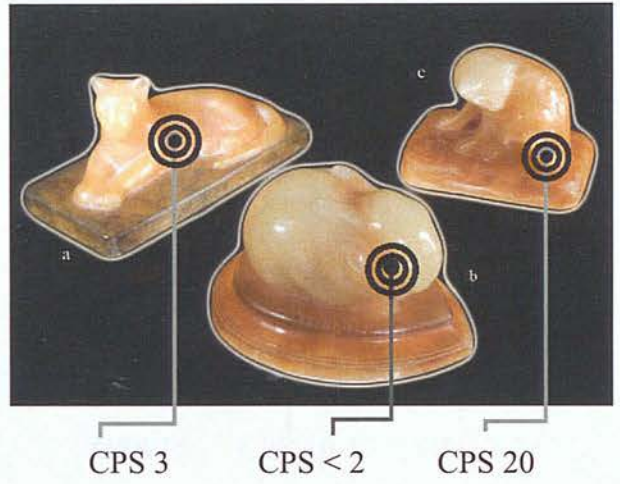
CPS 1

55. Fox;  
CPS 1

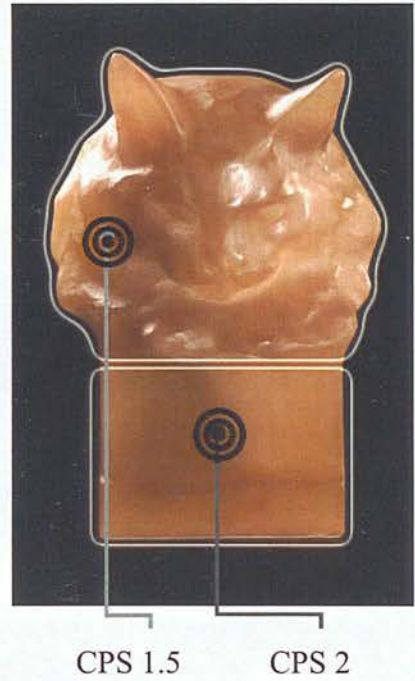


CPS 1

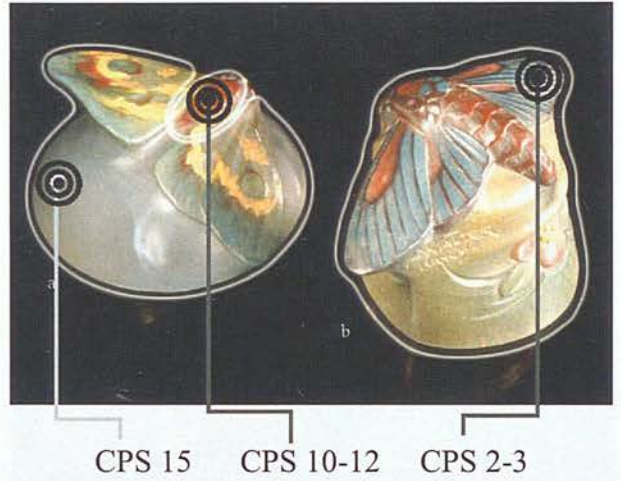
- 56. a) Lioness paperweight; CPS: 3
- b) Rabbit paperweight; CPS: < 2
- c) Kitten paperweight; CPS: 20



- 57. Cat's head;
- Head CPS 1.5     base: CPS 2

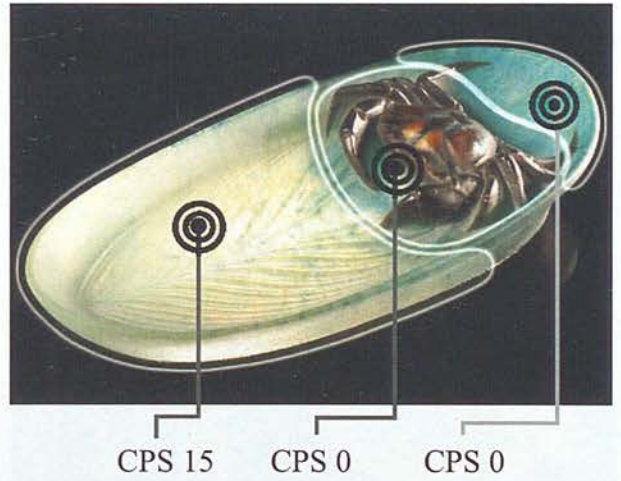


58. a) Moth paperweight; Grey base and the wings of moth: CPS 15  
 red-brown body of the moth: CPS 10-12  
 b) Moth paperweight; CPS 2-3

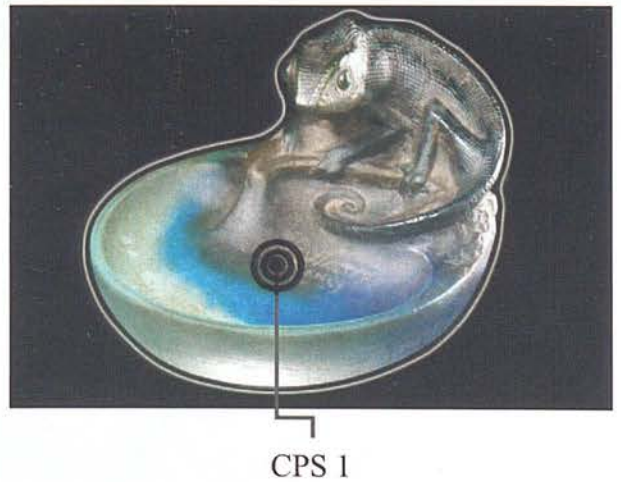


59. Oval crab dish;  
 Interior of the dish: CPS 15 crab: CPS 0

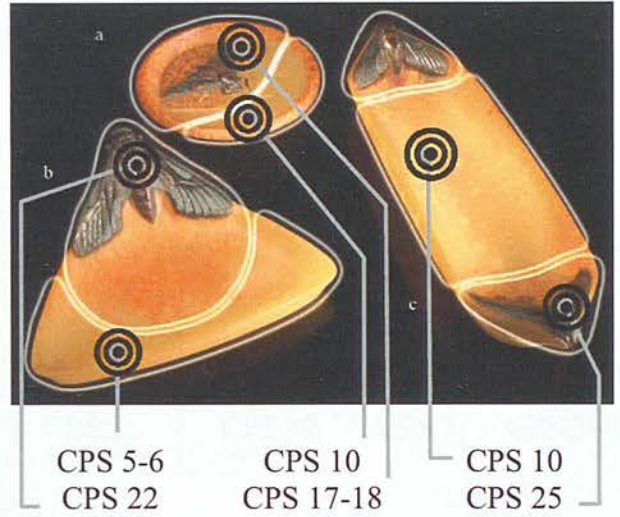
blue end: CPS 0



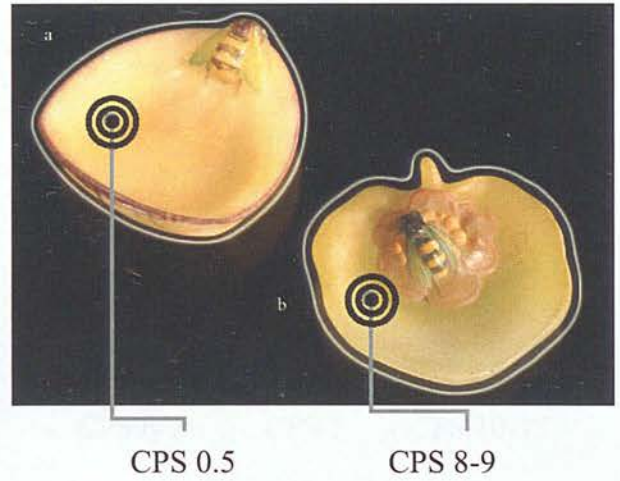
60. Chameleon dish;  
 CPS 1



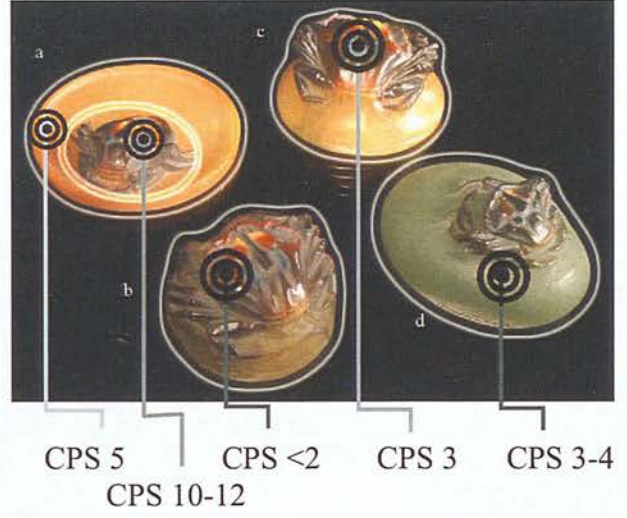
61. a) Round moth dish; Yellow lip and base of dish: CPS 10  
 moth and ochre areas: CPS 17-18  
 b) Triangular moth dish; Yellow lip: CPS 5-6    ochre and moth: CPS 22  
 c) Boat shape moth dish; Yellow interior of dish: CPS 10  
 moths at both ends: CPS 25



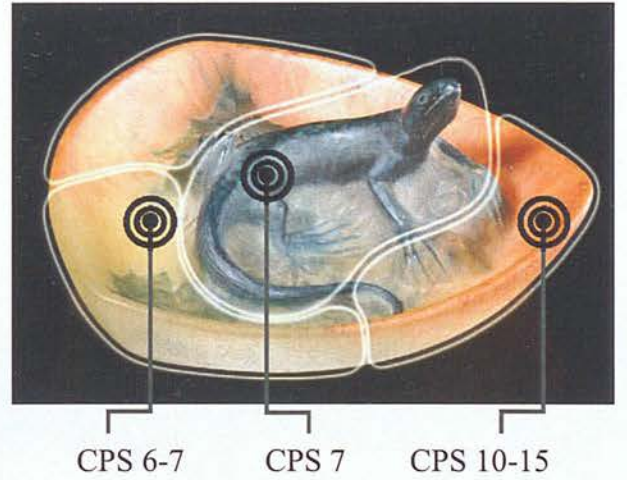
62. a) Triangular dish with bee; CPS 0.5  
 b) Leaf dish with wasp; CPS 8.5-9



63. a) Pin dish; Yellow base and lip: CPS 5 crab: CPS 10-12  
 b) Brown crab paperweight; CPS < 2  
 c) Yellow crab paperweight; CPS 3  
 d) Green crab paperweight; CPS 3-4



64. Dish with green lizard;  
 Lizard: CPS 7 yellow in base: CPS 6-7 ochre lip: CPS 10-15

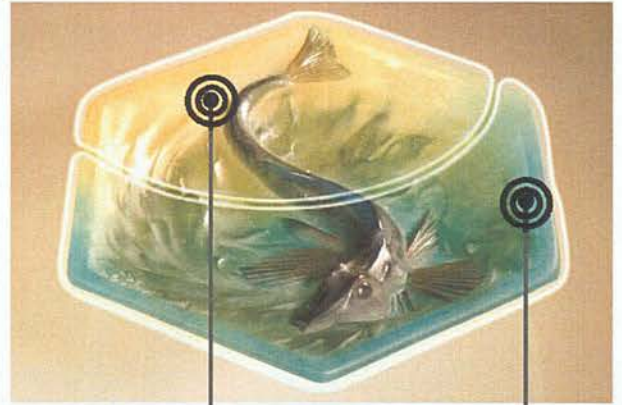


65. Dish with flying fish;  
CPS 1.5



CPS 1.5

66. Hexagonal dish with flying fish;  
Yellow: CPS 2-4    blue: CPS 2



CPS 2-4

CPS 2

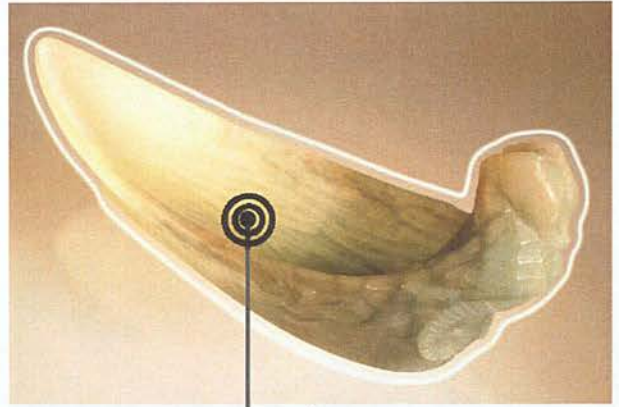
67. a) Small dish with red fish; CPS 0.75  
b) Small dish with shoal of fish; CPS 0.5



CPS 0.75

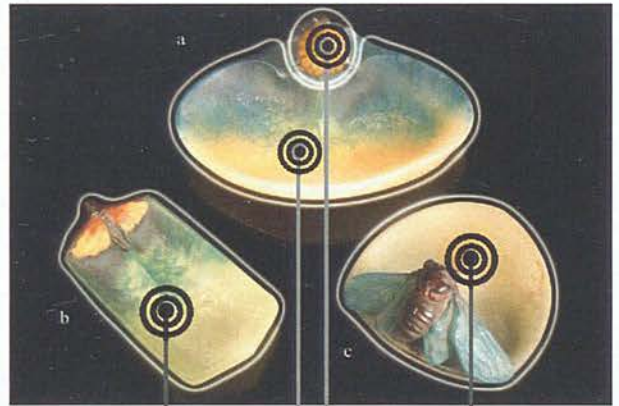
CPS 0.5

68. Dish with sea horse;  
CPS 1.5



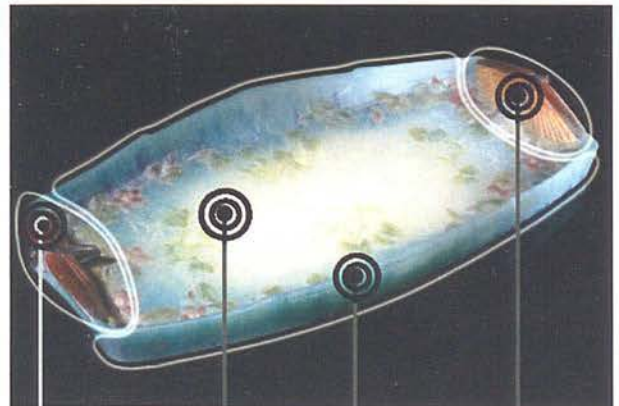
CPS 1.5

69. a) Oval dish with yellow tortoise; Dish: CPS 1    tortoise shell: CPS 7  
b) Oblong dish with yellow moth; CPS 1  
c) Spade shape dish with moth; CPS 1



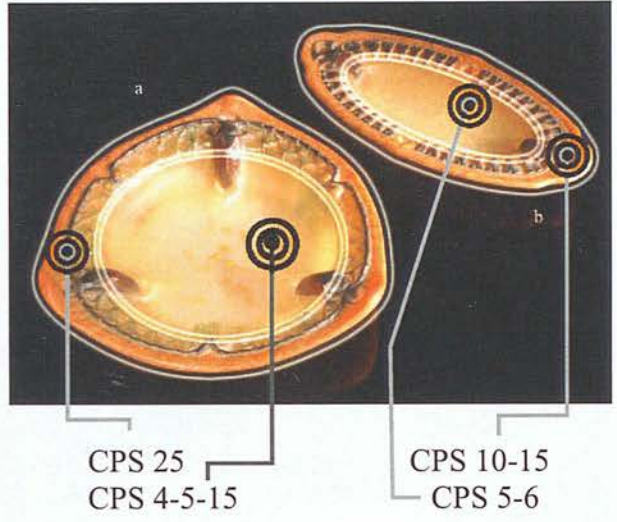
CPS 1    CPS 1    CPS 7    CPS 1

70. Rectangular dish with moths; Base and interior of dish: CPS 0.0  
blue lip: CPS 0.0    moths: CPS 0.0

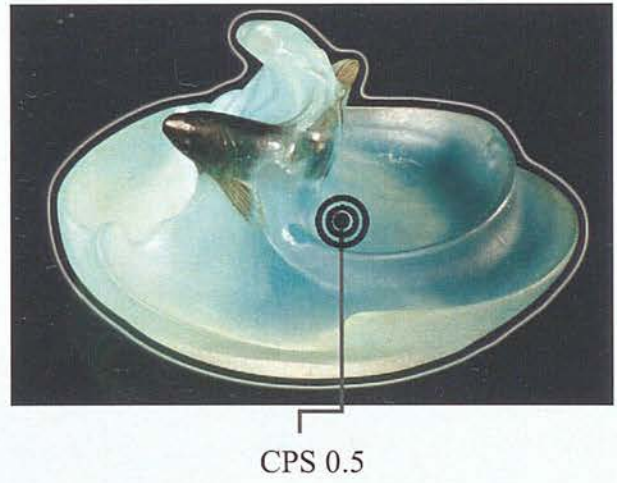


CPS 0    CPS 0    CPS 0    CPS 0

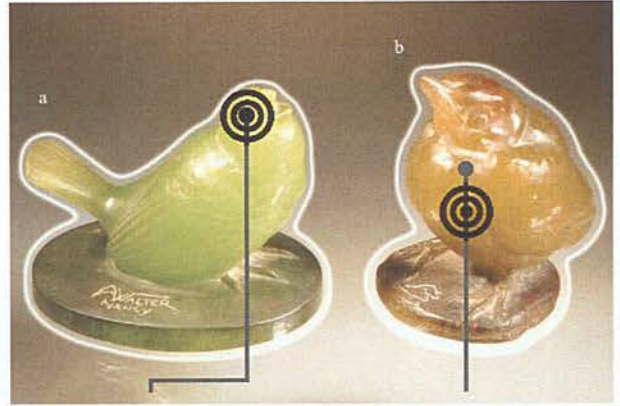
71. a) Triangular dish with wood boring beetles;  
 Ochre lip: CPS 25      dish interior: CPS 4-5-15  
 b) Oval dish with beetles; Ochre lip CPS 10-15    dish interior CPS 5-6



72. Dish with fish breaking through wave;  
 CPS 0.5



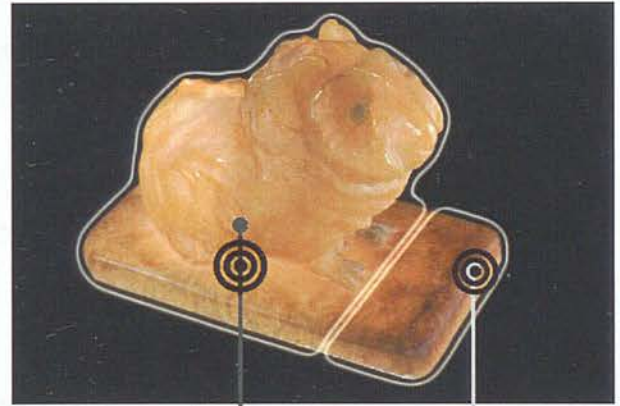
73. a) Green bird paperweight; CPS 1  
 b) Yellow bird paperweight; CPS 2-3



CPS 1

CPS 2-3

74. Guinea pig:  
 Guinea pig: CPS 4-5      opaque edge on base: CPS 5



CPS 4-5

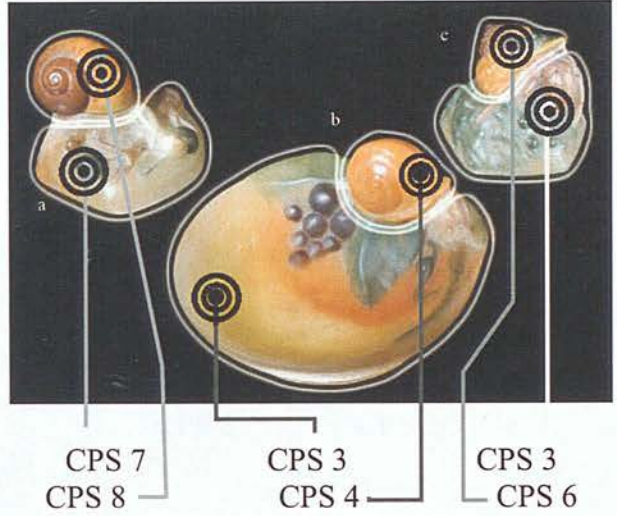
CPS 5

75. Fennec fox;  
 Fox: CPS 1

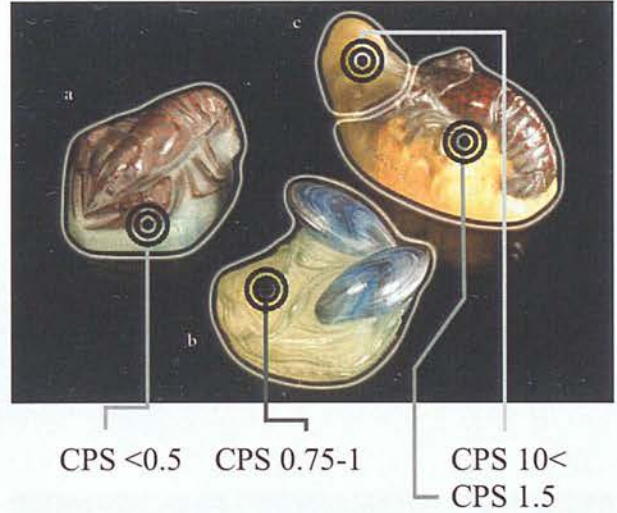


CPS 1

76. a) Snail paperweight; Base: CPS 7 snail shell: CPS 8  
 b) Dish with snail; Yellow base: CPS 3 snail shell: CPS 4  
 c) Hermit crab paperweight; Base: CPS 3 shell: CPS 6



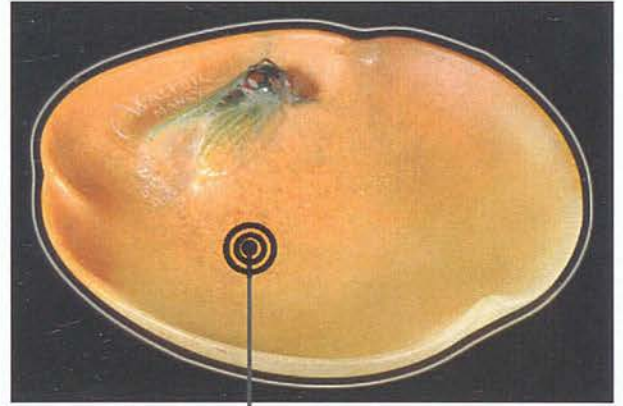
77. a) Red lobster paperweight with green base; CPS < 0.5  
 b) Two mussels paperweight; CPS 0.75-1  
 c) Red lobster paperweight with yellow base; Lobster: CPS 1.5  
 olive green end: CPS 10<



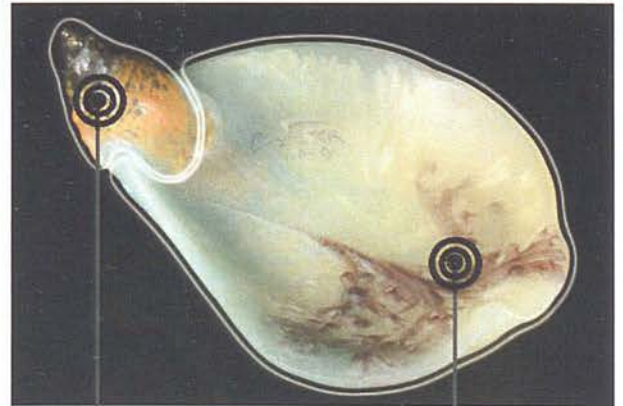
78. Snail on grape vine paperweight;  
Base: CPS 2-3    snail: CPS 5



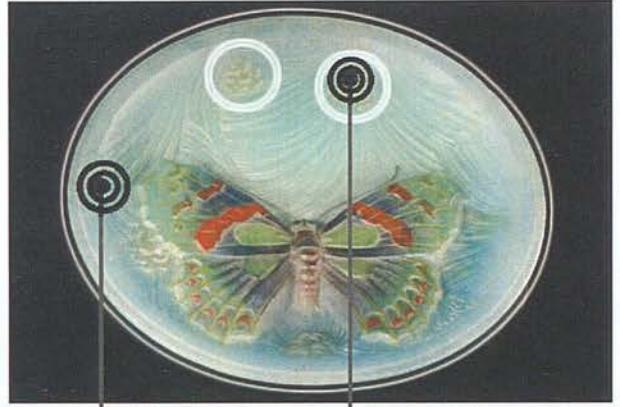
79. Dish with cicada;  
CPS 35



80. Dish with shell;  
Dish: CPS 0    shell: CPS 4

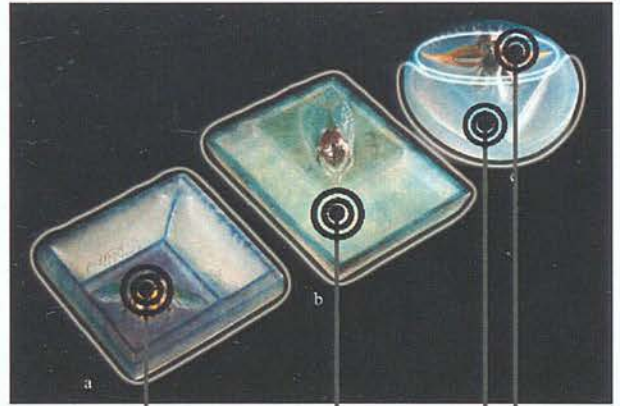


81. Dish with Butterfly;  
 Butterfly and dish: CPS 2-3      yellow flowers: CPS 15



CPS 2-3      CPS 15

82. Three ring and stud trays: a) CPS 1  
 b) CPS 0.5  
 c) Blue dish: CPS 1      wings on moth: CPS 5



CPS 1      CPS 0.5      CPS 1      CPS 5

83. Covered bowl with bees and honeycomb;  
 Bowl: CPS 10      lid: CPS 7-10



CPS 10      CPS 7-10

84. Covered box with berries;  
CPS 2



CPS 2

85. Covered box with rose hips and snail finial;  
Box and lid: CPS 0      snail and ochre areas in rim: CPS 4

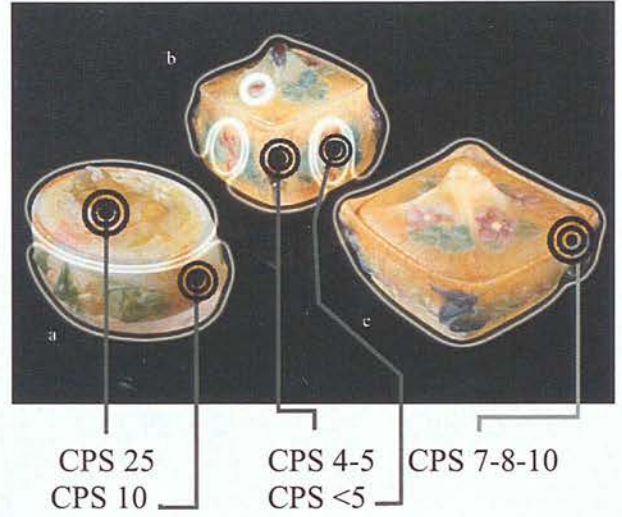


CPS 0

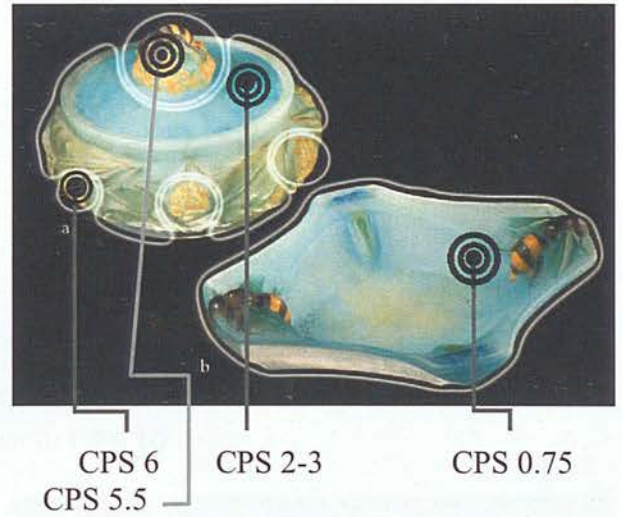
CPS 4

CPS 4

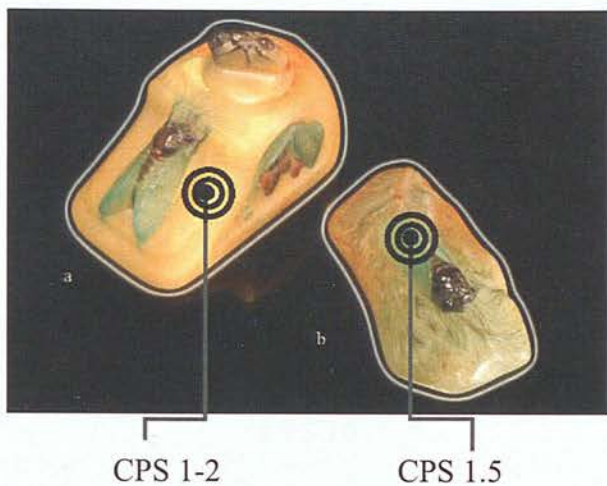
86. Three covered boxes; a) Lid: CPS 25      box: CPS 10  
 b) Box and lid: CPS 4-5      red berries: CPS <5  
 c) CPS 7-8-10



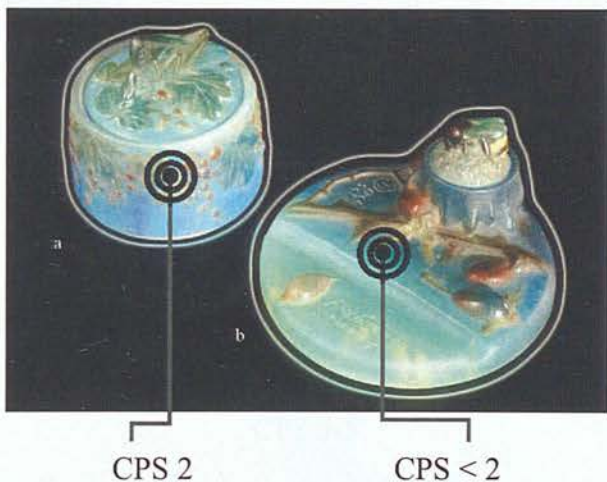
87. a) Covered bowl with bee;  
 Blue lid: CPS 2-3      yellow finial (flowers and bee) on lid: CPS 5.5  
 yellow florets on box side: CPS 6  
 b) Dish with wasps; CPS 0.75



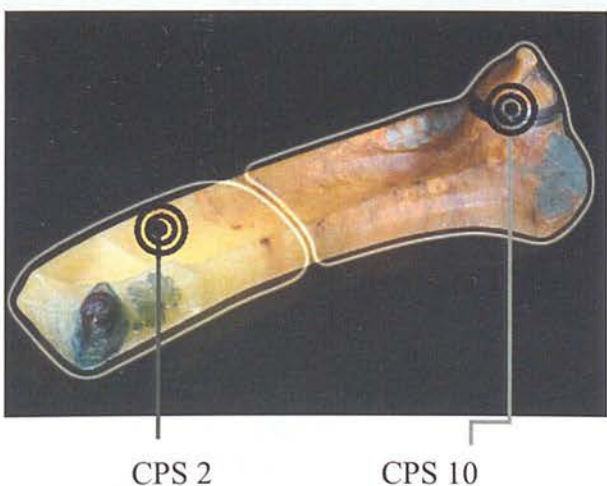
88. a) Inkwell with cicada and ant finial; CPS 1-2  
 b) Paperweight with cicada; CPS 1.5



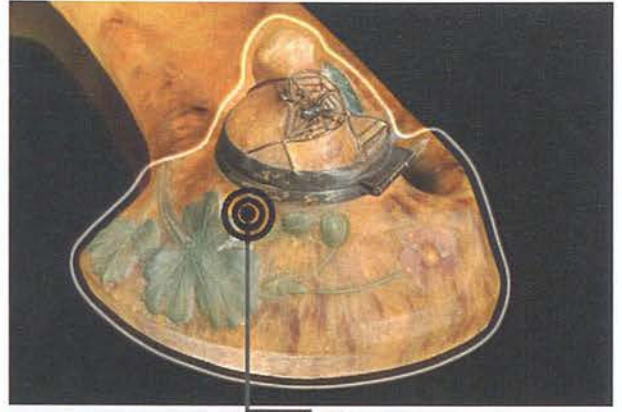
89. a) Covered box with grasshopper finial; CPS 2  
 b) Inkwell with bees and cherries; CPS < 2



90. Inkwell and pen tray;  
 Pale yellow end: CPS 2      silver spider inkwell: CPS 10

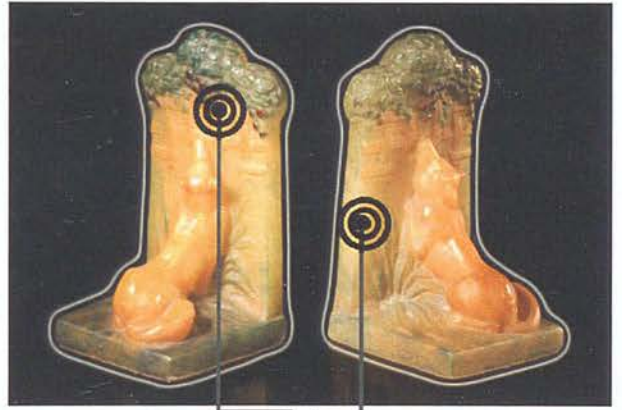


91. Detail of no.90 (CPS as on previous page)



CPS 10

92. Pair of fox bookends;  
CPS 3-5 (both pieces)



CPS 3-5

93. Pair of squirrel bookends;  
CPS 0.5 (both pieces)



CPS 0.5

94. Large hollow duck light fitting;  
CPS 2



CPS 2

95. Pair of fish bookends;  
CPS 0.5 (both pieces)



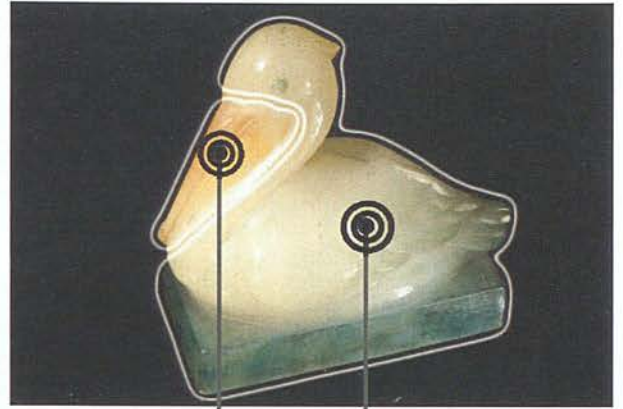
CPS 0.5

96. Hollow dove light fitting;  
CPS < 0.5



CPS < 0.5

97. Hollow pelican light fitting;  
Body of bird: CPS 0.5    beak: CPS 8



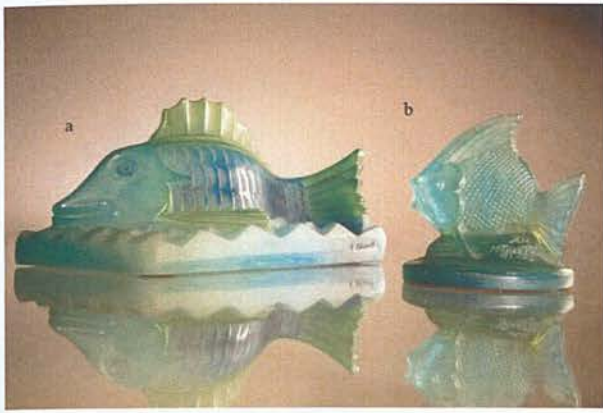
98. a) Fish Paperweight;  
CPS 2



98. b) Hollow fish light fitting; CPS < 2



99. a) Solid fish; CPS 0.5  
b) Fish ornament; CPS 1



CPS 0.5

CPS 1

100. a) Dove ashtray;  
CPS < 1



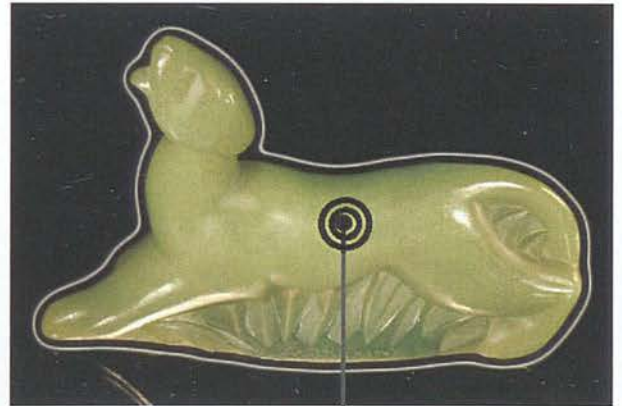
CPS < 1

100. b) Dove paperweight; CPS < 1



CPS < 1

101. Panther;  
CPS 1



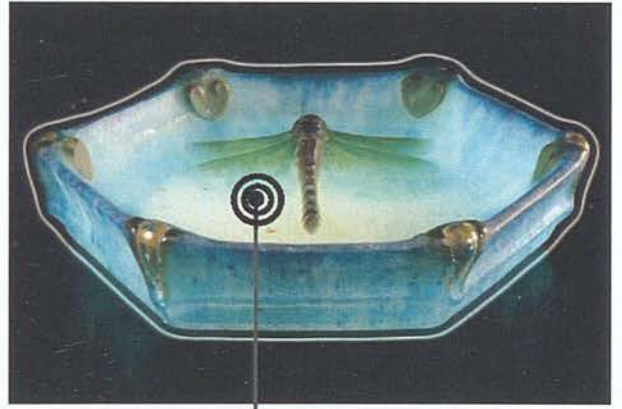
CPS 1

102. Duck paperweight;  
CPS 0.5



CPS 0.5

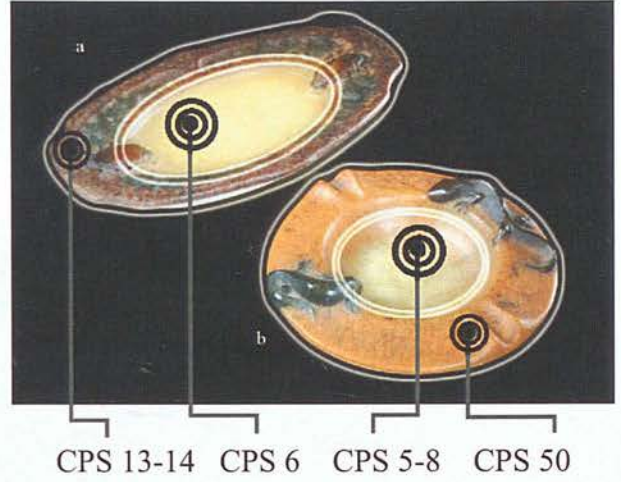
103. Hexagonal dragon fly plate;  
CPS < 0.75



CPS < 0.75

104. a) Tray with beetles; Yellow interior of dish: CPS 6  
brown edges and lips: CPS 13-14

b). Ashtray with salamanders; Yellow interior of dish: CPS 5-8  
ochre rim: CPS 50



105. a) Parakeet; CPS < 0.5    yellow flowers: CPS 5

b) Kingfisher; CPS < 0.5



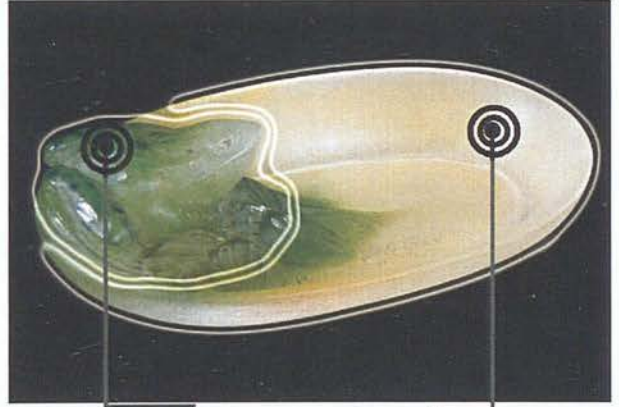
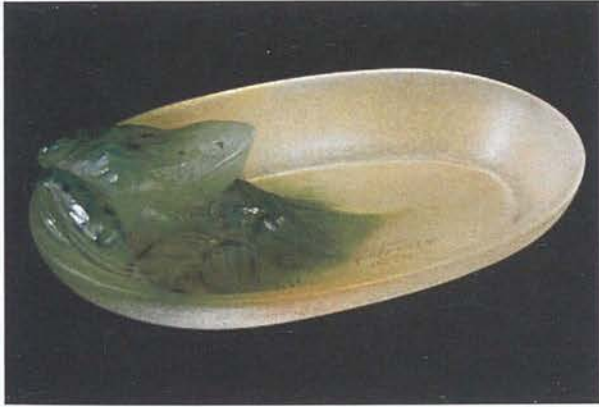
106. Oval dish with fish;  
Dish: CPS 2 fish: CPS 11-12



CPS 2

CPS 11-12

107. Oval dish with frog;  
Dish: CPS 1-5 frog: CPS 11-12



CPS 11-12

CPS 1-5

108. Small covered pot with cat finial;  
Cat finial: CPS 1-2      ochre colour: CPS 4



CPS 1-2

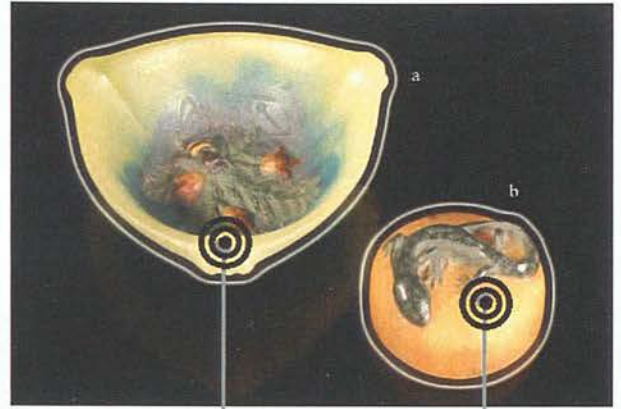
CPS 4

109. Dish with beetles;  
CPS 0.5



CPS 0.5

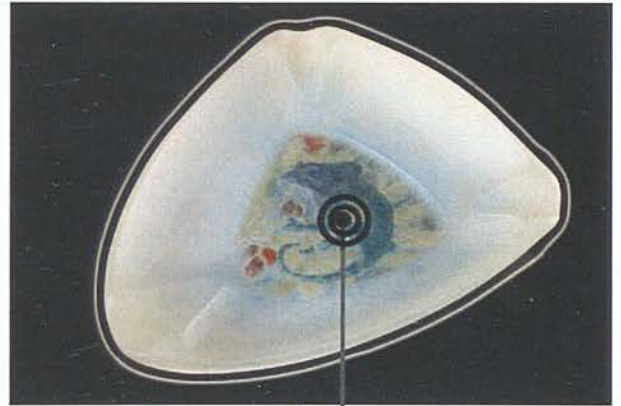
110. a) Small dish with bee; CPS 1  
 b) Paperweight with green lizard; CPS 1.5



CPS 1

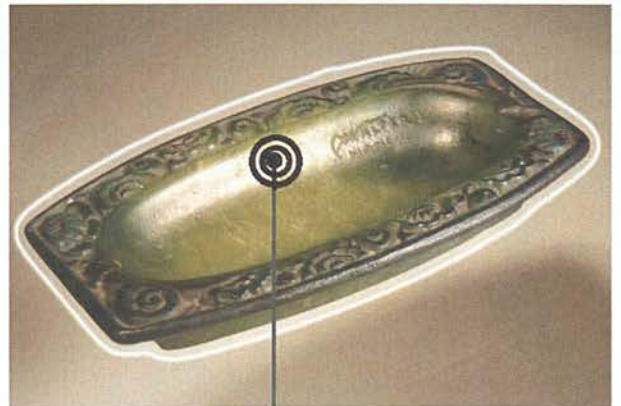
CPS 1.5

111. Triangular Chameleon dish;  
 CPS <3



CPS < 3

112. Rectangular dish with snails and flowers;  
 CPS 1



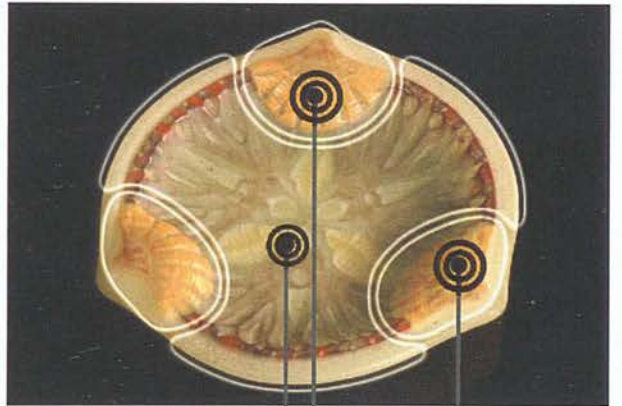
CPS 1

113. Hexagonal flat dish with crab;  
CPS 2-5.5



CPS 2-2.5

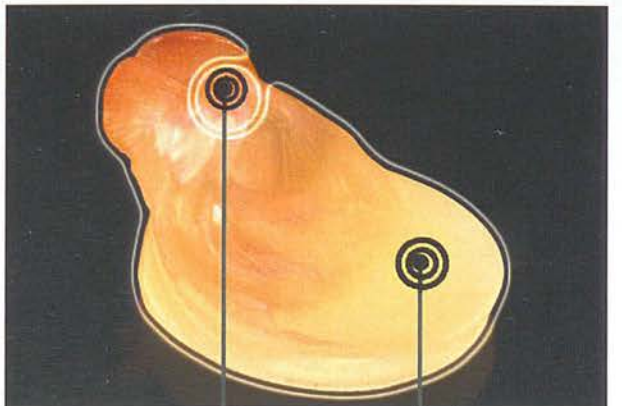
114. Triangular dish with shells and seaweed;  
Dish: CPS 5      yellow shells: CPS 10



CPS 5

CPS 10

115. Dish with angelfish;  
Dish: CPS 25-35      red snout of fish: CPS 30-50-65



CPS 30-50-65

CPS 25-35

116. Dish with snail;  
Dish: CPS 4-5      snail: CPS 8-10-12



CPS 4-5

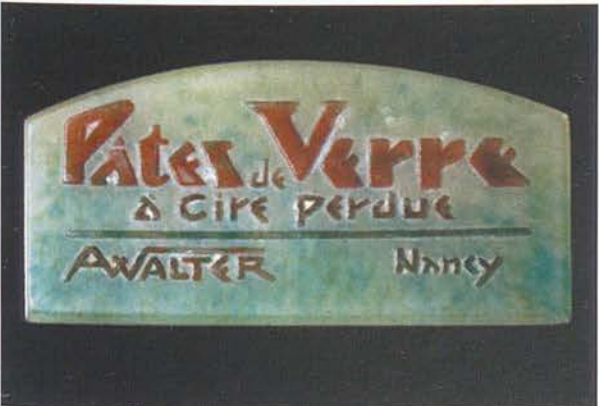
CPS 8-10-12

117. Hexagonal dish with dragonfly;  
CPS 0.5-0.75



CPS 0.5-0.75

118. Point of sale name plate;  
CPS 0.5



CPS 0.5

## **The results and Interpretation of the data.**

From a review of the data, this collection has many pieces made with radioactive material. As recorded by the monitor, levels vary from twice that of a normal background reading (CPS 4) to peaks of CPS 35-40 and above. This radioactivity is in all likelihood to be produced from salts of uranium rather than other matter. We know from historical records that uranium was used as a colourant in glass from about 1840, and continued to be used up until the 1940's (Skelcher. B, 2002). This 100 year period of uranium use, contains all of Walter's working life, including the period when he was at l'Ecole de Sèvres, where he undoubtedly came across uranium as a colourant in glazes (Hamer, 1991). It is known other glass and ceramic manufacturers used uranium in their work in the same period, but what is remarkable about this collection (and presumably by default about the remainder of his work) is that Walter included uranium as a colourant in lead crystal (Strahan, 2001). Its appearance was totally unexpected. To my mind of all the discoveries I have made about his work this is perhaps the greatest of them all. As discussed in Book II: Chapter 4 the use of uranium in lead crystal has hardly been investigated (or well recorded) despite the evidence of its use.

### **A view of the collection taken from the CPS readings.**

As one aligns the CPS readings with images of the actual pieces it becomes apparent that the collection falls into two general categories, with three smaller groupings.

They are:

Group A: Those in the yellow, orange and amber range of colouring.

Group B: Those in the blue and green spectrums.

A third group, Group C is where both colour ranges are used as decoration in one piece, and, as one would expect, low and high readings are obtained from the same object.

A fourth, Group D, are a smaller group within the collection. They have a dominant brownish-rose colour to the majority of its appearance.

And there are some anomalies, which are harder to explain. These are recorded and discussed below.

## Group A.

The group of those pieces in the collection, which show high readings of radioactivity, and by conclusion contain uranium as a colourant, is generally contained within the yellow/ orange/ amber range of colours. The *Three Moth Dishes*. Cat. Nos. 61a, b. and c. are good examples of this.



Fig 1. *Three Moth Dishes*. Cat. Nos. 61a, b. and c.

This intense opaque orange-amber is seen throughout Walter's work. It is usually associated with a translucent pale yellow glass that forms a base for the decoration. It is not the colour here that gives the highest reading. In all three pieces the yellow orange-amber colour reads between CPS 5-10. In all three dishes the dark colouring of the moths gave a CPS reading between 17 and 25.

The areas of recorded radioactivity appear in both the translucent and the opaque range of these colours, and at varying levels; anything between CPS 4 and 50. One particular piece, Cat No. 115, one of Walter's more remarkable and famous works, has readings, which measure CPS 35 – 50-65.



Fig 2. *Dish with Angel Fish*. Cat. No. 115.

This last reading of CPS 50, which fluctuated up to 65 CPS was in the intense orange pink snout of the fish. It would indicate the use of a large quantity of uranium salt in the creation of this colour. The reading here is in marked contrast to the reading of the original uranium discovery in the *Small Square Covered Box*, (Cat. No 86b) of between CPS 4 and 5.

## Group B.

In the blue and green range of colours, which generally use salts of copper, cobalt and chrome as colourants, the readings appear devoid of significant levels of radiation.

Cat. No 20 is a good example of this.



Fig 3. *Flat Dish with Butterfly*. Cat No. 20.

The intense blue of the dish is contrasted with the detail of a red and green moth. The whole dish read at CPS 0.5, a very low reading considering that background reading was CPS 2. Cat. No. 53a and b, and Cat. No.8 also fall into this category.



Fig 4. *Two Paperweights*. Cat. No. 53.



Fig 5. *Frog Dish*. Cat. No.8.

Both birds measured CPS 1, which shows that no uranium or radioactive material was associated in their making.

## Group C

Some of the insects' bodies and some of the crustaceans (i.e. in specifically detailed and controlled coloured areas) showed high levels of radioactivity in them. Cat. No.78  
A large paper weight: Snail on Grapevine for example has a snail whose shell registered CPS 5 (double the normal background level), but the rest of the dish has a ground of green and ochre glass that registered CPS 2-3.



Fig 6. A large paperweight: *Snail on Grapevine*, Cat. No.78.



Fig 7. *Dish with Hermit Crab*. Cat. No 21



Fig 8. 3 Covered boxes.  
Cat No. 86a, b and c.

Cat. No.21 also gave a reading of CPS 21 for the hermit crab's shell, while the rest of the dish read at CPS 2-3. Cat.

No.86b gave a reading of CPS 4-5 for the amorphous cloud-like effect for the box and lid, but a reading of above CPS 5 for the berries and the bug.

### Group D

All these body-markings (and berries) are generally coloured with yellow ochre and brown or red hues. The relatively high CPS readings suggest that those with a reading higher than CPS 2 must include uranium somewhere in their composition. It had been previously thought in earlier research that these brown-reds were made solely from iron oxide and the ochres from cadmium. The results were particularly noticeable where the rest of the dish/object was made with a blue colourant that gave a very low CPS reading with little chance of contamination from the surrounding glass colourant.

The high CPS readings from the two dishes below came as a particular surprise.



Fig 9. *Dish with Stag beetles*. Cat. No. 26.

The CPS readings for this dish were between 3 and 20. That is 10 times the normal background level. The *Dish with Snail*, below, is similar.



Fig 10. *Dish with Snail*. Cat. No. 116.

The CPS readings for this dish were between 4 and 12. That is 6 times the normal background level.

It had been assumed from earlier research that the brown-rose colour seen in these works had been produced at 1270° C using gold chloride ( $\text{AuCl}$ ), perhaps mixed with a little Crocus Martis ( $\text{FeSO}_4$ ) at 800° C to make it purple. Instead, the high CPS readings (3–25) suggest that in these cases the colour was produced by the use of an uranium salt, and it was utilised in the brown-red in the insects' bodies as well. A more detailed analysis of the *Dish with Stag beetles* (Cat. No. 26) is discussed in the next chapter (Chapter 4) where Raman spectrometry and XRF were used on this and two other pieces, the *Chameleon Dish*, Cat No. 24 and the *Small Square Covered Box*, Cat. No.86b

## Anomalies in the CPS readings within the 161 pieces in the collection of Walter.

1. Examples are where a yellow-orange-amber colour is used, which in some pieces reads with a high CPS, but in others gives very low levels of radiation reading: No.51 is a good example of this. It produced a reading of CPS 2 (a normal background reading) compared to its catalogue neighbour Cat.No. 50.



Fig 11. Cat. No. 51



Fig 12. Cat. No.50

Its colours look remarkably the same with readings between CPS 5 and CPS 10 (over twice the normal background reading). It may be because these two pieces were produced some years apart Bergé designing Cat. No.50 earlier in Walter's career, and Houillon designing Cat. No. 51 much later. Perhaps, later towards the end of Walter's working life, and with the change of designer, the colourants (or their production) changed too. New colours could be reproduced that contained little or no uranium salts. But then we see in Cat. No.s 56 a, b and c readings of CPS 3, CPS 2< and CPS 20 respectively.



Fig 13. Cat. No's 56 a, b and c



Fig 14. Cat. No.57

Their catalogue neighbour Cat. No.57, made at roughly the same time and stylistically similar in production, gives readings of CPS 1.5 and 2. And all four of these pieces were produced at around the time when Bergé had died (1932) and the style of Art Nouveau had waned in the public taste.

2. There are also some anomalies in the blue range of colours that are worth reporting, alongside the above. The group shown in Cat. No. 16 are a case in point. Their readings are listed below:

- 16. a) Two entwined lizards: CPS: 1.25.
- b) Single green lizard: blue base: CPS 1.5; lizard: CPS: 3-4
- c) Chameleon: chameleon snout: CPS 9-10; ochre base: CPS: 9;  
        chameleon body CPS 8.



Fig 15. Cat. No 16a



Fig 16. Cat. No 16b



Fig 17. Cat. No 16c



Fig 18. Cat. No 18

The two entwined lizards of a) read at CPS: 1.25, yet their base is an ochre colour, which one would suppose to be made from an uranium salt if other examples are to be believed. No yellow/ orange/ amber is seen at all in b), as it is effectively a blue lizard depicted on a blue dish. Yet that lizard has a reading of CPS 3-4, nearly twice that of a normal background reading. It gives a strong indication that either a radioactive material was used in its creation, or that it has been contaminated with a radioactive salt.

In c) the blue of the Chameleon's body registers at CPS 8 and the ochre is at CPS 9. These readings are in contrast to the blue lizard in Cat.No 18 (a lizard almost identical in colour to the one in Cat.No. 16b), which gave a reading of between CPS 35 and 40. Why the amounts of radiation readings would vary so much between similar coloured pieces is uncertain, especially when the colouring formulae would be

the same. A much more detailed analysis of the chemical composition of these pieces using SEM, XRF and Raman spectroscopy would be required to understand what is contained in the bodies of the glasses.

## **Conclusions**

Varying levels of uranium were found across the body of the work in the exhibition. The layout of the catalogue roughly begins with Walter's early work with his employment at Daum, and finishes with his late work as an independent artist around the beginning of the Second World War. This is about 30 years of continuous production. From an analysis of the data collected, uranium appears within his work throughout this period. This suggests that the colour palette was adopted and refined at an early stage in his career at either at Sèvres or Daum, and that he had access to uranium as a colourant throughout his working life. Given that Daum, Gallé and Baccarat (art glass manufacturers in and around the Nancy region (Strahan, 2001) were using uranium as a colourant in their blown glass before 1900 it would make perfect sense for Walter to have adopted a format of colouring glass in a particular range that had been tried and tested before.

It is then clear that from the examination above, uranium salts were in the colourant for the opaque, painted details in his work. This was also confirmed by the XFR analysis on the 3 other pieces of Walter's work in Chapter 4. Whether this was a deliberate choice of uranium salt as a colourant, or that there was a base glass that contained uranium (by chance or design) is sometimes unclear. The contradiction in high and low readings of radioactive material in similar colours would feed in to the hypothesis that Walter did not need to use uranium to achieve the same end colour in the opaque colours of the paintwork. These colours in all cases can be produced from more basic salts as I show in Appendix 2. It may well be that sometimes Walter made his opaque colours using clear glass as a base in which to place his salts, and sometimes from a batch of glass that contained an uranium salt and in others the inclusion of uranium was a deliberate choice to produce the colour, as in the body of the beetles in the 'Dish with Stag Beetles' Cat No. 26 (see Chapter 3 above).

A wider analysis of Walter's work would be needed to give clear answers to this question of his use of uranium. It would require the comprehensive cataloguing of a much larger selection of his whole work using both the Broadfield House Collection and other private and public collections, with a reliable assessment as to when he made his each piece. This has never been done before. Apart from the scientific knowledge it would glean, it would also be an important exercise to do historically, as it is simply not known how extensive Walter's production was. Without his notebooks or first hand commentary it is still hard to say how any one piece was exactly made. It would also require the knowledge of when Daum, Baccarat and other crystalries in the Metz and Nancien region were using uranium, and whether or not they supplied Walter with any products, either in their raw state as chemicals or as coloured glass ready to use or both.

How the set of 161 objects in the Broadfield House collection of Walter and their related data compare to the work of other *pâtes-de-verre* artists from that period is unknown. The examination of some of Walter's pieces with a radiation monitor throws up many questions as to how and why uranium was used at Sèvres and who amongst the six or seven or so other *pâtes-de-verre* artists working there also used it. Both Argy-Rousseau and Decourchement had formulae for colours using uranium salts in their notebooks, so it could hardly be confined to just Walter. A starting point would be to ask if Henri Cros used an uranium salt as a colourant as he produces colours in his pieces similar to Walter's. This is one area of discovery that is ripe for further investigation.

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## Appendix 2:


139 Samples of Colour.


B001  
Copper Oxide (CuO) 0.02g 

B001 (840°C)  
Copper Oxide (CuO) 0.02g 

B002  
Copper Oxide (CuO) 0.2g 

B003  
Copper Oxide (CuO) 1.2g 

B004  
Cobalt Oxide (CoO) 0.4g 

B005  
Cobalt Oxide (CoO) 0.7g 

B006 (exterior surface)

Cobalt Oxide (CoO) 1.4g



B006 (interior surface)

Cobalt Oxide (CoO) 1.4g



B006 Foundry

Cobalt Oxide (CoO) 1.4g



B007

Copper Oxide (CuO) 0.1g

Cobalt Oxide (CoO) 0.1g



B008

Copper Oxide (CuO) 0.25g

Boric Oxide (B<sub>2</sub>O<sub>3</sub>) 1g



B009

Copper Oxide (CuO) 0.25g

Lead Bisilicate (PbO.2SiO<sub>2</sub>) 5g



B010

Copper Oxide (CuO) 0.5g  
Lithium Carbonate (Li<sub>2</sub>O<sub>3</sub>) 1g



B011

Copper Oxide (CuO) 0.25g  
Magnesium Carbonate (MgCO<sub>3</sub>) 15g



B012

Cobalt Oxide (CoO) 0.01g  
Chrome Oxide (Cr<sub>2</sub>O<sub>3</sub>) 0.01g



B013

Cobalt Oxide (CoO) 0.1g  
Chrome Oxide (Cr<sub>2</sub>O<sub>3</sub>) 0.014g



B013 Foundry

Cobalt Oxide (CoO) 0.1g  
Chrome Oxide (Cr<sub>2</sub>O<sub>3</sub>) 0.014g



B014

Cobalt Oxide (CoO) 0.05g  
Chrome Oxide (Cr<sub>2</sub>O<sub>3</sub>) 0.065g



B015

Cobalt Oxide	(CoO)	0.1g
Chrome Oxide	(Cr <sub>2</sub> O <sub>3</sub> )	0.1g



B016

Cobalt Oxide	(CoO)	0.1g
Zinc Oxide	(ZnO)	5g



B017

Cobalt Oxide	(CoO)	0.1g
Tin Oxide	(SnO <sub>2</sub> )	5g



B018

Copper Carbonate	(CuCo <sub>3</sub> )	1g
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B019

Copper Carbonate	(CuCo <sub>3</sub> )	1g
Cobalt Carbonate	(CoO)	0.1g
Zinc Oxide	(ZnO)	5g



B020

Copper Carbonate	(CuCo <sub>3</sub> )	1g
Lead Bisilicate	(PbO.2SiO <sub>2</sub> )	5g



B021

Copper Carbonate (CuCo<sub>3</sub>) 1g

Zinc Oxide (ZnO) 5g



B022

Copper Carbonate (CuCo<sub>3</sub>) 1g

Tin Oxide (SnO) 5g



B023

Copper Carbonate (CuCo<sub>3</sub>) 1g

Lead Oxide (PbO) 5g



B024

Copper Carbonate (CuCo<sub>3</sub>) 1g

Copper Oxide (CuO) 0.25g



B025

Copper Carbonate (CuCo<sub>3</sub>) 1g

Copper Oxide (CuO) 2g



B026

Cobalt Carbonate (CoCo<sub>3</sub>) 0.1g



B027

Cobalt Carbonate

( $\text{CoCo}_3$ )

0.1g

Lead Oxide

( $\text{PbO}$ )

5g



B028

Cobalt Carbonate

( $\text{CoCo}_3$ )







0.1g

Zinc Oxide

( $\text{ZnO}$ )

5g



G001	Chrome Oxide	(Cr <sub>2</sub> O <sub>3</sub> )	0.01g	
G002	Chrome Oxide	(Cr <sub>2</sub> O <sub>3</sub> )	0.1g	
G003	Chrome Oxide	(Cr <sub>2</sub> O <sub>3</sub> )	0.25g	
G004	Chrome Oxide	(Cr <sub>2</sub> O <sub>3</sub> )	0.4g	
G005 (D1)	Chrome Oxide	(Cr <sub>2</sub> O <sub>3</sub> )	0.8g	
G005 (D2)	Chrome Oxide	(Cr <sub>2</sub> O <sub>3</sub> )	0.8g	

G005 (D3)

Chrome Oxide

(Cr<sub>2</sub>O<sub>3</sub>)

0.8g



G005 (D4)

Chrome Oxide

(Cr<sub>2</sub>O<sub>3</sub>)

0.8g

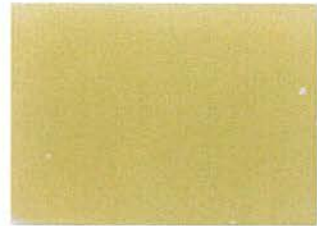


G005 Foundry

Chrome Oxide

(Cr<sub>2</sub>O<sub>3</sub>)

0.8g



G006(a)Y

Chrome Oxide

(Cr<sub>2</sub>O<sub>3</sub>)

0.08g

Iron Oxide (yellow)

(Fe<sub>2</sub>O<sub>3</sub>)

0.01g



G006(a)R

Chrome Oxide

(Cr<sub>2</sub>O<sub>3</sub>)

0.08g

Iron Oxide (red)

(Fe<sub>2</sub>O<sub>3</sub>)

0.01g



G007

Chrome Oxide

(Cr<sub>2</sub>O<sub>3</sub>)

0.6g

Copper Oxide

(CuO)

2g



G007 (fire polished)

Chrome Oxide	(Cr <sub>2</sub> O <sub>3</sub> )	0.6g
Copper Oxide	(CuO)	2g



G008

Chrome Oxide	(Cr <sub>2</sub> O <sub>3</sub> )	0.1g
Tin Oxide	(SnO <sub>2</sub> )	5g



G009

Chrome Oxide	(Cr <sub>2</sub> O <sub>3</sub> )	0.5g
Lead Oxide	(PbO)	5g



G010

Chrome Oxide	(Cr <sub>2</sub> O <sub>3</sub> )	0.5g
Lead Oxide	(PbO)	5g
lead Bisilicate	(PbO.2SiO <sub>2</sub> )	5g



G011

Chrome Oxide	(Cr <sub>2</sub> O <sub>3</sub> )	0.5g
Zinc Oxide	(ZnO)	5g
Tin Oxide	(SnO <sub>2</sub> )	5g



G012

Copper Oxide	(CuO)	0.6g
Iron Oxide (red)	(Fe <sub>2</sub> O <sub>3</sub> )	0.3g



G013

Copper Oxide	(CuO)	1.2g
Iron Oxide (red)	(Fe <sub>2</sub> O <sub>3</sub> )	0.2g



G014

Copper Oxide	(CuO)	0.8g
Iron Oxide (red)	(Fe <sub>2</sub> O <sub>3</sub> )	0.1g



G014 Foundry

Copper Oxide	(CuO)	0.8g
Iron Oxide (red)	(Fe <sub>2</sub> O <sub>3</sub> )	0.1g



G014 Foundry (2nd Pour)

Copper Oxide	(CuO)	0.8g
Iron Oxide (red)	(Fe <sub>2</sub> O <sub>3</sub> )	0.1g



G015

Copper Oxide	(CuO)	1g
Iron Oxide (red)	(Fe <sub>2</sub> O <sub>3</sub> )	2g



G016

Copper Oxide	(CuO)	0.4g
Manganese Dioxide	(MnO <sub>2</sub> )	0.5g



G017

Copper Oxide

(CuO)

0.4g

Manganese Dioxide

(MnO<sub>2</sub>)

0.5g

Iron Oxide (red)

(Fe<sub>2</sub>O<sub>3</sub>)

1g



G018

Vanadium Pentoxide

(V<sub>2</sub>O<sub>5</sub>)

0.25g



G019

Vanadium Pentoxide

(V<sub>2</sub>O<sub>5</sub>)

1g



G019 (820°C)

Vanadium Pentoxide

(V<sub>2</sub>O<sub>5</sub>)

1g



G019 (840°C)

Vanadium Pentoxide

(V<sub>2</sub>O<sub>5</sub>)

1g



G020

Vanadium Pentoxide

(V<sub>2</sub>O<sub>5</sub>)

1.25g



G021

Vanadium Pentoxide	( $V_2O_5$ )	1g
Tin Oxide	( $SnO_2$ )	5g



G022

Vanadium Pentoxide	( $V_2O_5$ )	1g
Tin Oxide	( $SnO_2$ )	5g
Lead Bisilicate	( $PbO \cdot 2SiO_2$ )	5g



G023

Vanadium Pentoxide	( $V_2O_5$ )	1g
Tin Oxide	( $SnO_2$ )	5g
Zirconium Silicate	( $ZrSiO_4$ )	5g



G024

Vanadium Pentoxide	( $V_2O_5$ )	1g
Tin Oxide	( $SnO_2$ )	5g
Zirconium Dioxide	( $ZrO_2$ )	5g



G025







Copper Oxide	( $CuO$ )	0.25g
Magnesium Carbonate	( $MgCO_3$ )	15g



G026

Chrome Oxide	( $Cr_2O_3$ )	0.1g
Zinc Oxide	( $ZnO$ )	1g



Y001	Potassium Dichromate	$(K_2CrO_4)$	3g	
Y002	Antimony Oxide	$(Sb_2O_3)$	0.25g	
Y003	Antimony Oxide	$(Sb_2O_3)$	1g	
Y004	Antimony Oxide	$(Sb_2O_3)$	2g	
Y005	Antimony Oxide Lead Oxide	$(Sb_2O_3)$ $(PbO)$	1g 5g	
Y006	Antimony Oxide Lead Oxide Iron Oxide (red)	$(Sb_2O_3)$ $(PbO)$ $(Fe_2O_3)$	1g 5g 1g	

Y007

Antimonate of Lead (Pb<sub>3</sub>SbO<sub>4</sub>) 5g



Y008

Antimonate of Lead (Pb<sub>3</sub>SbO<sub>4</sub>) 5g  
Lead Oxide (PbO) 1g



Y009

Antimonate of Lead (Pb<sub>3</sub>SbO<sub>4</sub>) 1g  
Iron Oxide (red) (Fe<sub>2</sub>O<sub>3</sub>) 1g  
Lead Bisilicate (PbO.2SiO<sub>2</sub>) 5g



Y010

Cadmium Sulphide (CdS) 0.1g



Y011

Cadmium Sulphide (CdS) 1g



Y012

Cadmium Sulphide (CdS) 1g  
Antimony Oxide (Sb<sub>2</sub>O<sub>3</sub>) 1g



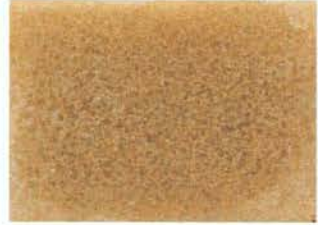
Y013

Cadmium Sulphide (CdS) 1g  
Zinc Oxide (ZnO) 1g



Y014

Cadmium Sulphide (CdS) 3g  
Zinc Oxide (ZnO) 1g



Y015

Cadmium Sulphate (CdSO<sub>4</sub>) 3g



Y016

Cadmium Sulphate (CdSO<sub>4</sub>) 1g  
Zinc Oxide (ZnO) 1g



Y017

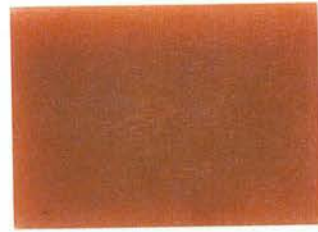
Onglaze (orange stain) 2g



Y018

Onglaze (orange stain) 1g

Onglaze (rose stain) 1g



Y019

Potassium Dichromate ( $K_2CrO_4$ ) 5g

China Clay ( $Al_2Si_2O_5(OH)_4$ ) 5g

Lead Bisilicate ( $PbO \cdot 2SiO_2$ ) 90g



R001

Iron Oxide (black)

(Fe<sub>2</sub>O<sub>3</sub>)

1g



R002

Iron Oxide (black)

(Fe<sub>2</sub>O<sub>3</sub>)

3g



R003

Iron Oxide (red)

(Fe<sub>2</sub>O<sub>3</sub>)

1g



R004

Iron Oxide (red)

(Fe<sub>2</sub>O<sub>3</sub>)

3g



R005

Iron Oxide (yellow)

(Fe<sub>2</sub>O<sub>3</sub>)

1g



R006

Iron Oxide (yellow)      ( $\text{Fe}_2\text{O}_3$ )      3g



R007 (exterior surface)

Iron Oxide (yellow)      ( $\text{Fe}_2\text{O}_3$ )      1g

Zinc Oxide                      ( $\text{ZnO}$ )      5g



R007 (interior surface)

Iron Oxide (yellow)      ( $\text{Fe}_2\text{O}_3$ )      1g

Zinc Oxide                      ( $\text{ZnO}$ )      5g



R008

Antimonate of Lead      ( $\text{Pb}_3\text{SbO}_4$ )      5g

Iron Oxide (red)              ( $\text{Fe}_2\text{O}_3$ )      5g



R009

Antimonate of Lead      ( $\text{Pb}_3\text{SbO}_4$ )      1g

Iron Oxide (red)              ( $\text{Fe}_2\text{O}_3$ )      5g

Lead Oxide                      ( $\text{PbO}$ )      5g





R010


Antimonate of Lead      ( $\text{Pb}_3\text{SbO}_4$ )      5g


Iron Oxide (red)              ( $\text{Fe}_2\text{O}_3$ )      10g





R011					
Iron Oxide (yellow)	(Fe <sub>2</sub> O <sub>3</sub> )	5g			
Zinc Oxide	(ZnO)	1g			

R012					
Iron Oxide (yellow)	(Fe <sub>2</sub> O <sub>3</sub> )	10g			
Zinc Oxide	(ZnO)	5g			

R013					
Iron Oxide (yellow)	(Fe <sub>2</sub> O <sub>3</sub> )	10g			
Zinc Oxide	(ZnO)	10g			

R014					
Zinc Oxide	(ZnO)	5g			
Lead Oxide	(PbO)	5g			
Iron Oxide (red)	(Fe <sub>2</sub> O <sub>3</sub> )	10g			

R015					
Iron Oxide (red)	(Fe <sub>2</sub> O <sub>3</sub> )	5g			
Thiviers Red	(FeOOH)	5g			
(iron oxyhydroxide)					

R016					
Onglaze	(red)	3g			

R017

Chrome-tin pink

(CaO.SnO.SiO<sub>2</sub>:Cr<sub>2</sub>O<sub>3</sub>) 1g



R018

Onglaze

(soft pink)

0.5g



R019

Vanadium pentoxide

(V<sub>2</sub>O<sub>5</sub>)

1g

Onglaze

(rose)

0.25g



R020

Ferrous Oxide (red)

(Fe<sub>2</sub>O<sub>3</sub>)

0.25g

Gold Ruby (gaffer)

(G221)

100g



R021

Ferrous Oxide (red)

(Fe<sub>2</sub>O<sub>3</sub>)

1g

Gold Ruby (gaffer)

(G221)

100g



R022

Ferrous Oxide (yellow) ( $\text{Fe}_2\text{O}_3$ ) 0.25g

Gold Ruby (gaffer) (G221) 100g




R023

Ferrous Oxide (yellow) ( $\text{Fe}_2\text{O}_3$ ) 1g


Gold Ruby (gaffer) (G221) 100g




W001  
Zinc Oxide (ZnO) 10g  
Tin Oxide (SnO<sub>2</sub>) 5g




W002  
Tin Oxide (SnO<sub>2</sub>) 1g  
Lead Bisilicate (PbO.2SiO<sub>2</sub>) 10g



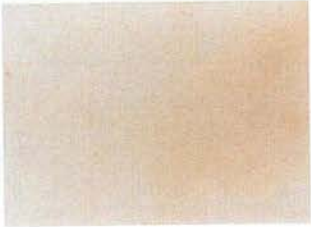
W003  
Silver Chloride (AuCl) 0.5g




W004  
Silver Chloride (AuCl) 1g



W005  
Silver Nitrate (AuNo) 0.5g



W006  
Silver Nitrate (AuNo) 1g



W007  
Crocus Martis                      ( $\text{Fe}_2\text{O}_3$ )                      0.25g



W008 (exterior surface)  
Iron Oxide (yellow)              ( $\text{Fe}_2\text{O}_3$ )                      1g  
Zinc Oxide                              ( $\text{ZnO}$ )                              5g  
Tin Oxide                                ( $\text{SnO}_2$ )                            10g



W008 (interior surface)  
Iron Oxide (yellow)              ( $\text{Fe}_2\text{O}_3$ )  
Zinc Oxide                              ( $\text{ZnO}$ )  
Tin Oxide                                ( $\text{SnO}_2$ )



W009 (exterior surface)  
Iron Oxide (yellow)              ( $\text{Fe}_2\text{O}_3$ )                      1g  
Tin Oxide                                ( $\text{SnO}_2$ )                            10g









W009 (interior surface)  
Iron Oxide (yellow)              ( $\text{Fe}_2\text{O}_3$ )                      1g  
Tin Oxide                                ( $\text{SnO}_2$ )                            10g



W010  
Cadmium Sulphide                ( $\text{CdS}$ )                              1g  
Zirconium Oxide                    ( $\text{ZrO}_2$ )                            0.5g



BV001	Manganese Dioxide	(MnO <sub>2</sub> )	0.3g	
BV002	Manganese Dioxide	(MnO <sub>2</sub> )	1g	
BV003	Manganese Dioxide	(MnO <sub>2</sub> )	1.5g	
BV004	Manganese Dioxide	(MnO <sub>2</sub> )	3g	
BV004 Foundry	Manganese Dioxide	(MnO <sub>2</sub> )	3g	
BV005	Manganese Dioxide	(MnO <sub>2</sub> )	0.5g	
	Copper Oxide	(CuO)	0.4g	

BV006

Manganese Dioxide (MnO<sub>2</sub>) 0.2g  
Cobalt Oxide (CoO) 3g



BV007

Manganese Dioxide (MnO<sub>2</sub>) 0.05g  
Cobalt Oxide (CoO) 0.5g



BV007 Foundry

Manganese Dioxide (MnO<sub>2</sub>) 0.05g  
Cobalt Oxide (CoO) 0.5g



BV007 Foundry (2nd Pour)

Manganese Dioxide (MnO<sub>2</sub>) 0.05g  
Cobalt Oxide (CoO) 0.5g



BV008

Manganese Dioxide (MnO<sub>2</sub>) 0.1g  
Cobalt Oxide (CoO) 0.1g



BV009

Manganese Dioxide (MnO<sub>2</sub>) 1g  
Cobalt Oxide (CoO) 0.1g



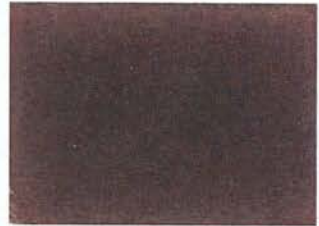
BV010

Manganese Dioxide (MnO<sub>2</sub>) 0.3g  
Ferrous Oxide (red) (Fe<sub>2</sub>O<sub>3</sub>) 0.3g



BV010 Foundry

Manganese Dioxide (MnO<sub>2</sub>) 0.3g  
Ferrous Oxide (red) (Fe<sub>2</sub>O<sub>3</sub>) 0.3g



BV011

Manganese Dioxide (MnO<sub>2</sub>) 0.3g  
Ferrous Oxide (red) (Fe<sub>2</sub>O<sub>3</sub>) 0.4g



BV011 Foundry

Manganese Dioxide (MnO<sub>2</sub>) 0.3g  
Ferrous Oxide (red) (Fe<sub>2</sub>O<sub>3</sub>) 0.4g



BV012

Manganese Dioxide (MnO<sub>2</sub>) 3g  
Ferrous Oxide (red) (Fe<sub>2</sub>O<sub>3</sub>) 3g



BV013

Manganese Carbonate (MnCO<sub>3</sub>) 0.25g



BV014

Manganese Carbonate

( $\text{MnCO}_3$ )

1g



BV015

Crocus Martis

( $\text{FeSO}_4$ )

0.25g



BV016

Crocus Martis

( $\text{FeSO}_4$ )

1g



BV017

Crocus Martis

( $\text{FeSO}_4$ )

1.5g



BV018

Crocus Martis

( $\text{FeSO}_4$ )

3g



**Appendix 3:**

**29 Formulae from the Argy-Rousseau notebooks**

**'The Production of Pâte de Verre'.**

## APPENDIX 3

### 29 Formulae from the Argy-Rousseau notebooks 'The Production of Pâte de Verre.

#### Introduction.

The formulae contained within this appendix have been transcribed directly from the Gabriel Argy-Rousseau notebooks 'On the Production of Pâte de Verre', which were disseminated in 1978 during a symposium at the Royal College of Art. The colours described by Argy-Rousseau are for making colour at founding temperature at around 1240-70° C. I have taken these formulae and used them to produce colour at around 800° C. The results are therefore not the same as of they would be at the founding temperature. Colour made at this lower temperature is not incorporated into the matrix of the glass and is therefore translucent and /or opaque, not transparent.

As with all the colour samples in Appendix 2 the samples illustrated have been made using Gaffer Glass 42% lead crystal and were fired to a temperature of 800° C.

In my copy of the notebooks recipe number 18 calls for:

Uranate of Ammonia          U<sub>2</sub>O<sub>7</sub> Am<sub>2</sub>          5g

This would appear to be an incorrect chemical coding for the uranate. Uranate of Ammonia – or Ammonium diuranate as it is commonly called - has a chemical code of ((NH<sub>4</sub>)<sub>2</sub>U<sub>2</sub>O<sub>7</sub>). The chemical code 'Am' refers to the element 'americum', which was not discovered until 1944 and is not associated with glass colouring or production in any way (Barbalace, 2010). As there are known recipes for colouring glass using ammonium diuranate I have assumed that this is what was meant either by the translators of the notebooks or by Argy-Rousseau himself (Strahan, 2001). I have left the text as it was found and inserted the correct code underneath.

**Formula No. + Predicted colour.**

**Oxide**                      **Chemical Code**                      **Weight per 100g glass**

**R1. Turquoise clear**

Copper

CuO

0.2g



**R2. Grey-blue clear**

Cobalt

CoO

0.01g

Chrome

Cr<sub>2</sub>O<sub>3</sub>

0.01g



**R3. Yellow-green**

Copper

CuO

1g

Iron

Fe<sub>2</sub>O<sub>3</sub>

2g



**R4. Brown-violet**

Manganese

MnO<sub>2</sub>

3g



**R5. Blue**

Cobalt

CoO

1.4g



**R6. Brown- violet**

Cobalt

CoO

0.2g

Manganese

Cr<sub>2</sub>O<sub>3</sub>

3 g



**R7. Green**

Chrome

 $\text{Cr}_2\text{O}_3$ 

0.01g

**R8. Green**

Chrome

 $\text{Cr}_2\text{O}_3$ 

0.4g

**R9. Grey-blue (bluer)**

Cobalt

 $\text{CoO}$ 

0.1g

Chrome

 $\text{Cr}_2\text{O}_3$ 

0.014g

**R10. Brown yellow**

Iron

 $\text{Fe}_2\text{O}_3$ 

3g

Manganese

 $\text{MnO}_2$ 

3g

**R11. Clear violet**

Cobalt

 $\text{CoO}$ 

0.05g

Manganese

 $\text{MnO}_2$ 

0.5g

**R12. Clear yellow brown**

Iron

 $\text{Fe}_2\text{O}_3$ 

0.3g

Manganese

 $\text{MnO}_2$ 

0.3g



**R13. Yellow-green**

Copper	CuO	0.8g
Iron	Fe <sub>2</sub> O <sub>3</sub>	1g

**R14. Yellow-green**

Copper	CuO	0.6g
Iron	Fe <sub>2</sub> O <sub>3</sub>	0.3g

**R15. Grey blue**

Cobalt	CoO	0.05g
Chrome	Cr <sub>2</sub> O <sub>3</sub>	0.065g

**R16. Green**

Copper	CuO	0.4g
Manganese	MnO <sub>2</sub>	0.5g

**R17. Violet**

Cobalt	CoO	0.1g
Manganese	MnO <sub>2</sub>	1g

**R18. Orange yellow**

Uranate of Ammonia	U <sub>2</sub> O <sub>7</sub> Am <sub>2</sub>	5g
--------------------	---	----

((NH<sub>4</sub>)<sub>2</sub>U<sub>2</sub>O<sub>7</sub>),

(Sample shown was produced at founding temp. of 1270°C)

**R19. Green**

Chrome	Cr <sub>2</sub> O <sub>3</sub>	0.8g
Iron	Fe <sub>2</sub> O <sub>3</sub>	0.1g



**R20 . Blue**

Iron	Fe <sub>2</sub> O <sub>3</sub>	3g
Manganese	MnO <sub>2</sub>	3g
Cobalt	CoO	0.4g

**R21. Blue**

Cobalt	CoO	0.7g
--------	-----	------

**R22 . Blue-black I**

Iron	Fe <sub>2</sub> O <sub>3</sub>	3.5g
Manganese	MnO <sub>2</sub>	3g
Cobalt	CoO	0.45g

**R23. Turquoise**

Copper	CuO	1.2g
--------	-----	------

**R24. Brown-black**

Iron	Fe <sub>2</sub> O <sub>3</sub>	2.4g
Manganese	MnO <sub>2</sub>	3.4g
Cobalt	CoO	0.6g

**R25. Green**

Chrome	Cr <sub>2</sub> O <sub>3</sub>	0.8g
--------	--------------------------------	------

**R26 . Clear yellow brown**

Iron	Fe <sub>2</sub> O <sub>3</sub>	0.9g
Manganese	MnO <sub>2</sub>	0.9g





## **Appendix 4:**

### **The Bars of Colour.**

## APPENDIX 4.

### The Bars of Colour.

#### Introduction

The purpose of this set of experiments was to see and show how each salt reacted to one another. The salts chosen are traditionally used in glass colouring. At founding temperature of around 1240° C - 1270° C the salt is incorporated into the matrix of the glass and colour is formed. The salt is 'locked in' to the body of the glass and it becomes inert. At 800° C colour may be formed and dissolved into a glass solution, but the salt remains outside of the glass's matrix (Weyl, 1999). It can therefore remain volatile to heat and pressure, or produce another chemical reaction when placed alongside another salt. As most of Walter's work appears to use the colours made from these salts I wanted to see what the consequences would be when they were placed in a mould alongside one another and fired to around 800° C, and see if any of the reactions were similar to any effects seen in Walter' work.

The salts and glass frits were placed in long bands or bars, so the results could be read clearly. In the set of experiments all of the salts were laid next to one another at least once.

The set of 10 salts were as follows:

		Quantity x per 100g glass frit
Copper oxide	CuO	0.2g
Chrome oxide	Cr <sub>2</sub> O <sub>3</sub>	0.1g
Cobalt oxide	CoO	0.4g
Manganese oxide	Mn <sub>2</sub> O	0.3g
Iron oxide (yellow).	Fe <sub>2</sub> O <sub>3</sub>	1.0g
Iron oxide (red)	Fe <sub>2</sub> O <sub>3</sub>	1.0g
Potassium dichromate	K <sub>2</sub> CrO <sub>4</sub>	3.0g
Vanadium pentoxide	V <sub>2</sub> O <sub>5</sub>	1.0g
Cadmium sulphate	CdSO <sub>4</sub>	3.0g
Antimony oxide	Sb <sub>2</sub> O <sub>3</sub>	1.0g

The two salts of iron (red and yellow) were used as they had been in previous tests. I wanted to see what differences, if any, would be when they were placed next to another salt. Black iron oxide was not included as it produces a dull, grey black result when fired at around 800° C (see Appendix 2: R001).

Each salt was measured out to the formulae above and included in a batch of glass frit (42% lead crystal). These formulae had been established in previous research and had been tested individually, the weight of salt giving a good colour. The glass frit used was a general mix of powder and small grains of glass no larger than 2mm in diameter. Gum Arabic was mixed in with the frit and salt to ensure the salt would adhere to the particles of glass.

The mix of salts and glass were laid into prepared refractory moulds as shown in Fig 1 below.



Fig 1.

These are shallow open moulds (approximately 15 mm deep), allowing for a complete oxidising atmosphere for the reactions to take place. As most of Walter's

work was produced in shallow, open moulds any reaction one salt would have on another would show up easily and could be compared to Walter's work.

The dimensions of the moulds were governed in part by the internal dimensions of the kiln I was using 40cm X 40cm, but also by the number of salts used. The two longest of the bars (Bars 1 and 2) contained all 10 salts. The dimensions of the individual samples (as illustrated in Appendix 2) were 35mm X 50mm, so I employed the same sizing for each of the samples within each bar here.

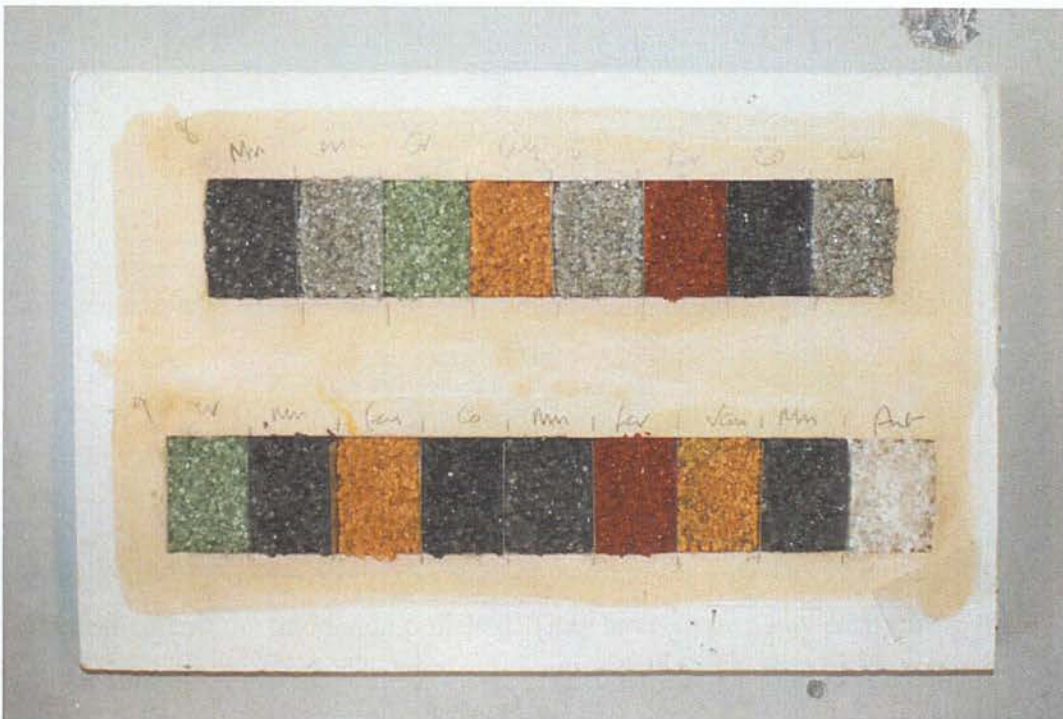


Fig 2.

As can be seen in Fig 2, above the layout of the salt/glass mixes produced their own interesting bands of colour. The colour of the salt/glass mix does not necessarily give a clue as to the fired end product, but in their raw state they making it easier to see where one formula was placed next to another. Manganese, copper and cobalt oxides are grey-black in their raw state. Antimony oxide is white. Only chrome

oxide and red iron oxide give a clue as to their end colour. For comparison with their fired state the top set of frit and oxide is Bar 5. The lower set is Bar 4. They can be seen still in their mould in Fig 3 below, having just been removed from the kiln after firing.

The prepared moulds with the salts were then placed in a kiln and fired to 840o C.

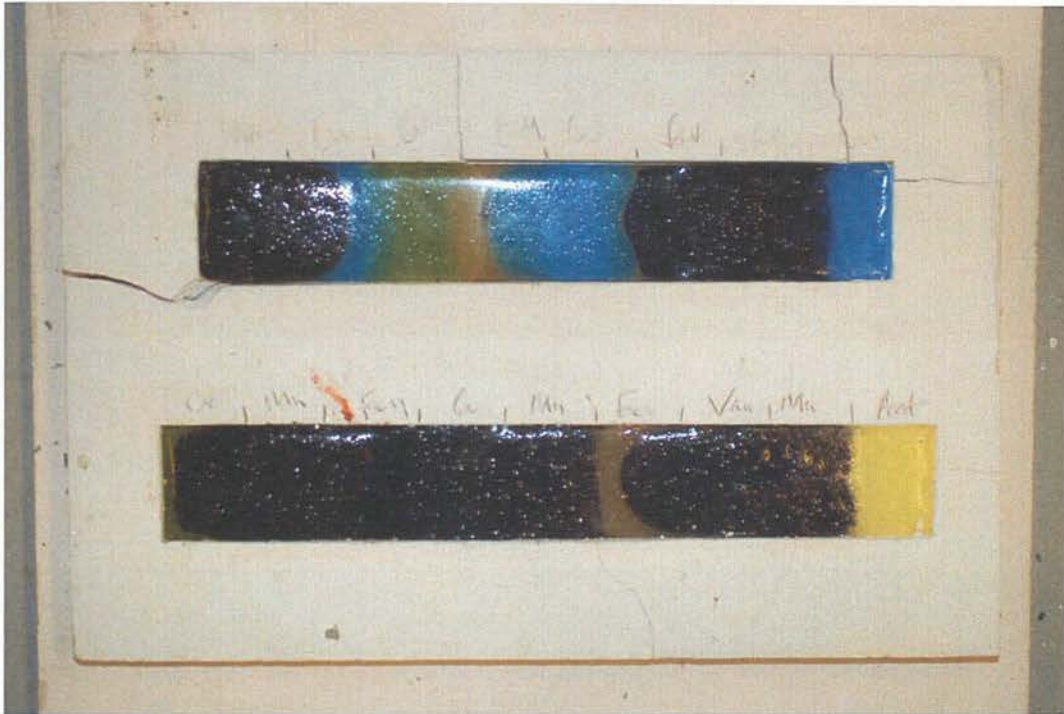


Fig 3.

The fired bars were removed from the kiln and examined.

The image in Fig 4, below shows the underneath of the two bars before the bars were cleaned and the underside polished. They have come away easily from the refractory mould.

Fig 5. shows the thickness of the bars after firing. They are less than 10mm thick.

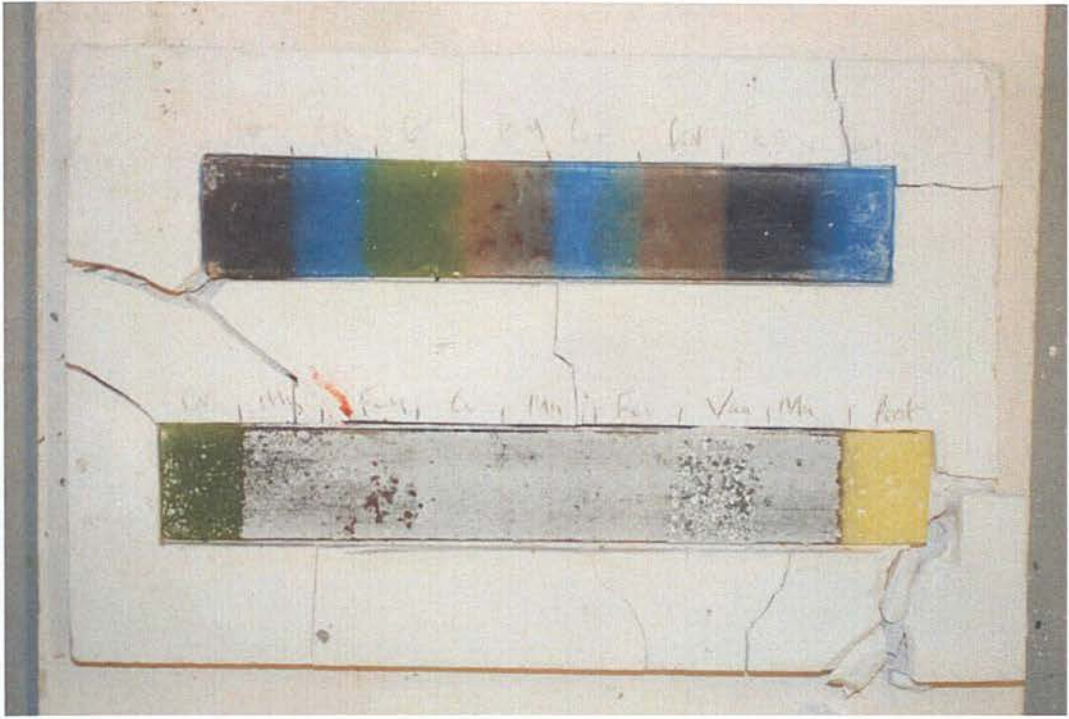


Fig 4.

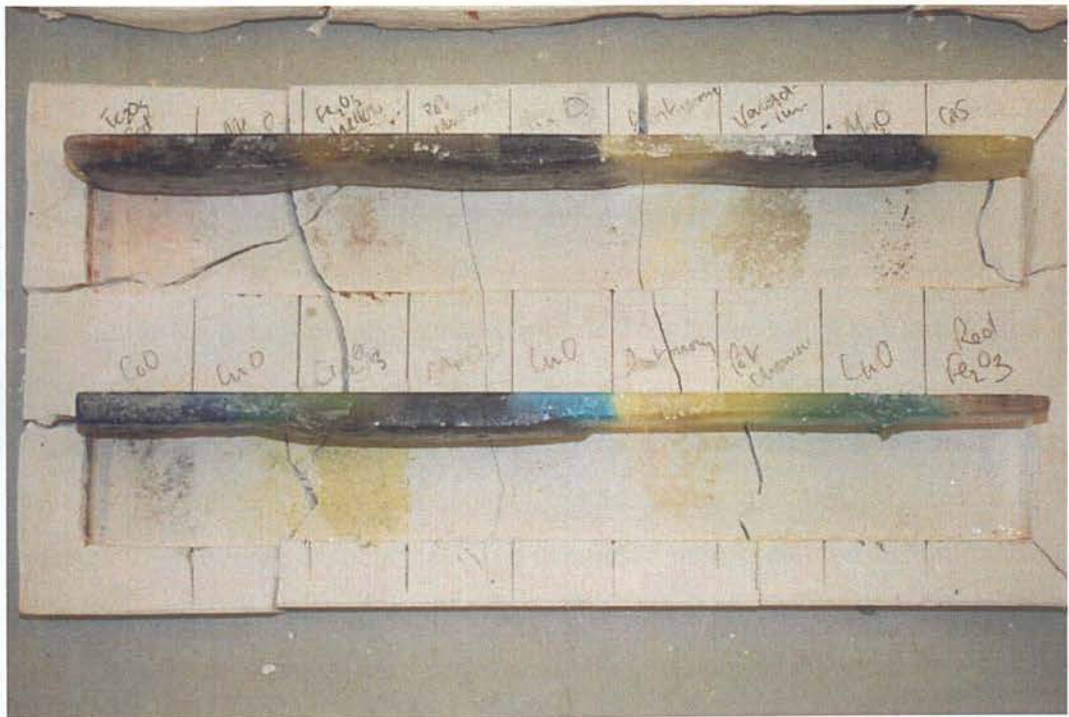
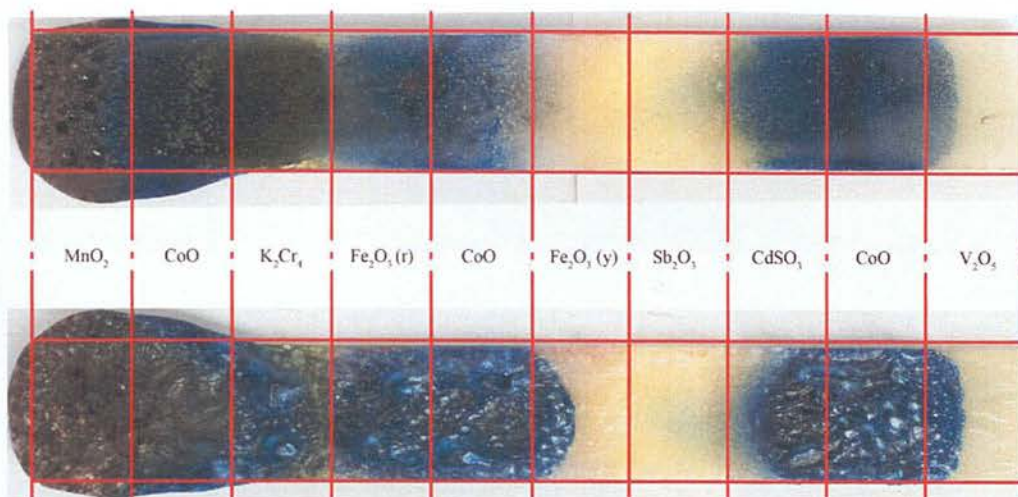


Fig 5.

## BAR 1

TOP

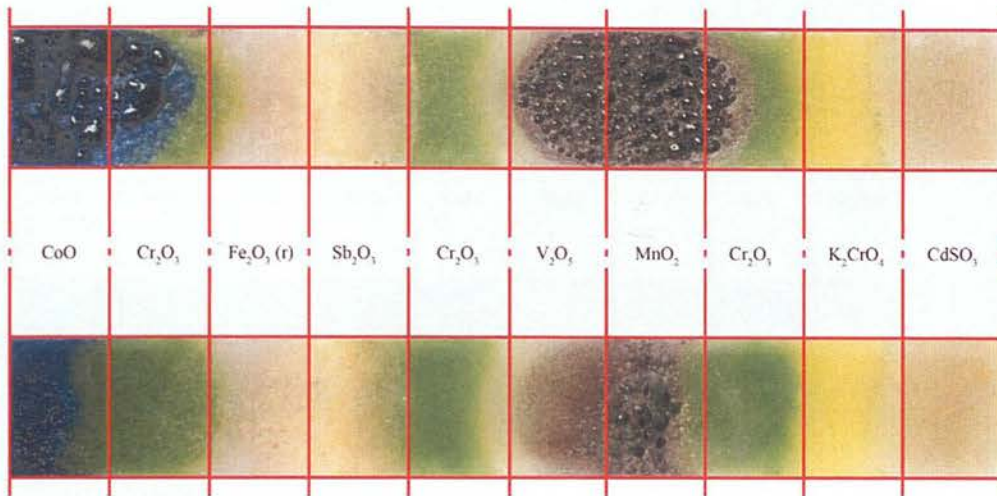


UNDERSIDE

Both the manganese and the cobalt salts on the left of the bar have produced strong gaseous reactions and have spilled out over the containing edges of the mould. Their respective colours of blue and purple are clearly identifiable. Similarly, the cobalt salts in the middle and on the right have spread across the top of their neighbours. Nothing remains of the red iron salt and very little of the strong yellow of the potassium is seen either. The red iron salt in has not produced its predicted brick-red pigment. It is not clear whether this because of chemical interference from the cobalt salt or the potassium dichromate or both. To a lesser extent this is true of the yellow iron salt in the centre of the bar. There is small trace of an unremarkable pale pink colour where one would expect a strong red. The antimony oxide next to it has produced its predicted pale yellow colour, but has begun to be pushed across the colour bar by the force of the cobalt. The cobalt salt has obscured the cadmium salt and obliterated any colour. The vanadium salt on the far right of the bar has held its own against the reaction of the cobalt salt and has produced some familiar pale leaf green colour.

## BAR 2

TOP

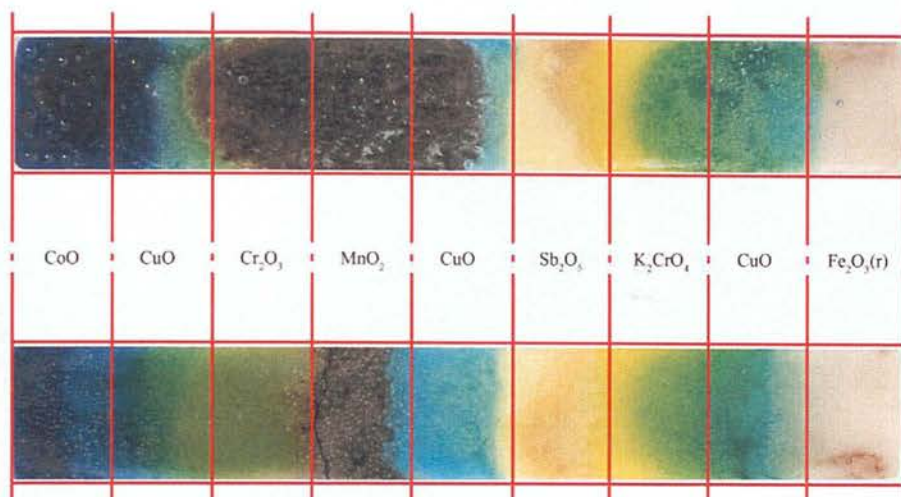


UNDERSIDE

The cobalt salt on the far left of the bar has spread over its neighbour, the chrome salt. The chrome has spread across the floor of the mould - presumably having been pushed down by the expansion of the cobalt, and being able to take up some of the space where the cobalt was. The chrome salt has produced its traditional green colour. It appears not to have shifted much into the area of the red iron salt, but as with the iron salts in Bar 1 the predicted red-brick colour has not appeared. As with the iron salts in Bar 1 an indistinct pale pink has emerged instead. The antimony salt next to it has produced a little colour, but the chrome salt and the yellow iron salt either side of it have shifted position to discolour the antimony's yellow. This positional shift from the chrome has possibly something to do with the gaseous reaction of the manganese, which has expanded and pushed the band of vanadium in into a semi-circular shape. The vanadium has been discoloured too. Its pale green colour as not emerged, but is represented instead by a pale milky hue. The chrome next to it has stood up well against the gaseous reaction of the manganese although the intensity of its colour has been affected. The chrome salt has also sat well next to the potassium dichromate, which itself has produced its familiar bright yellow. The cadmium salt on the far right has produced some colour.

## BAR 3

TOP

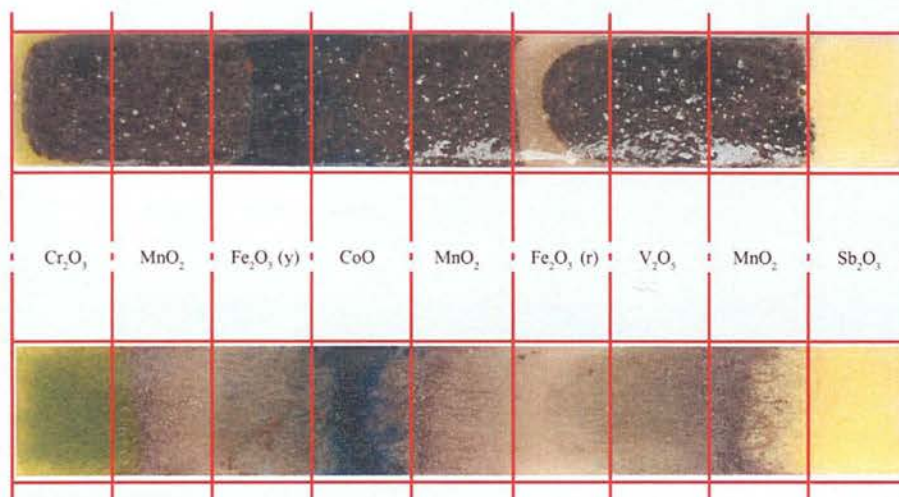


UNDERSIDE

The cobalt oxide in on the far left has produced a strong gaseous reaction and merged with the copper salt next to it turning the turquoise colour of the copper to a mid sea-blue. The chrome green colour has merged with the turquoise to produce an emerald colour. On the top side of the bar the manganese has replaced the chrome division although the chrome is still visible on the underside. The manganese oxide has spread across the top part of the copper salt in the middle of the bar. The copper oxide here has produced a good turquoise colour, as has the antimony next to it. The potassium dichromate has produced good colour too, but it position has been invaded by the Copper salt on the right hand side. Where the salts have mixed a brilliant green colour has been produced. The red iron oxide on the far right of the bar has produced a small amount of its traditional red colour, but the majority of the salt has produced the familiar washed-out pale pink colour.

## BAR 4

TOP

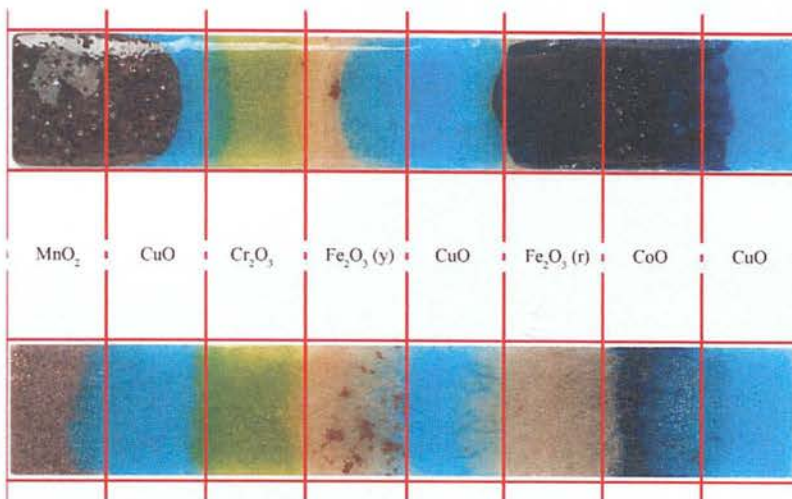


UNDERSIDE

The colours in the majority of this bar are dominated by the reaction of the manganese dioxide. At the left end of the bar a good chrome green has been produced, and at the other end the antimony salt has produced a good strong yellow. The yellow iron oxide (third from the left) has made a very small amount of red brick colour, the rest being a transparent pale pink through which one can clearly see the blue colour of the cobalt salt. The blue of the cobalt is a strong blue, but has been 'squeezed' by its neighbouring salts. This is more to do with the gaseous nature of the cobalt taking the salt upwards and allowing the closest next to it to flow into the space created. On the top surface the position of the cobalt appears to have moved completely away from its division and is resting mainly over the yellow iron oxide. It is the same occurrence with the manganese salts. Little trace of it is visible on the underside. Where there should be the salts with the iron oxide, there appears to have been a replacement by the vanadium salt. The manganese salt has made a small amount of colour on the underside but produced a large gaseous reaction. The antimony has maintained its position and colour.

## BAR 5

TOP

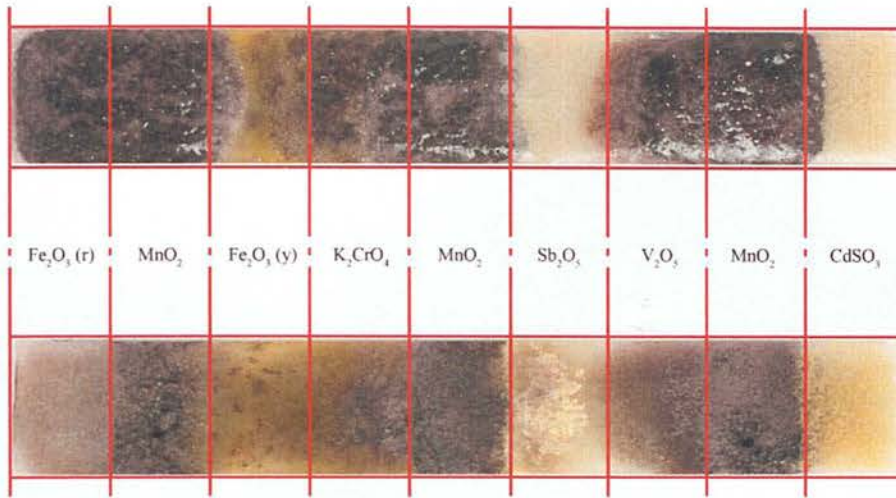


UNDERSIDE

The colours in this bar have generally been produced where each salt was placed. There is less evidence of contamination from one salt to the next on the underside, although the top side does show movement of the salts especially where the cobalt and manganese salts have produced their gaseous reactions. There has been a little movement as the manganese and the cobalt have moved upwards from the bottom of the mould to the top of the segment, but compared to the previous four bars all the salts are clearly identifiable from where they were placed in their separate divisions. There is a strong turquoise colour made from the copper salt in all three of its positions. The chrome green is also a good strong colour, and much less muddled than in the previous 4 bars. The yellow iron oxide has produced more of the red brick colour it should have, but once again this is in a relatively small amount and is set against a much wider background of a pale pink colour. The colour produced is also a coagulation of intensity rather than a fine spread of colour as one sees in the chrome or the copper. The red iron oxide (third division from the right) has not produced this effect, but is a clear pink colour. The cobalt salt on the right of the bar has spread across the topside of the iron red, but has interfered little on the underside. The gaseous reactions of both the manganese and the cobalt salts are not so violent as in the other 4 bars. It is uncertain why this is.

## BAR 6

TOP

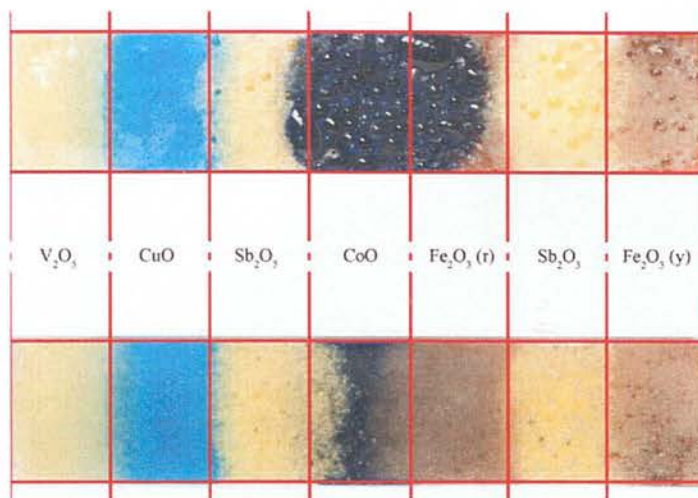


UNDERSIDE

As with Bar 4 the effects of the manganese dioxide dominate the colours in Bar 5. With the exception of the cadmium sulphate in the extreme right hand position of the bar all the other salts have been contaminated in one way or another. The yellow iron oxide had coagulated partially while the red iron oxide on the extreme left has produced a pale pink. Little of the bright yellow of the potassium dichromate remains and where it shows is above the position of the yellow iron oxide. Any colour from the vanadium salt has been obliterated, but some of the antimony has remained. This may be due to the higher melting temperature required by antimony oxide for it to flow.

# BAR 7

TOP

















UNDERSIDE

With the exception of the cobalt salt (in the centre of the bar) all of the salts have remained in position. The vanadium, copper and antimony have produced good strong colours, while both iron salts have produced a pale pink colouring.

# BAR 8

TOP

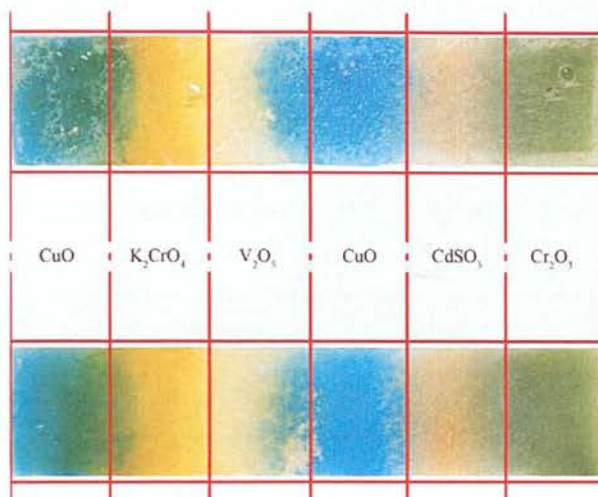
						
$\text{Fe}_2\text{O}_3$ (y)	$\text{Fe}_2\text{O}_3$ (r)	$\text{K}_2\text{CrO}_4$	$\text{Sb}_2\text{O}_3$	$\text{Fe}_2\text{O}_3$ (r)	$\text{CdSO}_4$	$\text{V}_2\text{O}_5$
						

UNDERSIDE

The colours here appear to have been bleached out. The strong colour of the potassium dichromate and the antimony oxide are present, but the other colours are pale, particularly the iron oxides – the red of which has been almost obliterated.

## BAR 9

TOP

















UNDERSIDE

The potassium dichromate and the copper slats have produced strong colours. The colour of the vanadium salt has been bleached out. The cadmium salt has been affected too, its colour resembling the vanadium. The colour of chrome salt, too, has been modified; its usual intensity has been lessened.

# BAR 10

TOP

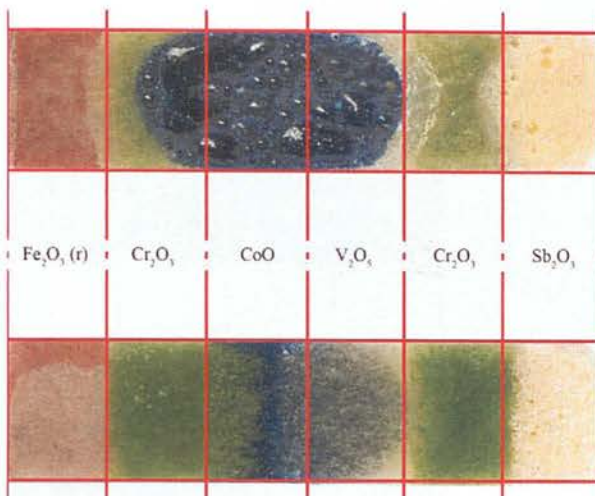
						
$\text{Fe}_2\text{O}_3$ (r)	$\text{Fe}_2\text{O}_3$ (y)	$\text{Fe}_2\text{O}_3$ (r)	$\text{K}_2\text{CrO}_4$	$\text{Sb}_2\text{O}_3$	$\text{Fe}_2\text{O}_3$ (y)	$\text{CdSO}_4$
						

UNDERSIDE

The results of this bar show how the potassium dichromate may have radically affected all the colours in the rest of the bar. All four divisions of the iron salts have been bleached out where some of the red colour of the salts should have remained. The colour of the antimony has been altered too as well as the colour produced by the cadmium.

# BAR 11

TOP

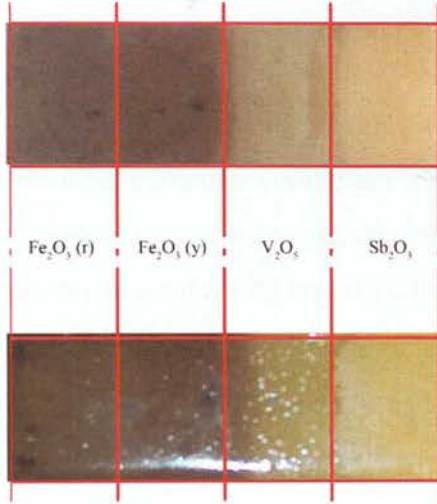


UNDERSIDE

In the absence of potassium dichromate the red colour of the iron oxide has appeared. The green of the chrome salt has emerged too and is not very affected by the gaseous exchange in the cobalt salt. On the top surface of the bar the cobalt has moved across its neighbours. The underside shows how its rise has pulled the rest of the division upwards allowing both the chrome and the vanadium salts to take up the gap. The usual pale colour of the vanadium has been altered to a pale beige colour. The remaining chrome and the antimony divisions have stayed in their relative positions.

BAR 12

TOP



UNDERSIDE

## The results and conclusions.

The results of this experiment are clearly observed in the images of the bars above. In many cases colours have merged with each other and drifts of colour (and therefore salt) are seen 'moving' across their divisions. In others bars predicted colour (such as in the case of the red of the iron oxides, the vanadium and the cadmium salts) has not formed: they have become pale and colourless and the divisions have little to identify them as containing iron oxide. Discoloration has affected most of the colours in some way – except in the case of the potassium dichromate, which appears to produce its bright yellow hue. The cobalt and manganese salts have produced strong gaseous reactions, spilling their mixes over the edge of the mould and across their neighbours, in some instances over two divisions. These two particular salts have created aerated forms in the glass (similar to pumice) where the others, despite their colour spoiling are dense glassy areas. In his notebooks Argy-Rousseau describes both oxides of cobalt and manganese as having a tendency 'to boil' when used in the crucible (i.e. heating it up to produce colour), and recommends putting only half the quantity needed in the crucible compared to the other salts used for the formation of colour (Argy-Rousseau,)

One notable occurrence is that the potassium in Bar 10 seems to bleach out the colour from its neighbours. Its absence in Bar 11 appears to have allowed the formation of the usual red colour found when using an iron salt/oxide. This is also observable in Bar 7, which has an absence of potassium dichromate.

Similar results have occurred across all 11 of the bars where raw salts are placed next to each other. The conclusion drawn from this set of tests is that it is very unlikely that Walter employed any of these salts in their raw form as colourants at 800° C within a mould, with perhaps the exception of the copper oxide, but that needs to be tested further to establish its accuracy. What can be stated is that none of the effects of the cobalt, manganese and potassium (which have such radical effects on colour and the texture of the glass) is observed in any of his work in the Broadfield House Collection or elsewhere. The effects in application of the chrome

oxide, potassium dichromate and the iron salts are further discussed in Book II:  
Chapter 4.

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## Appendix 5:

**Definitions of the systems used in the examination of 4 Walter pieces.**

## APPENDIX 5

**Definitions of the systems used in the examination of 4 Walter pieces from the Broadfield House Glass Museum collection are as follows:**

SEM and XRF are non-invasive and non-destructive methods of enquiry. They use techniques that examine the surface of the glass only, not the interior of the glass body. The composition of the surface layers may not be representative of the bulk of the glass, but, nevertheless, important information is derived from its analysis, and much can be understood.

The **Scanning Electron Microscope** (SEM) is a type of electron microscope that images the sample surface by scanning it with a high-energy beam of electrons in a raster scan pattern. The electrons interact with the atoms that make up the sample producing signals that contain information about the sample's surface topography, composition and other properties (Schweitzer, Friday, October 6, 2006)(Scanning Electron Microscope).

**X-ray fluorescence** (XRF) is the emission of characteristic "secondary" (or fluorescent) X-rays from a material that has been excited by bombarding with high-energy X-rays or gamma rays. The phenomenon is widely used for elemental analysis and chemical analysis, particularly in the investigation of metals, glass, ceramics and building materials, and for research in geochemistry, forensic science and archaeology (Handbook of Practical X-Ray Fluorescence Analysis. 2006, Bertin, 1975).

**Raman spectroscopy** is a spectroscopic technique used in condensed matter physics and chemistry to study vibrational, rotational, and other low-frequency modes in a system. It relies on inelastic scattering, or Raman scattering of monochromatic light, usually from a laser in the visible, near infrared, or near ultraviolet range. The laser light interacts with phonons or other excitations in the system, resulting in the energy of the laser photons being shifted up or down. The shift in energy gives information about the phonon modes in the system. Infrared spectroscopy yields similar, but complementary information (Gardiner, 1989).

## Comments.

All three methods draw quantifiable results and the analysis of their readings can give the composition of the glass. XRF gives immediate results, while not being complete at their time of reading, do give an indication of what is being seen. This proved very useful as we saw an element not expected (the uranium), and were able to investigate it further immediately. Percentages of each element are given, and although not necessarily accurate to the decimal point allow summations to be made. The results, follow those of Homberg, Klapproth and John M. Grey. These scientists' processes of examination, however, were destructive in the analysis of the composition of antique glass. Raman, SEM and XRF are an extension to their methods, with the advantage they do not interfere with the object in anyway giving a much wider and detailed understanding of the composition of the object investigated.

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**Appendix 6:**

**Analytical Report on the examination of the Small Square  
Powder Dish (Cat No. 86b).**

**Scientific Investigation a 19<sup>th</sup> century Amalric Walter powder dish  
(C&AR No.)**

Andrea Hamilton and Lore Troalen

Date: 05<sup>th</sup> March 2008

**Summary**

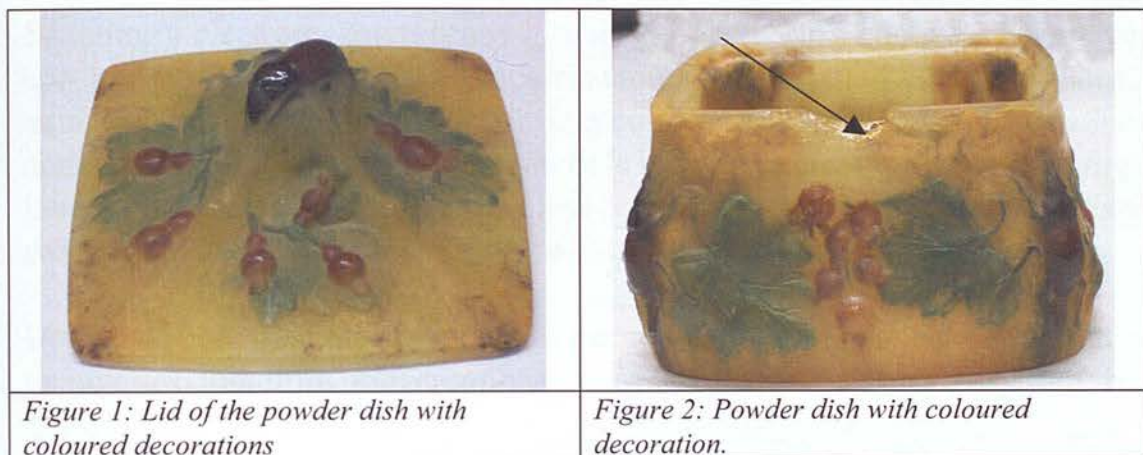
Analysis was carried out on a 19<sup>th</sup> Century glass powder dish, made using the pate de verre process by Amalric Walter. The purpose of the investigation was to characterise the pigments used and composition of the glass, which was achieved by using non-destructive X-ray fluorescence (XRF) and scanning electron microscopy (SEM) with an energy dispersive spectrometer (EDS). Results show that a uranium compound was used to achieve the main, translucent pale yellow colour of the dish and lid.

**Keywords:** 19<sup>th</sup> century powder dish, pate de verre, Amalric Walter, glass analysis

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## Introduction

Pate de verre is a method of glass making, which involves packing a refractory mould with glass frit of any colour and a binding agent before firing. This typically gives a moulded appearance to the object as can be seen from figures 1 and 2. Coloured decoration, such the insect and foliage motifs shown below, was typically achieved by painting the inside of the mould with glass paste, made from pigment, binder and finely fritted glass before firing.



The most obvious colours present are the pale yellow of the background, opaque toffee coloured regions and the red, green and black/black-mauve of the decoration. All of these colours were examined both by SEM, which was used on the lid and XRF which was used on the dish itself.

## Method

### **X-ray fluorescence**

Analysis by non-destructive, energy dispersive XRF was undertaken using the qualitative method 'old XRF' as detailed in the appendix. XRF is a surface technique; hence the analyses may not be representative of the deeper composition of the glass.

### **SEM-EDX**

Scanning electron microscopy analysis with an energy dispersive spectrometer (SEM-EDS) was carried out in controlled pressure mode, using the back scatter detector for data collection. This allows examination and analysis of non-conducting materials without coating with a conducting layer. The analyses produced are less accurate or precise than those from coated samples but provide semi-quantitative compositional data.

Details of both methods are given in the appendix. Both of these are surface techniques therefore the composition of the surface layers may not be representative of the bulk.

## Results and Discussion

### **1- XRF results**

Lead (from the glass-lead crystal frit used) is always strongly present. Listed below are the elements found in the various coloured regions:

Pale yellow background: Uranium (U) and iron (Fe).

Opaque, toffee coloured regions: Iron (Fe) and Uranium (U, traces)

Black: Iron (Fe), zinc (Zn), chromium (Cr) and Cobalt (Co).

Green: Iron (Fe), chromium (Cr), Uranium (U, traces), zinc (Zn) and cobalt (Co)

Black-Mauve: zinc (Zn, strong peak), Iron (Fe), chromium (Cr) and Uranium (U, traces)

Red: zinc (Zn, strong peak), Iron (Fe), chromium (Cr) and Uranium (U, traces)

The presence of non-depleted uranium can be explained by its widespread use as a colorant in glasses and glazes from the 1930's to the

1940's [Strahan]. To verify, radioactivity was measured using a Geiger counter and fluorescence was observed under ultraviolet light.

### Radioactivity Measurement

The radioactivity of the object was investigated using a mini-monitor, consisting of a partially compensated Geiger-Müller tube to obtain an extended low energy response. The instrument is scaled over the range 0.5 to 1000 $\mu\text{Sv h}^{-1}$  (0.05 to 100mR/h). The useful energy range is from 30keV to 1.25MeV but response is maintained down to at least 17keV. It is suitable for measuring radiation from X-ray apparatus operating at or above 45kVp.

The radioactivity detected was little, 2.5 $\mu\text{Sv/h}$  at 0cm from the object and close to 0 $\mu\text{Sv/h}$  at 20 cm distance from the object. Local safety rules and precautions should be followed when handling and storing the object.



Comparing data from the more toffee coloured, opaque region of the chipped area, shown in figure 2, with data from the pale yellow region shows some iron in the opaque region and more noticeable levels of uranium in the translucent area. This would suggest that the pigment used for the toffee coloured region does not contain uranium. The chipped part of the box is the only area where a contrast between the translucent and more opaque region is directly visible. As the opaque toffee colour is in the interior of the glass it is not amenable to XRF detection elsewhere. Cobalt seems to occur in the green and the black areas. The red tones (brown-mauve body and red berry) have almost identical spectra and both contain the highest levels of Zn, followed by black then green. Fe and Zn are higher in the red than the green with both colours containing Cr. The presence of Zr could be an impurity or inclusion in the glass used.

## 2- SEM-EDX results

The semi-quantitative SEM analysis given below provides a guideline only as no calibration standards were available in advance. For this reason uranium is not quantified, although it was detected.

These are preliminary results indicate lead rich glass (c. 32-40%) which contains a small amount of sodium, potassium and calcium.

Elements as oxides %	Green	Red	Violet
Na <sub>2</sub> O	0.84	0.97	1.57
<b>K<sub>2</sub>O</b>	<b>3.97</b>	<b>3.61</b>	<b>5.01</b>
CaO	0.53	0.33	0.30
MnO	0.00	0.01	0.00
Fe <sub>2</sub> O <sub>3</sub>	0.53	0.41	<b>0.43</b>
Al <sub>2</sub> O <sub>3</sub>	2.01	0.36	1.31
<b>SiO<sub>2</sub></b>	<b>44.85</b>	<b>43.89</b>	<b>46.17</b>
Cl	0.37	0.25	0.25
<b>PbO</b>	<b>32.26</b>	<b>39.97</b>	<b>40.39</b>
BaO	0.00	0.07	0.03
SnO <sub>2</sub>	<b>3.23</b>	<b>3.70</b>	0.32
Sb <sub>2</sub> O <sub>3</sub>	<b>1.30</b>	<b>0.73</b>	0.04
CuO	0.03	0.01	0.00
TiO <sub>2</sub>	0.15	0.03	0.09
P <sub>2</sub> O <sub>5</sub>	0.05	0.00	0.03
SO <sub>3</sub>	2.86	0.38	0.13
MgO	0.82	0.34	0.45
As <sub>2</sub> O <sub>3</sub>	<b>6.05</b>	<b>4.79</b>	<b>3.35</b>
Cr	<b>0.15</b>	0.14	0.13

In the green glass, some small particles associating tin and antimony were characterised. These particles were not found in the red and black-mauve areas. In the red glass some tiny particles were found possibly suggesting cadmium but peak identification is tenuous.

## Conclusions

It is known that the colour produced by uranium varies according to the quantity of uranium and salt used, composition of the glass and kiln atmosphere all have an effect on the colour produced. Uranium in heavy lead glasses gives rise to a yellow without green fluorescence, known as *Annagelb* [Weyl]. Antimony can be added to produce a stable yellow in lead glasses [Strahan] which could be the case here, as indicated by the SEM results. However, as it was not definitely detected by XRF, another method should be used to confirm. The yellow fluorescence of the object under ultraviolet light suggests the uranium is present in the glass in the hexavalent state ( $U^{6+}$ ) such as the uranyl ion ( $UO_2^{2+}$ ). The presence of excessive alkali (sodium, potassium, calcium) or iron can convert the uranyl group to uranate which does not fluoresce [Strahan]. Weyl suggests that in lead rich glazes, lead uranates are precipitated, however as uranates do not fluoresce under ultraviolet light [Strahan], it would seem they are not present here and that uranium exists in the form of the uranyl group.

The red tones (red berry designs and mauve-brown body of the beetle design) contain notable levels of zinc and also some chromium. According to Weyl, chromium in zinc containing glazes produces a brown colour, partly due to the formation of zinc chromite and partly due to the stabilisation of chromates. Chromium in lead glass can also impart a yellow or red tone to the glass from the formation of lead chromate [Weyl]. In terms of the iron content, it is unlikely that iron could be entirely excluded from the base glass used, but the heightened levels of iron in the reddish shades suggest it has also been deliberately used. The detection of cobalt is slightly tenuous and should be confirmed via another analytical method. It is unknown what role cobalt plays in producing the green and black shades of the leaves and the beetle body, but cobalt most often imparts a strong blue shade to glass. Perhaps it is possible that the dark brown-red tones are created from zinc chromite and lead chromate, while the green tones are created by lead chromate and cobalt blue? This is speculative though and it is unclear what the role of iron is in the brown-red tones.

## **Appendix: Methods**

### **X-ray Fluorescence**

The XRF system used was an Oxford Instruments ED 2000 with Oxford Instruments software XpertEase vs 2.70. The analysed area was irradiated with a primary X-ray beam produced by a Rhodium target X-ray tube. The primary beam was collimated to give an analysed area of about 4mm x 2mm. Secondary X-rays were detected with a silicon (lithium) solid state detector. The detection limit varies depending on the elements, matrix and analytical conditions, but is typically in the range of 0.05%-0.2%. As the analytical technique has a limited penetration depth, the reported compositions may not be representative of the bulk of the alloy if there is a chemically distinct surface layer.

### **Controlled Pressure Scanning Electron Microscopy with energy dispersive microanalysis**

The system used was a Camscan MX 2500 operated at 20kV and 20Pa to prevent charging. The analytical system was a Noran Vantage energy dispersive system.

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## **APPENDIX 7.**

**Dr. Hamilton's 2 Reports on the Examination of 3 Pieces from the  
Broadfield House Collection of Walter using XRF and Raman.**

## **APPENDIX 7.**

### **DR. HAMILTON'S 2 REPORTS ON THE EXAMINATION OF 3 PIECES FROM THE BROADFIELD HOUSE COLLECION OF WALTER USING XRF AND RAMAN.**

#### **Introduction.**

The following two reports were prepared by Dr. Andrea Hamilton from the Department of Engineering and Material Science, King's Building at Edinburgh University after examination of three pieces from the Broadfield House Walter Collection using X-Ray Fluorescence and Raman Spectroscopy. The examinations are discussed in detail in Book II.

## **Dr Andrea Hamilton's report on the analysis of the examination of three pieces from the Broadfield House Collection of Walter. 12/07/09.**

### **X-ray fluorescence 09/01/2009 -Amalric Walter dishes**

Three dishes were analysed using X-ray fluorescence, which will be referred to as the 'Beetle Dish' (Cat. No. 26), 'Chameleon Dish' (Cat. No. 24) and 'Floral Dish' (Cat. No. 110), named after the character of the main decorative motif on the objects.

#### **Method**

The XRF system used was an Oxford Instruments ED 2000 with Oxford Instruments software XpertEase vs 2.70. The analysed area was irradiated with a primary X-ray beam produced by a Rhodium target X-ray tube. The primary beam was collimated to give an analysed area of about 4mm x 2mm. Secondary X-rays were detected with a silicon (lithium) solid state detector. The detection limit varies depending on the elements, matrix and analytical conditions, but is typically in the range of 0.05%-0.2%. As the analytical technique has a limited penetration depth, the reported compositions may not be representative of the bulk of the material if there is a chemically distinct surface layer.

#### **Beetle dish**

The dark red base of the dish: Lead (Pb), uranium (U), zirconium (Zr), manganese (Mn), iron (Fe), tin (Sn). Dark red decoration on the beetle: Pb, no U, Zr and Mn. Zinc (Zn) much higher, Fe much higher and chromium (Cr) is present (but not in the base of the dish) and Sn. Black decoration on the beetle: Similar in composition to the red decoration but contains cobalt (Co).

#### **Chameleon dish**

Toffee coloured base of the dish: Pb, U, Fe, Zr, Green decoration on chameleon: Again no U on decoration. Levels of Fe are similar to the base but Cr, Co, Zr and Zn are present. Minor tin (Sn) Comparing the blue and green decoration on the chameleon: The green has Cr where the blue does not and (the green) possibly has a higher quantity of Zn. Co is slightly higher in the blue. Both have Sn. Comparing the green and the olive green, both on the chameleon body: The green shades are very similar in composition but the olive green appears to have less Cr, Co.

## **Floral dish**

Comparing the clear green on the floral dish base with the (lighter) green on the chameleon body: The chameleon green has more Cr, Co and Zn. Comparing the clear green on the floral dish with the olive green on the chameleon head: The olive green more Zn, tin (Sn) and the clear green (floral dish) has more Fe. Comparing the yellow on the back of the bee with the ochre decoration: The bee yellow has nickel (Ni) and Co where the ochre has very little to none and has less Zn. Both shades have Fe. Both have small amounts of Sn and Sb.

Comparing the olive green (chameleon) with the ochre decoration: The ochre decoration has a lot more Zn, Fe and possibly a little more antimony (Sb) and Cr.

## **Conclusions:**

The main body of the object.

The translucent to opaque dish bases, coloured dark red (beetle dish) and toffee (chameleon dish) contain uranium while the decorative motifs and the clear green base of the floral dish do not. Zirconium is always present, suggesting it is a constituent or impurity of the lead glass used for both the base and the decoration. Red base (beetle dish): Pb, Fe, U, Zr, Mn (minor), Strongest Sn peak Toffee base (chameleon dish): Pb, Zr, Fe, U, very little to no Sn. Clear green base (floral dish): Pb, Zr, Fe no U, very little to no Sn.

## **Decorations**

Zinc is strongly present in all decorations and was probably used as an opacifier. The red/black shades (beetle dish) were obtained by using Fe, Cr, Mn (minor) with the addition of Co for black. Green on the chameleon dish uses Cr, Co, Fe levels are the same as the base. The lighter green and olive green are similar except the olive shade has a little less Cr and Co. Blue is achieved by higher levels of Co and slightly less Cr. The clear green base of the floral dish appears to be made with relatively few reagents: Uranium is not present and Fe is the only colouring agent really detected. The yellow on the bee motif is produced by using Fe, Cr, Co and Ni and the darker ochre yellow on the same dish (floral) is made from Fe, Cr and more Zn, but no Co and no or little Ni. Comparing shades: The olive green paint has a higher opacifier content (Zn and Sn) than the clear green floral dish which uses more Fe.

### **Decoration colours**

Red (Beetle): Fe, Cr, Mn, Sn Black (Beetle): Fe, Cr, Co, Mn, Sn Green (chameleon): Fe, Cr, Co, a little Sn Olive green (chameleon): As green but less Cr and Co, some Sn (slightly higher than green) Blue (chameleon): Fe, Cr, Co but less Cr and more Co than green, Sn as for green Yellow (bee on the floral dish): Fe, Cr, Co, Ni, a little Sn and Sb (antimony) Ochre yellow (Floral dish): Fe, Cr, a little Sn and Sb. Red, black, bee yellow and ochre are the highest in iron. Weyl: Fe, Ni and U are strongly light absorbing in heavy lead glasses but apparently zinc oxide produces a bluish colour in the presence of Fe but it is not clear whether this applies to lead glasses too. Cr in lead glasses is likely (p141) to produce orange to red shades. However Weyl states that a variety of shades ranging from green to olive and brown have been obtained in ceramic glazes by using chromium oxide. Cobalt produces a blue shade and Ni can be used to produce yellow in silicate glasses, but Weyl states that when introduced to heavy Pb glasses, it gives rise to a purplish colour.

NOTE: the bee was decorated with black and yellow stripes, it is therefore not possible to be certain the beam was focused on the yellow region and not the black. Also, elements lighter than Ca are difficult to accurately detect using X-ray fluorescence.

### Raman Report conclusions.

A Renishaw InVia Raman microscope was used with a 488 nm Ar+ laser and optical extension to a specially constructed external XYZ stage to examine the Walter pieces. We used a power range of 5-100 mW and all spectra were recorded over the range 100-3200  $\text{cm}^{-1}$  using the 20x objective from a Leica microscope and a Peltier cooled CCD. Spectra were smoothed using an adjacent averaging routine and peakfitted with Gaussians using Origin software. The peak located at  $\sim 1070 \text{ cm}^{-1}$  were used as an indication of the lead content in accordance with Robinet *et al.* [ref] who find a linear shift in summit of this band with lead content in the glass. The empirical equation for band position is  $B_{1070} = -1.178x_{\text{PbOwt}} + 1104$  with an accuracy of  $\pm 3 \text{ wt}\%$ . Nine spectra were analysed from two different Walter pieces giving an average PbO content of 42 wt%. No obvious sharp peaks belonging to a crystalline phase were detected suggesting that all pigments used were incorporated into the glassy matrix with no precipitates in the sample regions analysed with Raman spectroscopy.

## **Appendix 8:**

### **Definition and Contextualisation of My Personal Work.**

**APPENDIX 8.**

**Definition and Contextualisation of My Personal Work.**

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## APPENDIX 8

### Definition and Contextualisation of My Personal Work.

#### Introduction

The works illustrated in this Appendix are the results of my research in this PhD study. They reflect what I have discovered about pâtes-de-verre through my exploration and understanding of Walter's methodology and techniques, and also what I have learnt about its history and nature. While the methodology I use follows Walter's (such as the creation of paints from ground glass colour and metallic salts), I have felt the need to expand his making techniques. I started this research with the idea that my personal work had to illustrate Walter's processes, but I quickly discovered I am not Walter. I am a very different artist and have had to adopt his methodology and techniques to suit my own use and my own subject matter. This, I realised, is the correct way to push forward what has been discovered about his processes. Having unravelled his working methods they are now there to be plundered and picked over. For his processes to be relevant to the modern artist they must be adaptable and able to be adapted.

Generally speaking, I have utilised as much of what I know about Walter's techniques and applied them to my own work. But, in the formation of colours, I am a very different beast. As I discussed in Book II, Walter made colour at founding temperature before crushing the glass up and using it in various ways. He rarely used metallic salts, and only then in a limited way during the casting process to prevent unstable or unpredictable results. I, on the other hand, have used metallic salts in the majority of my works. The very reason he avoided them is what I embrace. The palette of my 224 colours has developed solely from my research on him, and I doubt I would have come across them without this investigation. Walter and I may speak different dialects in our respective pâtes-de-verre making, but the language is the same.

In order to make for a clarified discussion of each of the works illustrated in this section I have separated the general methodology and technique of making from the main discussion of the visual imagery and design choices. Those I have placed into Appendix 9. I chose to do this because a great deal of the methodology is similar within several pieces, and identical processes, such as the production of two part moulds, the placement of the various glass pastes and internal core making, are repeated. Therefore, in the first work, which I discuss (*The Sense of My Screaming Skin...*) I have included some of the general methodology, so as to introduce the reader to the processes involved in the preparation of the works. Sometimes colour suggests form as it has with that work. I have included the formulae for the colours in the section below indicating where they were introduced and what effects they produced in the clear lead crystal.

1. The Sense of my Screaming Skin (Manifesting my Bi-polarity).



Fig 1.

The form here grew out of the establishment of the main themes I was to pursue through my later work: Tribal, sex, masks, duality. I used as a starting point the image of a gas mask from the Devus.co.uk website, which sells fetish gear. The masks (modelled on one supplied by the Danish Army) are used in sex play to create both a sense of alienation in the observer, so making the participant seem more dangerous, and heightening the sexual action. In the middle of the sculpting of the work I discovered I had a form of the Bi-polar II syndrome. After some consideration I decided that I would try to express something of the condition with this work. It gave a context for the shapes and forms I was beginning to establish as I modelled.

What the viewer sees then in this work is a manifestation of something almost inexpressible in words. It is what is experienced when the Bi-polar condition moves out of its median state of calm. Chemical surges that pulse through the body, black areas of rage and self pity that morph into impenetrable troughs of deep loneliness, and a sensation of prickles like needles being run across the surface of one's skin. Imaginary horns shunting through the cranial lobes are felt during these highs and lows. Inside of one's head another creature is trying to break free. Like Ayrton's minotaur the anguished bellowing of the dumb beast takes hold. Its cries metamorphose into shape, and they start to grow out like mush and bone. All of it feels as if it is taking place behind a suffocation mask of implacability.

At the same time I was looking at African and South American ceremonial garb, especially the ones from the Xingu Tribe of the Amazon. The headdresses appealed to me and something of their shapes has informed this work. The modelling process in clay was a hard thing to do. To be at once both inside the emotion and yet independently removed as the sculptor is a schizophrenic effort. I literally 'felt' my way into producing this piece and had to get it to a stage of realisation before I could step back from it and see what I had created. Sometimes the actual act of modelling triggered off episodes of emotion, which resulted in the clay being smashed and worked like pounded meat.

A male chastity device, made from machined surgical steel, is placed as the gas mask's opening for the breathing hose. The original symmetrical shape was now

distorted and confused having been deliberately smashed in. The light plays on its surface and it seems to shimmer it's a moment of calm in a violent ground.



Fig 2.



Fig 3.

The two images above (Figs 2 and 3) show the initial sculpt in its plaster. This method of making a plaster shape before casting in wax, follows the same methodology as Walter and Bergé used for their works, and it is one I have generally employed for all the work illustrated here. The advantage is that the surface of the plaster can be worked to clarify dimension, or to have more modelling added to, something that would have been very difficult if the sculpt had been from clay. The dark modelled areas on the plaster here are made from 'Plastellina', a modern version of a 19<sup>th</sup> century modelling clay, which incorporated clay dust into linseed oil. Bergé used a very similar material and methodology to produce leaves and other details from sprig moulds for Walter's pieces before casting a master mould. Making the form in plaster also allows the artist to consider where colour and or texture can be applied, and notes can be made on the form itself, as can be seen on the surface of the plaster form in Fig 3.

During the whole sculpting process I decided to use the volatile nature of some of the chemicals to help describe the piece in colour. A colour bar was chosen, which had produced a set of purple and yellow colour ways (see Fig 4, below). This colour combination is an interesting one, as it suggests decay and corruption, infection and bruising. The yellow-grey colour of the general mask was achieved using silver chloride, which originally in tests had produced a champagne colour, but which also had a revolting quality to it, having the appearance of snotted-phlegm. The fired result turned out to be different from what I envisaged, and in a way is better. The intended champagne colour became a yellow-grey. This may be a result of there being a reduced atmosphere within the mould that allowed the silver's metallic nature to become more apparent. The glass has also been imbued with a plastic quality that matched the original rubber gas mask. Yellow and grey in combination is a good one for this piece, as dirty yellow, or yellowing-grey, suggests something unclean or stained.



Fig 4.

The colour bar above was chosen for this piece as it had produced a remarkable line of colour (See Appendix 4: Bar 6). The wax shapes of the feather/bones were invested

in a refractory mix before being steamed out and the cavity filled with glass frit and the various salts in subtly different ways (i.e. the amount of frit placed in and the layering of the different frits). Although in theory all the pieces made in this manner should be identical, in practice each is radically different. This unpredictability is exhilarating.



Fig 5.



Fig 6.

Each feather/bone shape has its own beauty to it as can be seen in Figs 5 and 6. The glass is sometimes transparent with a stain to it, sometimes dark and opaque. The shapes take on a quality and meaning of their own as a result of the metallic salts used. Although none of Walter's work looks at all like this, they are nevertheless very Walter-like in their production. They could not have been made without a comprehensive understanding of his process, and the information discovered from my attempts to extract his methodology by practical means. The making of these pieces had a defined effect on the rest of my work. I knew at once that with these feather/bones I had solved my own palette of colours.



Fig 7.

2. Piss Mask.



Fig 8.

'Piss Mask' is a direct assembling, a co-joining, a literal shunting together of shapes from two unconnected cultures. In this piece I have collided two worlds and made a piece that exists on its own outside of those worlds. On one hand there is in the piece the image of an African tribal woman with a lip plate (Fig 9). On the other the image of a latex mask (Fig 10). As I discuss in Book III, it exemplifies Roland Loumasis' view that new urban, tribal cultures are constantly being amassed from what is around us (Vale, 1989).

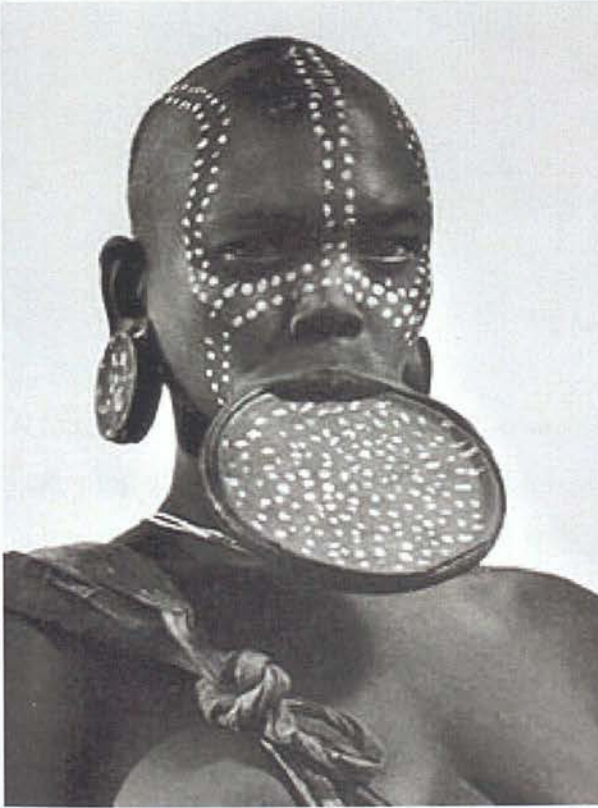


Fig 9.



Fig 10.

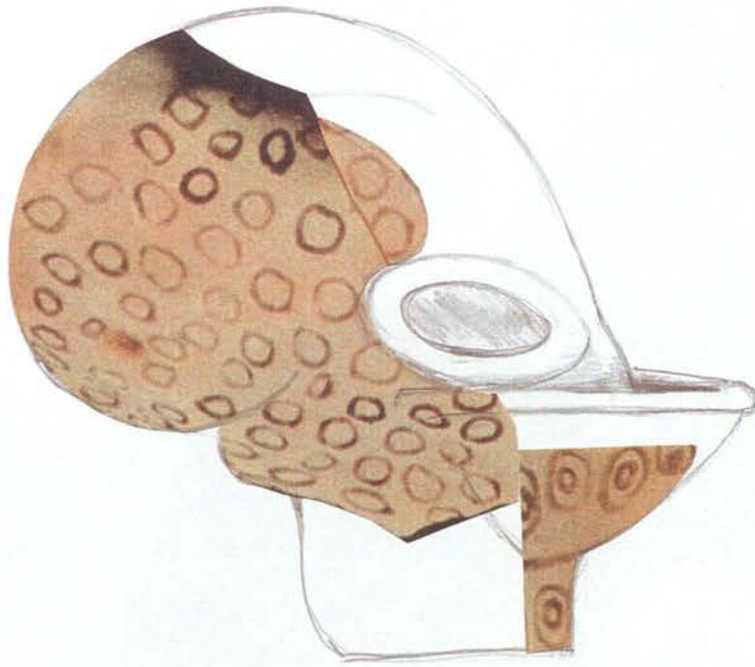


Fig 11.

A rough drawing, made by collage, shows what I was aiming towards at the beginning of the design process (Fig 11). It is in effect a mask that acts as a urinal, but in my modelling of the shape I have tried to remove the alienating quality of the rubber mask and introduce to the final shape a sense of humanity. This was achieved by ensuring the eye sockets of the mask had a sense of living form within them. There is a very real human within the overall piece, and one is not sure if the shape is a mask or a human. The boundary of what is mask and what is flesh is blurred. In the original design I used painted markings on flesh from an Amazon tribe to show texture, and these marks stayed with me, and the work.

In this piece I have tried to create a thing of beauty out of a sense of revulsion and a shying away from subjects that alarm. Pierced distorted flesh and sexual gratification from playing with (and being 'forced' to drink) toilet/body fluids, both send messages that repel and disturb (to some minds). By fusing together these elements I am trying to create a final image of beauty and disorder. It is deliberately designed to confound the viewer with its duality.



Fig 12.

### 3. And So I Press My Lover's Palm to Mine.



Fig 13.

This work is partially derived from the photograph in Fig 14, below. The design process began with the choice of subject matter, and I was fortunate to have a strong visual image already established in this photograph. Unlike Walter's (and Bergé's) design process this head was not modelled up, but cast from life using a colleague in the Post Graduate Research School at Edinburgh College of Art. My choice of model was partly because he came from Nigeria: the portrayal of a West African head in such a pose adds subtly to the perception of 'slave'. In doing this, our minds are confronted in a subconscious way. My choice was also made on the basis that he has perfectly symmetrical features and is regarded as being handsome. Like most artists

or poets I want my muses to be things of beauty. Once cast in wax the head was then slightly worked on to change its appearance and to allow for the positioning of the ropes and the mouth-piece. Life casts always have a curiously 'dead' quality to them, so work is always needed to bring them back into an expressive form.

On first inspection we think we see a 'Sub' or sex-slave, bound and forced to participate in some sort of extreme sexual activity. There is no doubt what I have produced is a image of subjugation and humiliation. Some may find it disturbing, others arousing. But the very nature of the phrase 'sexual play' immediately contextualises the image and changes our perception. The relationship between slave and master in such a situation is one of intimate trust and agreement. Nothing is forced: all is play-acting and spectacle. To the participants the framework of trust, its boundaries and rules are part of the excitement. It directs the drama.

This work then subtly plays with the idea of who is in charge. Is it the Dominant Master whose space we step into as we view the work? Or the Sub, who we immediately empathise with and yet who willingly places himself into a position of subservience and thus allows anything shoved into his mouth? In this context it is the Sub that makes the rules, extends the contract by acquiescing, and has the right to say 'No'. He exemplifies Deleuze's theory that the true sadist is the masochist (Deleuze, von Sacher-Masoch, 1991).

In order to play with the audience's perception and to motivate them to question what they see, the finished piece also comes with part of a poem by the 20<sup>th</sup> American author and poet Robert Lowell. The partial text is taken from the poem 'The Banker's Daughter.' and is about the life of Marie de Medici, the French Queen of Louis the 14<sup>th</sup>. In a curious connection it was Louis 14<sup>th</sup> of France who employed Palissy, but that is not why I use it. This section of Lowell's poem fully expresses the intimacy of two people joined in sexual unison and is applicable to any form of lovemaking. The title of my glasswork is taken from the opening line.

The Banker's Daughter.

Verse 4: lines 22-25.

'And so I press my lover's palm to mine;  
I am his vintage, and his living vine  
Entangles me, and oozes mortal wine  
Moment to moment.'

The accompaniment of the text creates a duality in the viewer's perception. While the immediate image of the glass itself is one of subjugation, humiliation and control, the addition of the text changes our perception by 180°. What we now see is not an act of unremitting violence by a sexual perpetrator on an innocent victim, but is instead a participatory act of mutual trust and love. The place of the viewer has suddenly moved one step closer to acceptance, not rejection. The space between what is seen and what we think we see is challenged.



Fig 14.



Fig 15.

The image on the right (Fig 15) shows what I was trying to achieve in my use of paints within the piece. The paintwork in the image, while attempting to revolt or

arouse in its scatological depiction, is most likely just smeared food, such as whipped puddings.

As a result of the accidental alchemy of the chemical event during the kiln firing process an extraordinary visual effect has been created, and this has added to the interpretive quality of the final work. I am sure that the end product would not have worked as well without its effect. It would seem that the refractory mould was compromised by the chemistry of the manganese dioxide when fired to around 800° C. This was due to the quantity of gases trying to escape from the relatively enclosed mould. What they have done is to crack the mould in an hexagonal, crazed pattern. This has allowed some of the glass to flow out into the cavities and so produced an hexagonal crazed effect on the surface of the glass. Fig 16, below, shows the head being removed from the mould, and one can see how the refractory mould has been damaged. The result, however, has an important effect on the way the piece is received by the eye. To my mind it adds another dimension to what we view. It reveals the frisson of the moment. The viewer is now seeing what the 'Sub' feels and experiences in his own mind.



Fig 16.

The way the piece came out from its mould gave me the opportunity to make its tongue as a contrast to the exterior of the head. I was anxious to make at least one piece of glass that looked like a semi-precious stone, and this tongue seemed the right object to use for this experiment. I mixed a pink ceramic glaze into the lead crystal frit. The texture, colour and the way the pink lead crystal holds the light make it a very successful piece, and it is easy to mistake it for rose quartz. By making this one piece I have linked my pâtes-de-verre work to those manufacturers of fake Church reliquary of the early medieval period, whom R.E. Raspe discusses in his catalogue of James Tassie (see Book II).



Fig 17.

4. Dolly Mixture Sub-boi: Sperm und Glitter.

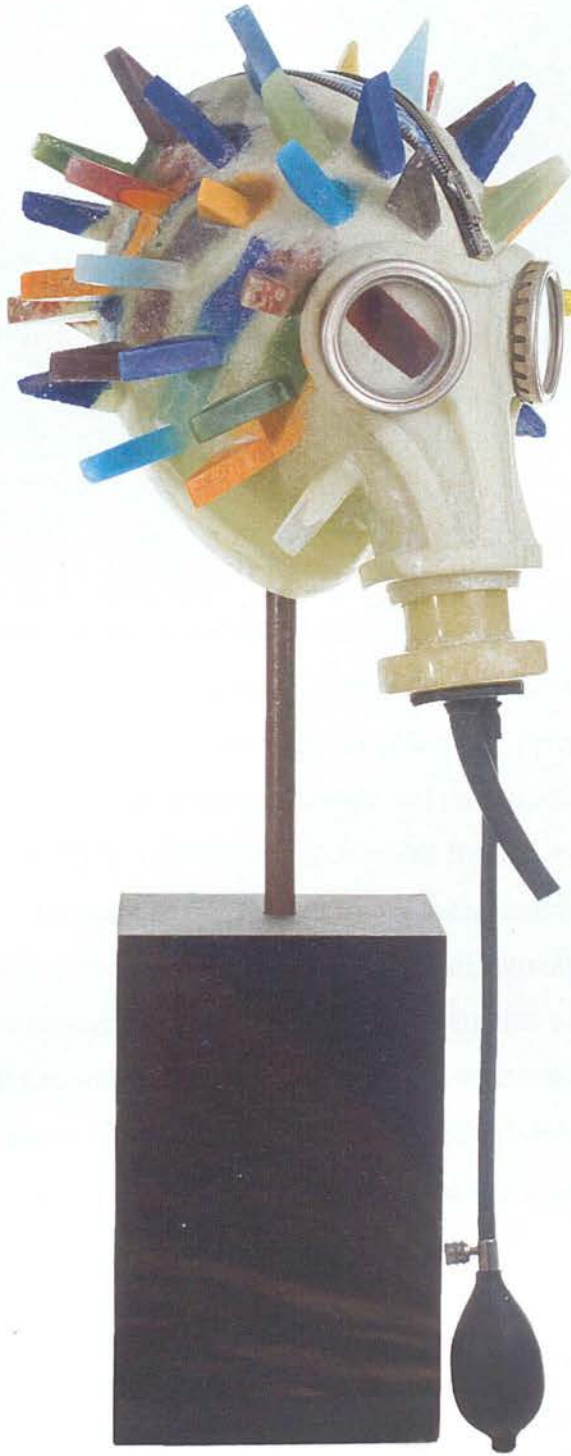


Fig 18.



Fig 19.

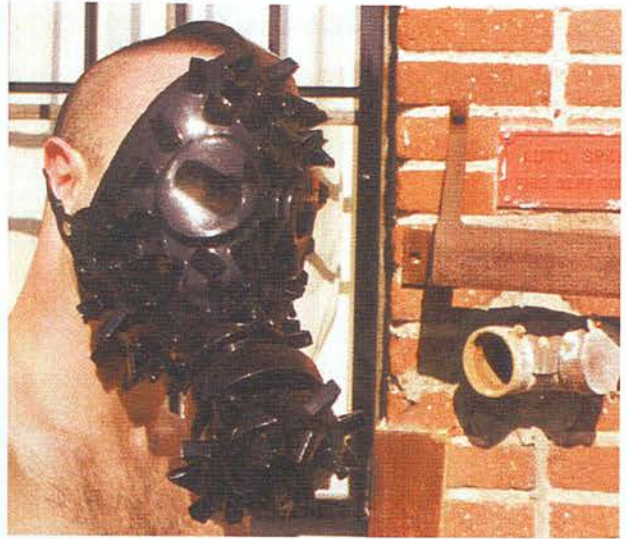


Fig 20.

This piece arises out of an exploration between the duality of something that engenders a feeling of alienation in the viewer the moment it is seen, and the desire to confound that threat with joyful and playful colour. By doing so the original image is visually subverted. I revisited the gas mask I had started to use in the *'The Sense of My Screaming Skin'* (Fig 1, above), and extended its possibilities with the spikes and protrusions from the mask in Fig 18. With both these masks the humanity of the wearer is radically altered. Even the eyes become dehumanised. Both masks have been designed to disturb. In Fig 19 the eyes holes are that of something from Jules Verne's *'20,000 Leagues Under the Sea'*. Along with its colour an unnatural and uncomfortable image is achieved. Its message is that the basic necessity of living, i.e. the ability to breath, is controlled by something other than lungs. That is part of its attraction in sexual role-play.

The spiked mask in Fig 20 has a similar function. It is deliberately designed for sex play and the wearer becomes a brutalistic creature. He is part machine-tooled Man and part animal. Its purpose is to scare the viewer or participant. Like theatre masks they remove the wearer from the observer, allowing an introduction of terror to a situation that is about trust and intimacy.

The candy-cane colours I have used completely undermines all those destructive emotions. Their joyful quality takes the piece out of the sado-masochists' dungeon and presents it as an object of fun and humour. It has become a thing of the playroom, a toy.



Fig 21.

5. A Duality of Sorts. No.1.



Fig 22.

This work is deliberately designed to be provocative. It takes a Western face and places on top of it a Maori tattoo called a 'Moko'. I have taken its design from two 19<sup>th</sup> century engravings of Maori figures, and have also added daubed marks in yellow, which indicate hair. In New Zealand, where I studied glass, it is considered contentious for non-Maori to use Maori imagery or motifs in their work. Many Maori regard their artwork, its tradition and meaning as their exclusive intellectual property. The use of it outside a Maori cultural setting by non-Maori artists is considered to be insulting and culturally insensitive. My use of these facial tattoos therefore produces a dilemma for the New Zealand viewer, and the New Zealand artist. Their engagement is fraught with layers of political and social controversy. In the presentation of their

own mask to the outside world New Zealanders show themselves as a united community. The reality is that it is a divided nation. To the non New-Zealand viewer, who exists outside the political controversy, the work has none of the meaning of its antipodean nature. They only see pattern, line and colour on shape and form, and perhaps something tribal. The cultural space between what the viewer sees and what they think they see shifts, and becomes dependant on political perspective and agenda.

The argument by some Maori against the non-Maori use of cultural references is that they are sometimes used in a way that was not intended by the original motif maker, and is therefore offensive to its spiritual meaning. This is described as 'cultural appropriation'. Many contemporary white artists of New Zealand fear such an accusation, and shy away from introducing Maori imagery directly into their work. Cultural appropriation, however, is a two-way street as I have come across one Maori stone carver who chooses to use Greek mythology in his work. I would suggest that if I questioned his use of European cultural references in his work he would be offended. Having grown up in Malaya where cultural cross fertilisation has developed a vibrant culture, I regard the Maori point of view as limited. The claim from those political activists who promulgate the idea is that Maori culture is 'purer' than that of other New Zealand communities, and is based on the idea that Maori have a spirituality which superior to the non-Maori's. I find this argument presumptuous, as in my experience no-one in this world holds the citadel to spirituality.

My personal attitude is that it is not for anyone to tell me, or any another artist for that matter, what I can or cannot depict. As Gilbert and George argued in Jonathon Dimbleby's 2010 television series 'The Seven Ages of Britain', for centuries artists were slaves to the Church, which told what they could or could not depict. Then artists were slaves to Industrialists, who told them what we could or could not depict. We are now in an age of artistic freedom where artists may depict what they like (Claypole, 2010). Inevitably their argument directly conflicts with some cultures and political movements.

This piece then deliberately confronts and challenges both Maori and New Zealand Pakeha in their preconceptions. I have used three documented cases from the early

19<sup>th</sup> century to inform my decision-making. The cases report three separate incidences of European sailors, all British, who were stolen from their ships, and kept as slaves by Maori tribes. Depicted below are two of the British sailors, one called John Rutherford and the other Barnet Burns (Fig 23 and 24, below). Both men were captured and forcibly tattooed. This was in a period before New Zealand was part of the British Empire and still under Maori dominance.



Fig 23.



BARNET BURNS.

Fig 24.

Two of the sailors became *causes celebres* when they eventually adopted Maori culture and rose to ranks of chiefs. Their stories were recorded by Christian missionaries, and were published along with steel engravings of their tattoos and tribal dress. By choosing their stories I am asking where is the cultural appropriation? Who is appropriating who, and what?

This half of the head is directly contrasted by its other half, which is made to look as if it has been painted with brightly coloured oil pastels, or paint in the manner of the 19<sup>th</sup> century Impressionists. Its marks attempt to describe the musculature of the flesh after the surface skin has been removed. On the one hand is the tribal, which by its

natural philosophy is not about the individual or self-expression. It is instead about maintaining the tribal unit and the tradition. On the other is the Western tradition, which allows the artist to express form, shapes and colours that have meanings central to him/her. The two halves of the same head cannot live with each other. Two nations are divided by a common artistic language.

In this work I have used the death mask of Napoleon Bonaparte. It has a strong classical form and comes from the same period as the engravings below. It also lives within the same illustrative world of James Tassie, and is therefore a nod at the 18<sup>th</sup> century miniatures of James Tassie. By placing the Moko onto the surface of the mask the dead face is brought alive. A similar action occurs with the left hand side of the mask. The colour placed over the surface (although actually being part of the glass' body) brings a dead surface to life. By placing abstract colour over the form the head is contemporised.



Fig 25.



Fig 26.

In the creation of this piece I have tried to produce something that is as elusive to grasp as ash floating in air. This piece is again part of my Bi-polar experience, and, like *'The Sense of My Screaming Skin'* is the manifestation of a very real event – in this case a being that inhabits part of my consciousness, and perhaps inhabits a part of everyone's consciousness, unless they exist without imagination. I term him 'Apelpismos: the Spite of No-Hope'. 'Apelpismos', in Ancient Greek translates as 'desperation due to the lack of hope'. His story runs like this:

'In opening the box, Pandora, the foolish wife of Epimetheus, unwittingly let out all the spites of the world that now plague mankind. One, however, remained. A liquid embryo called 'No Hope'. Realising that his existence would bring to the world a terror much worse than those they had released, Pandora and Epimetheus trapped him, and locked him back into the box, thus saving the world from a general mass suicide.'

'But part of that story is not true. The box was already broken and its lock shattered. In order to keep the evil from the daylight they placed him in a helmet belonging to the damned king Tantalus, and made by the smith-god Hephaestus. Mistakenly thinking he would be hidden away, Pandora and Epimetheus wrapped the helmet in the membrane that divides the realm of Sleep from Awake. There the evil thrived, and grew. As the mantle of Rest falls he goes abroad, taunting passers with his knowledge of their failings, of their weakness, and suckling on their dread.'

I have chosen to portray this figure as a piece of liquid light attached to a helmet-like structure of volcanic rock. It is a play of textures and surfaces. The highly polished yellow-amber of the premade Gaffer Glass lead crystal is in direct contrast to the dark impenetrable cold lava of the helmet. The quality of the lead crystal that is produced by Gaffer Glass means that there is a liquid quality to the finished polished object. The high refractive index of their casting crystal allows for a great visual depth. The volcanic rock-like matter that forms the helmet, was created from Formula BV014, which uses Manganese carbonate ( $MnCO_3$ ). Some of this rock-like glass has been worked and polished to look like obsidian, the volcanic glass. The stand on which it is displayed attempts to describe a primitive spinal cord. Although this is not from

where the imagery for this work derives it does has a quality to it that suggests the work of H.R.Giger. The use of the rubber cords extends the work below its stand, turning the steel platform into part of the work. The shape of the helmet was an attempt to express something from the shadows of mythology, a primeval, draped form perhaps that is also partly a protective device. In sculpting this piece I was also aware of an element contained in it of the limestone Batu Caves in Kuala Lumpur. An image of them can be seen in the first section of writing in Book III, which shows the similarities and perhaps explains the visual metaphor.



Fig 27.

7. The Mayan Christ.



Fig 29.

This work was made at the very beginning of my research when I was trying to find a subject matter with which to work. It depicts what appears to be an artifact from a pre-Colombian civilization, and is presented in a museum-like way, with a piece of associated carving beneath it. One of the headdress' horns or roundels appears to have been lost too. The whole is possibly made out of mosaic stone.

In its making the glass has been deliberately produced to look like South American jade. Its design is in fact an assembly of two or more Mayan and Aztec masks taken from pottery and stone. I have deliberately chosen to combine the forms to create a new work that references vanished civilizations. By making a piece that lives in another world I am trying to question some of our cultural perceptions. I have chosen to carve lines into the surface of the glass to represent the separate mosaic segments. If this had been done on a Caucasian head we would view the work in another way, possibly with some repulsion. Because the imagery somehow exists in another time and culture these things are acceptable.

The head itself is an arresting image. It sits devoid of body as a gessoed Christ or Baptist figure. I have used a head that hangs in the Musée de Cluny in Paris. Two images of it are below in Figs 30. I have tried to capture the peaceful quality of a figure in repose and awaiting resurrection. The florets in his ears of the Mayan Christ and the one below represent the trinity and rebirth. In some ways, Schneider's 'Coupe de serpent...' with its Biblical symbolism nudges the imagery, although this is not obvious. The title is an after-thought that links two cultures.



Fig 29.

## 8. The Phallus.

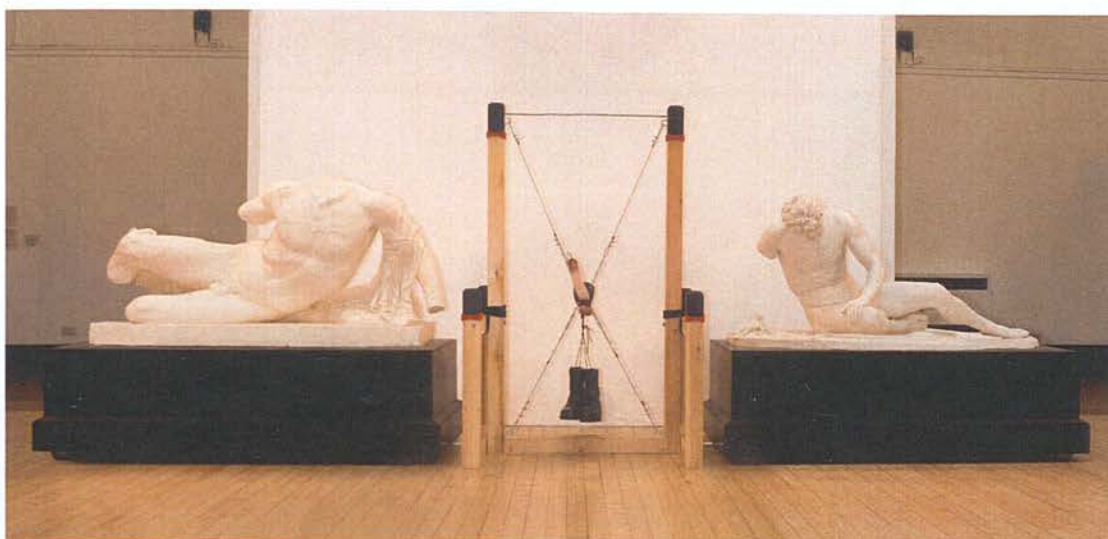


Fig 30.

This work comes directly from the relationship between the focus on genitalia in gay male iconography and the sense of masculinity and maleness. The question that keeps re-occurring in my mind is 'where does masculinity sit?'. In the two plaster statues shown below and with which I have contextualised this work it certainly does not sit in the exposure of the phallus. In both these statues the phallus has been either lost or removed yet both figures remain male and exemplify the classical ideal of 'maleness'. Indeed, the absence of complete limbs seems hardly to matter. The figure of *'The River God'* (seen on the left in Fig 30, above) has neither limbs nor phallus. To my mind it is a powerful image of strength and sexual masculinity. *'The Dying Gaul'*, (seen on the right) is an image of the defeated warrior, his life strength sapping away, yet it too remains a potent picture of masculinity: he is very sexy, and in sado-masochistic terms the image is arousing. The work in this piece draws therefore from their imagery to place and contextualise itself.



Fig 31.



Fig 32.

In my piece I have chosen to depict not the male figure *per se*, but the genitals, the object of gay sexual desire. In the modern gay culture, unlike the classical ideal, the larger the phallus, the greater the sense of masculinity. In my piece the scrotal sac and testes are tied up in what is termed in S and M play or CBT (Cock and Ball Torture), which is itself a particular fetish, focusing as it does the main attention and sensitivity onto the genitals. The testes are weighted with army boots, which increases the pain/pleasure experience of the wearer and increases the object of fetishisation by the viewer participant. Like the participants in the Thaipusam religious experience a balance in the duality of pain and pleasure is achieved. Ejaculate is splashed across the boots in order to suggest a heightened moment just passed, but not ended.

In this work I have created a large gymnasium frame that supports the glass phallus. It is a relatively monumental structure for the glass it holds. The frame is copied from similar construction used in the dungeons and playrooms of the Sado-masochist. The steel wires are in the form of a St. Andrew's cross, a structure, which slaves or Subs, are tied to. The colours of black, white and red also represent the colours of the BDSM world, the red adding a sense of tension.



Fig 33.

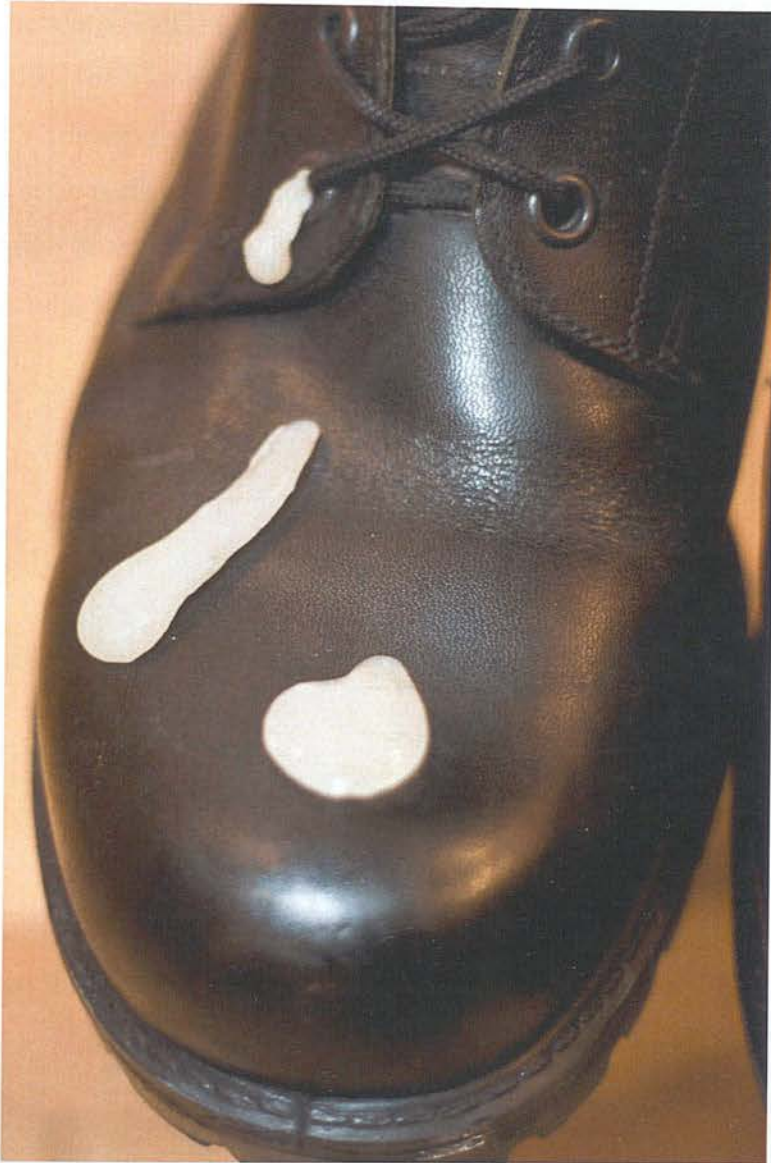


Fig 34.

The overall image itself can be interpreted in several ways. With the absent body of the figure suggested by steel cable, and the focus of the viewer's gaze completely on the genitals, an image is provoked of male warrior violence and sexual desire. The over-large erect phallus and army boots imply the imposition of imperial power and force. There is also a hint of sexual violence; although one is not sure who is the victim and who the perpetrator. And it is a thing of beauty too and is part of a playground. At the same time the 'warrior' is tied to its wooden frame, suggesting our dominance of what we see. Where exactly is the threat? And with the use of lead crystal glass to produce the phallus and testes, the piece is turned an image of

impotency. A 14" glass phallus is a totally useless thing, both practically as an implement of sexual pleasure or as an implement of violence. It is only useful as a conduit for one's imagination. Its real effect is felt only in the mind space of the viewer. The piece, of course, does come from a fascination of the exposed erect phallus in art. Artists in the ancient world and in modern times have constantly treated the subject as serious matter for illustration. In these works, below, the focus of singular attention is certainly on the phallus, but it is viewed either as an object of veneration, beauty, fetish, admiration or objectivity.



Fig 35. *Filette*,  
Louise Bourgeois, 1968.



Fig 36. *Princesse X*,  
Constantine Brancusi, 1916.



Fig 37. Greek Hermes, c 100 BC.



Fig 38. *Man in Polyester Suit*,  
Robert Mapleson, 1980.

In any of the above images it is hard to say which is which. All have elements of those five definitions. It is this I am trying to achieve here in my work: Beauty and rage, threat and desire, violence and impotence, in one piece.

9. The Objects of My Desire.

*Ben*

*Danny*

*Steve*

*Marc*

*Every lad's brain I've ever wanted to fuck,*

*It's a cruel necessity...*

*But it's what the makes the sugar sweet.*



Fig 39.

I have approached this work in the same way as I have approached getting to understand Walter, the man. That is, in an oblique way. The head was modelled first out of clay and plaster and directly modelled from an historical artefact as an exercise in historical research. Much later it was cast and polished, then I decided what to do with it. The whole is an assemblage of ideas. Trial and tests to make something of it took a long while, and it was only when the piece was literally turned on its head that it made sense and its purpose fell into place. It is a portrayal of the mind's desire and a three dimensional version of toilet wall graffiti. In completing the making of it I have taken the idea of crudely drawn marks of the public lavatory and have materialised them into a three dimensional object. The head of a Mayan artefact, something of rare beauty is turned upside down and debased. Or maybe not. Maybe by looking at it in a totally different way I have given it back its original purpose. The artefact here becomes a sexual fetish object. When I look at these types of artefacts in museums I wonder what they really were. What the viewer 500 years ago really experienced when he/she regarded them. We are told they were used in some sort of ceremony, for religious purposes or for the veneration of the dead. Yet never are we told they were made to express sexual desire (unless the object is erectly phallic). In the same way that we are told metal chastity belts were made for wives to wear while their the Crusader husbands were away fighting the Saracen, and were imposed on them so that their husband's object of desire was intact when they returned, the truth, I suspect, is that these crude devices are in fact 18<sup>th</sup> century fetish gear. I have found no evidence they were ever made in the Middle-ages.

I have coloured the head in a contemporary way, although I find much of pre-Columbian sculpture colour modern and contemporary. The original is made from grey granite. The strangeness of the brilliant yellow against the turgid blue makes for a disturbing colour junction. The blue suggest a lack of oxygen in the lips and forehead, indicating strangulation and death. The yellow is the vibrancy of life, although it is an acid yellow, which suggests pain and a lack of comfort.

This piece deals with the very real desire to fuck men in a twisted way: Dangerous twisted screwed up, wired, fish hooked and hung upside down almost in a butcher's fridge. These feelings and notions are all things we feel at some point either literally

or metaphorically, and not necessarily in a sexual way. The head is captured in a tangle of black graphic lines, as on a toilet wall. By using rubber cord I link it with SM fetish gear. The piece also refers in some way to Simon's experience at Inferno, which is recounted earlier in this book. Perhaps what we are looking at is what is felt by those participants. The placement of the head in a box refers to the artefact held in a museum vault or a dungeon. It is certainly suggests the entrapment of an object of desire, held as a collector's piece. The box has no back to it as I wanted the viewer to see the all around the piece, the mechanism of the machine if you will. In that sense the work has become like a broken automata, adding another layer of imagery that needs to be peeled away. It is uncertain if the piercings on the head are from the original history of the piece, which in all likelihood they are, and if the tangle of wire has become old and corrupted with age and/or archaeological recovery. Or are they new manifestations placed by the mind's desire to illustrate what should be there. The title holds the key. Like much of my research in this thesis more questions arise than can be answered. It may even be about nothing as Lucian Freud suggested about his paintings 'They are about nothing. It is what the viewer brings to the piece' (Harries, 1985).



Fig 40.

10. Sex with Cyanide: In the Mind of the Autoerotic Asphyxiationist.

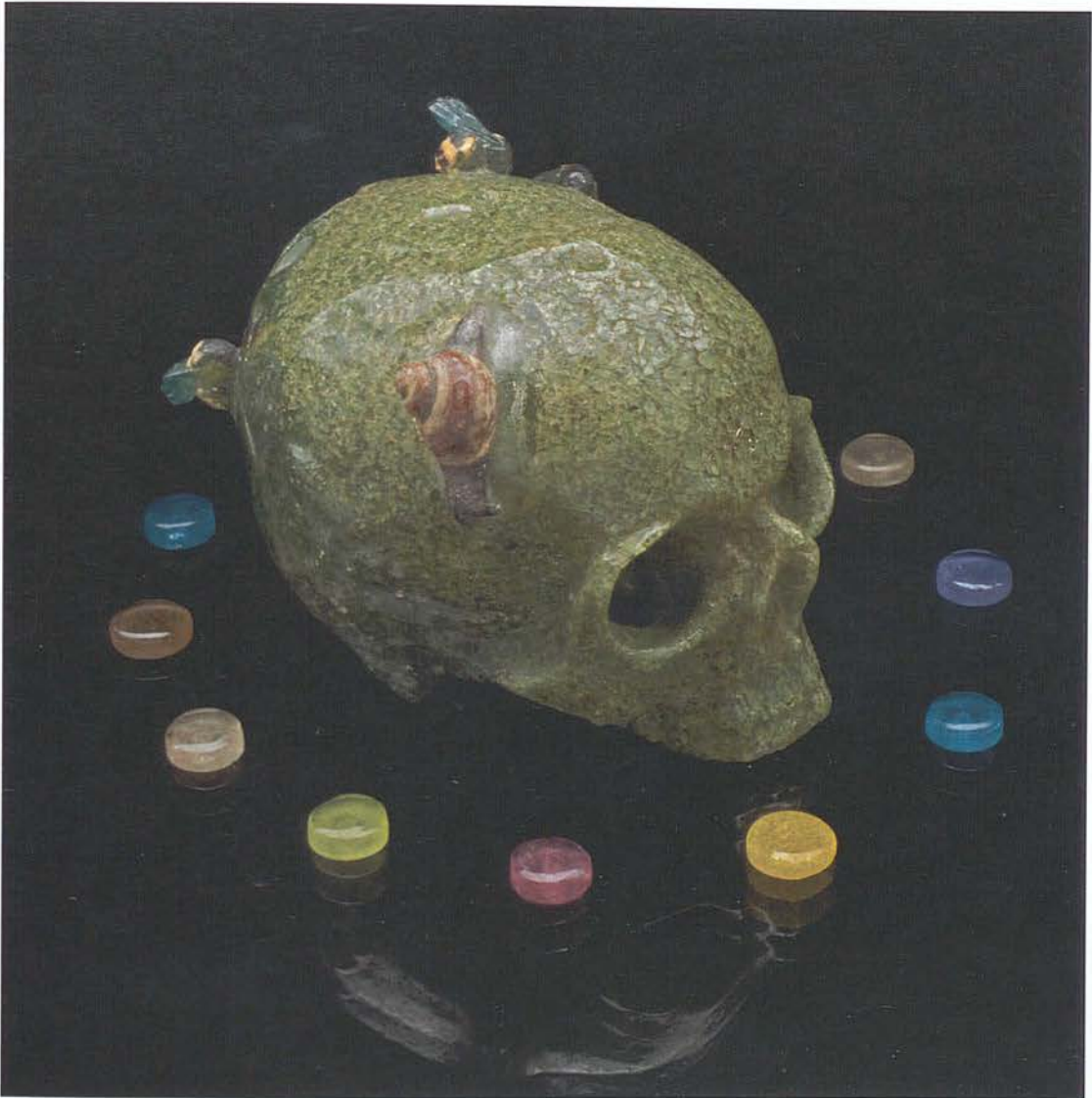


Fig 41.

The work delves into the mind of a player in the dangerous game of autoerotic asphyxiation. It is an area of sexual play that is seldom discussed, except when the game ends badly and an unfortunate celebrity or Member of Parliament is found dead in a hotel bedroom or mews house. The play involves the use of air restriction by a belt or rope round the neck while reaching a heightened state of orgasm. Chemicals also play a part in the experience to add to its intensity. The moment that is experienced is something we all feel to a greater or lesser extent in an orgasm. It is

what the French have termed 'le petit mort', which is translated into English as 'the little death'.

It has been described to me that in that moment time begins to free fall and protons of images float and coalesce. I have depicted that experience as a moss-green skull surrounded by floating colour. A mix of turgid colours and a brilliant pinks seem to express the feeling correctly. The skull and the points of colour are supposed to emerge from a shallow bath of mercury. This was not possible to create, but the idea of the piece is still here.

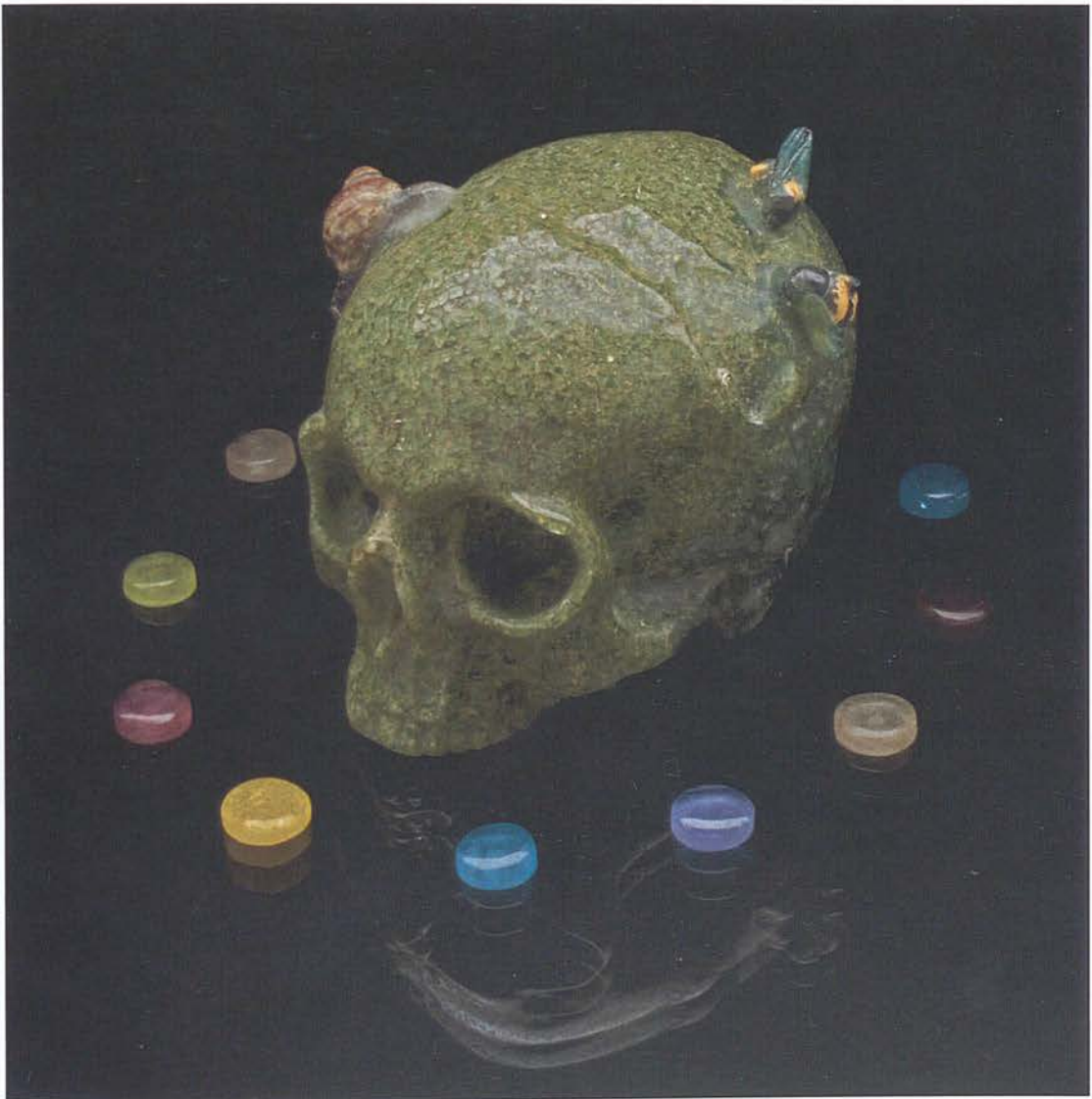


Fig 42.

## 11. The Standing Men.

The three pieces produced are part of much larger group of thirteen I had planned to do. They were motivated in part out of the exploration of masculinity in *'The Phallus'*. The silhouette of the male form came from researching some of Anthony Gormely's ink and earth drawings made in the late 1980s and 90s. In those works he takes the male form and reduces it to a simple silhouette in the form of symbol or sign. The mediums he uses to make the marks on the paper can be as diverse as watercolour paints, earth mixed with water, or bodily fluids such as blood and semen.

Three of his works are illustrated below in Figs 43, 44 and 45.



Fig 43.



Fig 44.

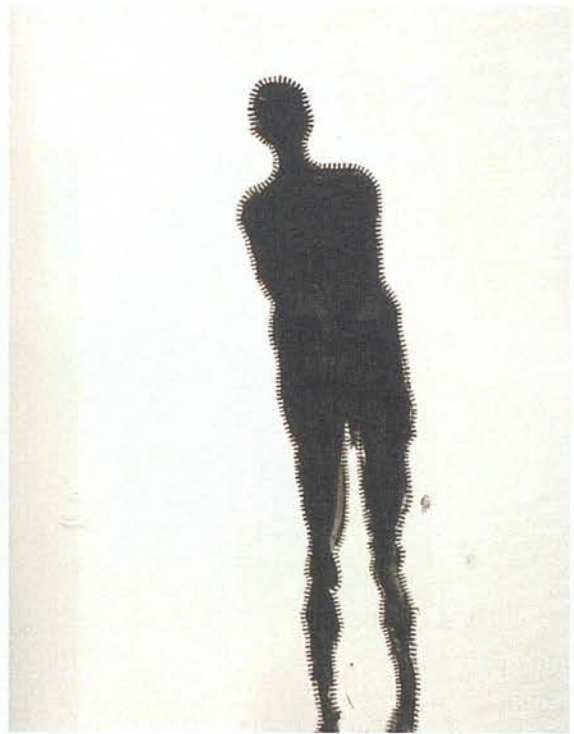


Fig 45.

The three illustrations here are the starting points for my three men. It is how one makes marks or textures or colours within a confined form and then how they are translated into glass that interested me. The man in Fig 40 has marks of watercolour on paper. The Man in Fig 44 has the feel of a medical slide showing a slice of body matter, and the one in Fig 45 brings to mind both the upright phallus and the Alembic of Gerhart Dorn in Book III, Fig 2. My drawings are inevitably very different to Gormley's, and in the translation into glass some of the original marks have metamorphosed. This is due partially to the relative uncontrollable nature of the kiln I used to make each piece (see Appendix 9), but also partially due to the experimentation within the process itself. Serendipity becomes a force and a measure of what can be achieved.

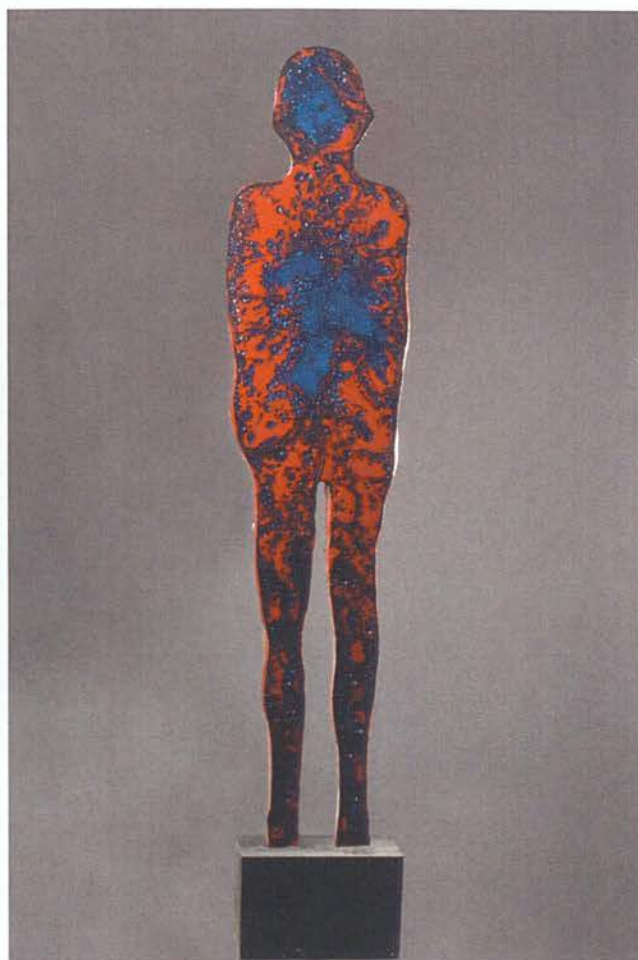


Fig 46.

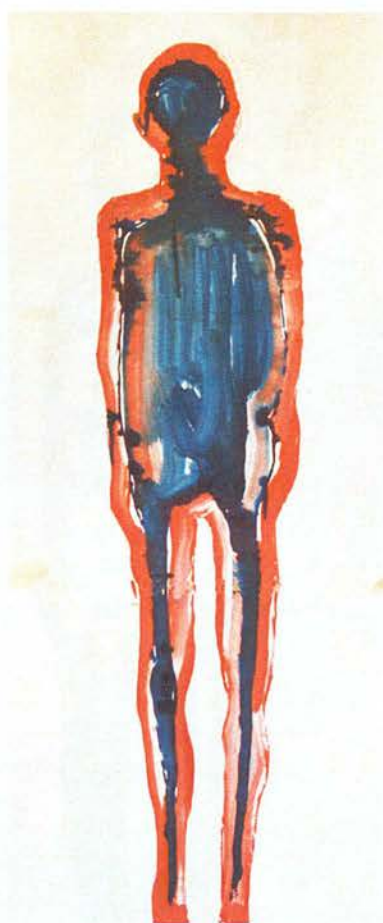


Fig 47.



Fig 48.



Fig 49.



Fig 50.

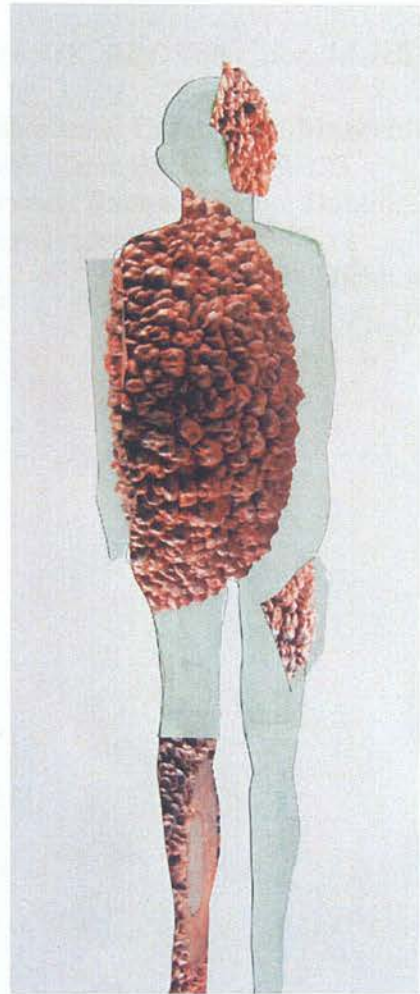


Fig 51.

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**Appendix 9:**

**On the Making of My Personal Work.**

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## Introduction

The information contained in this appendix shows the mould making methodology along with the various techniques I have employed to make my personal work. The methodology of production I use is a traditional one for casting glass, and is one I have adapted to my own hand. Within the making of each individual work the various methodologies subtly shift to take into account the shape and nature and demands of each piece. In general though the methodologies are relatively similar and are ones which any pâtes-de-verre maker or glass caster would recognise. I learned the techniques of making plaster moulds and kiln control during my film and animation career and have applied that knowledge directly to my glass making as the material language is the same. The application of the various pastes and paints is described with each piece. In some cases their treatments are specific to a certain area to achieve a designed effect. In other cases the chemical nature of the metallic salts is allowed to work on their own. Occasionally, both methods are employed in one piece, but in all instances the methodologies and techniques involved are ones Walter would recognise.

The works laid out below follow the same order as in Book III and Appendix 8. Each work then may be cross-referenced with the images in those sections to help to build a complete picture of how my work has evolved. I have not always included identical processes in the text below, as much of them are repetitive, but all pertinent points of methodology and technique are fully described and illustrated.

Alongside the technical aspects of mould making (and placements of the pastes into their moulds) I also indicate which formulae I have used. These formulae can be cross-referenced in Appendix 2, where they may be seen as individual samples. The colour results in the finished works may, however, be considerably different when combinations of the formulae are placed next to one another. This is due to the effects of specific chemicals responding to another's influence under heat and pressure within the kiln.

In Appendix 4 is shown what occurs when some of the metallic salts are placed next to each other in shallow open moulds. The results gives a good visual indication of

how volatile some of the salts are and what can happen when they interact with their neighbours. Not all formulae in Appendix 2 have been tested alongside each of the other 223 possibilities. That set of tests would amount to some 50 176 samples ( $224 \times 224 = 50\,176$ ), which, for this study, would have been impractical.

### **A comparison of my methodology to Walter's.**

The basic techniques shown below are generally the same as Walter's: areas of detail are defined by the specific placement of colour either as paints (made from ground glass) or as an amorphous mass underlying that detail. Appendix 11 gives an explanation of what is understood about Walter's techniques, gleaned from the investigation at the University of Wolverhampton. Where my processes differ from Walter's is that I have concentrated on making colour at around 800° C for my work and Walter generally did not. Colour that I produce is either premade at around 800° C and then incorporated into Walter's *pâtes-de-verre* process, or is created within the mould itself as part of the kiln firing process. This is a development of my research into Walter's techniques. As discussed in Book II Walter tended to use coloured glass that had been premade at 1270° C before fritting it into small sized particles, or grinding it down for his paints. The few colours he produced at 800° C were the red for his berries and possibly some matt blacks and browns. The concentration of my research efforts into the manufacture of colour from metallic salts has yielded a range of 224 colours, and it is some of this palette that I have used in my work. There are a few exceptions, of course, when I have utilised colour produced at 1270° C, such as in the piece *'Piss Mask'* or the previous reproduction of Walter's chameleon dish (in Book II), or when I have experimented mixing lead crystal with Gaffer Glass's blowing crystal as in *'And So I Press My Lover's Palm to Mine'*. In *'Piss Mask'* I have used a pre-made ruby-coloured glass instead of the usual clear glass base. This ruby-coloured glass however does have a unique chemical profile, as the colour itself needs to 'strike' during the kiln firing process at around 710° C. This chemical need aligns its alchemy to my processes, and the ruby-coloured glass has been mixed with metallic salts to alter the colour's result. In the limited instances where I have used off-the-shelf Gaffer Glass colour this is indicated, but generally it can be assumed I have made the majority all of the colours seen in the works.

## **The general methodologies and techniques.**

The methodology for making the works illustrated below employs two different methods of casting. They are:

- a) 2-part moulds with a further layer of refractory mix to seal and contain the inner layer. These I used for the larger heads such as the *'Dolly Mixture Sub Boi'* and *'Piss Mask'*.
- b) One piece open moulds. These were made for *'The Mayan Christ'* and *'The Object of My Desire'*.

The recipe for the refractory mix is given below and is one I have continually used throughout my work here. I established it before I started the research in this study, and it is one I am used to using. How it compares with Walter's own mix I do not know, as there is no available evidence of recipes of his mould making work. But what may be observed in two photographs of the interior of his studio in Nancy, and taken in the 1930s are shelves packed with cottle moulds. It can be assumed therefore that Walter used that mould making technique to make his casts. Cottle moulds are prepared by pouring the refractory mix into a linoleum-walled surround. They were a traditional method of mould making used in the ceramics industry until the Second World War, which also gives an indication as to how and when Walter came to use them for the manufacture of his pâtes-de-verre. As there is no evidence of kiln casting seam lines on any of the 161 pieces in the Broadfield House Collection of Walter it must be assumed that Walter used only one piece moulds for his work. This is backed up by the fact that there is little evidence of cold-working on any of the objects to either remove seams or to polish away surface imperfections. This was established in my previous research at the University of Wolverhampton.

## **1. The Formula for my Refractory Mix:**

In all of my mould making, whether for 2-part moulds or open moulds I use equal parts per volume (eg. 1000 ml) water, plaster, flint/silica

1 part water + 1 part plaster + 1 part flint/silica.

This is for the first layer only. For the second and subsequent layers I add 300ml volumetrically of fibreglass strands.

## **2. The Glass Pastes.**

The various glass pastes which I use to make my work are made from different sizes of clear fritted Gaffer Glass lead casting crystal and incorporate metallic salts.

Occasionally the clear crystal was replaced with another colour or Gaffer Glass blowing glass, which is compatible with their lead crystal. Depending on the textural effect required, smaller or larger sizes of frit are sieved out. The smallest are less than 1 mm in diameter and the largest between 3-4 mm. I have found that the smaller the particle of glass the more opaque the glass becomes after a firing. The larger the frit size the more transparent, although transparency and translucency is also dependent on other factors:

- a) The metallic salt used: cobalt oxide and manganese dioxide, for instance, make for dense opaque effects, where, as copper oxide is the reverse.
- b) The top firing temperature: The higher the temperature the more likely the smaller particles will become translucent. That, of course, is also dependent on the amount of salt used and its particular quality. Chrome oxide, for instance, can create a transparent or translucent effect when used in minute quantities. When it is used in larger measures it creates a dense effect. Copper oxide creates a translucent effect irrespective of the amount used.

The metallic salt is measured according to the formula being used. The glass and the salt are then mixed together before gum Arabic and water are added to them. The amount used varies on the size of the frit, but I use about 50 ml of liquid gum Arabic to every 300ml of glass frit/powder, plus an extra 50 ml of water if necessary. When using the glass powder for paint, fat-oil is used to create a thick paste, which can then be thinned down with turpentine to the consistency of oil paint. Both these methods of introducing 'gluing agents' into the glass powders and frit were established in my

previous research at the University of Wolverhampton. There methods of making were published in the accompanying booklet to that research (Stewart, Cummings, 2007).

N.B. Where the salt is indicated as just its name alongside a specific weight measurement in this section, e.g. manganese dioxide @ 0.3 g, it can be given that the weight measurement is per 100g of glass frit, i.e. manganese dioxide @ 0.3 g per 100g glass frit.

### **3. The 2 part moulds.**

As I discuss in Book I Walter made small, shallow objects that do not require much in the way of complicated mould making. The cottle moulds he made would suffice for the size and shape he required. The work I make is much larger in comparison and therefore requires large moulds. These require further layers and a wrapping of steel and/or copper wire to strengthen the mould and to prevent cracks forming, which may burst open during the firing process. The large size of each work also makes for difficulties in manhandling the refractory moulds especially when packed with glass. It is a complicated and long process, but I have found there is no alternative to this manufacturing process.

### **4. Internal cores.**

The pâtes-de-verre heads I have made for this study require a two-part mould in order to allow me to introduce the various glass pastes and salts into the interior of the mould's body. As all of these works are hollow an internal core had also to be created otherwise the pastes would run or fall to the bottom of the mould. The shape of each core is determined by the shape of the head and follows the silhouette of the piece at approximately 2.5 cm thick. This ensures a relatively uniform thickness of glass. An inner core is illustrated below in Fig 1.

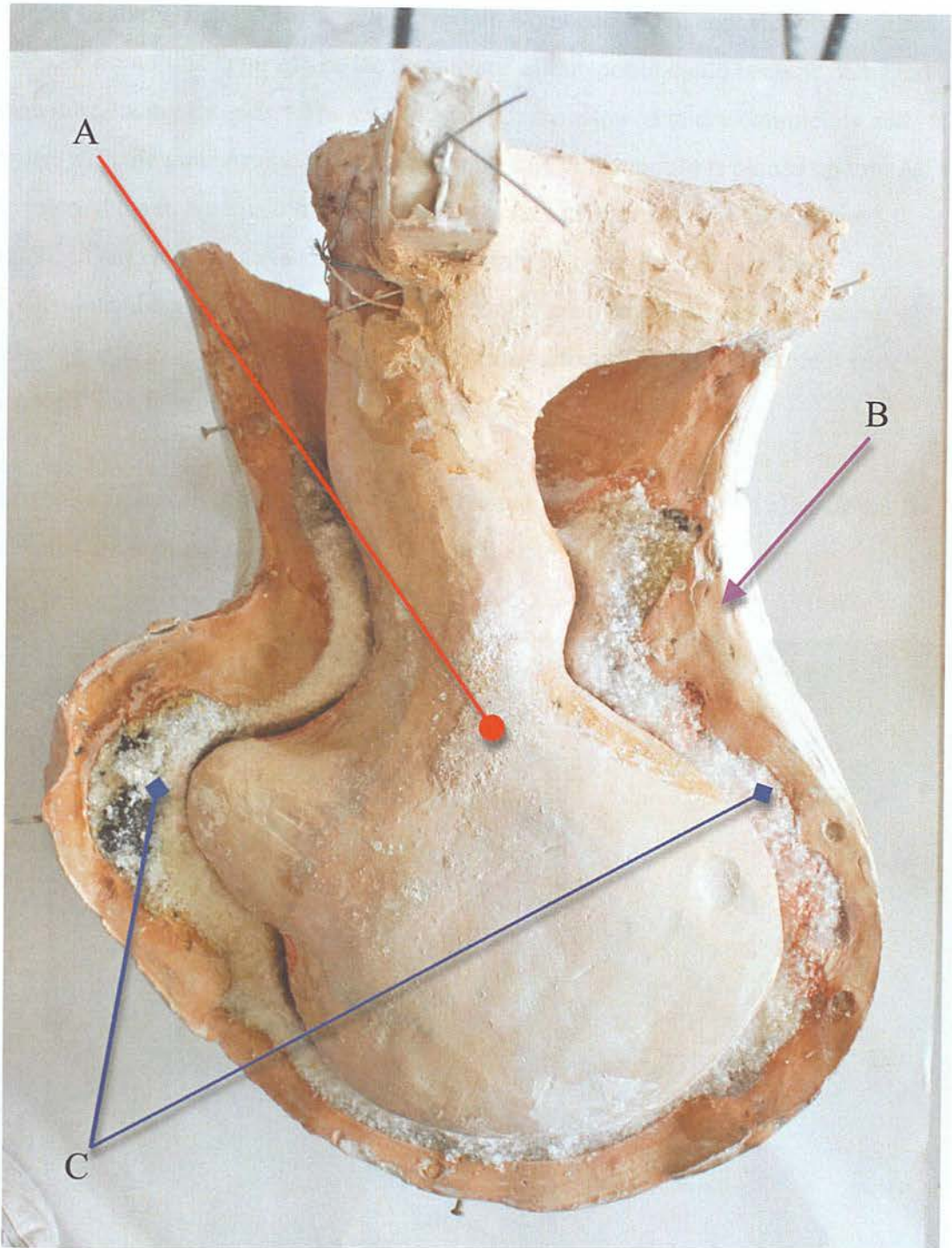


Fig 1. The internal core made for *'The Sense of My Screaming Skin'*.

- A. The internal core.
- B. The exterior mould, one half of the 2-part mould.
- C. The glass frit containing the metallic salts. The internal core (A) can be clearly seen in this image. It is sitting in place ready for the second half of the mould to be

placed on top of it. Both it and the external mould (B) have been painted with shellac in order to strengthen the surface of the mould when coming in contact with the glass pastes. Without this layer of shellac the surface of the mould could become damaged when introducing the glass. The glass pastes (C) are allowed to dry completely and harden with the gum Arabic before the second half of the mould is placed on top. All the internal cores are made from exactly the same refractory mix as the exterior mould. In my experience the use of the same mix ensures the differentials of expansion and contraction are minimised during the firing and annealing process. Below (Fig 2) is an image of a fired piece ('*Dolly Mixture Sub-boi*') before it is demoulded. The internal core (A) is indicated.

The image below in Fig 2 shows (A): the internal core still in position after firing. 'B' indicates the external mould, and 'C' the fired glass.

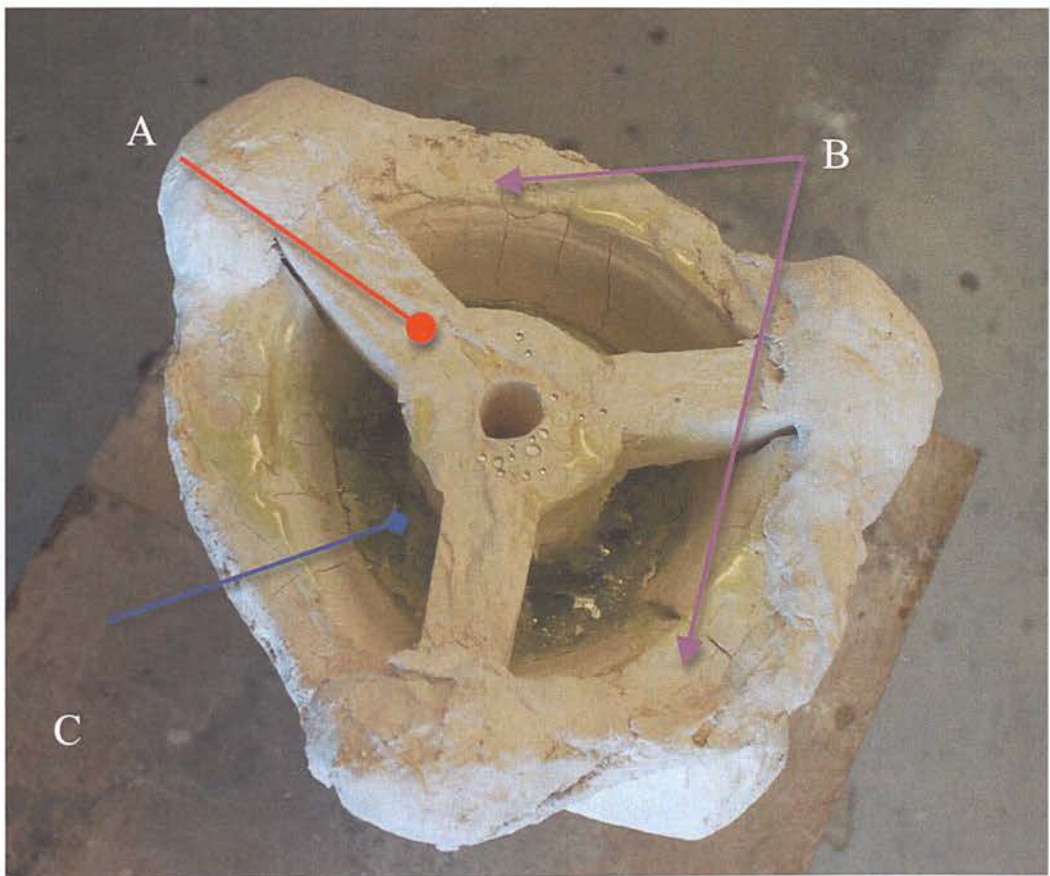


Fig 2. The fired mould showing the internal core.

In the centre of the core a circular flue can be seen. This hollow penetrates down into the middle of the core, acting as a vent for any gases to escape, rather than allowing them to pass through the glass. The flue has the added advantage of allowing the kiln's heat to be more evenly dispersed during the firing process, as well as allowing the internal part of the fired glass to lose heat more evenly during the annealing process. The hollow also lets the inner core expand and contract more efficiently. In doing, so less pressure is put on the glass form.

Unlike my work, most of Walter's works were produced in shallow open moulds with the glass being introduced via the 'foot' of the object (Stewart, Cummings, 2007, Cummings, 2009). Because his boxes were straight-sided (and relatively small) a separate internal core is not needed, and a single mould can therefore be made. The result is that the making process becomes much swifter and easier to manage. While Argy-Rousseau used white asbestos packed into the mould to create a core, which both supported the glass and created a fire polish during the firing process, there is no evidence Walter used this technique (Argy-Rousseau, G.). From what I have observed, the interior spaces of Walter's boxes, inkwells and jars were created from the original refractory mould. In that sense my mould making follows Walter's methodology.

## **5. Firing and Annealing Schedules.**

A slow rate of firing and annealing was used in all cases. Although the top temperature is the same for casting solid lead crystal the inclusion of the metallic salts means that the final structure of the glass is relatively compromised. The salts do not always meld into the particles of frit as can be seen in the skull of the piece '*Sex with Cyanide*'. To avoid any possible stresses in the glass arising from their use, a conservative firing schedule was devised. In most cases it was adhered to except where I thought a longer cycle was needed due to bulk of glass, or a start delay was required to allow for top temperature to be attained during college opening hours. In the case of the use of the vanadium pentoxide and the use of the ivory-coloured blowing glass, the top temperature was raised to 840° C and 850° C respectively. When casting Gaffer Glass's lead crystal with their blowing glass an annealing point of 510° C is adopted, and held for 10 hours. A 3° C per hour rate in drop of

temperature programmed in until it reaches 440° C when the usually annealing programme takes over. This allows the casting crystal to be annealed effectively alongside that of the blowing crystal.

The basic schedule was as recorded below:

Stage 1: Ramp up 50° C per hour to 200° C. Hold for 2 hours.

Stage 2: Ramp up 75° C per hour to 650° C. Hold for 2 hours.

Stage 3: Ramp up 75° C per hour to 820° C. Hold for 4 hours.

Stage 4: Ramp down at Full to 440° C. Hold for 8 - 10 hours.

Stage 5: Ramp down at 3° C per hour to 360° C. Hold for 8-10 hours.

Stage 6: Ramp down at 4° C per hour to 290° C. Hold for 8-10 hours.

Stage 7: Ramp down at 6° C per hour to 150° C. Hold for 8-10 hours.

Stage 8: Ramp down at 8° C per hour to 50° C. Hold for 8-10 hours.

Stage 9: End programme. Wait for kiln to come down to external ambient temperature.

1. The Sense of My Screaming Skin (Manifesting My Bi-polarity).

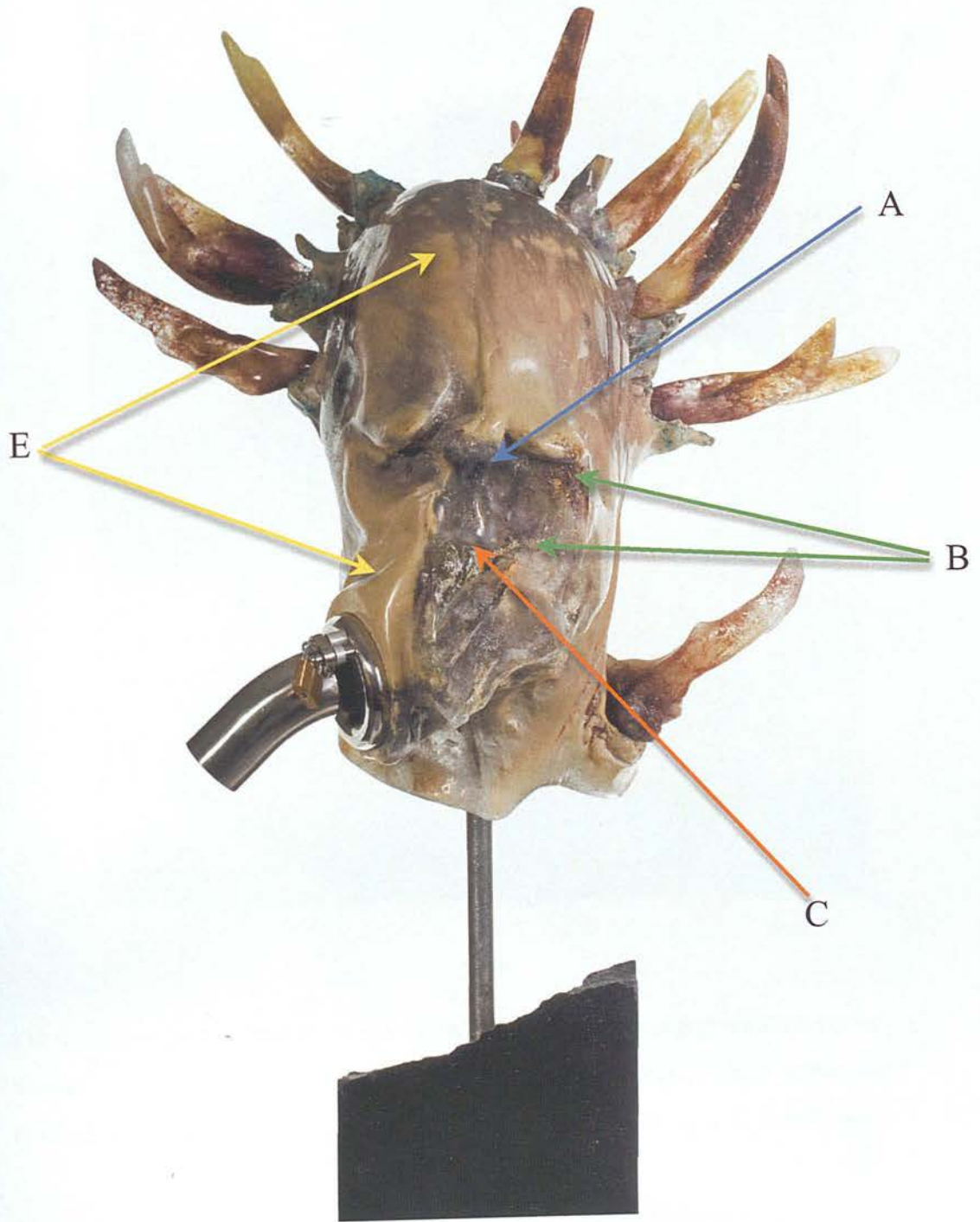


Fig 3.

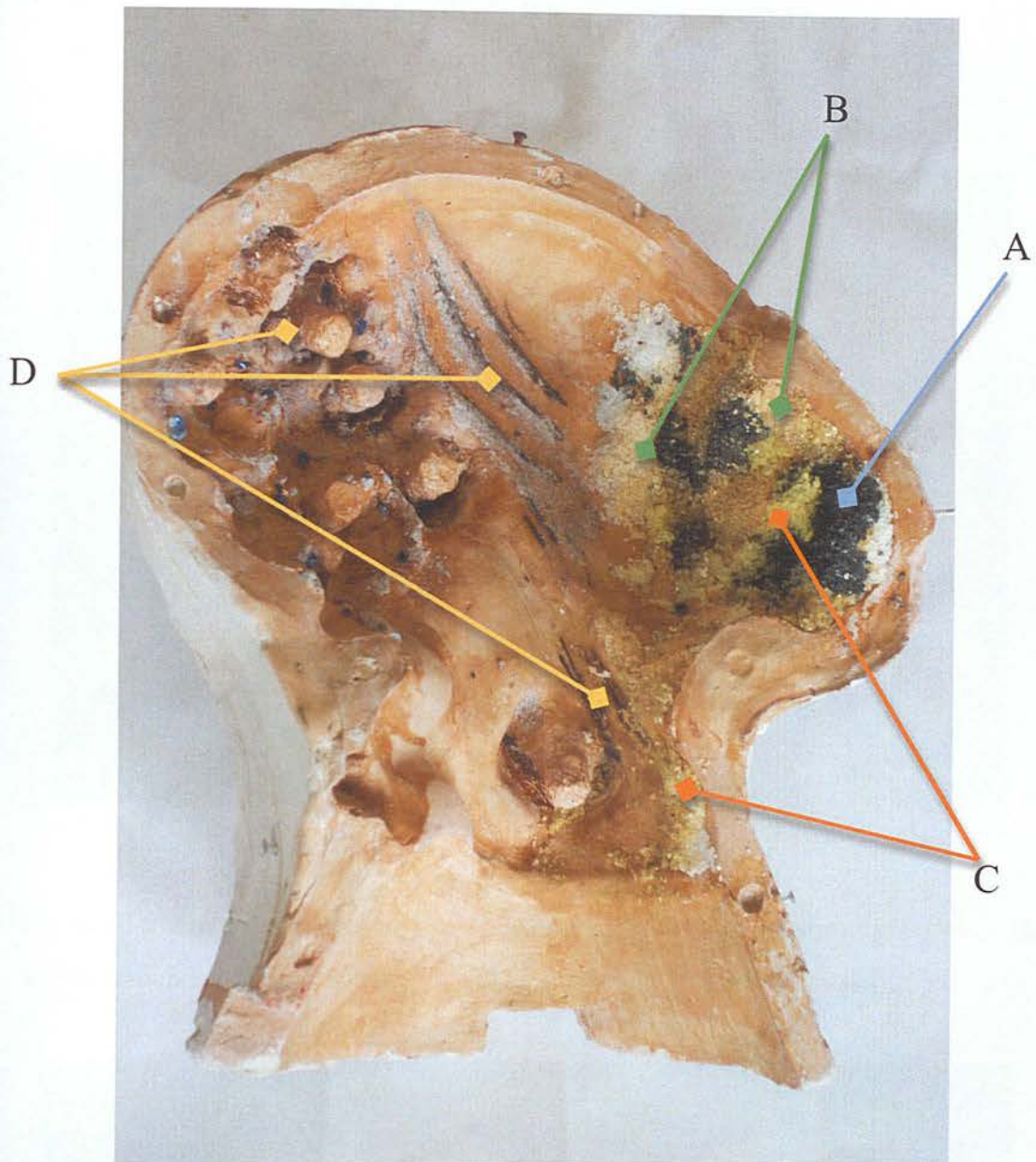


Fig 4.

Fig 4. shows the two halves of the mould having been prepared with a layer of shellac. Areas that required painted colours or defined areas of glass pastes were marked out, and those pastes were then introduced into the mould. These were:

- A. BV003: Manganese dioxide ( $\text{MnO}_2$ ) @ 1.5g (per 100g of glass frit)
- B. G020: Vanadium pentoxide ( $\text{V}_2\text{O}_5$ )@ 1.25g.
- C. Y0001: Potassium dichromate ( $\text{K}_2\text{Cr}_2\text{O}_7$ ) @ 3g.
- D. BV018: Crocus martis ( $\text{FeSO}_4$ ) (as paint (the dark lines) and as a colourant the mauve areas) in glass paste.

E. W003: Silver chloride ( $\text{AgCl}$ ) @ 0.5g.

F. Y003: Antimony oxide ( $\text{Sb}_2\text{O}_3$ ) @ 2g.

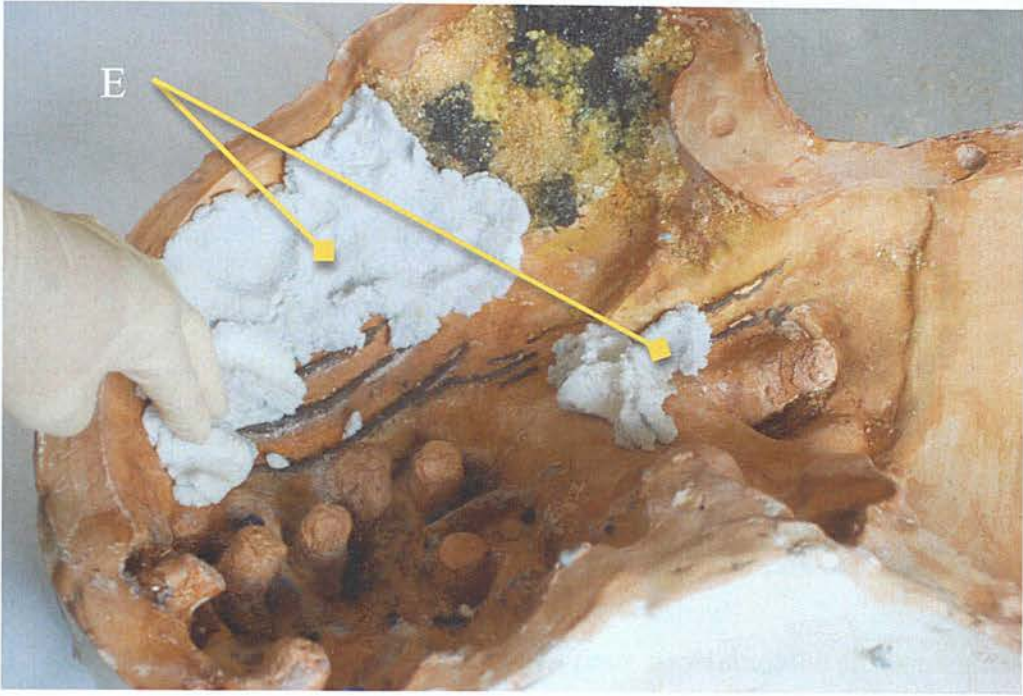


Fig 5.

Fig 5 and 6. The dried pastes and paint were then covered in a layer of glass paste (E), which contained silver chloride. This layer contained 15 kilos of glass frit.

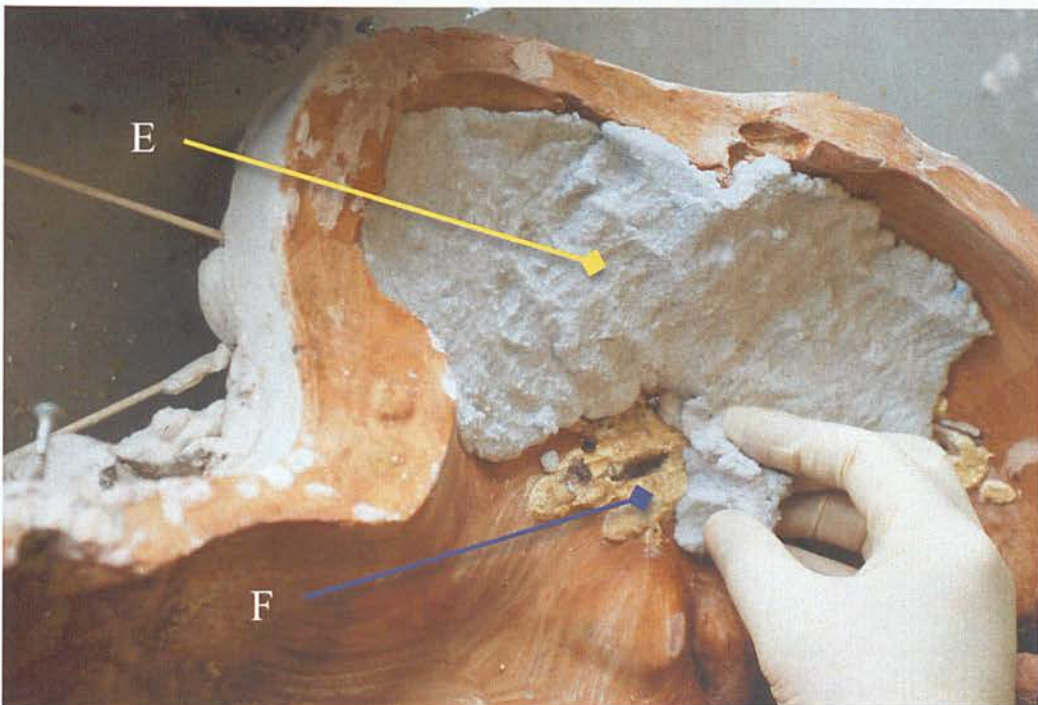


Fig 6.



Fig 7.

Fig 7 shows the finished layer of packed glass paste containing the silver chloride. The layer was allowed to dry for 4 days. During this time the gum Arabic hardened ensuring that the glass pastes stayed in position when the two halves were untied with the inner core (see Figs 8, 9 and 10, below).



Fig 8.



Fig 9.



Fig 10.



Fig 11.

Fig 11: Once the two halves of the mould were put together they were bound together with wire, in this case copper. The exterior of the mould was then covered in another two layers of refractory mix and fibreglass strands, before placing in the kiln and firing. This process is the same for every two-part mould I have made in this study.



Fig 12.



Fig 13.

In Figs 12 and 13 the single, long, colour bar was chosen for this piece as it had produced a remarkable line of colour. It clearly shows how one metallic salt interferes or reacts with its neighbour. The true colours of the salts may be seen as samples in Appendix 2 and again compared with the bars in Appendix 4. The salts in this colour bar were mixed into a fine frit measuring 1mm diameter approximately.

*a* = R003: Red Iron oxide ( $\text{Fe}_2\text{O}_3$ ) @ 1g.

*b* = BV002: Manganese dioxide ( $\text{MnO}_2$ ) @ 1g.

*c* = R005: Yellow Iron oxide ( $\text{Fe}_2\text{O}_3$ ) @ 1g.

*d* = Y001: Potassium dichromate ( $\text{K}_2\text{CrO}_3$ ) @ 3g.

*e* = BV002: Manganese dioxide ( $\text{MnO}_2$ ) @ 1g.

*f* = Y003: Antimony oxide ( $\text{Sb}_2\text{O}_3$ ) @ 1g.

*g* = G020: Vanadium pentoxide ( $\text{V}_2\text{O}_3$ ) @ 1.25g.

*h* = BV002: Manganese dioxide ( $\text{MnO}_2$ ) @ 1g.

*i* = Y011: Cadmium sulphide ( $\text{CdS}$ ) @ 1g.

The wax feather/bones shapes were invested in a refractory mix before being steamed out and the cavities filled with glass frit together with the various salts according to the place they lay at the colour bar. No one feather/bone has turned out the same way as another. The amount of formula put into each cavity differed slightly, so producing subtly differing results in the glass. Unlike its use in the colour bar the red iron oxide has remained as a red colour and formed a pink colour in the clear lead crystal of each feather/bone.

2. Piss Mask.

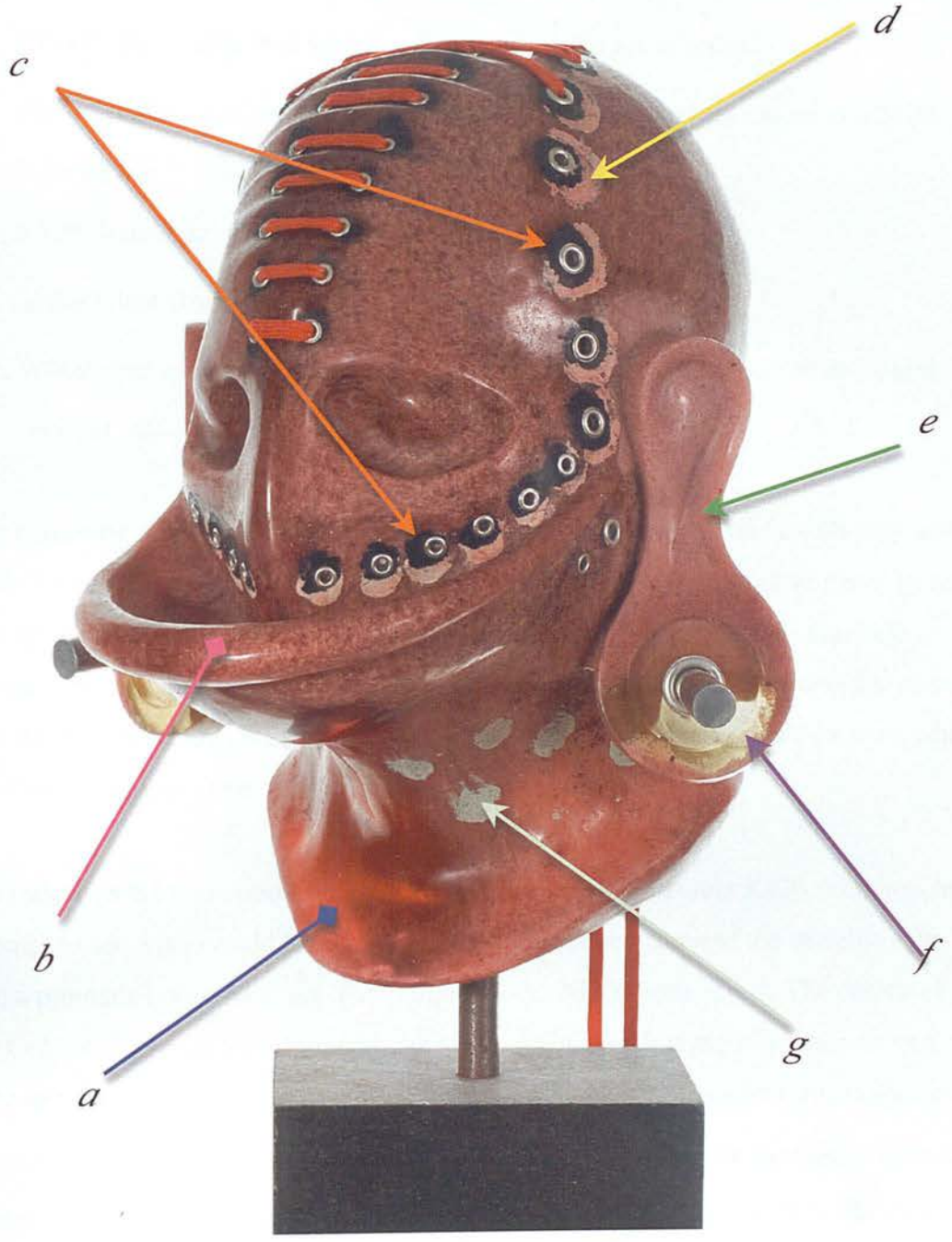


Fig 14.

List of Formulae:

*a...* Gaffer Glass Gold-ruby casting crystal (G221).

*b...* R020: Red iron oxide @ 0.25g + Gaffer Glass Gold-Ruby casting crystal (G221).

*c...* GB008: Zinc oxide was added to the mix @ 5g to act as a flux.

*d...* W008: (but uses red iron oxide instead of yellow iron oxide) mixed as a paint with fat oil.

*e...* R019: Vanadium pentoxide @ 1g + rose on-glaze @ 0.25g.

*f...* Gaffer Glass Bronze casting crystal (G219).

*g...* W009: (but uses red iron oxide instead of yellow iron oxide) mixed as a paint with fat oil.

The colouring of this work was an experiment to see how the formula with their salts could be extended from the simple rules of metallic salts in a body clear glass. In each case I have either changed subtly the quoted formula, or have added to premade colour. This was one of the last pieces to be made in this study and I wanted to show that these formula are just a base from which further experiments could be tried while working on a piece. The results in each case are successful.

As indicated the main body of the glass was made from Formula R020. This was an attempt to see what would happen if I began to introduce some of the metallic salts into a premade coloured glass. The sample produced a unique effect. The colour of the Gold-Ruby being transformed by the iron oxide, which itself was made to look very different from the usual samples that incorporated it. The Gold-Ruby colour can be seen around the area of 'a'. It is a transparent ruby colour. The iron oxide adds an opacity to it, but at the same time light is allowed to pass into the body of the glass. This is something to do with the size of the Gold-Ruby frit I have used. In crushing the chunks of the glass I managed to produce a larger quantity of 4mm size frit, which can still be seen in the work. The pale haze around these pieces is the smaller powdered Gold-Ruby and the iron oxide.

The ears were produced from clear lead crystal using Formulae R019 with a disc of Gaffer Glass Bronze casting crystal (G219). The Formula was mixed into a fine frit, approximately 1-2 mm in size. The ears were pre-cast and polished before being fitted into place in the wax positive of the head. They can be seen in position in the wall of the 2-part mould mould in Fig 15, below.

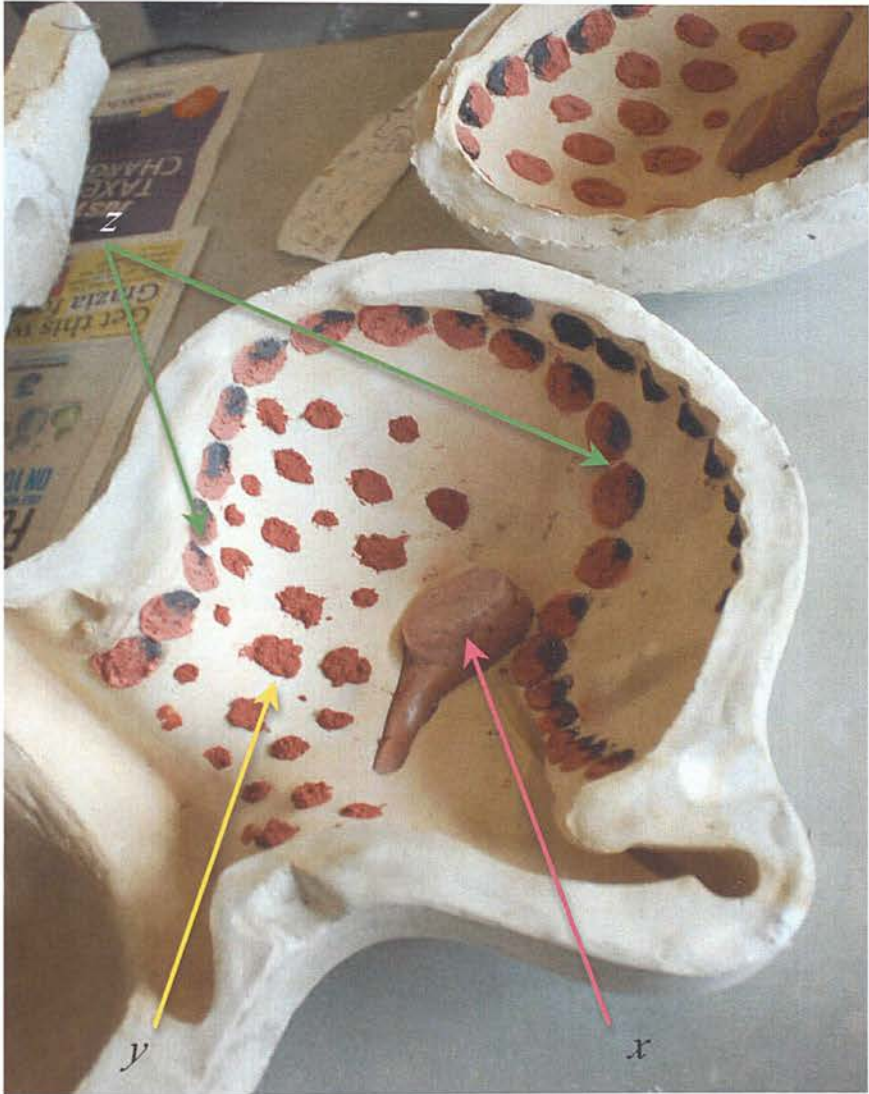


Fig 15.

'X' ... indicates the where the R019 ears are imbedded in the mould's wall.  
'Y' ... is Formula W009 mixed with fat oil to produce a paint. In this instance I exchanged the yellow iron oxide for its red counterpart. There is little difference between the red and the yellow when mixed in with other salts and I used what was to hand.

'Z'... shows the paint made from W008 and fat oil. It was placed on top of the black paint made from GB008 and zinc oxide. These marks were made using my thumb, as the African woman's tribal marks in Fig 17 possibly would have been (see Figs 15, 16 and 17 below).

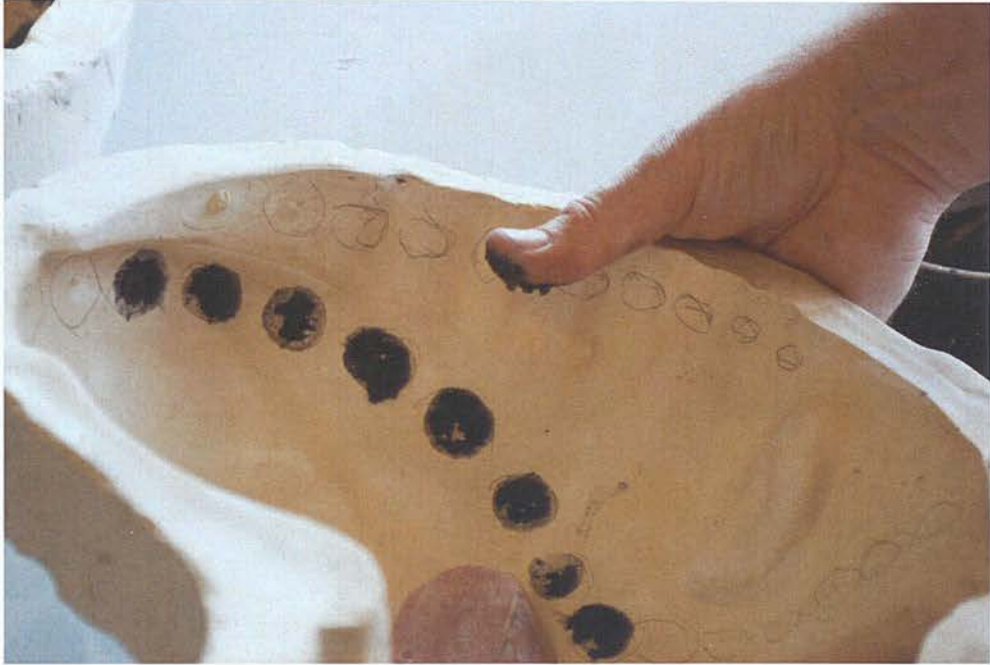


Fig 16.



Fig 17.



Fig 18.

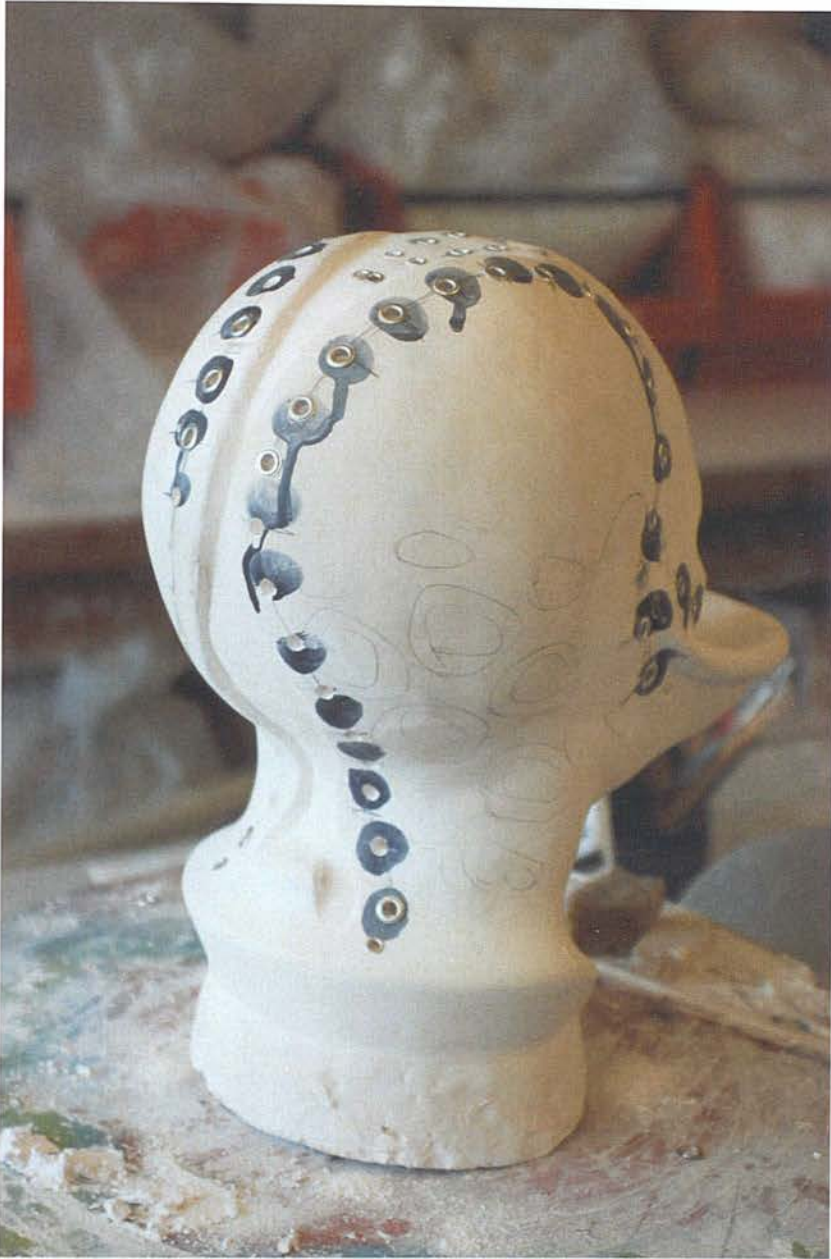


Fig 19.

Figs 18 and 19 show the advantage of making a plaster positive of the finished work. It allows the surface to be smoothed and polished to achieve the final surface required, and so reduces cold working after the piece is cast. But just as importantly finishing ideas and colours of paints can be tried out, which would not be possible on a wax or clay sculpt. On both images pencil marks and paint daubs using my thumb can be seen where I have essayed my thoughts about what to do, and how I should precede with this work.

3. And So I Press My Lover's Palm to Mine.

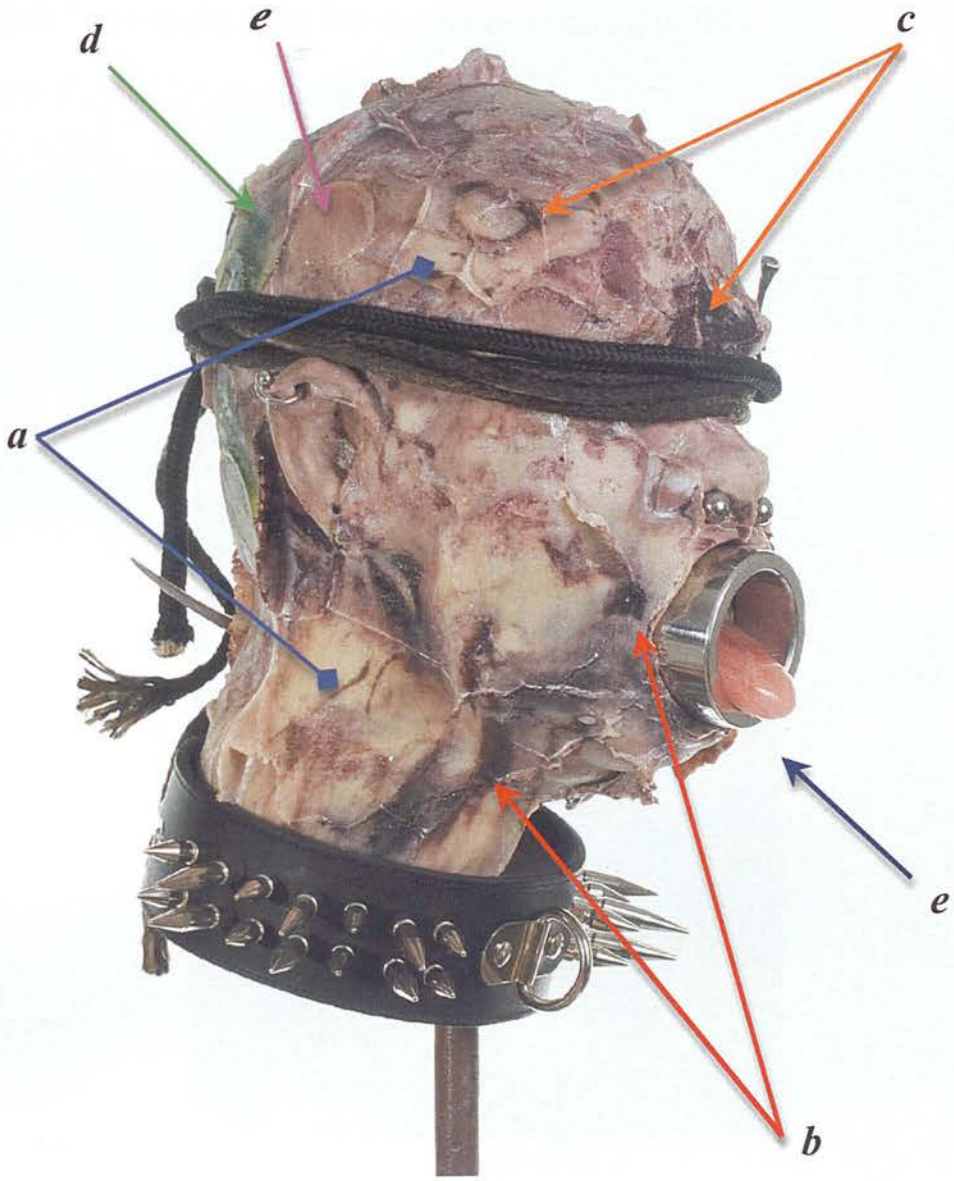


Fig 20.

List of Formulae:

*a* ... Ivory Gaffer-Glass blowing crystal (Opal G103): D1 frit (fine powder)

*b* ... BV004 (manganese dioxide  $MnO_2$  @ 3g): mixed in 1-4mm frit.

*c* ... BV018: frit 1-2 mm and powder.

*d* ... B019 with Gaffer Glass lime green casting crystal (G263).

*e* ... R018: pink on-glaze mixed in frit 1-4mm.



Fig 21.

Figs 21, 22, 23 and 24 show the wax positive that was formed to produce the finished work seen in Fig 20. Plaster bandage was used to take a cast from a life model. The wax positive was then worked to produce a satisfactory final image. This involved extending the neck to allow for the leather collar to be incorporated in the finished work. The mouth was opened up for the steel ring to be placed in position. Pre-cast

teeth made from formulae W002 were also put into the mouth cavity and were cast in place.

Several preformed glass disks were cast up using a pre-made lime coloured glass from Gaffer Glass's lead crystal range with a dark coloured glass made from B019. The interaction between the Gaffer Glass lime green (G263) and the metallic salts in B019 (copper carbonate, cobalt carbonate and zinc oxide) turned the original colour (shown in the sample of the formula) a darker green colour. Two pink discs were also added. One was made from a sample of using pink ceramic on-glaze, R018. These were all inserted into the wax before moulding up. As can be seen in Fig 26 they remained imbedded in the refractory walls of the mould.



Fig 22.

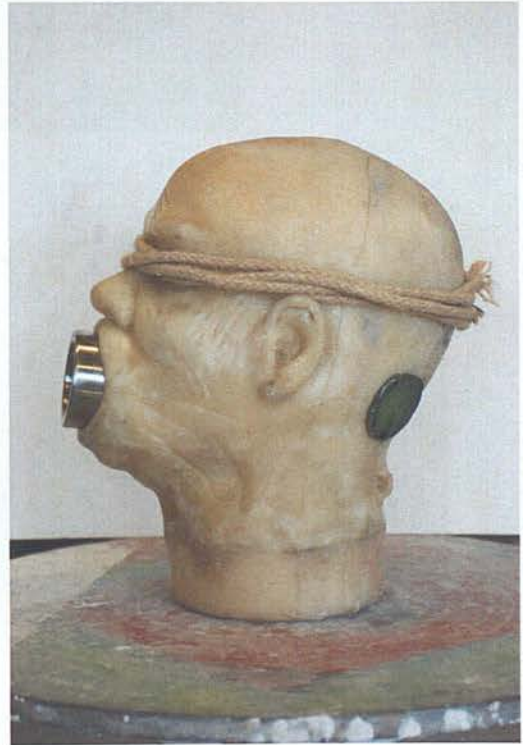


Fig 23.



Fig 24.



Fig 25.

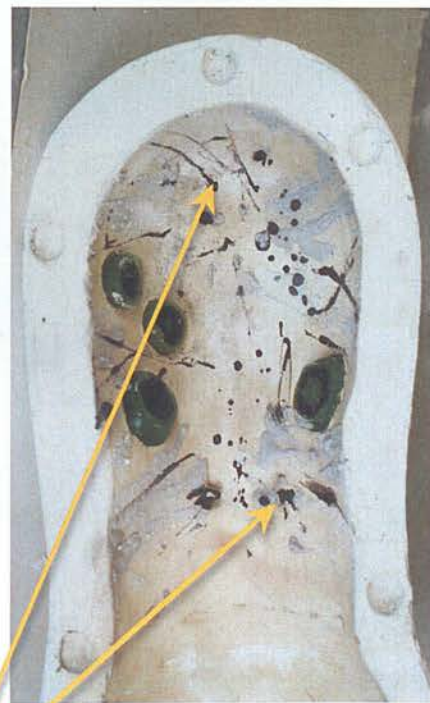


Fig 26.

B

Fig 25 and 26 show the interior of both halves of the 2-part mould made to create this piece. I have splattered into the mould Crocus martis ( $\text{FeSO}_4$ ) with a mix of zinc oxide ( $\text{ZnO}$ ) added to it (indicated as 'B'). It was mixed using gum Arabic, not the fat oil, in order to disperse the effect. The paler adjacent mauve (indicated as 'C' in Fig 27, below) areas are BV018 in a paste of glass frit. These two effects were designed to reproduce some similar marks, which did not appear on the finished piece in *'The Sense of My Screaming Skin'*.

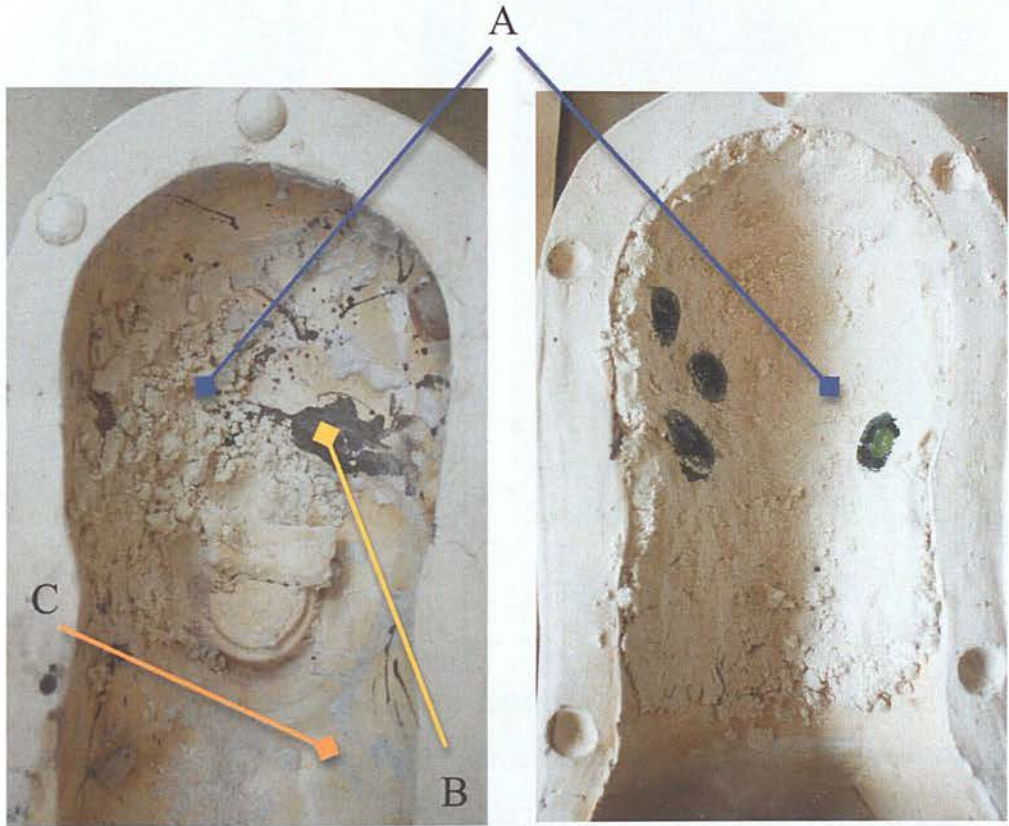


Fig 27.

Fig 28.

Figs 27 and 28 show where and how the 3 different pastes were introduced into the mould.

A...shows the layer of opaque ivory-coloured blowing glass being put in. It was mixed with gum Arabic before being placed in the mould to a thickness of approximately 8 -10 mm.

B... indicates the Crocus martis with zinc oxide was splattered as a paint.

C... indicates the pastes of the BV018.



Fig 29.



Fig 30.

Fig 29, above, shows the black layer of BV004 being introduced on top of the layer of ivory coloured blowing glass. This was approximately 2-4 mm in thickness.

Fig 30 shows the one half of the 2-part mould (with its two layers of glass pastes already in place and with the inner core) ready to be fitted with the first. As with all the other 2-part moulds, the two halves were sealed with extra layers of refractory mix, fibreglass and wire.



Fig 31.

Fig 31, above, shows the cast head during the de-moulding process. The first layer of refractory mould has fractured into hexagonal shapes. Fissures can be easily seen running away from the main body of the head. They have allowed some of the glass to flow into them, thereby creating a honeycomb effect over the surface of the glass. The seam line of the mould can also be clearly seen. This effect may have been caused by the volatile expansion of gases from the manganese dioxide in formula BV004 at  $850^{\circ}\text{C}$ . Unable to fully escape through the mould's opening they have pushed their way through the layer of opaque ivory blowing glass into the mould's layers causing it to fracture in a spectacular way.



Fig 32.

Fig 32 shows the same crazed effect at the back of the head of the cast piece. The refractory layer came off easily and in the same honeycomb shapes. There was no indication of what to expect, however, when the mould was removed from the kiln. Fig 33, below, shows the mould just after it was taken out of the kiln.

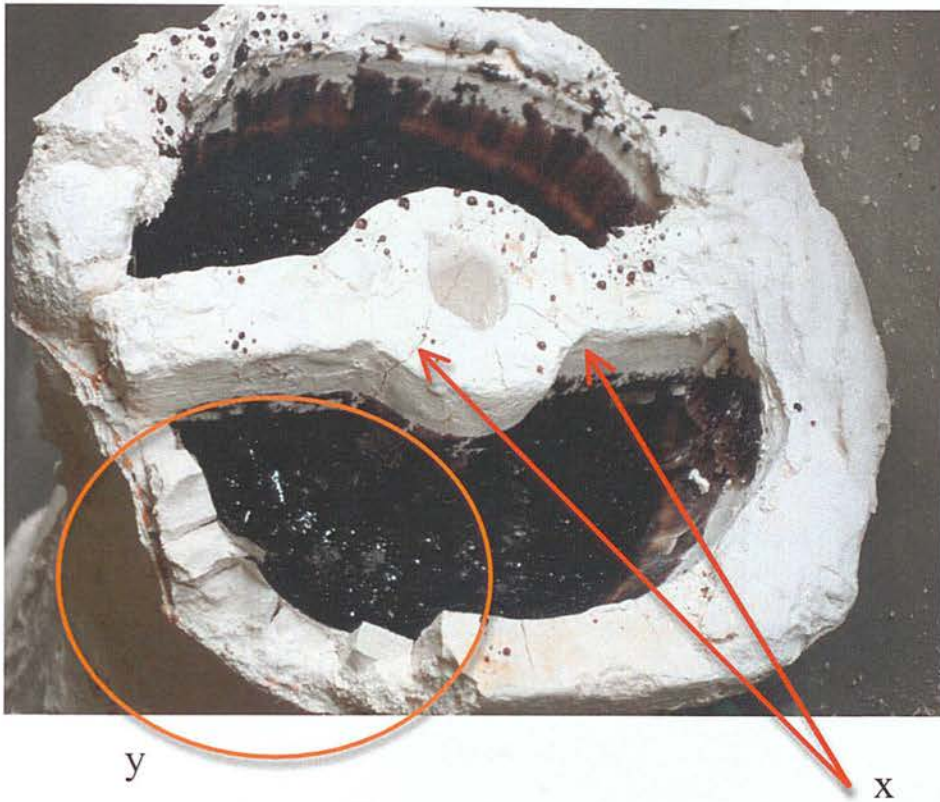


Fig 33.

My first impression of the mould (seen here in Fig 33) is that there has been a successful firing. The mould appears intact. On closer examination, however, the inner core has been affected in some way as it shows the same crazed patterns on the outer de-moulded layers as indicated by 'x'. As I lifted the mould out of the kiln a piece of the reservoir broke off around the 'y' area, revealing the crazed patterns. Below, in Fig 34, is a cross section of the reservoir. The sample is on a scale of 1:1 and clearly shows how aerated the structure of the glass is.



Fig 34.

As can be observed in the sample in Fig 34, above, there has been a vigorous gaseous reaction. It appears it was more violent than predicted from the samples made in shallow open moulds. The serendipity of the overall effect was better than I had hoped. As a result it has given the finished work another dimension that would have been hard to have produced in any other way.

4. Dolly Mixture Sub-boi: Sperm und Glitter.



Fig 35.

## List of Formulae.

- a... G019: vanadium pentoxide @ 1g.
- b... BV108 : Crocus martis @ 3g with zinc oxide @ 1g.
- c... GB002: Nicle oxide @ 1g with zinc oxide @ 10 g.
- d... B004: cobalt oxide @ 0.4g.
- e... B013: cobalt oxide @ 0.1g with chrome oxide @ 0.014g.
- f... G001: chrome oxide @ 0.01g.
- g... Y003: antimony oxide @ 1g.
- h... R005: yellow iron oxide @ 1g.
- i... Gaffer Glass Gold-Ruby casting crystal (G221).
- j... Y003: antimony oxide @ 1g.
- k... Gaffer Glass Emerald casting crystal (G260).
- l... B003: copper oxide @ 1.2g.
- m... BV003: managnese dioxide @ 1.5g.
- n... G003: chrome oxide @ 0.25g.
- o... Y008: antimonite of lead @ 5g with lead oxide @ 1g.
- p... B001: copper oxide @ 0.02g.

In Fig a. the green of the mask's head appears as two different colours (indicated by  $\mathcal{X}$  and  $\mathcal{Y}$ ). Although the piece is made with one batch of glass with the same vanadium pentoxide incorporated into it the glass around  $\mathcal{X}$  has a whitish quality, while other areas around  $\mathcal{Y}$  are more leaf green in appearance. Again in the glass in the nose-hose (indicated by  $\mathcal{Z}$ ) has a yellow leaf-green hue to it compared to  $\mathcal{X}$  and  $\mathcal{Y}$ , and is more like its G019 sample.

Without further tests one can only assume that the discrepancy between the three colours is due to the relative inability of exchange of gases in the two moulds. The difference between the colours of  $\mathcal{X}$  and  $\mathcal{Y}$  may be due to  $\mathcal{X}$  being situated in the lower half of the enclosed mould, and is therefore in a more reductive atmosphere, which then produces the white effect. The  $\mathcal{Y}$  areas of glass were in the upper half where

relatively more oxidation takes place and so a greener colour is produced. The glass of Z was sitting in an open mould, which would allow the necessary chemical exchanges to take place to produce the correct colour.

The making process for this piece was complex, involving, as it did, several preparatory stages of manufacture before the final work was cast.

1. A plaster form was made from clay and then cast to create the basic form that would be worked upon. The shape was developed using modelling clay and plastic foam to produce the form seen below in both Figs 36 and 37.



Fig 36.



Fig 37.

2. A silicone cast was taken of the final form and reproduced in glass. In Figs 36 and 37, above square indentations can be seen. These are locating holes for the spikes, which were added during the later wax stage.



Fig 38.

3. The spikes were cast in wax (Fig 38), then covered in refractory mix.
4. The moulds were steamed out and the spikes were then...
5. Cast in glass. See Fig 39, below.



Fig 39.

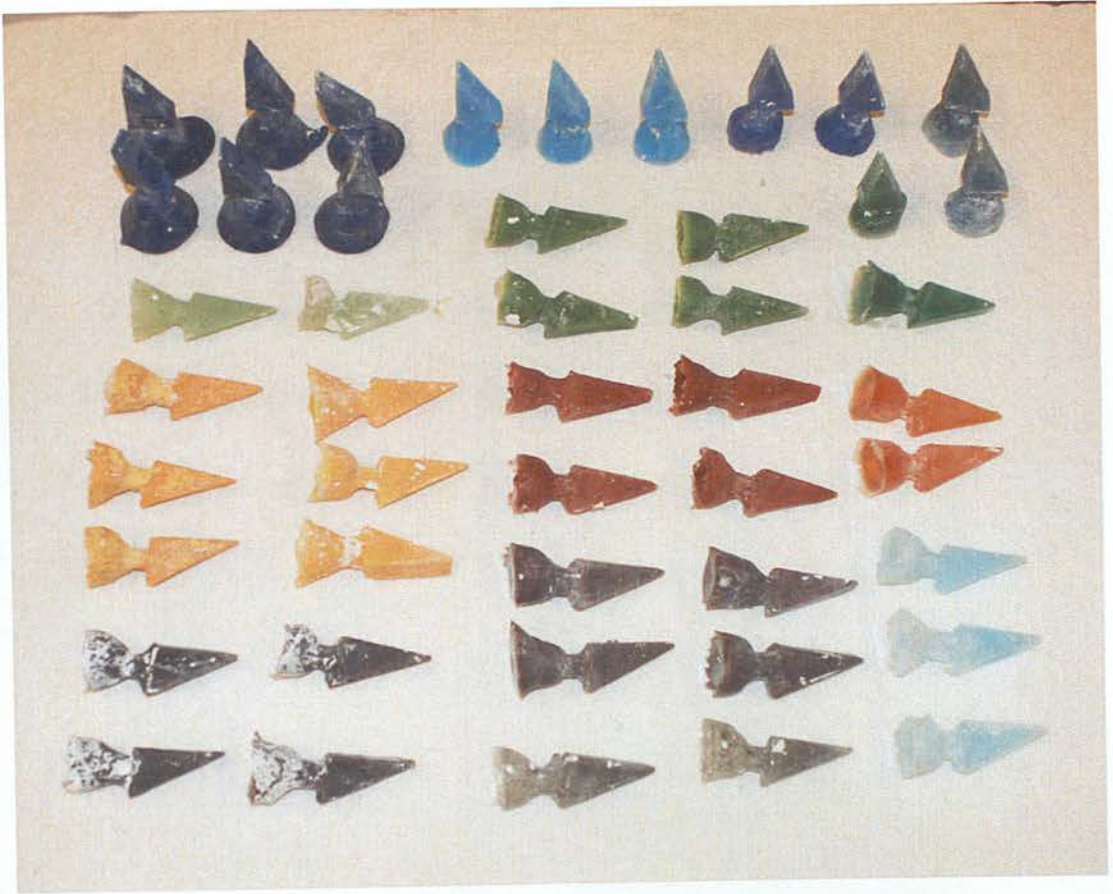


Fig 40.

6. The spikes were cut off from their reservoir sprues and polished, before being assembled onto the wax of the mask (see Fig 41, below).

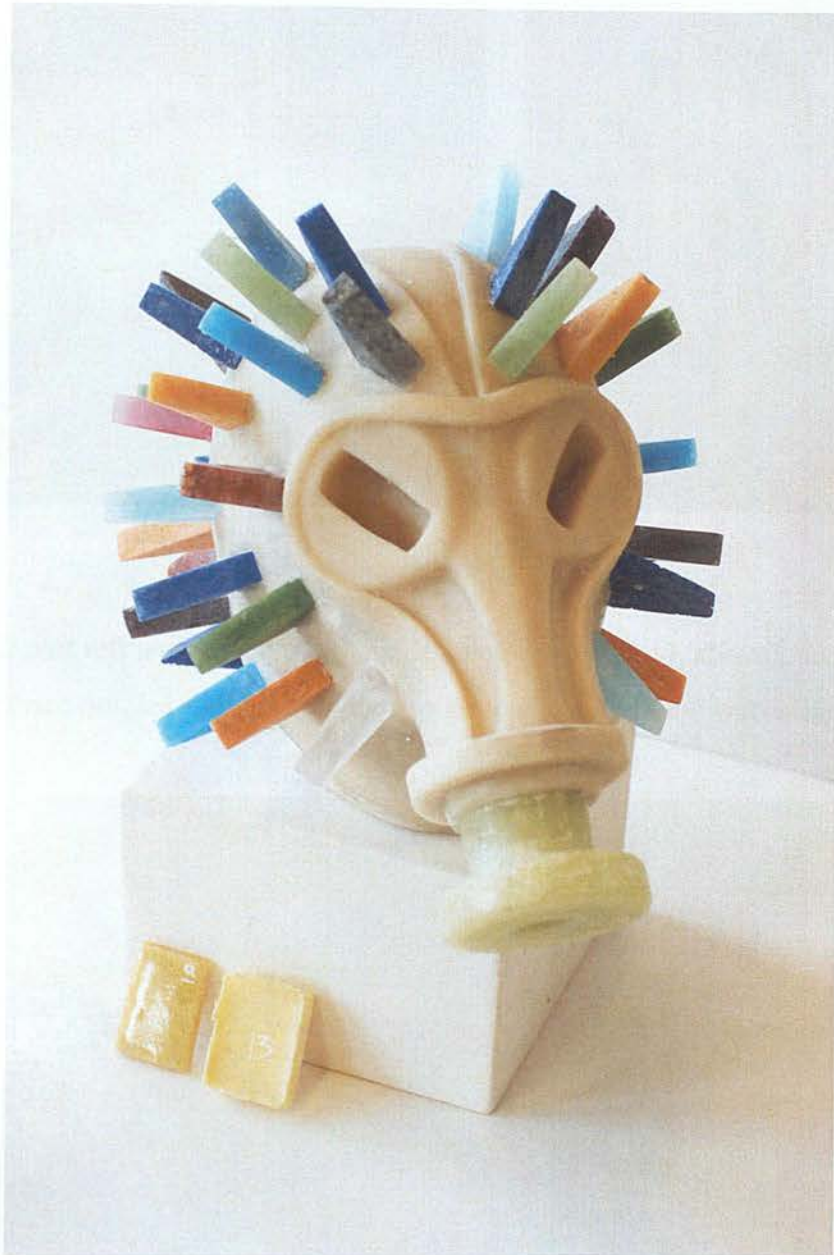


Fig 41.

7. The polished spikes were pushed into the wax using the location holes that had been established with the clay and plaster sculpt. A separate nose-horn had been made using formula G019: vanadium pentoxide @ 1g per 100g of glass frit. This was fitted to the wax, but removed before firing.



Fig 42.



Fig 43.

8. A 2-part refractory mould was made (see Fig 42 and 43, above), and the wax steamed out, leaving the coloured spikes embedded in the wall of the mould.



Fig 44.

9. A blue tattoo design was painted into the mould using powdered foundry glass and fat oil. The formula for the paint was B006. It was allowed to dry completely before a layer of glass paste containing formula G019 (vanadium

pentoxide @ 1g per 100g glass) was introduced over it. This can be seen as the orange pigment in Fig 45, below



Fig 45.



Fig 46.

Fig 46 shows the glass mask being revealed as the mould is removed. The colours in the spikes and the painted tattoo design have remained in the places they were positioned (Fig 47).



Fig 47.

5. A Duality of Sorts. No.1.



Fig 48.

List of formulae:

*a*... R012

*b*... G006. The formula was mixed with Zinc oxide @ 1g.

*c*... Y005: antimony oxide @ 1g with lead oxide @ 5g.



Fig 49.

Fig 49 shows one half of the wax shape taken from the death mask of Napoleon Bonaparte. I have added an ear and the back of the cranium. An open mould was prepared for this piece by building up layers of refractory mix over the wax (see Fig 50, below)



Fig 50.

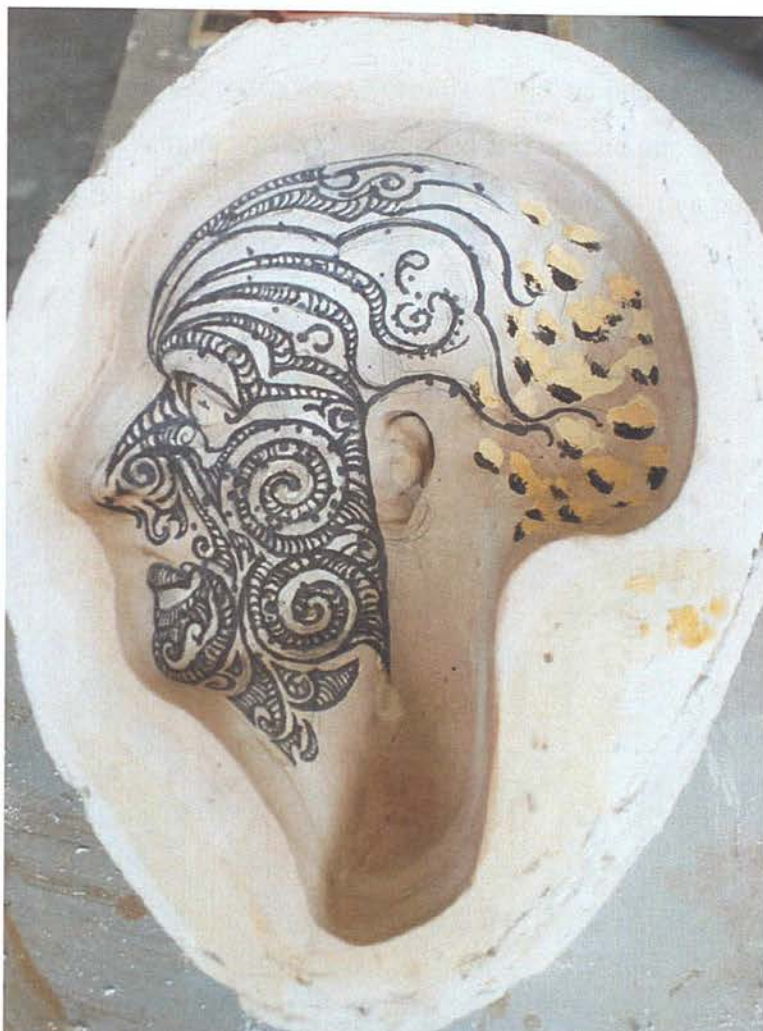


Fig 51.

Fig 51, above, shows the detail of the Moko (the tattoo design) having been painted into the refractory mould. The lines are fine and sit exactly where they were brushed in. In the final casting they have remained exactly in place with little or no bleeding. The yellow daubs representing hair have remained in place as well. Fig 51 shows a slightly different angle of the interior of the mould. These types of open moulds, similar in vein to those of Walter, make for a much easier application of painted detail and introduction of the coloured pastes.

To make an intense black of the painted lines I produced a sample of G006. It was crushed up to produce a fine powder, and mixed with fat oil. In order to ensure the salts were 'fixed' and would not disperse away from the mix, I introduced 1g of zinc oxide into the powdered glass, as Walter did when using his iron oxides. This ensured there was little travelling of the black paint marks and no bleeding of the line.

The yellow paint marks were made from Formula Y005, using antimony oxide and lead oxide as a flux. A sample was prepared, fired and ground into a fine powder, before mixing with fat oil. It was then applied into the mould with a paintbrush.



Fig 52.

Here in Fig 52. the lines of graphite pencil can be seen where I have drawn the Moko's design onto the surface of the refractory mould. The graphite marks burn off and appear to have no affect on the glass. The danger, though, is that the sharp point of the pencil pushes into the surface of the mould, thereby making a raised mark on the finished glass. The shellac toughens the surface layer of the mould thereby reducing the risk of this damage from both pencils and the glass pastes. They also can scuff the surface of the refractory moulds especially of the mould mix is a soft one.

The shellac also allows pencil marks to be actually made on the mould as an unshellac-ed surface does not allow the graphite to adhere.



Fig 53.

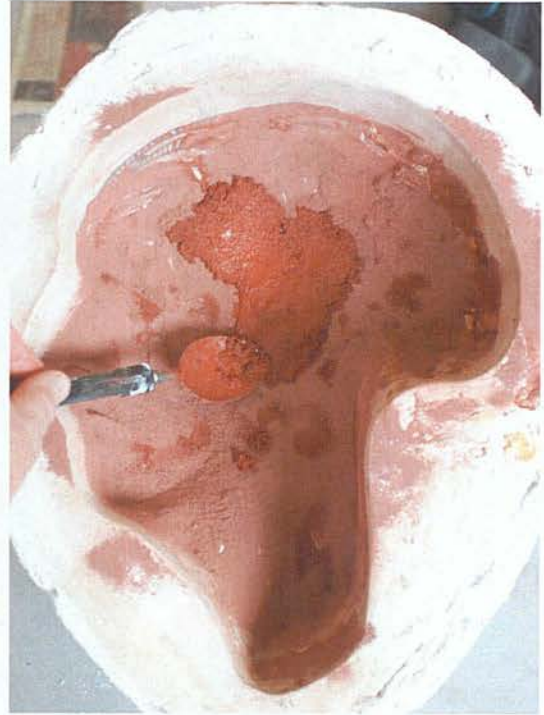


Fig 54.

A mix of Formula R012 was prepared. This incorporates 10g red iron oxide with 5g of zinc oxide per 100g of glass frit. Despite allowing the black and yellow paints to dry completely they remained quite fragile. To protect them from the next layer of pastes a dusting of the mixture was put over them (Fig 53). The rest of the R012 was mixed in with gum Arabic and water and then carefully put on top (Fig 54). This amounted to about 5 kilos of paste. A small, final layer of G001 (comprised of chromium oxide) was added in along with the reservoir ends of the spikes from the '*Dolly Mixture Sub-boi*' piece (Fig 55).



Fig 55.

The creative idea behind the addition of the reservoir ends of the spikes came from the collection of Tassie gems seen in Book I of this thesis. Unfortunately, the colours became absorbed into the mass of the red glass, the red iron oxide having polluted much of the chrome oxide during the firing (see Fig 56, below). A similar effect of the red iron oxide can be seen in Standing Man 3 Fig 104 on page 92.

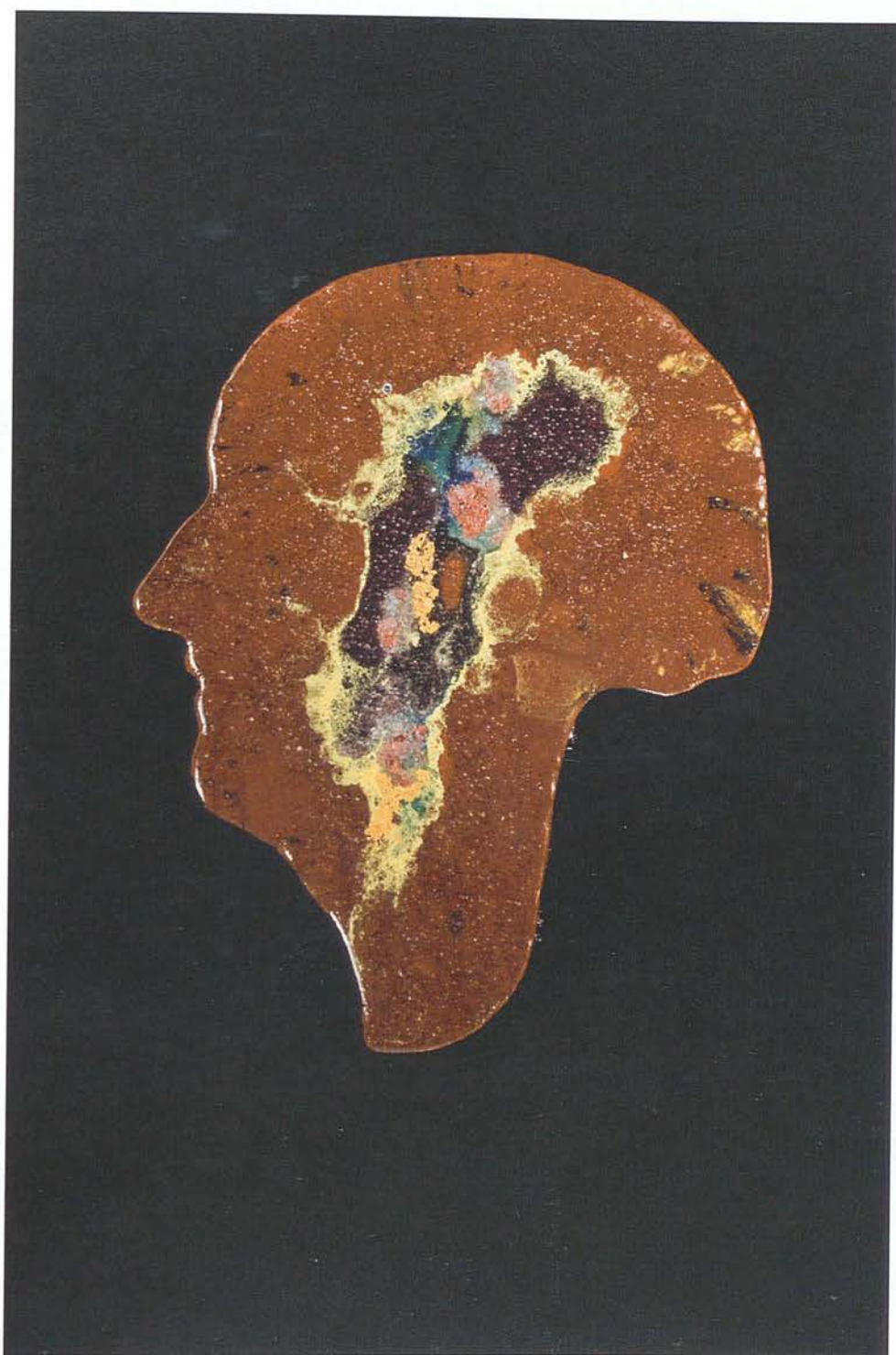


Fig 56.

A large tracing of chrome yellow is to be seen on the finished fired-polished side in Fig 56, above. This is formed from the mass of G001, but has become yellow instead of green. The red iron oxide has pushed its way upwards forcing the other colours to slump into the main body of the glass. The multi-coloured sprues have slumped inwards and most of their vibrancy has dissipated.

A Duality of Sorts. No. 2.

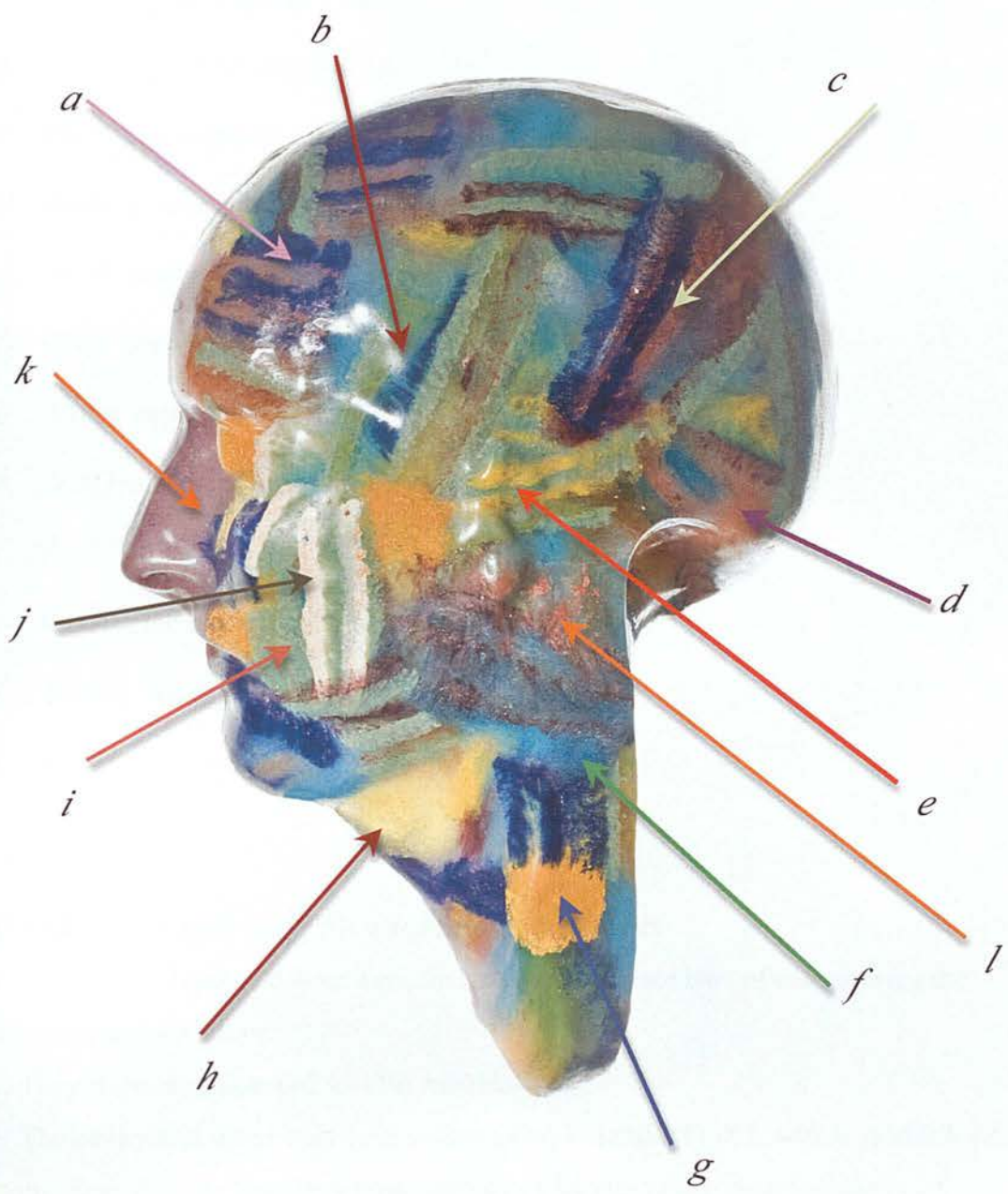


Fig 57.

List of Formulae:

*a...* B004: cobalt oxide @ 0.4g.

*b...* G002: chrome oxide @ 0.1g.

*c...* BV003: manganese dioxide @ 1.5g.

*d...* R019: rose on-glaze with vanadium pentoxide @ 1g.

*e...* Y005: antimony oxide @ 1g with lead oxide @ 5g.

*f...* B003: copper oxide @ 1.2g.

*g...* Y008: antimonate of lead @ 5g with lead oxide @ 1g.

*h...* Y003: antimony oxide @ 2g.

*i...* RH XX missing

*j...* W001: zinc oxide @ 10g with tin oxide @ 5g.

*k...* BV001: manganese dioxide @ 0.3g

*l...* R004: red iron oxide @ 3g.

The effect seen here in Fig 57. was made in three stages:

1. The painted lines of colour were first made as separate bars of colour using the formulae quoted above.
2. They were then slumped into the mould.
3. The cavity was filled with solid colour using Formula BV001, which used 0.3 g of manganese dioxide, and the whole mass was taken up to casting temperature of 820° C.

## 6. The Spite of No-Hope.



Fig 58.

I chose to use Formula BV014 for this work. The manganese carbonate in it produces a dark purple, volcanic rock-like glass. In its sample form the result is a much more aerated structure. In this piece, however, the structure is denser with smaller bubbles. This may be due to the enclosed mould the glass and salt were contained in having an effect on the gas exchange. As can be seen in the top part of the helmet, (indicated by the green arrow  $x$  in Fig 58) the colour of the purple darkens. This part of the glass mix is closer to the opening of the mould, which would allow the glass to be in a more oxidising atmosphere. Figs 59 and 60 (below) shows the space of the reservoir/mould opening (the top of the helmet), which has been filled with the BV014 coloured glass as its volume it has expanded with the release of gases.



Fig 59.



Fig 60.

The glass in the reservoir's space had to be cut off. I had anticipated that there would be this expansion, but not to such an extent. I had allowed for a 10% reduction in the amount of glass used to compensate for the expansion of the volume, but this was an underestimate. When the glass helmet was de-moulded it was noticeable that the refractory mould mix adhered to the surface of the form. It took a great deal of time and effort to remove it. There was also a lot of metallic salt residue left on the surface of the form, particularly at the bottom of the piece. This is presumably where it had fallen to the bottom of the mould and had not reacted with the glass. Fig 60 shows the form after it had been scrubbed clean.

The bubble of green and clear glass (indicated as *b* in Fig 58) is the uranium oxide test made by Derek Walls, and which is reported in Book II. The stand is made from a combination of rubber-painted steel and electrical cable.



Fig 61.

The clear amber-coloured glass fragment of skull was cast using Gaffer Glass casting crystal Mid Yellow (G242) with Yellow/amber (G245) @ 10%. The finished piece was polished and then attached to the Helmet using silicone sealant (seen in Fig 61).



List of formulae:

*a...* G014 (foundry) : placed in as 3-4mm frit.

*b...* B006 (foundry) : placed in as 1-4mm frit.

*c...* G005 (foundry) : placed in as powder and 1mm frit.

*d...* Copper oxide @ 0.25g + Magnesium carbonate @ 1.5g in fine powdered frit.

*e...* Y006 : premade sample, crushed, placed in as 1-4mm frit.

*f...* G025: premade sample, crushed, placed in as 1-2mm frit.

*g...* W001: premade sample, crushed, placed in as 1-4mm frit.

*x...* G014: (foundry) : ground to a fine powder, mixed with fat oil and brushed in.



Fig 63.

In Fig 63, above, a plaster reproduction of a clay positive was made and worked on until the final shape was achieved. Here I have used silkscreen mesh to give the surface of the plaster a smooth polish. Casts, in silicone rubber, were taken from all the elements involved in this mask (the head, the floret ear pieces and the roundel)

and waxes produced. The silicone rubber mould allowed for undercuts and fine detail to be preserved. It is also simple to remove from the mould, as it is flexible.



Fig 64.

Fig 64 shows elements of the *'Mayan Christ'* and *'Dolly Mixture Sub-boi'* being prepared in wax. The silicone mould for the roundel can be seen bottom right.

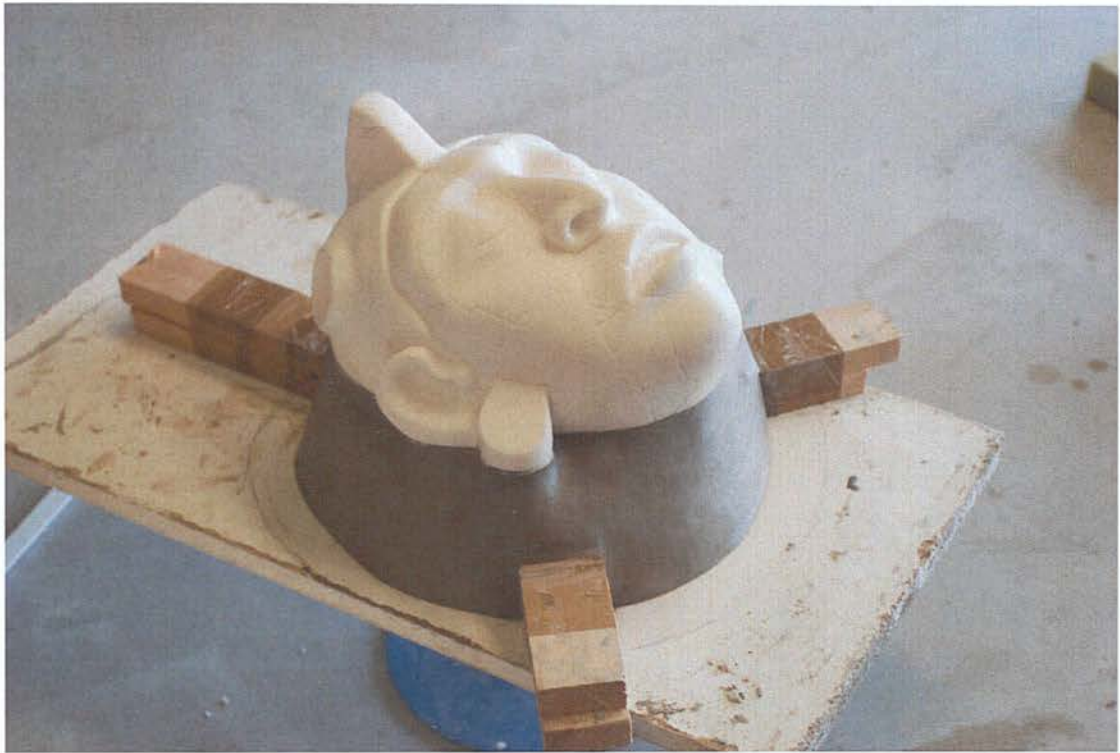


Fig 65.

The silicone positive was placed on a clay mound, which will form the reservoir for the mould. Wooden blocks were incorporated into the clay mound. These produce spaces for the location of the arms of the floating inner core (see Fig 71). A layer of refractory mix was poured over the shape and further layers built up to complete the mould.

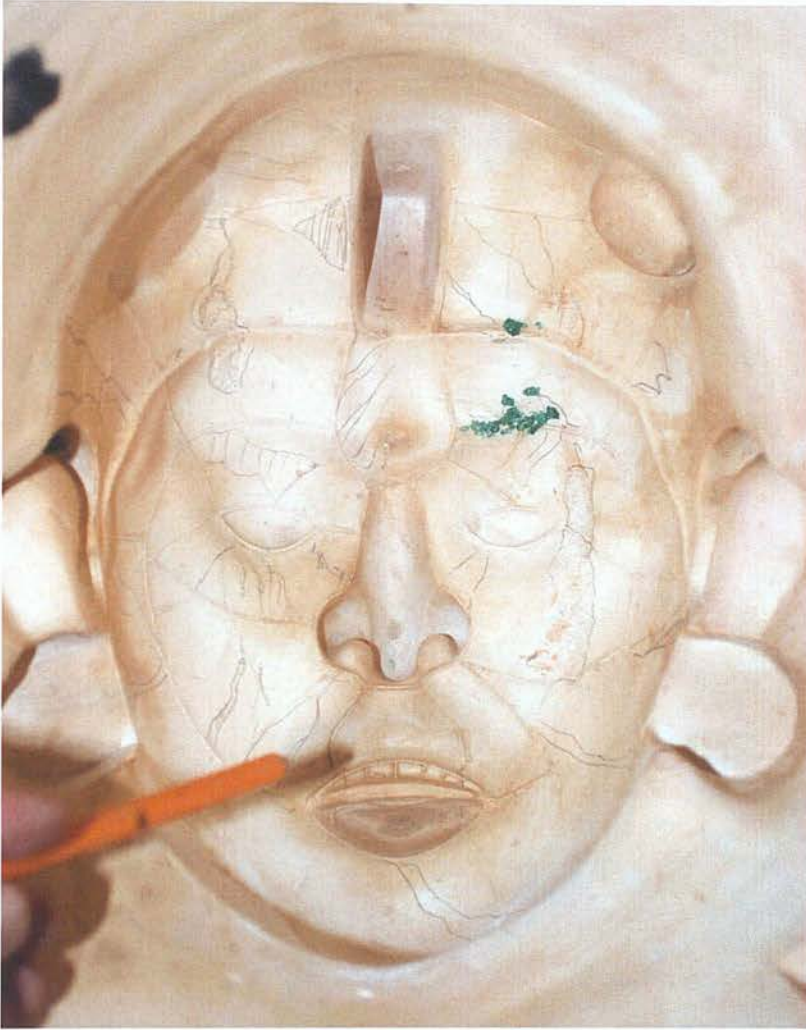


Fig 66.

Once the mould was dry the silicone rubber was removed. Shellac was painted into the interior and allowed to dry. The complex areas where colour was to be placed were lightly drawn in using a pencil as can be seen in Fig 66, above.



Fig 67.

The first layers of glass pastes (G014) were then introduced using a mixture of frit and powdered glass mixed with fat oil (Fig 67, above).



Fig 68.

The next layer of colours was introduced (B006, G005, Y006 and W001) before being back-filled with G025 (Fig 68). This final layer of 5 kilos of colour was prepared by making large tablets of approx 20cm x 15 cm x 1.5cm, which were fired into shallow moulds (see Fig 69, below).



Fig 69.

Several of these tablets were made before being broken up into small chunks in with a pestle and mortar (Fig 70, below). They were ground down to a coarse frit before mixing with gum Arabic and being placed into the mould.



Fig 70.



Fig 71.

A floating inner core was prepared from the refractory mix to create the cavity in the back of the mask. This was fitted into the mould, the arms being located into the slots prepared for them when the mould was made (see Fig 65). Fig 72, below, shows how they are slotted in.



Fig 72.

Fig 72: Just before firing the inner core was pushed down to locate its arms into the slots. To prevent it from moving during firing the arms were secured in place with wire and a smeared layers of refractory mould mix and fibreglass strands.



Fig 73.

Fig 73 shows the mould just after completing its firing programme. This method of preparing such an inner core is a successful one.



Fig 74.

Fig 74 shows the mask being worked on. The surface was polished using a Foredom Multiflex with tools I make myself from diamond and resin pads. In this image I am cleaning up the mosaic lines using a jeweller's file.

8. The Phallus.

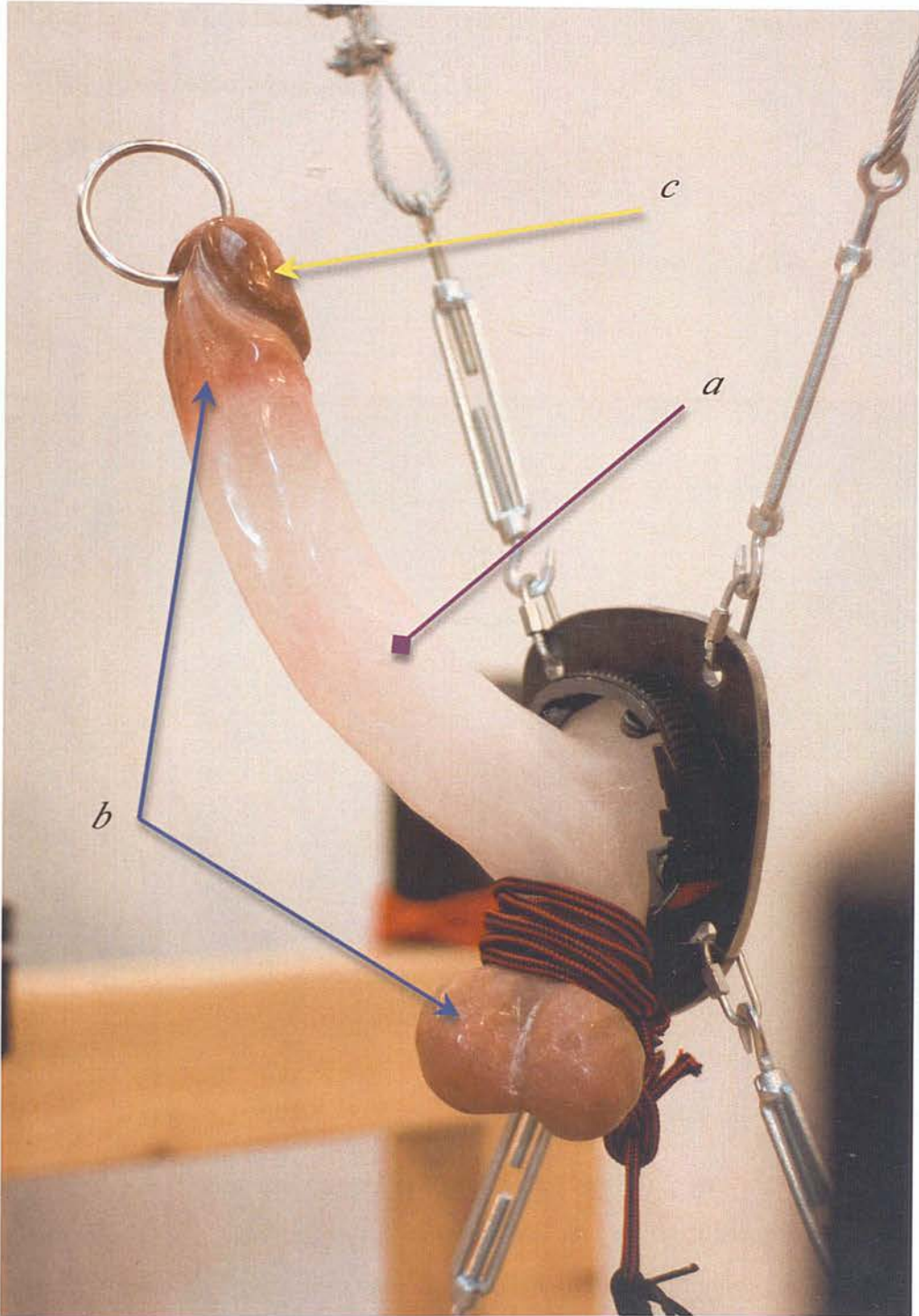


Fig 75.

List of Formulae in Fig a.

*a*... Clear Gaffer Glass lead crystal.

*b*... R018: Rose-coloured on-glaze @ 0.25g.

*c*... R020.



Fig 76.

The phallus was cast in two stages. The first stage (Fig 76) began with the formation of the phallus using glass pastes to create the head and testes of the piece. The main shaft was filled with 4mm frit in clear lead crystal mixed with a tiny, indeterminate amount of pink on-glaze (R018).



Fig 77.

As it was de-moulded it became clear the pink was too intense a colour for the piece, making it look comical (see Fig 77, above).



Fig 78.

To rectify this problem the head and testes of the cast piece were cut off and remodelled into another wax shape, as can be seen in Fig 77, above. The whole piece was then cast and fired again with clear lead crystal in 4mm frit being put into the shaft. The surface was finished to a high polish that is seen in Fig 75.

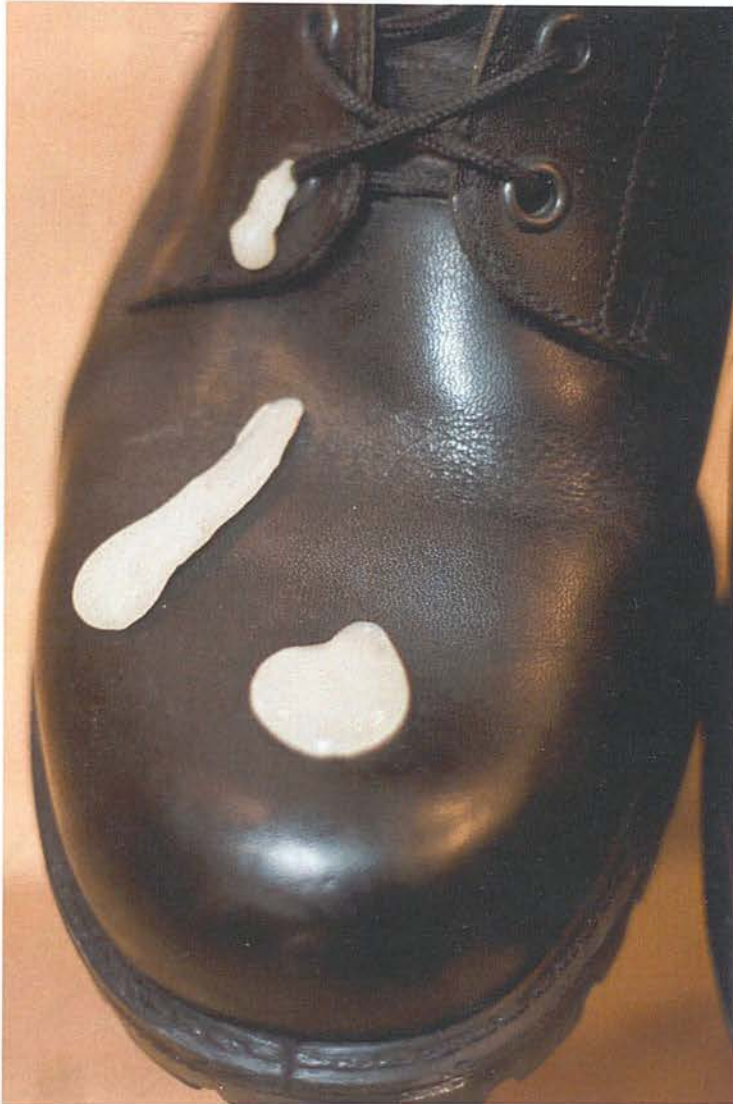


Fig 79.

The seminal ejaculate (seen in Fig 79, above) was produced by producing a separate sample of W007 using Crocus Martis @ 0.25g, which was then crushed to a frit of about 0.5 – 1 mm. It was then mixed with about 20% of clear lead crystal frit of the same size. The shapes were piled on a kiln shelf and fired to 800° C for one hour to achieve the effect seen here .

9. The Objects of My Desire.

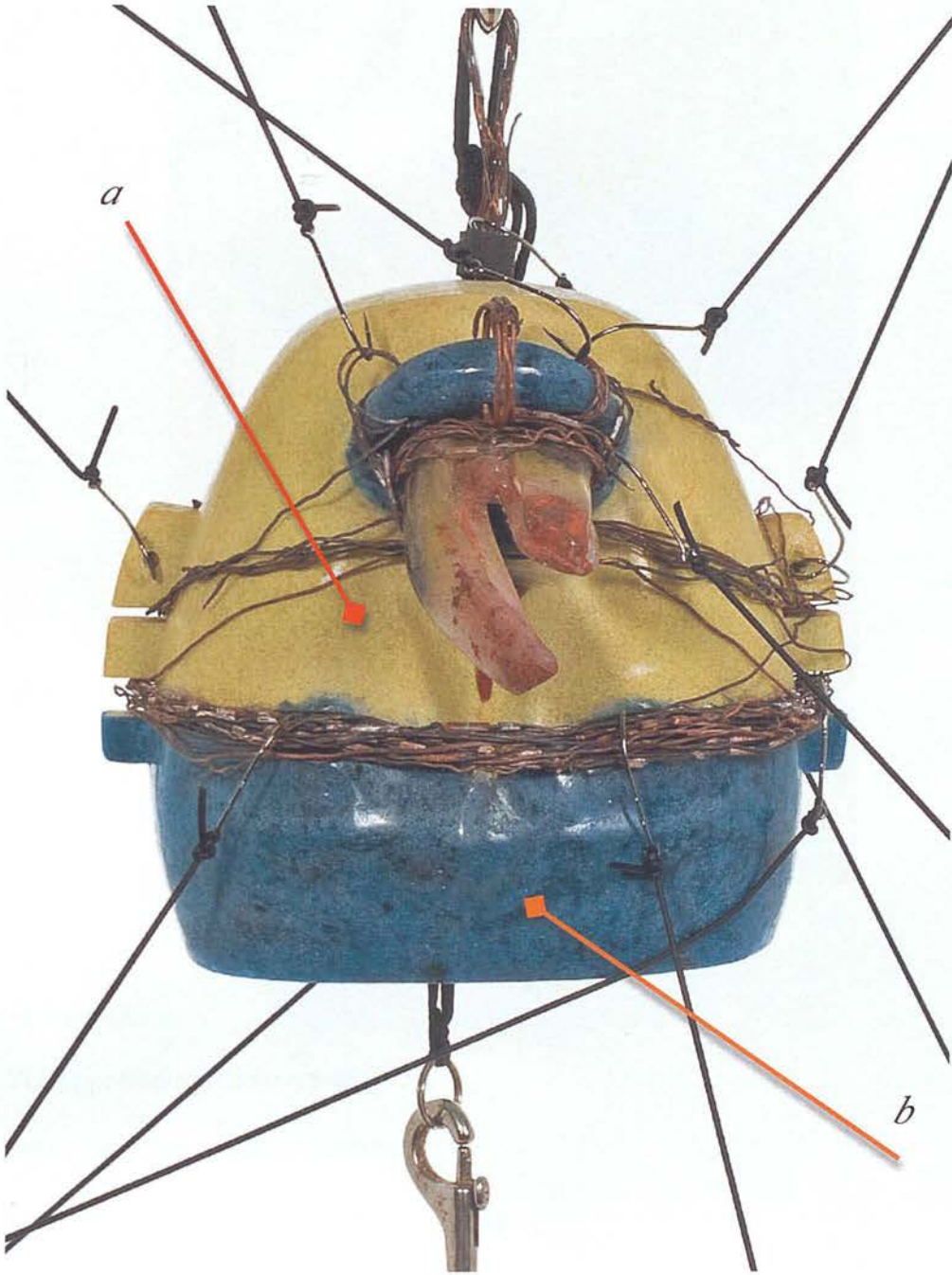


Fig 80.

List of Formulae:

*a*... G008: chrome oxide @ 0.1g with tin oxide @ 5g.

*b*... B019: copper carbonate @1g with cobalt carbonate @ 0.1g  
with zinc oxide @ 5g.

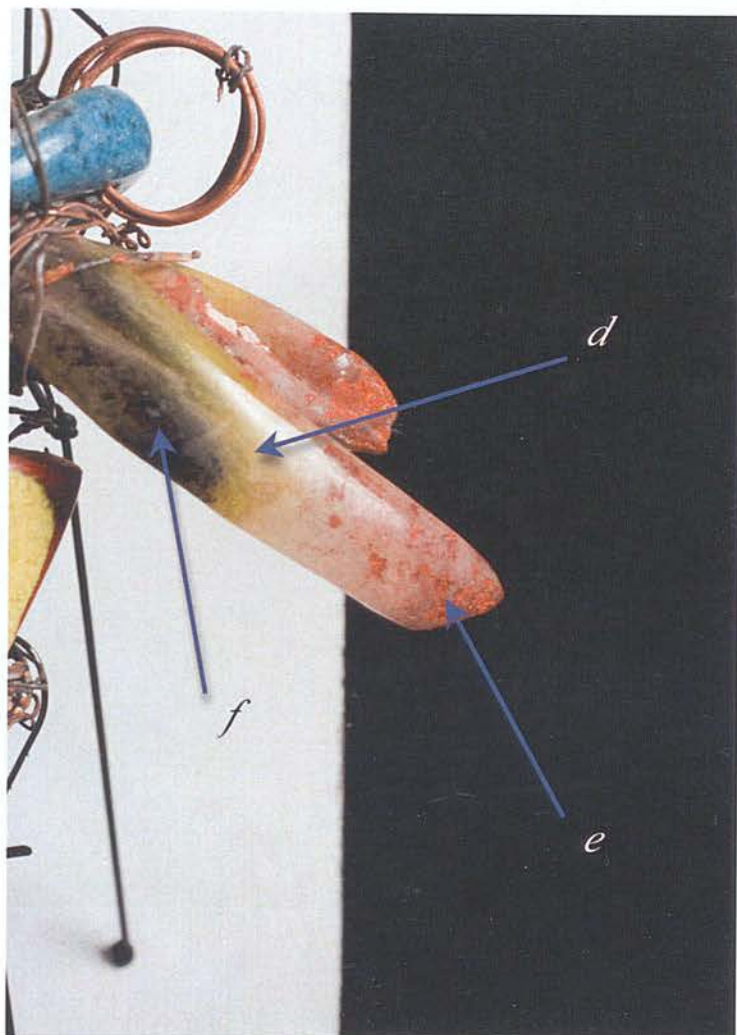


Fig 81.

List of Formulae:

*d*... Y001: potassium dichromate @ 3g.

*e*... R003: Red Iron oxide ( $\text{Fe}_2\text{O}_3$ ) @ 1g.

*f*... BV002: Manganese dioxide ( $\text{MnO}_2$ ) @ 1g.

The process in Fig 82 was straight forward. The two colours were prepared as large sample tablets, crushed to the size of 1- 4mm frit and put separately into the prepared mould. An image of the process is below in Fig 82.

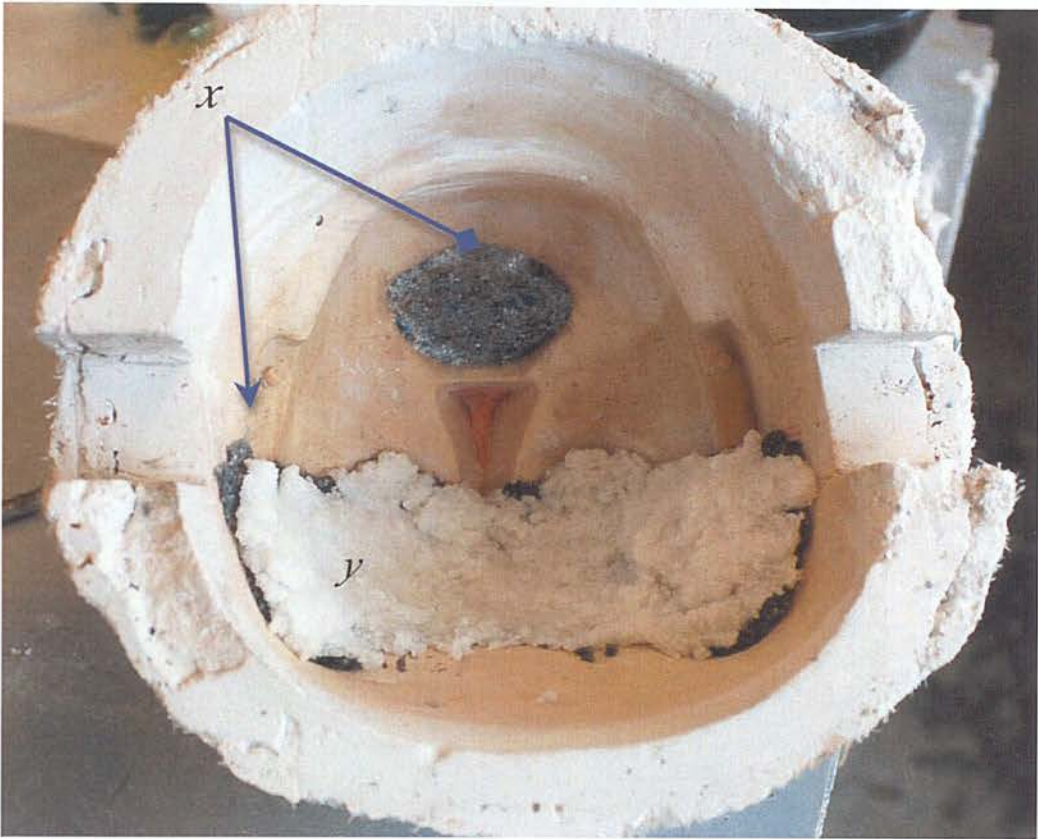


Fig 82.

Formula B019 is indicated by the letter 'x' in Fig 82, above. It was pressed into the mould and allowed to dry before a layer of fine powered clear glass paste ('y') was added on top. This was allowed to dry as well before the G008 was added. The layer of clear glass paste prevents the two colours from contaminating one another too much. As can be seen in the finished work in Fig 80 the two colours did not interact very much where they met. A clear definition between the two colours was achieved.

10. Sex with Cyanide: In the Mind of the Autoerotic Asphixionist.

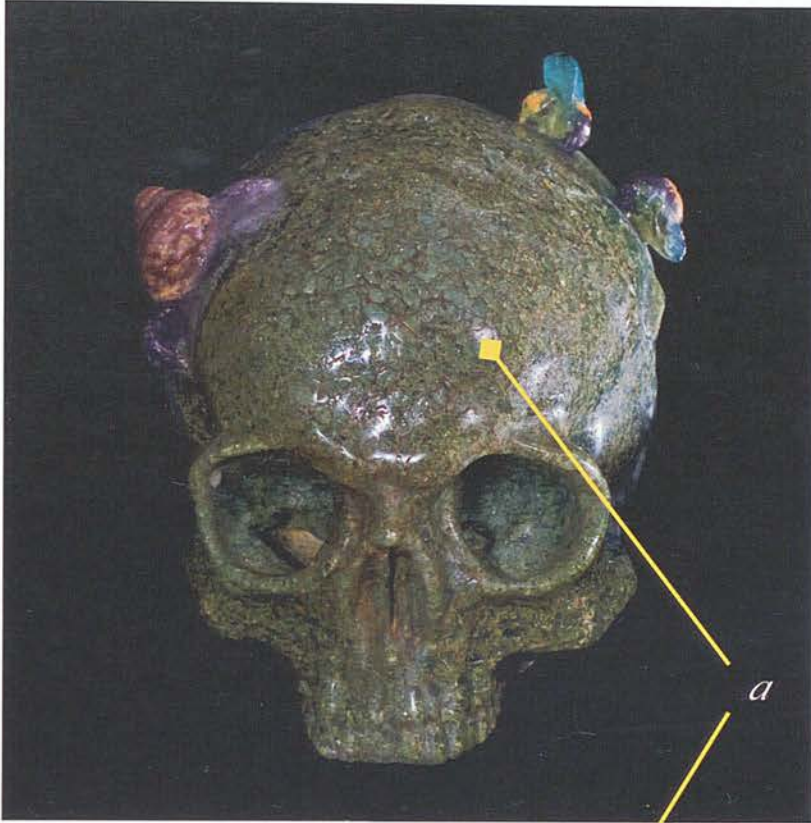


Fig 83.

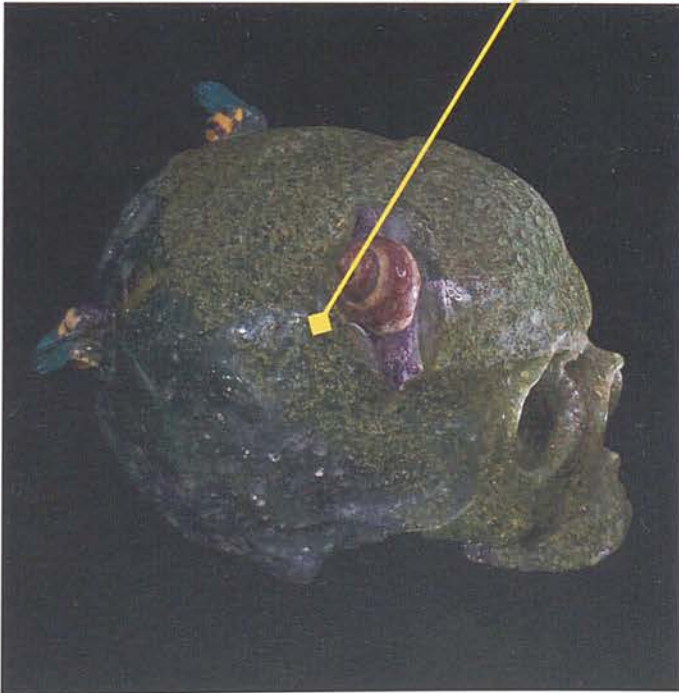


Fig 84.

List of Formulae:

*α*... G004: chrome oxide @ 0.4g.

The skull was made from Formula G004 being mixed in with a large sized frit with a diameter of about 4mm. The discrepancy in colour in the two greens is due to wax deposits remaining in the mould. This was a result of the type of wax being changed in Edinburgh College of Art's Glass Department. The new wax (from which the skull was made) had a higher melting temperature than its predecessor. This resulted in deposits of wax remaining on the refractory mould's surface despite a thorough cleaning with steam and boiling water. Those deposits have burnt off during the firing process but have discoloured the glass leaving some areas grey. The structure of the glass melt has also been affected. Instead of a solid mass (seen in the top half of the skull and indicated *α* in Figs 82 and 83), the glass is aerated with gases.

The process of making this piece is described below.



Fig 85.

The wax skull was placed on a clay mound (see Fig 85), which was to become the reservoir of the mould. The skull was covered in refractory mix producing a one-piece semi-open mould. The glass frit containing the G004 Formula was packed into the cavity and fired to 800° C. To ensure the pieces of frit were just fused the kiln was held at this top temperature for one hour.

The bees and the snail were made separately and located into the wax in the same way as the spikes of the *'Dolly Mixture Sub-boi'*.



Fig 86.

The wax positives of the bees and the snail were cast up in cottle moulds. They are seen here, in Fig 86, awaiting the refractory mix.



Fig 87.

Fig 87, above, shows the cavity of the bee's shape being painted with colour.

The paints for the bees and the snail were created using finely ground colour mixed in with fat oil. The cavity was back-filled with premade Gaffer Glass colour: Lime green (G236) and Lagoon (254).

The formula for the colours are listed below:

The bees:

Black: GB008 with zinc oxide @ 1g.

Yellow: Y005.

The snail:

Brown: BV010 (foundry)

Black: GB008 with zinc oxide @ 1g.

Yellow: Y005.



Fig 88.

Fig 88 shows the snail having had its details painted into the shape. The cavity was back filled with pre-made Gaffer Glass lead crystal colour.

## 11. The Standing Men.

Although the end results are visually very different all three Standing Men were created in very similar ways. A clay model of a silhouette was made before being covered in refractory mix. The clay was pulled out and the cavity filled with both premade colour and colour using the formulae in Appendix 2. The process to arrive at the finished pieces involved 2 or 3 firings. The reasons are discussed below. All three had designs made for them. As the firings progressed the designs grew less important and the effects took over.

The purpose behind these 'Men' was to see how the formulae I had created stood up to firing in relatively shallow open moulds in the manner of Walter. Due to the size of the pieces and their moulds the kiln used was one employed for slumping and fusing. It had elements only in the ceiling of the lid and there were issues around insulation and temperature control. The kiln's controller itself was not reliable. At 700° C the controller ramped up the heat at 110° C per hour, which made for an unreliable firing. It was impossible therefore to control the temperature and the length of its hold. With a more reliable kiln it would be possible to record exactly how these formulae worked in such moulds.

Standing Man: No.1.

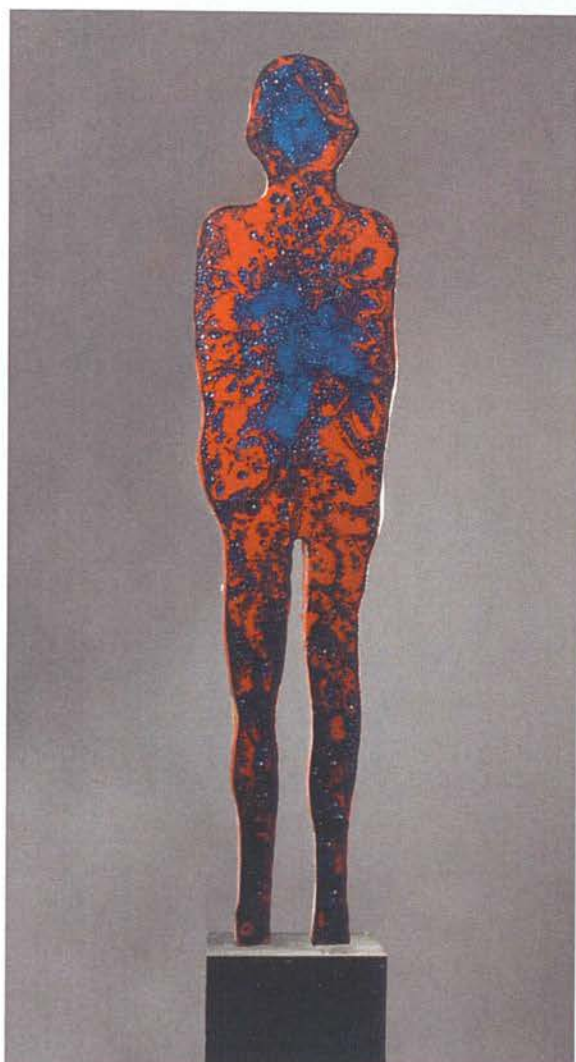


Fig 89.

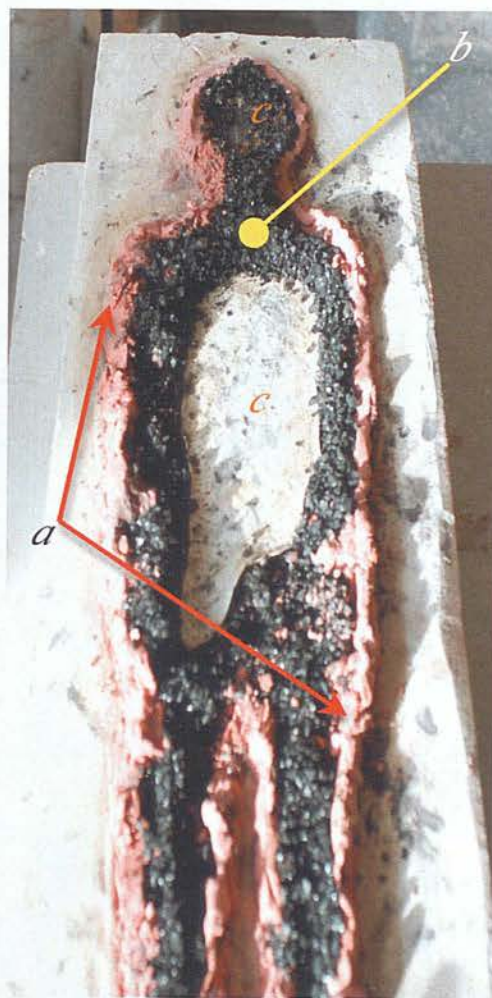


Fig 90.

To achieve the effects seen in Fig 89 the walls of the mould (of the piece to be cast seen in Fig 90) were packed with a red blowing glass from Gaffer Glass (*a*). It is a dense opaque red and the frit was a fine powder. The rest of the cavity was then filled with B006 (cobalt oxide @ 1.4g) mixed with a clear lead crystal frit about 4-5 mm in diameter (*b*). The 'chest cavity' of the figure (*c*) was filled with a solid refractory plug. A similar plug was placed in the head area (although it is not clear in the image in Fig 90, above) After the first firing the plug was removed and the cavity was then filled with B018 (copper carbonate @ 1g). The effects of the copper carbonate may be seen in Fig 92, below, and marked by *c*.



Fig 91.

In Fig 91, above, the mould's internal walls have been packed with the red blowing glass. The pâtes-de-verre has been allowed to dry completely before the cobalt oxide mix is introduced into the mould.



Fig 92.

Fig 92, shows the same piece after its firing and before it was removed from the kiln. The combined chemical reaction of the cobalt oxide and the copper carbonate made for a messy casting. Until I began polishing I had little idea of what lay beneath the surface. The end effect is one of brain patterns, and melds in with the original idea that these 'Men' would be slices of matter on a microscope slide as can be seen in Fig 93, below.



Fig. 2.11: Brain hemisphere with subarachnoid hemorrhage and brain-stem hemorrhage following a stroke.

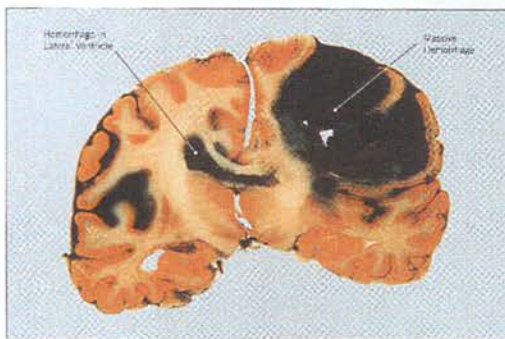


Fig. 2.12: Brain slice with massive hemorrhage following a stroke.

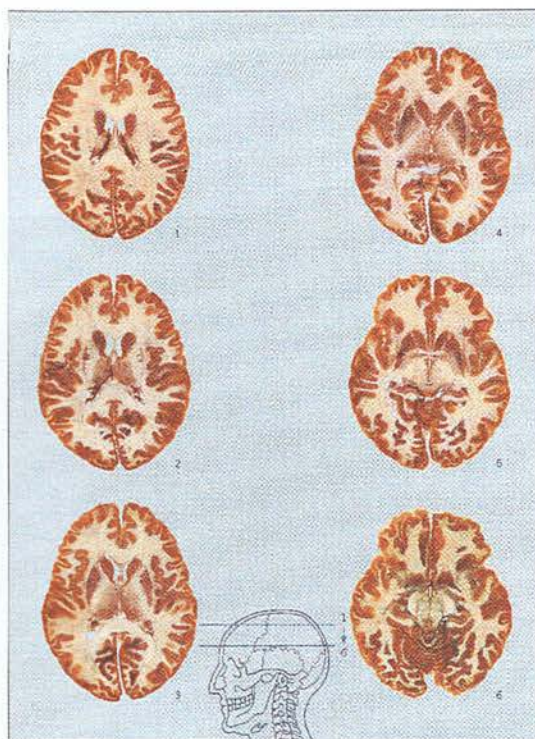


Fig 93.

Standing Man: No.2.



Fig 94.



Fig 95.

The original design can be seen laid next to the mould in Fig 95, above. Areas of premade colour using Gaffer Glass casting crystal and Y005, which corresponded to the colours in the ink design were laid into the mould. They had been cast in sections and followed the shape they were to represent.



Fig 96.

Fig 96 shows the packed mould. The areas of white coloured glass are finely powdered clear lead crystal. Ceramic fibre paper and bricks were used to tightly pack the mould in case the mould cracked and the molten contents escaped.



Fig 97.

Fig 97 shows the cast piece before removing from the kiln. After it was de-moulded the piece was covered again with refractory mould mix. This time the fire-polished surface was imbedded in the plaster mould mix. An identical firing was made, which allowed the white (clear glass), which had risen to the surface of the casting to push through the more solid green layers underneath. The effect is seen in Fig 98 below and is akin to the original Gormley watercolour design in Fig 99.



Fig 98.



Fig 99.

Standing Man: No.3.

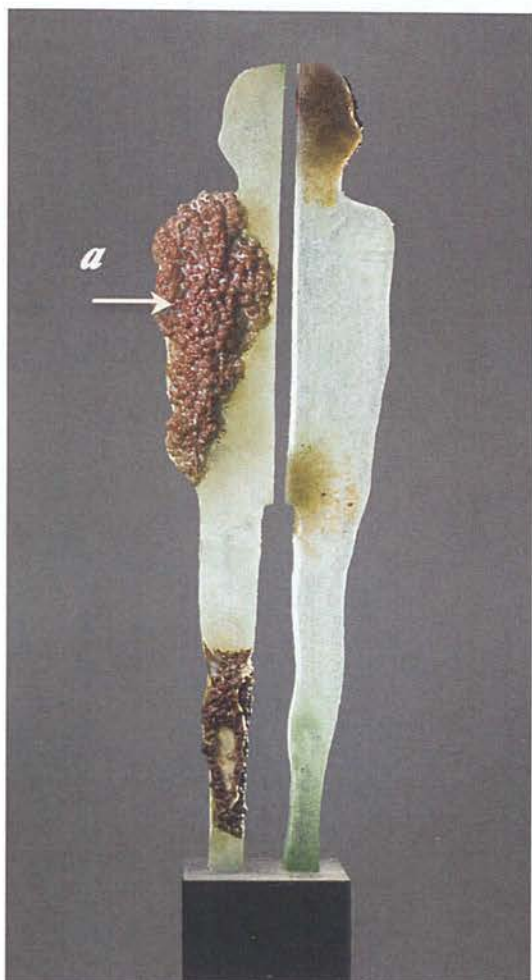


Fig 100.

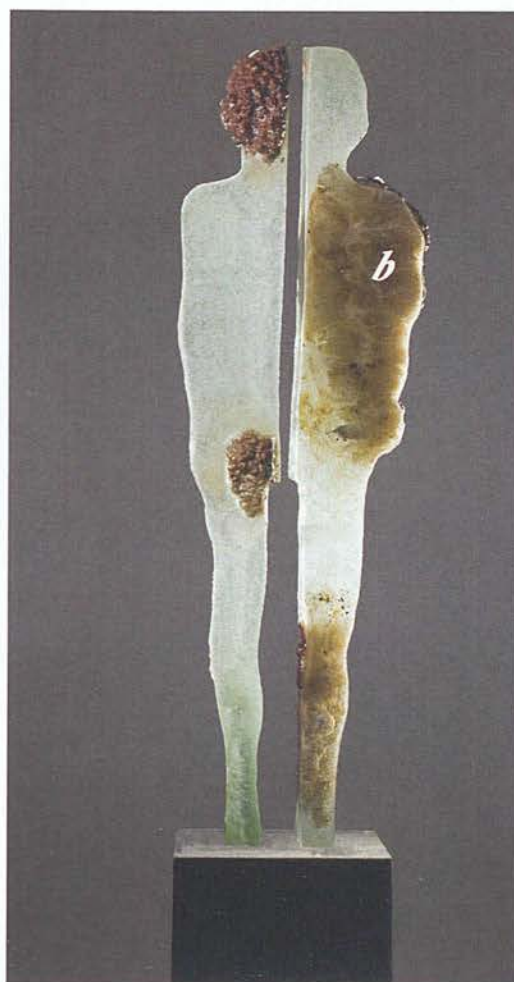


Fig 101.

The Man in No. 3 was made in two halves and can viewed back and front (Figs 100 and 101). The red- brown crustated areas (indicated as *a*) can be seen on the reverse of the form as *b*. These elements were made as separated pieces (of pates-de-verre) using R004. After they were de-moulded and cleaned -up they were then embedded into the wax form of the Man and recast with a back-fill of chrome oxide @ 0.005g: that is half the amount in G001.



Fig 102.



Fig 103.

Figs 102 and 103 show details of the red elements after their second firing.

Fig 104 and 105, below, show the pâtes-de-verre being laid in place into the moulds before firing.



Fig 104.



Fig 105.



Fig 106.

As can be seen in Fig 106, above, the iron oxide of G004 has moved through the chrome-coloured glass producing a mass of tobacco brown colour.

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## Appendix 10:

**James Tassie (1742-1798).**

## APPENDIX 10.

### JAMES TASSIE (1742-1798).

#### Introduction

James Tassie is important to this research paper as he is a key to opening up the world of the 18<sup>th</sup> century gem and paste makers, and through them the larger history of glass pastes. By studying his work, along with the catalogue of his work assembled by R.E. Raspe, I have been able to glean an understanding from where pâtes-de-verre originated and have begun to trace its lineage. What has emerged from this area of study is that 'pastes of glass' have a long continuous history. In his essay on Henri Cros in 'Particle Theories', Olivié admits that Tassie was maker of pâtes-de-verre (Olivié, 2005). This is a significant statement from an authoritative (French) source as it allows one to look back from Henri Cros's developments and encourages a freedom of exploration in historical terms. The information here gives a background to Tassie and his education, as well as a formula for his glass pastes commissioned by the late 19<sup>th</sup> century historian and curator John M. Grey.

The wider development by 18<sup>th</sup> century scientists of the process of analysing ancient glass and how it is linked in with Henri Cros and his work (and by inclusion Walter) is discussed in Book I, Chapter 6.

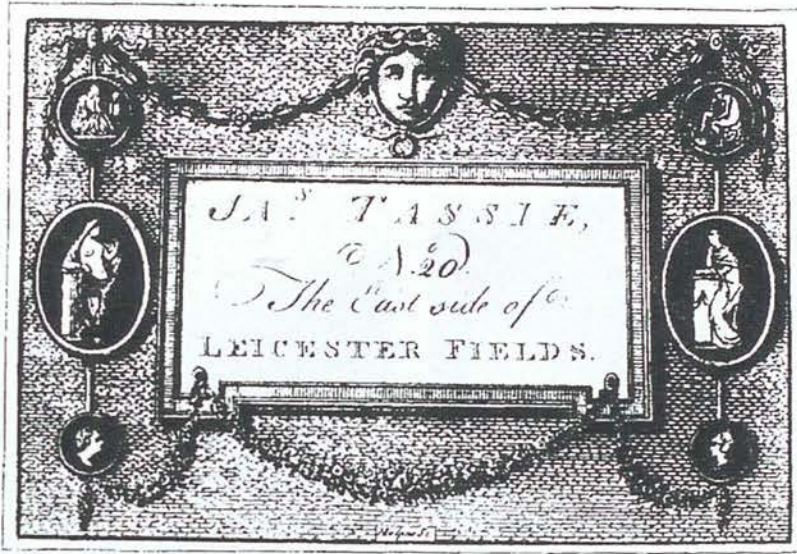


Fig 1. Trade card of James Tassie when he was established at  
No.20 Leicester Fields, now Leicester Square, London.

The most celebrated of 18<sup>th</sup> century Europe's gem makers was the British maker James Tassie (1742-1798). He was born in Eastwood, Pollokshaws near Glasgow and trained as stonemason before studying art at the Academy in Glasgow. He finished his training in 1763 and travelled to Dublin where he was introduced to Dr. Henry Quin, King's Professor of Physic in the School of Physic, Dublin University. Under Quin's tutelage Tassie became familiar with the processes of taking casts from original Roman gems stones (i.e. intaglio seals and cameo ware) and began to experiment alongside the professor. Quin based his methods on the work of Guillaume Homberg, the 18<sup>th</sup> century chemist who was employed in the laboratories of the French Duke of Orleans, but here is no doubt he and Tassie experimented and developed their own techniques and methodology. Together they are attributed with developing the 'white paste composition' or vitreous paste glass, which Tassie was to use throughout his career (see Fig 3) (Smith, 1995). On Quin's advice and encouragement Tassie left Dublin in 1766 and settled in London where he set up his own establishment in Leicester Fields (later known as Leicester Square). He rapidly grew successful and the rich and fashionable, who met there on a regular basis, frequented his workshops. By

using the iconography of Greek and Roman bas-relief carving Tassie made his own versions of the ancient world's portraiture and transferred its iconography to the modern 18<sup>th</sup> century.



Fig 2. Portrait of James Tassie by David Allen. The Scottish National Portrait Gallery. Tassie is shown holding one of his medallion portraits.



Fig 3. Profile busts of the Roman Emperors by James Tassie in his signature white vitreous glass paste.

The fashion for collecting 'gems' began in the 17<sup>th</sup> century with tourists wishing to bring back memorabilia in the form of original mementoes from their visits to Italy and Greece. The fashion for young aristocratic men, as part of their education, to experience the Greek and Roman classical world in its own setting meant the ancient world was being opened up and plundered for its knowledge and its artefacts. The discoveries of Pompeii and Herculaneum sent shock waves through Europe as for the first time the ancient world could be seen in colour. This need to have a souvenir of their experience was not confined to British tourists. French, German, Danish, Russian visitors to Italy and Greece all required an actual piece of the place to take home with them. They felt that by collecting original pieces of Roman and Greek art, such as existed, they could ally themselves to the increasing political and artistic

influences the Classical world had on the emerging 18<sup>th</sup> century desire for observational enquiry (MacFarlane, Martin, 2002). 'Gems', as they soon became called, were the objects to collect. A brief analysis of them shows they are essentially small pieces of jewellery. Signet rings, seals, pieces of necklace, cameo heads to be mounted on other artefacts. Some were made out of precious and semi-precious stone, and some made from glass. Their desire and fashion grew out of lack of other real, tangible objects. Frescoes were few and far between. Glass and ceramic objects tended towards the domestic and mundane, unless one was lucky with something like the discovery of the Portland vase, and manuscripts from antiquity did not exist in any large numbers outside of monastery libraries. The ability to purchase (or take) large portions of classical temple remained for the few multi-millionaires such as Elgin. These 'gems' were therefore affordable and readily available. Jewellery is by definition attractive and transportable, and a market grew up with the noblemen of Europe vying with each other as to who could have the most interesting cabinet. As the demand outstripped the supply fakes grew (Smith, 1995).

Early collectors of these fakes were obviously under the impression they had bought the real thing, and remained ignorant of their deception until proved otherwise. That forgeries were around showed, in Italy at least, there was a tradition of making small objects from glass pastes, which had had to have been learned somewhere. The change in attitude to forgeries came, however, with the development of plaster casts of originals sculptures as useful tools for instruction the arts for those who could not see the real thing or possess the original. Phillipp Daniel Lippert (1702-1785) of Dresden was amongst the first to produce plaster cast of the intaglio gems, but included in their sale a manuscript catalogue and letter of authentication (Smith, 1995). It changed the way an 18<sup>th</sup> century audience viewed the forgeries. If one could not have the real thing a copy was ideal. The work of the reproducer became celebrated, and the best makers were regarded as artists.

Cultivated British aristocrats home from their Grand Tours in Italy, as well as the artistic intelligencia of the urban salons who had a desire to align their tastes to that of Classical Rome, Robert Adam and the Enlightenment, collected Tassie's work. As they went across Europe (to collect more) so did his reputation. Tassie himself went to France and purchased from Mademoiselle Feloix 200 of her gems. Feloix had

learnt her craft from her father who had been in the employ of the Duke of Orleans making reproductions of gems under the direction of the German scientist Guillaume (or Wilhelm) Homberg (1652 – 1715). It was Homberg who had made the breakthrough in the discovery of how to analyze the composition of ancient glass in 1714 in France. He published his experiments on the saturation of bases by acids in the *Recueil de l'Académie des Sciences* (Homberg, 1712). Homberg employed a new instrument of analysis (the burning glass) and was able to correlate its products with those of existing chemical methods of distillation and solution. In 1691, he had given the first modern definition of mineral salts, which has remained true today (Holmes, 1993).

Homberg's clarified method of analysis and description rapidly became established technique in laboratories around Europe. Later, when his work entitled 'Manière de Copier sur le Verre Colore les Pierres graves' ('The Manner of Copying Engraved Gem Stones with Coloured Glass') was posthumously published in 1732 by the *Memoires de l'Academie des Sciences*, makers of glass utilised his work to reproduce and mimic the fabled qualities of Roman glass pastes (Homberg, 1712). Dr Henry analysed Roman glass in this way in the 1760's (Kirkpatrick, 1919). Although Quin had a small furnace he utilised the methods of Homberg exactly (Smith, 1995), which would suggest the process was easily followed and reproducible.

The simple and destructive method of dissolving a piece of ancient glass in acids and extracting the results gave Quin the composition of the salts and other components that comprised the original material (Smith, 1995). The data could then be used to 'rebuild', as it were, a modern version. The original piece would be destroyed, but invaluable knowledge was acquired. Ironically this process was applied once again, but on a piece of Tassie's, in 1894 by John M. Grey (Curator of the Scottish National Portrait Gallery and Keeper of the Tassie Collection), when Grey was compiling his work about James and William Tassie. He asked Alexander Crum Brown (Professor of Chemistry at Edinburgh University between 1869-1908) to discover what the composition of Tassie's glass was (Smith, 1995). Crum Brown's results were described by Grey as 'a very fusible glass, essentially a lead potash glass' of around 33% lead.

Professor Crum Brown's analysis of the composition of Tassie's glass.

	%
Silica (SiO <sub>2</sub> ) .....	49.29
Lead Oxide (PbO) .....	33.54
Ferric Oxide (Fe <sub>2</sub> O <sub>3</sub> ) and Aluminium Oxide (Al <sub>2</sub> O <sub>3</sub> ).....	0.50
Lime (CaO).....	2.17
Arsenious Anhydride (As <sub>2</sub> O <sub>3</sub> ) .....	3.08
Potassium Oxide (K <sub>2</sub> O) .....	10.40
Sodium Oxide (Na <sub>2</sub> O) .....	0.88

It is worth comparing to the report and data analysis of Walter's '*Small Square Covered Box*' in Appendix 6. The composition of Tassie's glass is remarkably similar to Walter's albeit with a lower lead content.

It was a combination of the finesse of his modelling with the quality of his glass that made Tassie and his work famous. His showrooms in London became a salon for the fashionable and wealthy, and the one scintillating order from Catherine the Great of Russia for 16,000 of his best pieces assured his place as the most celebrated of the gem makers in Europe. The catalogue of the order made by R.E. Raspe in 1791, which later was expanded to 20,000 and included further works by Tassie and his nephew William Tassie, is still the best description and identification of their work (Raspe, 1786).

The work of these 18<sup>th</sup> century antique gem makers was more than a production of artistic enquiry and scientific achievement. Their thirst for the discovery of how the ancients made their glass, pastes or otherwise, did not arise out of a bland and dilettante, amateur search for cultural knowledge. Instead it was driven by a commercial, hard-nosed desire to reproduce (and so make money from) rare, antique cameo and intaglio glass objects. Their foundations certainly lay in the processes hinted at by Roman authors such as Pliny the Elder (Pliny, Healy, 2004), but the results came from the ability of science to reveal the secrets. For the 18<sup>th</sup> century makers and purchasers Art was entwined with Science. In fact Art was a science.

The fashion for collecting gems went on until the late 19th century. Tassie and his nephew Edward Tassie passed their business onto their assistant's nephew Edward Laing. He then later transferred his workshops to Edinburgh and continued making portrait pastes until his death in 1880, a continuous manufacturing process of 120 years. That in itself is significant as it shows how a single process can be maintained and passed on across centuries. In a wider context for makers now the fascination with and the subsequent collecting of 'gems' (modern and historical, original and reproduced), gave the existence of pâtes-de-verre a rich injection of oxygen. That in turn transferred it from a product of deceit to one valued for its own ends.

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## APPENDIX 11

### Walter's Methodology.

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### Walter's Methodology.

#### Introduction

The information placed here comes from two sources. The first and major part is copied from the booklet published at the end of the AHRC research project at the University of Wolverhampton between 2005-7. It explains Walter's methodology of creating one of his pieces as worked out from the research there (Stewart, Cummings, 2007). The second source, which is on page 11, is from the catalogue accompanying the exhibition of Walter at Broadfield House that ran alongside the research project. The text and diagrams are by Keith Cummings and further insight into how Walter placed his coloured pastes in the open mould (Cummings, 2009).

Most of the methodology of Walter and his techniques discussed below are illustrated in Appendix 9. Everything I have learnt on the previous research project at the University of Wolverhampton has been applied to my own work. The information here then is for clarification.

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# THE MANUFACTURING PROCESS

Before any of Walter's pieces were cast in wax there were up to 11 stages to go through to complete a mould suitable for a wax reproduction.

1. A maquette of the finished pieces was modelled up from a watercolour design to give a good impression of the mass and volume of the work in glass. This was usually done in a material similar to modern-day 'Plasticine' – clay dust mixed with linseed oil. **33**
2. The maquette would then be broken down into its component parts – creature, the base/dish etc, and any 3 dimensional detailing or decoration to be added (foliage, small bugs etc). **34**
3. The creature itself would then be sculpted up in the same clay and linseed oil mix. **35**
4. The base, dish or 'plinth' would be modelled up separately, and then reproduced in plaster.
5. This plaster positive was then worked, shaped and polished to ensure a perfectly smooth surface for the rest of the decoration to be added to. A large 'reservoir' base would have also been added.
6. Alongside this a multi-part plaster mould would have been taken from the clay maquette of the creature. From this a wax positive would be made.

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7. The two positives, wax creature and plaster base, would then be combined and any extra detailing added (foliage, small bugs, etc) either modelled directly onto the plaster, or pulled out of a 'sprig mould' before being added onto the plaster base. **36**
8. This final assemblage would then be cast in a multi-part plaster mould ensuring all details were achievable. This would be the 'Master mould' or the 'Original mould'.
9. A plaster positive was then cast from this mould.
10. It, in turn, was cleaned up, refined, sealed with shellac and a second multi-part mould taken from it. All subsequent reproductions of the object, either in wax or plaster, would be taken from this final mould. The original multi-part mould, the 'Master', was preserved and not used again unless something disastrous happened to the second final mould or it had been over-used and the details eroded.
11. A wax (or plaster) was then created. **37**

Once a wax positive has been prepared a good smooth surface needed to be ensured. The fewer blemishes at this stage the fewer blemishes will have to be rectified in the polishing of the glass. This can be done by polishing the wax with a heated linen cloth. Once the surface of the wax had been refined enough it was ready to be cast.

You can in this detail of the head of one of Walter's chameleons a seam line left on the wax from the original plaster mould and which was not cleaned up before it was cast in glass. **38**



All of Walter's pieces (after he left Daum) include his signature and that of the designer/sculptor he worked with. Walter, in the steps of the precedent established by Schneider at Daum had been credited as the designer/maker of the works with his name impressed into the surface of the glass. Walter continued this ownership but generously included the name of the sculptor with whom he was working. In all likelihood the names have been pressed into the wax/clay model and then tidied up when it was cast in plaster **39**

### THE REFRACTORY MIX

There are no existing recipes from Walter as to the recipe of the refractory mix he, or his sculptors, used. Other glassmakers at the time were using the following mix and it is doubtful Walter's studio was any different:

**Plaster 28%**

**Calcined Kaolin (china clay) 22%**

**Kaolin 3%**

**Ground sand 10%**

**Sand in Grains 37%\***

The mix was by weight, and once the sieved ingredients were amalgamated it was put through a cylindrical wooden mill with wooden balls and sieved again. It was then incorporated gently into water until a bulk of the plaster mix sat just below the surface. It was allowed to thoroughly soak in before mixing to a cream-like consistency. A cylinder of linoleum was placed around the model leaving at least a minimum of 1cm space between it and the widest part of the model.



Repe. D. Bastien © INVENTAIRE GENERAL/ADAGP  
(collection particulière - tous droits réservés)

In all the tests quoted here I have use a basic recipe for the refractory mix. It follows much the same ingredients as above and is a simple mix of plaster, silica flour and water. It is measured by volume 1:1:1.

That is: 1 Water: 1 Plaster: 1 Silica Flour. Each designer, sculptor or glass artist has his/her own mix with which they are comfortable.

For the first layer the quoted above mix is sufficient in strength to withstand the firing process. Subsequent layers have the addition of brick grog and/or stranded fibreglass to about 20%. The volume of water is also increased by about 10%.

Silica is added to the water first by sieving, or gently sprinkling the dry powder in by hand. Only then is the plaster is incorporated into the mix in the same way as the silica allowing it to dissolve into the water before mixing together all three ingredients. For the pâtes-de-verre process this is hugely important. If the silica is not thoroughly integrated into the mix the mould can be very soft in areas. This is of especial importance when pushing and tapping the glass pastes into the mould cavity. As pressure builds up the unmixed silica can crumple in on itself thereby destroying the interior of the mould's surface. **40**



In smaller pieces a large cottle mould was created and the silica/plaster/water mix poured in around the wax positive.

However, a problem lies in the end-size of the plaster mould: Large round shapes tend to follow less the line of the object within the mould, and use up a great deal of plaster. This creates several problems:

1. The first is that it takes much longer for the plaster to dry out completely before firing.
2. The second is that heat penetration during firing is somewhat reduced due to the unevenness of the mould's wall compared to the shape inside – thicker/thinner depending on the shape.
3. This in turn has to be compensated for during the firing schedule.
4. There is the added disadvantage that bulkier moulds take up more space in the kiln.

The experienced caster can compensate for all of these things. It is sometimes preferable to hand-build the mould. This has the advantage of control over the thickness of the walls, a relatively smaller resulting mould, and thus a more manageable bulk.

Once the wax has been steamed out any cracks that appear on the interior surface of the mould can be easily repaired. This should be done whilst the mould is still initially damp. If it is left for longer than 24 hours the repair is always weak, as the mould will contract at a much faster rate than the fill-in mix. However a good repair may also be achieved after the mould has been completely dried out and the painted layer of shellac is still moist. When dry the entire inner surface of the mould is sealed with a coating of 'shellac'.



41

## SHELLAC

Shellac is a brittle or flaky secretion of the lac insect *Coccus lacca*. It has been used in the furniture industry for since the mid 19th century to 'French Polish' items and as an adhesive in the gilding of furniture. **41** Shellac is organic and it burns away leaving no residue or stain within the body of the glass. It is soluble with Methylated spirits and comes as a ready made up liquid or as dry flakes (hence the idea that they were the beetles' wings) which are then reconstituted in a quantity of Meths. The ready-made solution of shellac generally looks like, and is the consistency of, maple syrup. It needs to be thinned down with Meths to about 50% before applying to the plaster. It was found that this sealing layer does 5 things:

1. It toughens the immediate layer of refractory mix allowing one to draw lightly onto the surface, so determining where areas of colour need to be laid. **42**
2. It prevents the spread of plaster dust from the lip of the mould into the interior which inevitably contaminates the glass.
3. The shellac substantially reduces the osmotic process of the refractory mould on the glass pastes thus allowing for a greater manipulation of the colours within the mould. Conversely it allows for the rectification of mistakes and/or spills.

4. Because of this 'protective' layer the refractory mix has less of a tendency to corrode the surface of the glass. The surface of the glass is therefore much smoother and less corroded.
5. When demoulding the fired mould falls away from the glass object very easily leaving a surface that requires little cleaning.

Professor Cummings had earlier formed the hypothesis that it was during the firing process that Walter had coloured his work. This was in line with the idea of *pâtes-de-verre* being 'a self-colouring polychrome sculptural technique'. Experiments were devised to test this theory.

Assuming that Walter fired his pieces at around 800° (a good temperature for melding glass particles) a firing programme was written (see page 20) and a quantity of moulds were made to produce small tiles and blocks. A batch of 100kg of 50% lead crystal was ordered and specially made by Plowden and Thompson of Stourbridge to echo the same glass batch that Walter would have used.

A decision was also taken to replicate as much as possible the original conditions of materials used. Thus ceramic oxides, after an initial investigation into their technical spec and chemical coding, were rejected in favour of pure oxides, which it was hoped would be far nearer to the ones used at the turn of the 19th/20th century.



42

## THE PREPARATION OF GLASS FOR PÂTES-DE-VERRE

The method for preparing glass frit to be used in pâtes-de-verre is as follows:

1. Into a deep plastic container is placed the measured quantity of glass needed. Water is then added to at least three times the volume of glass.
2. The mix is agitated so that all the glass comes into contact with moving water. It is then allowed to settle which it will rapidly do.
3. As the cloud of glass falls to the bottom of the container a milky residue is left. On the surface will be seen floating glistening filaments. These are miniscule parcels of glass.
4. The bulk of the water is carefully poured off.
5. This process should be repeated a minimum of 3 more times.
6. The glass frit can then be dried on newspaper used straight away.
7. The remaining water in the glass is sufficient to make the 'paste'. Oxides can then be added.
8. Gum Arabic is then added to act as a binder.

Overleaf are the recipe lists, the quantities used, the size of the grains, what colours were produced. The amount of oxide quoted is for 100g of glass.

Two methods of crushing the cobalt blue glass were employed. Firstly tablets were 'fritted' by heating in the kiln to 500o, and then dropped into a bucket of cold water. Glass treated this way is under extreme tension so consequently shatters into small fragments similar to windscreen glass. This frit was put into a pestle and mortar and pulverized **63** until it was about the size of D3 frit. Half of the quantity was then taken out and placed in a porcelain ball mill. **64**

The mill was left to run for 48 hours. **65**

The remaining glass in the mortar was pulverised further using a pestle. A very small quantity of water was added to lubricate the crushed glass. After about half an hour of manual grinding it seemed as if a suitable grade had been achieved somewhere between D2 and D1. However, when mixed with the fat oil, the powdered glass proved not to be fine enough. A gritty mix was produced which coagulated in places. This in turn produced a grainy surface effect when fired. The glass in the porcelain ball mill emerged as a much finer powder that is almost weightless. When mixed with fat oil this method of grinding produces a much softer and less gritty mix that can be easily thinned out with pure turpentine. However, both the cobalt colour of the 'paints' when fired proved to be an identical match to the detailing on Walter's pieces. **66** **67**



Once the glass has been reduced down to a fine enough powder a little fat oil is mixed in to it. Fat oil comes in various grades. Having tried several tests it was found that the preferred quality of oil is that of 'Essence Grasse'. This is used by the porcelain painters of Limoges to bind together their enamels and colours. It is a pale gold in colour and had a gentle scent to it, less acrid in smell than the industrial fat oil (which is similar to engine oil in viscosity and appearance). The ceramic painters in France all have their own individual preferences to what they use. Some even preferring aniseed oil, lavender oil or even orange oil as the medium to hold their mix. These were tried but were found to be too thin in body to hold the glass completely.

1. Place a small quantity of the powdered glass into a small dish and add the oil. This dish should have an airtight lid as the oil, like turpentine, will gradually evaporate.
2. Incorporate the oil into the dry powdered glass using a rigid plastic or wooden tool. It is important that at every stage the glass (even the glass which is made from iron oxide) is not contaminated with external sources of iron or other metals (this includes steel, brass, zinc or tin).
3. When the right consistency is obtained – a blob of the 'paint' should be able to be pulled up from the main body of the mix and allowed to create a 'soft peak' (as one would with a meringue mix). The aim is for a consistency similar to thick toothpaste. It can then be slacked with some pure turpentine (not white spirit or any other synthetic substitute).

68 69 70



## ITS APPLICATION INTO THE MOULD

With a quantity of good quality watercolour brushes the 'paint' can easily be applied into the prepared mould. The size of the opening into the mould will determine how readily the brush will reach into the cavity. With practise and care it is possible to reach even the most awkward of the mould's interior regions. **71**

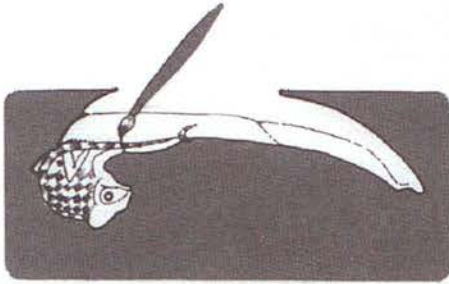
It is important that some time should pass between applying each layer of paint. It is not possible to build up a thick layer of colour one go. All that happens is the oil will try to find its own level and so flood over the mould. Patience is required. Nor is it possible to speed up the process either by putting the mould into an overly warm atmosphere as the oil slackens and runs into other colours. Whilst this frog's markings are charming enough the creature originally started out a spotted toad. The toffee and blue colours ran together as the oil warmed. **72**

When the paints are sufficiently dried out it is then possible to pack the mould with the rest of the pâtes-de-verre. Because the layer of fat oil and glass mix is resistant to water there is very little danger of it being disturbed when the other pastes are incorporated. Any spillages or mistakes during this stage can be cleaned up and/or rectified. **73**

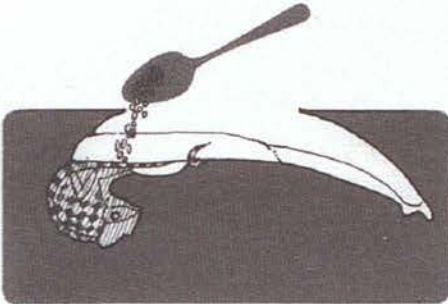


## ADDING THE 'PASTES'

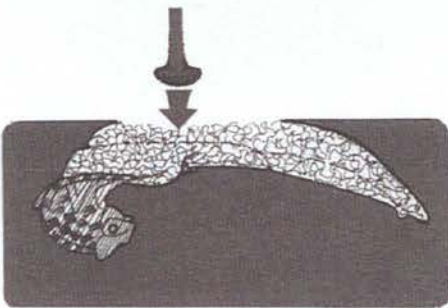
The glass, water and gum Arabic paste is carefully placed into the mould a small amount at a time. With each layer it is necessary to pack the mix firmly. Because the mould has been sealed with shellac, the paste remains viscous so holding its position. However, care should be taken to avoid any damage of the interior surface of the mould. Any excess fluid that oozes out of the mix can be mopped up using a paper towel.



Once the wax has been steamed from the refractory mould, details that will appear on the surface of the glass are applied directly to the mould. They are fine grains of glass mixed with ceramic oxides in a medium, and applied with a fine brush.



The areas of colour adjacent to the surface detail are applied as larger grains of coloured glass.



The main body of the cast is filled with glass grains, and pressed down into the mould cavity with specially shaped wooden tools. This helps to pack the glass together and eliminates settling due to air trapped during firing. After firing to 850°C the mould is cooled to room temperature over three days, broken away from the glass cast, which is selectively polished.