

INSULAR GLASS AND AMBER STUDS,
SEVENTH TO TWELFTH CENTURY AD:
DATING, CHRONOLOGY AND WORKSHOP PRACTICE

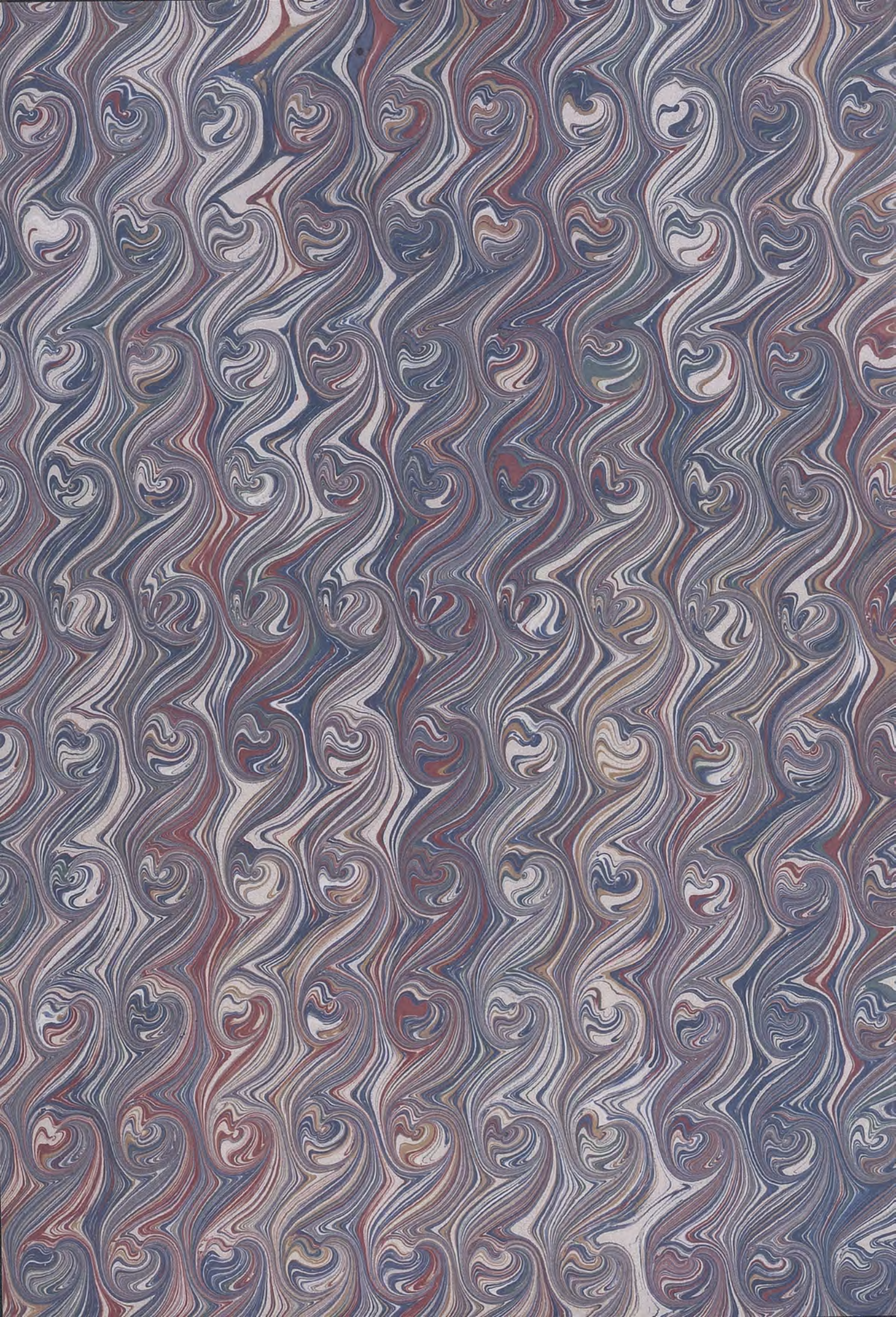
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Jennifer M. Gleeson





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VOLUME I

Submitted by Jennifer M. Gleeson

PhD in History of Art

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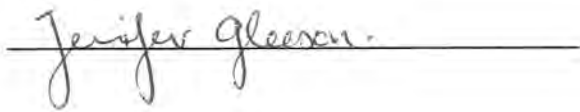
15th February 2017

Supervisor: Dr. Rachel Moss

Declaration

This thesis is entirely my own work and has not been previously submitted as an exercise for a degree at this or any other university.

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A handwritten signature in cursive script, reading "Jennifer Gleason", is written over a horizontal line.

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Summary

Studs of glass and amber are found alongside panels of gold filigree and embossed silver foils, are an integral part of high status Insular metalwork created between the seventh and twelfth centuries. No over-arching survey has been carried out on the materials, form, colour, and techniques employed to make such studs. While this study sets out to address this dearth of information, due to losses over time this survey cannot be definitive, what does remain provides a snapshot which may tell us something of the relationship that existed between artefacts traditionally grouped together by date or workshop tradition, or shed light on issues such as authorship or workshop practice.

Chapter one provides a general introduction to Insular metalwork including, its development, general approach to materials, techniques and design. It outlines the impact of Christianity on metalworking and other influences such as Continental, Late Roman and Germanic metalwork and La Tène styles. The intrinsic importance of the goldsmith as an active participant in all aspects of Insular metalwork is compared to the extrinsic role assigned to some goldsmiths within other cultural contexts. This chapter also outlines issues regarding authorship, dating and workshop practice.

Chapter two examines in detail the range of vitreous materials, amber, gemstones and pigments used to enhance or compliment polychrome studs. It outlines the physical attributes, working properties and sources for the materials. Where relevant the historical and contemporary use of the materials in an Irish context is outlined. Contemporary legal and exegetical texts indicate that the Insular understanding of colour was more than simply aesthetic. Various sources are explained in an attempt to see how the colour ranges created by Insular craftsmen fit these descriptions.

Chapter three outlines the fundamental techniques associated with Insular metalworking and assembling an artefact. This context is used to show that basic metalworking techniques such as casting high relief ornament in metal and *champlevé* enamelling were developed to, and cross-applied to, work both glass and amber. It demonstrates that Irish stud makers employed casting and imprinting techniques and eschewed reductive techniques associated with lapidary methods employed beyond Ireland.

Chapter four analyses the working signature on a selection of glass studs with silver grilles found on the Derrynaflan paten and ring and the Ardagh chalice to determine whether these can shed light on issues such as authorship, chronology and

workshop tradition or practice. It will be shown that a number of craftsmen of disparate skill, contributed to each artefact suggesting workshops were busy, mixed ability settings with a supervising goldsmith. Those with greater levels of skill are associated with a greater level of detail, in some cases more materials, including silver and gold, and their placement on a prominent position of an artefact. Lesser work is assigned to peripheral regions and is associated with less ornate settings. Three general levels of goldsmith can be deciphered from the evidence on the artefacts with original design and graphic qualities important features of the higher order studs. Among the artefacts surveyed, two studs suggest that a single stud-maker contributed one stud to two separate artefacts.

In terms of chronology and dating the similar processes applied to amber and glass suggests that both materials were worked in the same way using heat to form them into comparable forms with similar ornament. Both glass and amber are formed into relief studs, combined with silver grilles and set with gold caps and both are heated to a viscous state and embedded into recessed channels. The use of elements such as sub-conical settings adaptable to both amber and glass suggests that these materials were interchangeable on different versions of an artefact rather than assigned to different periods. This evidence is used to argue that dating or chronological sequence based upon use of glass or amber may be unsafe and other factors need to be considered.

Table of Contents

Volume 1

Title Page

Declaration	1
-------------	---

Acknowledgements	2
------------------	---

Summary	3
---------	---

Table of Contents	5
-------------------	---

<u>Introduction</u>	<u>13</u>
---------------------	-----------

Literature review	13
-------------------	----

Aims of the study	20
-------------------	----

Methodology	21
-------------	----

Chapter one, Insular metalwork in its European context	25
--	----

Chapter two, materials employed in Insular metalworking	27
---	----

Chapter three, techniques employed in Insular metalworking	28
--	----

Chapter four, analysis of Insular stud-making	31
---	----

Authorship	31
------------	----

Workshop tradition	33
--------------------	----

Workshop practice	34
-------------------	----

Dating and chronology	34
-----------------------	----

The eleventh century revival	35
------------------------------	----

<u>Chapter One: The character of Insular metalwork</u>	<u>36</u>
--	-----------

1.1, The impact of Christianity on Irish metalwork	36
--	----

1.2, Connections and influences outside Ireland	38
---	----

1.3, Materials, techniques and design in Anglo-Saxon and Frankish metalwork	40
---	----

1.4, Anglo-Saxon metalwork	41
----------------------------	----

1.5, Merovingian metalwork	42
----------------------------	----

1.6, Insular metalwork, materials and techniques	44
--	----

1.7, Polychromy in Insular metalwork	45
--------------------------------------	----

1.8, Iron-Age and Romano-British sources for <i>champlevé</i> enamelling	46
--	----

1.9, Manufacturing techniques in Insular metalwork	48
--	----

1.10, Design principles in Insular metalwork	48
1.11, Insular ornamental motifs	50
1.12, Patronage	51
1.13, The Goldsmith in Insular society	53
1.14, Organisation of the Goldsmith's training	55
1.15, Status and identity of the Goldsmith beyond Ireland	58
1.16, Dating issues in Insular art	59
1.17, Discussion	62
Chapter Two: Materials and Colour in Insular metalwork	64
2.1, Primary structural materials employed to make studs and inlays	64
2.2, The historical use of glass in Ireland	64
2.3, Vitreous materials associated with stud-making	65
2.4, Blue glass in Insular metalwork	65
2.5, Green glass in Insular metalwork	66
2.6, Turquoise glass in Insular metalwork	67
2.7, Transparent yellow-orange and brown glass in Insular metalwork	67
2.8, Dark brown glass in Insular metalwork	67
2.9, Purple glass in Insular metalwork	68
2.10, Opaque yellow glass in enamelled glass studs and <i>champlevé</i> enamelling	68
2.11, Opaque white glass employed within enamelling and <i>millefiori</i>	69
2.12, Opaque 'liverish red' glass employed in <i>millefiori</i> and 'Celtic' glass	70
2.13, <i>Millefiori</i>	70
2.14, Non-soda-lime-silica opaque red 'sealing-wax' red glass	70
2.15, Potential methods of shaping glass	73
2.16, Sources for soda-lime-silica-glasses in Insular Ireland	75
2.17, Glass stud production sites	76
2.18, The historical use of amber in Ireland	77
2.19, Amber	77
2.20, Potential methods of shaping amber	78
2.21, Sources for amber	80
2.22, North Sea coast of England and Scotland	81

2.23, Viking sources for amber	81
2.24, Sources for amber in Ireland	82
2.25, Amber stud production sites in Ireland	83
2.26, Secondary ornamental materials associated with stud-making	84
2.27, Silver	84
2.28, Gold	84
2.29, Copper	85
2.30, Tin	85
2.31, Copper-alloy	86
2.32, Lead-tin alloy	86
2.33, Mercury	86
2.34, Sources for metals in Ireland	87
2.35, Cold pigments associated with stud ornamentation	88
2.36, Sources for pigments	88
2.37, Other semi-precious gemstones	89
2.38, The symbolic significance of glass	90
2.39, The symbolic significance of amber	92
2.40, Colour symbolism in early Christian Ireland	93
2.41, Discussion	95
<u>Chapter three: Techniques employed to make Insular glass and amber studs</u>	<u>101</u>
3.1, Introduction	101
3.2, Design phase in Insular metalworking	103
3.3, Casting copper-alloy mounts and pseudo-chip carved ornament	104
3.4, Insular <i>champlevé</i> enamelling	106
3.5, <i>Millefiori</i>	107
3.6, Embossed silver foils	107
3.7, Gold filigree	107
3.8, Niello	108
3.9, Corinthian Bronze	108
3.10, Mica inlays	108

3.11, Tinning and gilding	109
3.12, Connecting elements in Insular metalwork	109
3.13, Basic copper-alloy and glass forming techniques applied to stud-making	110
3.14, Creating copper-alloy based <i>champlevé</i> studs and inlays	111
3.15, Casting in an open clay mould	111
3.16, Creating a simple glass stud	112
3.17, Other methods proposed to make studs	112
3.18, Enhancements applied to simple geometric studs	114
3.19, Casting studs with relief or recessed ornament	115
3.20, Creating an enamelled glass stud	116
3.21, Enamelled glass with silver foil ribbon	117
3.22, Opaque red glass enamelled into a yellow background within a copper-alloy support	117
3.23, Mosaic glass panels on the Lismore crozier	118
3.24, Casting a monochrome soda-lime-silica glass stud with a metallic grille	119
3.25, Casting a monochrome opaque red glass stud with metallic grille	120
3.26, Casting a polychrome glass stud with metallic grille	121
3.27, Monochrome and polychrome glass studs with metallic ornament	122
3.28, Gold filigree ornamental insets within Insular glass studs	122
3.29, Beaded gold wire, granulation and filigree panels fused in-situ	123
3.30, Filigree insets cold connected to the stud	123
3.31, Techniques employed to form amber studs and inlays	123
3.32, Forming a simple loose amber stud	126
3.33, Flat amber studs formed within a setting	127
3.34, High-relief amber stud formed within a setting	127
3.35, Amber stud with metallic grille	127
3.36, Forming loose circular amber stud with central recess	128
3.37, Amber inlaid into the Ardagh chalice escutcheon mount	129
3.38, Inlaid amber surrounding the rock-crystal mount on the Ardagh chalice	129
3.39, Discussion	130
3.40, Principles of metalworking and applying ornament	131

3.41, Discussion of the cross application of techniques between glass and amber	131
3.42, Glass and amber stud technical processes	132
3.43, Discussion	134
Chapter Four: Analysis	136
4.1, Introduction	136
4.2, The Ardagh chalice	137
4.3, Ardagh chalice bowl-girdle, monochrome stud CAT.9.1	137
4.4, Ardagh Chalice bowl girdle, bi-chrome stud CAT.9.3	138
4.5, Ardagh Chalice bowl girdle, bi-chrome stud CAT.9.2	138
4.6, Ardagh chalice left handle, studs with silver grilles CAT.9.7 and CAT.9.8	139
4.7, Ardagh chalice left handle, studs with silver grilles CAT.9.13 and CAT.9.14	139
4.8, Ardagh chalice left handle, enamelled studs CAT.9.9 and CAT.9.10	140
4.9, Ardagh chalice right handle-escutcheon stud CAT.9.20	140
4.10, Ardagh chalice right handle-escutcheon, amber border CAT.15.1	141
4.11, Ardagh chalice medallion stud CAT.9.21	141
4.12, Ardagh chalice amber and blue glass studs on the medallion mount CAT.15.2 and CAT. 9.25	141
4.13, Ardagh chalice underfoot mount stud with gold beaded wire CAT.9.24	142
4.14, Ardagh chalice studs settings	142
4.15, The Derrynaflan paten	143
4.16, Dating of the Derrynaflan paten	143
4.17, Derrynaflan paten rim, monochrome blue glass studs CAT. 1.7 and CAT.1.3	144
4.18, Derrynaflan paten rim stud CAT. 1.7	145
4.19, Derrynaflan paten rim stud CAT. 1.3	145
4.20, Derrynaflan paten rim polychrome studs CAT.1.4, CAT.1.11 and CAT. 1.23	147
4.21, Derrynaflan paten rim CAT.1.4	147
4.22, Derrynaflan paten rim stud CAT.1.11	147
4.23, Derrynaflan paten rim stud CAT.1.23	148
4.24, Derrynaflan paten rim enamelled stud CAT. 1.2	149
4.25, Derrynaflan paten rim enamelled stud CAT. 1.14	149
4.26, Derrynaflan paten rim enamelled stud CAT. 1.5	149

4.27, Derrynaflan paten rim relief pattern stud CAT.1.20	150
4.28, Derrynaflan paten stud settings	150
4.29, Derrynaflan paten side monochrome stud CAT.1.35	151
4.30, Derrynaflan paten side polychrome glass studs with silver grilles CAT.1.31 and CAT.1.33	152
4.31, Derrynaflan paten side enamelled stud CAT.1.36	152
4.32, Settings on the side of the Derrynaflan paten	153
4.33, The Derrynaflan ring	153
4.34, Dating of the Derrynaflan ring.	153
4.35, Derrynaflan ring monochrome stud with curvilinear motif CAT.2.3	154
4.36, Derrynaflan ring bi-chrome studs with angular patterns CAT.2.1, CAT.2.7 and CAT.2.5	154
4.37, Derrynaflan ring enamelled studs CAT.2.2 and CAT.2.4	155
4.38, Derrynaflan ring, stud settings	155
4.39, Discussion	156
4.40, Comparison of studs and settings from different parts of the Ardagh chalice	156
4.41, Silver grille stud-makers on the Ardagh chalice	156
4.42, Silver grille stud-makers on the Derrynaflan paten rim	157
4.43, Comparison of the studs on the rim of the Derrynaflan paten to those on the side	159
4.44, Silver grille stud-makers on the Derrynaflan paten side	159
4.45, Derrynaflan ring comparison of the studs	160
4.46, Silver grilles stud-makers on the Derrynaflan ring	160
4.47, Workshop practice	161
4.48, Stud-makers of the Ardagh chalice handles and the Derrynaflan paten side	162
4.49, Elementary studs level (a)	162
4.50, Elementary studs level (b)	162
4.51, Intermediate level studs on the bowl-girdle of the Ardagh chalice and Derrynaflan paten rim	165
4.52, Advanced studs found on the rim of the Derrynaflan paten and Ardagh chalice medallion, escutcheon and underfoot mount	166

4.53, Studs and illustration	167
4.54, Stud-makers borrowing from other disciplines	168
4.55, Workshop practice implications	171
4.56, Workshop connections	172
4.57, Comparison of similar studs on the Derrynaflan paten stud CAT.1.3 and Derrynaflan ring stud CAT.2.3	172
4.58, Workshop connections Ardagh chalice and Derrynaflan paten	173
4.59, Chronology and dating during the Early Christian Period	174
4.60, Later enamelled studs on the Cross of Cong and Lismore crozier	178
4.61, Traditional enamelled stud from the knop of the Cross of Cong CAT.12.1	178
4.62, Enamelled stud twelfth-century variant CAT.12.3	178
4.63, <i>Millefiori</i> twelfth-century examples	179
4.64, Lismore crozier mosaic glass studs	179
4.65, Discussion	179
Chapter Five: Summary of Findings	184
5.1, Introduction	184
5.2, Workshop tradition and authorship	186
5.3, Workshop practice	187
5.4, Dating of artefacts	188
5.5, Chronology	189
5.6, Eleventh century revival	189
5.7, Areas for further study	191
Bibliography	194
Appendix	214
1. Map of Europe	214
2. Map of the British Isles	215
3. Map of Ireland	216
4. Map of glass stud production sites	217
5. Map of amber stud production sites	218
6. Map of glass and amber stud artefacts and production sites	219
7. Stud-making technique diagrams	220
diagram 1, enamelled glass	220

diagram 2, mosaic glass cabochon	221
diagram 3, enamelled mosaic glass plaque	222
diagram 4, mosaic glass disc	223
diagram 5, glass stud with fused metallic grille	224
diagram 6, glass studs with fused metallic inlay	225
diagram 7, polychrome glass with fused metallic inlays	226
diagram 8, glass stud with fused filigree cap	227
diagram 9, glass stud with cold connected metallic inlay	228
diagram 10, forming loose amber studs	229
diagram 11, forming high relief amber studs within a collet	230
diagram 12, forming amber studs and inlays with a flat surface	231
diagram 13, forming amber studs with a metallic grille	232
diagram 14, forming amber studs with recesses for metallic inlays	233
8. Position of studs on artefacts;	234
diagram 1, Ardagh chalice	234
diagram 2, Derrynaflan paten	237
diagram 3, Derrynaflan ring	239
diagram 4, Cross of Cong	240
diagram 5, Lismore Crozier	242
9. Glossary	243
10. Object list	249

Volume II

<u>List of illustrations</u>	<u>290</u>
<u>Illustrations</u>	<u>301</u>

Introduction

Studs of glass and amber are an integral ornament of high status Insular metalwork created between the seventh and twelfth centuries in Ireland and Scotland. They are found, for example, alongside panels of gold filigree on personal wear such as brooches, on Eucharistic vessels and other objects made for the Church. Their use was prolific; the Derrynaflan paten originally displayed thirty-six glass studs, the Ardagh chalice eighty-eight inlays of either glass, amber and one of rock-crystal and the Derrynaflan chalice has fifty-seven amber studs. Empty settings and extant studs suggest that the twelfth-century Cross of Cong displayed fifty-three studs at one point. The nature and extent of the use of glass and amber studs is unique to Insular metalwork. As they are conceived and developed from raw materials to final setting by an individual they record something of the working signature, resources and influences affecting the goldsmith. Although frequently referred to in the context of individual artefacts, no overarching survey has ever been conducted of the materials, form, colour, motifs and techniques employed to make studs on Insular metalwork.

Despite the losses, what does survive provides an important snapshot of the range of forms and techniques used, together with some insight into changing taste and or technical developments over the period of the study. It may also tell us something of the relationships that may have existed between artefacts traditionally grouped together by date or workshop tradition, or shed light on issues of authorship and workshop practice.

Literature Review

The most significant discovery to contribute to the understanding of stud craft was the uncovering of a stud still within the clay mould at Lagore *Crannóg*.¹ This find was important as it demonstrated the connection between casting and the manufacture of glass studs. It also demonstrated the first step in the formation of enamelled glass studs and highlighted the presence of fine metalworking at high status secular sites.

Françoise Henry was among the first to assess glass studs in her studies of other artefacts and Insular enamelling, making many astute observations regarding the creation of studs with silver grilles found on the Ardagh chalice². She determined that blue and red studs with silver grilles were not created as true enamels, but rather were

¹ Hugh Hencken, Liam Price, and Laura E. Start, 'Lagore Crannog: An Irish Royal Residence of the 7th to 10th Centuries A.D,' *Proceedings of the Royal Irish Academy. Section C: Archaeology, Celtic Studies, History, Linguistics, Literature* 53(1950) 130.

² Françoise Henry, *Irish Art, in the Early Christian Period to 800AD*, (London, 1965), p.95.

formed by placing a silver grille at the base of a clay mould, inserting red glass into certain points of the grille and applying a 'pearl' of blue glass to the reverse.

In terms of technical examination, the most important work on studs was conducted by Mavis Bimson of the British Museum in 1964, in particular her detailed, microscopic examination of the glass studs on the Ardagh chalice and 'Tara' brooch.³ She outlined different technical variations used in the fabrication of the studs. Studs with silver grilles, enamelled studs, with or without silver strips employed to separate colours and studs cast with relief patterns. Bimson was also involved in the recreation of a blue and red stud with silver grill confirming the technique proposed by Henry. In addition, she has examined the studs on the 'Tara' brooch and determined that the small relief 'head' studs were also formed by casting.⁴ While this author concurs with Bimson's findings regarding the techniques employed, her detailed microscopic study was confined to glass on these objects only.

Michael J. O'Kelly's detailed examination under microscope of the Moylough beltshrine included a detailed description of the two types of polychrome stud. These included the aforementioned examples with silver grilles, deciphered initially by Henry, which O'Kelly highlighted were similar to those on the base of the Ardagh chalice.⁵ This comparison led him and others, including Peter Harbison and Raghnaill Ó Floinn, to date the Moylough shrine to the eighth century.⁶ Similar to the work of Mavis Bimson this researcher agrees with the technique proposed by O'Kelly but this study was also confined to a selection of studs from a single object.

Since the discovery of the Derrynaflan hoard comprising a paten, chalice, strainer-ladle and ring, the corpus of high quality glass studs has been significantly expanded.⁷ The studs were recorded by Michael Ryan,⁸ with techniques and general appearance compared to the studs on the Ardagh chalice and 'Tara' brooch previously documented by Bimson.⁹ However, the examination of the paten studs took place prior

³ Mavis Bimson and A. E. Werner, 'Scientific Examination of Ancient Glass', *Annales du 3e congrès international d'étude du verre des 'journées internationales du verre'*. Damas, 14-23 novembre 1964 (Liege, n.d.) pp.200-09.

⁴ Bimson and Werner, 'Scientific Examination of Ancient Glass', p.208.

⁵ M. J. O'Kelly, 'The Belt-Shrine from Moylough, Co. Sligo,' *Journal of the Royal Society of Antiquaries Ireland* 95(1965). 174-5,184.

⁶ Peter Harbison, 'The Date of the Moylough Belt-shrine' in D. Ó Corráin (ed.), *Antiquity* (Cork, 1981), 231-39; Raghnaill Ó Floinn, *The Moylough Belt-shrine* (Dublin, 2008) p.12

⁷ Michael Ryan, *The Derrynaflan Hoard I, a Preliminary Account* (Dublin: National Museum of Ireland, 1983).

⁸ Ryan, *The Derrynaflan Hoard I*, pp.22-25.

⁹ Ryan, 'The Significance of the Hoard,' in *The Derrynaflan Hoard I*, pp.37-8.

to cleaning, conservation and reassembly of the paten at the British Museum in London. As a result the numbers assigned, by Ryan to the paten studs do not correspond to their current position on the paten. Secondly, Ryan briefly described but did not analyse the studs' techniques and instead focused on the symbolism of the gold filigree panels. Based on the general use of ornament, including the polychrome studs, the Derrynaflan paten has been chronologically linked to the Ardagh chalice and the 'Tara' brooch.¹⁰ Due to the simplicity of the ornament the ring was attributed to a slightly later date in the sequence.¹¹

Griffin Murray has dealt with the enamelled glass studs on the Cross of Cong in his study of that artefact which took place during the cleaning and conservation of the artefact at the Conservation Department of the National Museum of Ireland. He compared general features of the enamelled examples to earlier silver grille examples, rather than to comparable earlier enamelled studs. The enamelled examples on the Cross of Cong were also compared to the visually similar enamelled examples on the late eleventh-/early twelfth-century Lismore crozier.¹² Both Murray and Youngs have proposed that the red and yellow studs on the reverse were made using the *champlevé* technique based on the use of yellow and red glass.¹³ However both studies were focused on broader subjects, in Murray's case the entire cross and in Youngs case, the reference was found in a short article regarding the history of Insular enamelling.¹⁴ While related to *champlevé* enamelling, this writer has found that the technique is the result of a related, but different process.

Similarly, the discs on the Lismore crozier, within a broader description of the crozier, have been categorised as *millefiori* without a detailed examination dedicated to the studs alone.¹⁵ Françoise Henry identified them as *millefiori* and noted that the pattern was a veneer which did not permeate the stud. However, similarly to those who followed her assessment that the studs were simply *millefiori*, the general description of the studs was found in the context of a study of the Lismore crozier and not once

¹⁰ Ibid.

¹¹ Ibid.

¹² Griffin Murray, *The Cross of Cong* (Dublin, 2015), pp.136-38.

¹³ Susan Youngs, 'Enamelling in Early Medieval Ireland,' *Irish Arts Review* 13(1997) 51.

¹⁴ Both Griffin Murray and Susan Youngs identify the studs on the reverse of the cross as *champlevé* see Murray, *Cross of Cong*, p.138; Youngs, 'Enamelling in Early Medieval Ireland' 48.; Henry correctly recognises that the glass red applied to yellow, however she also identifies them as enamelling as practiced in the earlier period and discusses them alongside examples referred to as *champlevé*. Therefore, also inferring that these examples are *champlevé*. Françoise Henry, *Irish Art in the Romanesque Period, 1020-1170AD* (London, 1970) p.78.

¹⁵ Cormac Bourke, 'Lismore Crozier,' in *Art and Architecture of Ireland, Vol. 1 Medieval*, ed. Rachel Moss (Dublin New Haven London: 2014) p.315. Ragnall O'Floinn, 'The Lismore Crozier,' in *Treasures of Ireland*, ed. Michael Ryan (Dublin: 1983) p.171.

specific to the studs.¹⁶ While Henry's general observation is broadly correct in some cases on the crozier, the arrangement of the components within some studs and certain irregularities suggest that other more complex processes were employed and worthy of closer investigation.

Additional scholarship pertaining to the making of Insular glass studs includes entries in catalogues and excavation reports dealing with studs on an individual basis.¹⁷ To date there has been no published, dedicated study of their development, techniques of manufacture or colour, a surprising lacuna given the reliance by the forenamed studies on the medium for the dating of metalwork objects. In addition given the involvement of an artist at all stages of the manufacture of a glass stud, from preparing the vitreous material to cutting grilles and incorporating applied detail, no study has looked in depth at the working signature of studwork or compared the individual character of studs under magnification. As we have seen only superficial comparisons are made between polychrome glass studs with silver grilles, such as those on the Ardagh chalice, Derrynaflan paten and Moylough beltshrine which provided limited information.

Despite the occurrence of much amber in Insular metalwork and the detailed examination of artefacts which contain it, such as the Ardagh chalice and 'Tara' brooch strikingly little attention has been paid to the material within Insular scholarship. Detailed descriptions of artefacts such as the Hunterston brooch, where it is the sole inlay, describe how a stud was connected and its shape and dimensions but do not refer to the techniques employed to form the amber studs or inlays.¹⁸ In his study of the Ardagh chalice, Robert Organ notes that amber is displayed on the chalice, but there is no reference as to how the material was worked within his publication, a surprising omission given its technical remit.¹⁹ In fact, of greatest interest to Organ is the occurrence of 'malachite' underneath the amber, rather than the amber itself. Organ did

¹⁶ Ibid.; Ó Floinn, 'Lismore Crozier' pp.170-71.

¹⁷ Bimson and Werner, 'Scientific Examination of Ancient Glass.'; Ragnall O'Floinn, 'Millefiori Plaque,' in *The Work of Angels*, ed. Susan Youngs (London: 1989), p.202 no.199.;idem, 'Two Glass Rods,' in *The Work of Angels*, ed. Susan Youngs (London: 1989), p.203, a and b.;Michael Ryan, 'The Chalice,' in *The Derrynaflan Hoard I*, p.38.;Michael J. O'Kelly, 'The Excavations of Two Earthen Ringforts at Garryduff, Co. Cork ' *Proceedings of the Royal Irish Academy* 63C(1963) 74-5.; James Graham- Campbell, 'The Bell and the Moulds ' in *Excavations in Iona 1964-1974*, ed. R. Reece (London: Institute of Archaeology 1981) p.24.;Alan Lane and Ewan Campbell, 'Dunadd: An Early Dalriadic Capital,' (Oxford: 2000), pp.174-5.; H. Fairhurst, 'The Galleried Dún at Kildonan Bay, Kintyre,' *Proceedings of the Society of Antiquaries of Scotland* LXXIII no. 7th Series Vol. 1 (1939): 212.; M. Carver, 'An Iona of the East: The Early Medieval Monastery at Portmahomack, Tarbat Ness,' *Medieval Archaeology* 48(2004) p.16.

¹⁸ R.B.K. Stevenson, 'The Hunterston Brooch and Its Significance,' *ibid.*18(1974) pp.40-2.

¹⁹ Organ, 'Examination of the Ardagh Chalice', p.266.

not report how the amber was applied, only that the malachite base must have been applied as a paste.²⁰ As noted previously, Bimson's examination of the studs undertaken during a detailed examination of the chalice did not extend to amber. Within an international context Helen Fraquet in her over-arching publication on amber from prehistoric to the modern period notes that despite the common display of amber *en cabochon* on Celtic brooches such as the Hunterston brooch, of reportedly Northern Scottish provenance, are not included in any studies or histories of amber.²¹ Infact, even within Fraquet's overarching publication Insular material of Irish provenance such as the Derrynaflan chalice or 'Tara' brooch with extensive amber on display are not referred to. It would seem that within the general history of amber, amber worked by Insular Irish stud makers has been overlooked.

While the Ardagh chalice contains only relatively small amounts of amber, the Derrynaflan chalice contains significant amounts. However, in the published preliminary report on the Derrynaflan hoard, fifty-one of the fifty-seven amber studs on the chalice are un-labelled, in contrast with the individual labels dedicated to all of the gold filigree panels.²² In terms of technical process Michael Ryan has proposed that the studs on the Derrynaflan chalice were ground and polished into shape.²³ However Ryan does not point to the evidence that led him to conclude that grinding and polishing were employed.²⁴ He notes that the technical differences between the use of a semi-precious stone, even in the example of a soft material like amber and glass ornaments is significant.²⁵ Elsewhere he also briefly notes the potential of amber to be softened and pressed or partly moulded.²⁶ However, he does not elaborate beyond this brief comment or present any evidence pointing to the use of either technique. Within the 1989 *Work of Angels* catalogue, entries for two irregularly shaped circular studs note chipping around the base, which the authors presume is to act as a key for the stud to its backing, but there is no reference to working amber beyond these features.²⁷

²⁰ Ibid.

²¹ Helen Fraquet, *Amber*, ed. Peter G. Read, Butterworth Gem Books (London, 1987). p.27. There is no reference to Irish amber in Patty C. Rice, *Amber, Golden Gem of the Ages*, 4 ed.(Milton Keynes, 2006); David A. Grimaldi, *Amber, Window to the Past*, (New York, 1996) 'Amber'ii in Oxford online, <http://oxfordartonline.com/60/subscriber/article/grove/art.T002279>. Accessed 26/07/2014

²² Ryan, 'The Chalice,' p.4 fig.2.

²³ Ibid.

²⁴ Michael Ryan, *The Derrynaflan Hoard I*, p.13.

²⁵ Ryan, *The Derrynaflan Hoard I*, p.38.

²⁶ Michael Ryan, *Metal Craftsmanship in Early Ireland* (Dublin, 1993) p.13.

²⁷ Ragnall O' Floinn, 'Amber Stud,' in *The Work of Angels* ed. British Museum (London: 1989) p.208, nos. 15 & 6,.

Amongst the most useful sources of information regarding amber studs, for this study, is Niamh Whitfield's examination of the filigree on the 'Tara' brooch undertaken with the aid of a microscope.²⁸ She provides an in-depth description of the assembly and connection of the gold filigree and foil elements to the amber element, however, the shaping of the amber, beyond the scope of the study, is not explored. Aside from Ryan's brief reference to pressing amber, authors suggest that amber was shaped using reductive techniques such as cutting, grinding or polishing, where a raw nugget of amber had surface material removed to shape it into a more aesthetically pleasing texture and form.²⁹ This assumption of technique is most likely based upon the commonly known approach to hardstone working, recorded, for example, in the writings of Theophilus and in '*Mappae Clavicula*'.³⁰

Assessment of the techniques used in working amber is hindered by the fact that it is vulnerable to decay, and tends to discolour and opacify on the surface and degrade over time. It is also of note that stud settings, have previously, received little attention from scholars unless they are sumptuously ornamented with silver or gold detail as on the Ardagh chalice and Derrynaflan paten.

As we have seen most examination of studs, apart from the work of Mavis Bimson confined to the Ardagh chalice and 'Tara' brooch, discuss glass studs only in a general as a secondary feature of an overall analysis of an artefact, or in relation to metalwork in general. Studs are not judged thoroughly within the larger corpus of Insular metalworking techniques and their relationship to stud-making. While general comparisons have been made in terms of pointing out common similarities between studs, no one has looked at the specific working features of glass stud manufacture. Addressing this omission, this thesis will demonstrate that by examining glass studs important new information is revealed, such as insights into the individual hand that worked the material and formed the stud. In addition, little or no detailed attention has been paid to amber, nor has been the relationship between the two material explored.

Alongside a system of general stylistic comparisons based on the date of Insular manuscripts,³¹ metalwork objects have been drawn into a system of dating which has

²⁸ Niamh Whitfield, 'More Like the Work of Fairies Than of Human Beings': The Filigree on the 'Tara' Brooch, a Masterpiece of Late Celtic Metalwork.,' *ArchéoSciences* 33(2009). 235-41.

²⁹ O'Floinn, 'Amber Stud,' p.208.; Ó Floinn, 'Amber Ring Fragment,' p.208.

³⁰ Theophilus, *On Divers Arts*, trans. John Hawthorn, G. and Cyril Stanley Smith, 2 ed. (New York: Dover Publications Ltd., 1979) pp.189-91.; C.S. Smith and J.G. Hawthorne, '*Mappae Clavicula*', a Little Key to the World of Medieval Techniques,' *Transactions of the American Philosophical Society* 64, no. 4 (1974).

³¹ Based upon comparisons with ornament in the Lindisfarne Gospels, which is dated by a later colophon to c.698-721 various artefacts such as the 'Tara' brooch and Ardagh chalice are

the following material chronology. Polychrome enamels,³² and studs are associated with an eighth-century apogee in metalworking as exemplified by the Ardagh chalice,³³ while the ninth century saw a diminution in metalworking and an increase in the use of amber as an inlay, as found on the Derrynaflan chalice.³⁴ Thus artefacts such as the Ardagh chalice and Derrynaflan chalice are dated earlier and later based upon the use of polychromy and amber.³⁵ Similarly, the lack of filigree and a use of simpler polychrome ornament have resulted in the assignment of the Derrynaflan ring to a point in time after the creation of the Derrynaflan paten.³⁶

While scholarship has begun, finally, to see a general shift away from this system of stylistic comparison, much work still needs to be done in terms of the establishment of chronologies in Insular art.³⁷ Recent studies have highlighted the different motivations at play among those that actively promoted revivalism, at the turn of the last century, something which obviously had the potential to skew a chronological narrative based solely on style.³⁸ In the case of fine metalwork, a greater understanding of workshop practice, how skills were passed down through the generations, of patterns in patronage, and above all of technical processes, are far more likely to yield if not precise dates for objects, at least some indication of relative chronologies.

Few examples of fine metalwork are dated to the tenth century period and thus there appears to be a fall-off in glass and amber use at this time.³⁹ The survival of many fine examples of metalwork with glass studs dated by inscription to the eleventh-century and twelfth-centuries suggest a 'revival' in metalworking. The Lismore crozier

associated with a date c.700AD. Michael Ryan and Ragnall Ó Floinn, 'The Paten and Stand' in *The Derrynaflan Hoard 1*, ed. Michael Ryan, pp.30, 37.

³² Henry, *Irish Art in the Early Christian Period*, p.92.

³³ Dated to early eighth century by Michael Ryan, *The Derrynaflan Hoard 1*, 37-8.; E. Rynne, 'The Date of the Ardagh Chalice,' in *Ireland and Insular Art AD 500- 1200*, ed. Michael Ryan (Royal Irish Academy, 1987) pp.94-5.

³⁴ Michael Ryan, 'The Derrynaflan Hoard and Early Irish Art,' in *Approaches to Early Medieval Art*, ed. Lawrence Nees (Cambridge, Massachusetts: 1998) p.53.

³⁵ Ibid.; Ryan, *The Derrynaflan Hoard 1*, pp.37-8.

³⁶ Ibid., p.38.

³⁷ Lawrence Nees, 'Trends in Dating Works of Art', in *Insular and Anglo-Saxon Art, Art and thought in the Early Medieval Period*, ed. Column Hourihan (Princeton, 2001) pp.14-30.; Nancy Netzer, 'The Narrative on Insular Gospel Books' in *Insular and Anglo-Saxon Art, Art and thought in the Early Medieval Period*, ed. Column Hourihan (Princeton, 2001) pp.3-13.; Joseph Rafferty, 'Concerning Chronology,' in *Irish Antiquity: Essays and Studies Presented to Professor M.J. O' Kelly*, ed. D Ó Córráin (Cork, 1981) p.82.

³⁸ Rachel Moss, 'Historicism and Revivalism', in *Art and Architecture of Ireland, Vol. 1 Medieval c. 400-1600AD*, ed. Rachel Moss, (Dublin, New Haven and London, 2014) pp.12-14.

³⁹ Ruth Johnson, 'Mind the Gap: The supposed Hiatus in Irish Art of the Tenth Century' in *The Vikings in Ireland and beyond : before and after the Battle of Clontarf*, eds Howard B. Clarke and Ruth Johnson (Dublin, 2015), pp.206-231; Cormac Bourke, 'Early Irish Hand-Bells,' *Journal of the Royal Society of Antiquaries Ireland* 110 (1980), 57-8; Henry, *Irish Art in the Romanesque Period 1020-1170AD* (London, 1970), p.74.

and the later twelfth-century Cross of Cong, are among many artefacts remaining from the Romanesque period.⁴⁰ Henry was the first of several sources to point to the continuous use of *champlevé* enamelling on the Cross of Cong.⁴¹ She points to the technical differences between the use of red and yellow enamel discs on the Cross of Cong and *millefiori* on the Lismore crozier, compared to earlier examples from the eighth century. She interprets these as indicating the continuous use of enamelling and *millefiori* from the earlier period despite the losses of the Viking period.⁴² Henry writes that in the earlier period that yellow enamel was used against a red background while in the later period this was reversed to red against a yellow background.⁴³ In dispute of this Murray writes that this criteria cannot be used to ascertain the period of the enamelling.⁴⁴ Despite Henry's assertion, an in depth examination of the technical differences in stud production may shed some light on the connection with the earlier period and whether this is a 'revival' or represents a continuation of metalworking practice from the earlier period.

Aims of the study

Given these gaps in scholarship, and the questions that they raise, the overall aim of this thesis is to present a comprehensive study of the various stud materials and in particular the range of techniques and technical variations used to create studs between the late sixth and twelfth century.

Key research questions include:

- What techniques and processes were employed to form glass and amber studs between the late sixth and ninth centuries? Do the technical similarities or differences indicate any evidence pertaining to current artefact chronologies or dating systems which assigns polychromy to the eighth century and greater amber use to the late eighth and ninth century?
- Do these technical similarities and working signatures found within studs tell us anything regarding the relationships between artefacts traditionally grouped together, authorship, workshop practice? Do the individual

⁴⁰ Henry, *Irish Art in the Romanesque Period*, p.74. See also Henry S. Crawford, 'A Descriptive List of Irish Shrines and Reliquaries. Part II', *Journal of the Royal Society of Antiquaries of Ireland* 13, no. 2 (1923), 151-76.

⁴¹ Henry, *Irish Art in the Romanesque Period*, p. 78; Griffin Murray, *The Cross of Cong*, (Dublin, 2015), p.138.

⁴² Bourke, 'Lismore Crozier,' p.315; Ó Floinn, 'Lismore Crozier' pp.170-1; Henry, *Irish Art in the Romanesque Period*, p.78.

⁴³ Henry, *Irish Art in the Romanesque Period*, p.78.

⁴⁴ Murray, *Cross of Cong*, p.138.

signatures of the studs indicate anything regarding the proposed chronology of artefacts such as the Derrynaflan paten and ring?

- What techniques were used to form glass studs in eleventh- and twelfth-century high status metalwork? How do these techniques compare to earlier examples and processes, and what does this tell us about the relationship, if any, with the techniques employed during the earlier period?

Methodology

In order to answer these questions a selection of Insular metal artefacts, were identified from the collection of the National Museum of Ireland (NMI). These were chosen based upon use of amber and glass stud ornament, each demonstrating a range of stud making techniques and different levels of skill. This grouping was chosen to ensure access to a wide selection of stud processes including *champlevé* enamelling, and various types of glass and amber ornament. Aside from the technical and material range, the selection also includes examples of highly sophisticated design and technique and others which are considered somewhat simpler in form for comparison. Again, for comparative purposes, two later artefacts from the eleventh and twelfth century were requested for examination. At the suggestion of Dr. Ned Kelly, Keeper of Antiquities at the National Museum of Ireland, a preliminary examination of photographs of the artefacts in the Photographic Archive was undertaken and the initial group of selected objects was narrowed down to a smaller group, due to cut backs and the constraints on NMI facilities and staff. It was also suggested that less important or less pertinent artefacts could be analysed using the photographs and briefly viewed in the Treasury with the door of the display case open. The Moylough beltshrine, 'Tara' brooch, Killamery brooch, Ervey brooch, Lough Kinale bookshrine and Derrynaflan chalice were viewed in this manner.

The following objects were taken off public display and examined in detail for one day, the Derrynaflan paten, strainer-ladle and ring. Smaller items were grouped together and examined over one day. These were the Lagore *Crannóg* stud and mould, Lough Gara buckle, Coolure Demense plaque and an enamelled mount with glass studs ornamented with orpiment. The Derrynaflan paten and ring were subsequently made available for examination for a second day.

These objects include a broad range of glass stud types for comparison and are key artefacts in terms of understanding workshop practice and the practices of stud making. Due to time constraints and the fact that both artefacts had already undergone published scientific assessments the 'Tara' brooch and Moylough beltshrine were

viewed *in-situ* in the NMI Treasury, public display space for colour sampling. All studies were supported by a close reading of the high resolution images housed in the NMI Photographic Archive.

Amber studs and inlays on the Lough Gara buckle and Ardagh chalice represented the practice of amber used alongside glass, while the Lough Kinale bookshrine represented artefacts where amber was the sole polychrome inlay. The amber on the Ardagh chalice displays an unusual use of the material in annular form compared to standard studs. In the examples of the Lough Kinale bookshrine its particular studs represent standard geometrical studs and a broader range of technical approaches and material combinations not found on other well-known artefacts such as another amber-only artefact, the Derrynaflan chalice.⁴⁵ Furthermore, the Lough Kinale bookshrine is not on public display and its amber studs are not currently attached to the artefact, allowing a full examination. By examining the structure of the settings and remaining examples on the selected key artefacts, it was possible to determine the probable methods and processes employed by Insular craftsmen to both shape amber and combine it with other elements.

From the later eleventh century period, the Cross of Cong was chosen due to the two types of glass stud found on the artefact. A key undertaking was to firmly establish the process employed on the so-called *champlevé* studs on the reverse. The Lismore crozier's use of enamelled glass was compared to the Cross of Cong and similarly, analysis was made to determine how its '*millefiori*' discs had been made.

Due to the significant losses of both complete stud-decorated metalwork objects and individual studs from their settings over time, it is acknowledged that this survey cannot be definitive. It is dependent on the random survival of particular objects, which may well distort the true picture. However, this group of objects ensured that for the first time a broad range of glass, amber and *champlevé* based studs made into different stud forms was studied in depth.

An empirical object-based examination of the glass and amber studs, and their settings, was undertaken in the NMI using a natural daylight lamp and a jeweller's eyepiece for magnification. Due to NMI resource and time constraints, and the relatively large number of objects included in this study, a microscopic examination under

⁴⁵ The studs on the chalice are not unique, those on the handle escutcheons are comparable to similar on the 'Tara' and Hunterston brooches while the plain amber variety are comparable to the small circular amber ones found on the Ardagh chalice and the lentoid variety on the Lough Kinale bookshrine.

laboratory conditions (as employed by Bimson and Whitfield) was not possible. However, it is argued that any additional detail provided by a higher level of magnification would not have yielded any further practical information to impact the conclusions formed. To undertake microscopic examination, would have depleted time and resources and would have confined the study to a smaller group of objects and studs. Given the three-dimensionality of some artefacts, the employed eyepiece allowed quick access to difficult to reach areas and the assessment of a much broader number of studs, settings and other features.

In addition, as noted, prior to the physical examination of each artefact, at least one preliminary examination of each stud was undertaken using the high resolution photographs in the Museum's Photographic Archive. This resource allowed access to high quality detailed images which could be enlarged and reduced without damage to the artefact and negated the need for a microscopic examination. It also allowed repeated examinations to take place after the actual examination without the need to remove the artefacts from display. This allowed this researcher become familiar with the features specific to individual studs.

Of significant importance, and unlike other previous studies undertaken by other scholars, archaeologists and scientists, this analytical study, was informed by this researcher's considerable experience as a jewellery maker and silversmith. Trained in the National College of Art and Design, this author has a practical knowledge of working with metal, enamel, glass, amber, resins, wood and other mixed media and is fully aware of the properties of each and how varying processes impacts on these. Furthermore, the author drew upon seventeen years of experience as a post primary art and design teacher, which includes teaching jewellery and enamelling processes to students with a wide range of abilities and learning processes. This practical and educational training and experience informed the examination of stud techniques and process from a developmental and educational viewpoint.

During the close examination of artefacts, the colours of the glass and amber used were recorded for the first time using the Munsell Bead Colour Book, a system specially designed in conjunction with the Society of Bead researchers and the Corning Museum of Glass.⁴⁶ It was developed to assess the colour of loose glass beads by

⁴⁶ The Society of Bead Researchers is a not for profit scientific-educational corporation founded in 1981 to encourage historical, archaeological and material culture research on beads and beadwork of all materials and periods. See <http://www.beadresearch.org/>. See also www.Munsell.com.

comparing them against colour strips in natural day-light conditions.⁴⁷ However, several factors may affect the gathering of this information, such as ambient lighting, and therefore, as recommended by Munsell, all colours recorded in this study come with the caveat that they were gathered under field conditions. Firstly, due to the size of artefacts and time restraints, it was impossible to block out light pollution from ambient light sources. Secondly, almost all of the studs examined are attached to an artefact and therefore could not be fixed onto the tip of a teasing needle and assessed using transmitted natural light. However, despite the difficulties, a small number of stud colour samples were taken in the Treasury on the Derrynaflan chalice escutcheon, 'Tara' brooch, Ervey brooch and Killamery brooch and Moylough beltshrine. As the colours were gathered under field conditions, in accordance with Munsell Bead Color Book guidelines they are matched as close as possible to the Munsell samples. While not accurate enough for comparison with other scientific applications of the Munsell Bead Color Book, the information proved useful in the context of this study and can be used in future to assess which studs may prove useful for future scientific assessment using this method.

During the physical examinations, the studs were measured using a vernier calipers and photographed by this author. Information regarding material, colour, shape, form of the surface, size of the stud and applied ornament, composition of the ornament and museum number were recorded and are found in the object catalogue in the appendix. This object catalogue was informed by the example developed by Dr. Tara Kelly in her 2012 PhD entitled; *Commerce and the Celtic Revival, the history of the Irish facsimile industry, 1840-1940*.⁴⁸

During the examination of each stud, the constituent parts were considered in relation to one another including their materials, processes, the choices the maker made and how they overcame various technical difficulties. Studs were considered in relation to their setting or collet, in relation to other neighbouring techniques and materials. This information was used to make comparisons to other studs on the artefact and to metalworking in general. However, due to the large number of extant studs and the length restrictions of this study, a representative sample were included in the final appendix.

⁴⁷ Mags Mannion, 'An Examination of Glass Beads from Early Medieval Ireland', in *Making Histories, Proceedings of the Sixth International Conference on Insular Art*, ed. Jane Hawkes (Donington, 2013), pp.121-33.

⁴⁸ Tara A. Kelly, *Commerce and the Celtic Revival, the history of the Irish facsimile industry, 1840-1940*. (Trinity College Dublin, 2012) Vol.1

The general characteristics of Insular metalworking and studwork were determined through the empirical examination of the artefacts and by accessing secondary technical literature, in particular Niamh Whitfield's assessment of the use of filigree and Corinthian bronze on the 'Tara' brooch and Paul Craddock's summary of metalworking techniques in the *Work of Angels* catalogue, and the publications of Francoise Henry.⁴⁹ Publications by Susan Youngs, Raghnaill O'Flionn and Michael Ryan in the *Work of Angels* catalogue, Dr. Rachel Moss' Royal Irish Academy publication *Art and Architecture of Ireland 400-1600 AD*, are also referred to.⁵⁰ Michael Ryan's various publications on the Derrynaflan hoard and his work on the development of the large silver Eucharistic vessels were also scrutinised.⁵¹ The lives of the saints and annals provided information on historical and cultural contexts, religious communities' links with the Continent and the role of the patron in the commissioning of artefacts.⁵² In addition, secondary material was consulted regarding the status and training of the

⁴⁹ Niamh Whitfield, 'The 'Tara' Brooch: An Irish Emblem of Status in Its European Context' in *From Ireland Coming, Irish Art from the Early Christian to the Late Gothic Period and Its European Context*, ed. Colum Hourihane (Princeton, 2001), pp.216.; Michael Ryan, *Early Irish Communion Vessels, Church Treasures of the Golden Age* (Dublin, 1985); idem, 'Aspects of Sequence and Style in the Metalwork of Eighth-and Ninth- Century Ireland'; in *Ireland and Insular Art AD500-1200*, ed. Michael Ryan (Dublin, 1987); Michael Ryan, 'Eucharistic Vessels. Architecture and Liturgical Celebration in Early Medieval Ireland', in *De Re Metallica, the Uses of Metal in the Middle Ages. Avista Studies in the History of Medieval Technology, Science and Art*.ed. Robert Bork (Aldershot, 2005).; Michael Ryan, 'Church Metalwork in the Eighth and Ninth Centuries'; in *The Work of Angels*, ed. Susan Youngs (London, 1989), pp.125-30.

⁵⁰ Ludwig Bieler, *The Patrician Texts in the Book of Armagh* (Dublin, 1979); J.G. O' Keefe, 'The Rule of St. Patrick', *Ériu* 1 (1904); 'Cogitosus: Life of Saint Brigīt', eds Sean Connolly and Jean-Michele Picard, *Journal of the Royal Society of Antiquaries of Ireland*, 117 (1987); Annála Ríoghachta Éireann: Annals of the Kingdom of Ireland by the Four Masters from the Earliest Period to the Year 1616, ed. and trans. J. O'Donovan, 7 vols (Dublin, 1851; repr. New York, 1966), ii, 1033; *Chronicum Scotorum: A Chronicle of Irish Affairs...to 1135, and Supplement...1141-1150*, ed. W.M. Hennessy (London, 1866), p.279; 'The Annals of Tigernach', ed. W. Stokes, in *Rev. Celt.*, xvi-xviii (1896-97); Fergus Kelly, *A Guide to Early Irish Law*, Early Irish Law Series (Dublin, 1988).

⁵¹ Ryan, 'The Derrynaflan Hoard and Early Irish Art,' p.55; idem, 'Eucharistic Vessels. Architecture and Liturgical Celebration in Early Medieval Ireland' in *De Re Metallica, the Uses of Metal in the Middle Ages*. Avista Studies in the History of Medieval Technology, Science and Art. ed. Robert Bork (Aldershot, 2005), pp.125-45.

⁵² Rachel Moss, 'Altar, Processional and Reliquary Crosses', in *Art and Architecture of Ireland*, Vol. 1 Medieval c. 400-1600AD, ed. Rachel Moss, (Dublin, New Haven and London, 2014), pp. 266-68.; Éamonn Ó Carragáin, *The City of Rome and World of Bede*. Jarrow Lecture (Jarrow, 1994). pp.1-2.; Kathleen Hughes, *The Church in Early Irish Society* (London, 1966); Françoise Henry, *Irish Art in the Early Christian Period to 800 AD* (London, 1965); Raghnaill Ó Floinn, 'Patrons and Politics: Art, Artefact and Methodology', in Mark Redknap et al (eds), *Pattern and Purpose in Insular Art* (Oxford, 2001), pp.1-14; Niamh Whitfield, 'The 'Tara' Brooch: An Irish Emblem of Status in Its European Context' in *From Ireland Coming, Irish Art from the Early Christian to the Late Gothic Period and Its European Context*, ed. Colum Hourihane (Princeton,2001), pp.211-48.; Ó Floinn, 'Patrons and Politics,' pp.1-14.; Raghnaill Ó Floinn, 'Clonmacnoise: Art and Patronage in the Early Medieval Period' in C. Bourke (ed.) *From the Isles of the North*, (Belfast, 1995), pp.251-60.;

goldsmith in early Christian Ireland, including looking to the references in contemporary law tracts, and was considered alongside the status of the goldsmith in Anglo-Saxon Britain and the Continent to determine the status and skills associated with the profession.⁵³ This material allowed for the creation of a status profile and an assessment of technical knowledge associated with the goldsmith.⁵⁴ The survey of metalworking in general pointed to a favoured approach to achieving different metalworking techniques, problem solving and types of connections favoured across Insular metalworking.

This research was also informed by undertaking Continuing Professional Development courses and general evening courses in glass bead making, enamelling, silver-smithing calligraphy, weaving and printing. While some of these crafts may seem far removed from metalworking and stud-making, exploring and practicing as an artist revealed insights into the relationship between the stud-maker and their materials which differs across goldsmiths in other cultures. Furthermore, contemporary jewellers regard their approach to process in similar ways to other artists and readily borrow techniques, technology and processes from other media. Equally, different crafts and skills such as glass blowing and glass engraving may have similar vitreous materials in common, however, the manner in which the material is worked, and how the artist interacts, with the medium can be quite different, requiring different knowledge and a somewhat different skill strength. Similarly while fine art printing may seem to have little to do with metalworking, similar approaches, in terms of process, approach and the advantages of producing multiple high quality copies have their parallels in Insular metalworking from which stud craft emerged.

Within chapter one this examination of the prior knowledge and established common cultural knowledge associated with Early Christian Ireland's metalworking milieu was supplemented by a similar scrutiny of materials and techniques employed beyond this region. This study was undertaken to see if the work of Anglo-Saxon metalworkers would shed light on the approaches taken in Insular metalwork beyond

⁵³ Ragnhail Ó Floinn, 'Schools of Metalworking in Eleventh- and Twelfth-Century Ireland'; in *Ireland and Insular Art AD500-1200*, ed. Michael Ryan (Dublin, 1987), pp.179-87; Griffin Murray, 'The Makers of Church Metalwork in Early Medieval Ireland; Their Identity and Status'; in *Making Histories, Proceedings of the Sixth International Conference on Insular Art*, York 2011, ed. Jane Hawkes (Donington, 2013), pp.162-73; Neil McLeod, 'The Metalworking Tradition in Medieval Irish Law' in *Between Invasions: Britain and Ireland between the Romans and the Normans*, ed. Pamela O'Neil (Melbourne, 2004), pp.103-13.

⁵⁴ C. R. Dodwell, *Anglo-Saxon Art. A New Perspective* (Manchester, 1982); p.55; Elizabeth Coatsworth and Michael Pinder, *The Art of the Anglo-Saxon Goldsmith* (Woodbridge, 2002), pp.208-9.

those identified by other scholars.⁵⁵ In relation to Germanic Continental metalwork in 2014 the Louvre exhibition, *Le Trésor De L'abbaye De Saint-Maurice D'Agaune*, of Medieval treasures from both the Louvre and the abbey of St. Denis collection, proved useful.⁵⁶ The role of the patron and status of the goldsmith are outlined based upon evidence from ninth-century Law tracts and entries within the annals.⁵⁷

Chapter two- Materials employed in Insular metalworking

In order to address the first key research question regarding the techniques used to form glass studs it was necessary to examine the scientific reports pertaining to the materials' working properties, including melting points and how easily the material bonds with other associated materials. Information regarding the type of glass employed and relevant colourants relied upon the scientific examination and analysis of Insular glass carried out by Julian Henderson and Mavis Bimson.⁵⁸ The materials are divided into primary structural material and secondary ornamental material in line with the approach taken by stud makers. This evidence was garnered from archaeological and scientific reports, and other publications which deal with the primary and secondary materials employed to make studs.⁵⁹

⁵⁵ Coatsworth and Pinder, *The Art of the Anglo-Saxon Goldsmith*; Genevra Kornbluth, 'The Alfred Jewell reuse of Roman Spolia', *Medieval Archaeology* 33 (1989), 32-7.; Mavis Bimson, 'Aspects of Technology of Glass and of Copper-alloys: A Coloured Glass and Millefiori in the in the Sutton Hoo Grave Deposit' in ed. R.L.S. Bruce-Mitford, *The Sutton Hoo Ship Burial*, vol.iii (2pts), *Late Roman and Byzantine Silver, Hanging Bowls, Drinking Vessels, Cauldrons and Other Items*, ed. A. C. Evans (London, 1983), pp.924-44.; Janet Backhouse and Leslie Webster, eds., *The Making of England, Anglo-Saxon Art and Culture*, (London, 1991); Dodwell, *Anglo-Saxon Art*.

⁵⁶ Élisabeth Antoine-König, ed., *Le Trésor De L'abbaye De Saint-Maurice Agaune* (Paris, 2014).; Birgit Arrhenius, *Merovingian Garnet Jewellery*, (Stockholm, 1985); Lawrence Nees, *Early Medieval Art*, (Oxford, 2002).; Kessler, Herbert L. *Seeing Medieval Art. Rethinking the Middle Ages*. Ed. Paul Dudward and John Shinnors (Toronto, 2011); Peter Lasko, *Ars Sacra 800-1200*, (New Haven, 2 ed. 1994).

⁵⁷ See footnote; 50, 52-53.

⁵⁸ Julian Henderson and R. Ivens, 'Dunmisk and Glass-Making in Early Christian Ireland', *Antiquity* 66 (1992), 52-64; Julian Henderson, 'The Production Technology of Irish Early Christian Glass with Specific Reference to Beads and Enamels', in *The Glass in Britain and Ireland Ad 350-1100*, ed. J. Price (London, 2000), pp.143-59; Mavis Bimson and A.E. Werner, 'Scientific Examination of Ancient Glass', *Annales du 3e congres international d'etude du verre des 'journées internationales du verre'. Damas, 14-23 novembre 1964* (Liege, n.d.), pp.201-11.

⁵⁹ C.P. Stapleton, I.C. Freestone and S.G.E. Bowman, 'Composition and Origin of Early Medieval Opaque Red Enamel from Britain and Ireland', *Journal of Archaeological Science* 26 (1999); Julian Henderson, 'Production Technology of Irish Early Christian Glass', pp.143-59.; Helen Fraquet, *Amber* (London, 1987); T. Follet, 'Amber in Goldworking', *Archaeology* 38, no.2 (1985), 64-5; Stephen Briggs, 'The Discovery and Origins of Some Bronze Age Amber Beads from Ballycurrin Demense, Co. Mayo', *Journal of the Galway Archaeological and Historical Society*, 49 (1997), 104-21; Patty C. Rice, *Amber*, (Milton Keynes,); Andrew Ross, *Amber*, (London, Natural History Museum, 2009); Bioletti, Susan et al, 'The Examination of the Book of Kells using Micro-Raman Spectroscopy', *Journal of Raman Spectroscopy* 40 (2009), 1043-9; Jenny Dean, *A Heritage of Colour, Natural Dyes Past and Present*, (Tunbridge Wells, 2014); Youngs, *The Work of Angels*, (Dublin and London, 1989).

How the materials were used and processed within other craft activities in Early Christian Ireland was scrutinised to determine whether there was a connection or sharing of material knowledge, skills or processes across the region and the period.⁶⁰ It will be shown that although the materials glass and amber are shared with bead-making they are employed in very different ways suggesting a hierarchy of use. For the first time the adaption of secondary ornamental materials from other industries such as textiles and painting are outlined and discussed.

While it is generally reported that abundant amber display on an artefact is connected with Viking trade in the ninth century, this chapter outlines the evidence which points to the longstanding use of the material in Ireland prior to the arrival of the Vikings. It also presents the issues with amber provenance noted by Stephen Briggs, alongside potential Indigenous geological sources, secondary sources and the potential to import the material through Anglo-Saxon middle-men prior to the trading phase of Viking activity from the 840s AD.⁶¹ It shows that until artefacts with amber and potential sources in Ireland systematically scientifically assessed and ruled out, we cannot be definitive that amber sourced from the Vikings was the only source of the material in use.

Chapter three- techniques employed in Insular metalworking

The NMI photographic archive facilitated an examination of high-resolution images of glass and amber studs. These samples together with *ex situ* examples surveyed from publications were assessed for information regarding technique. As a result of the writer's current knowledge of and practical experience regarding glass working, the actual making of glass studs proved relatively straight forward to decipher. The individual approach of each stud maker and emphasis on reimagining and combining various techniques became the main focus of the examination of composite glass studs. To a trained silversmith and teacher, the small technical variations among

⁶⁰ Nancy Edwards, *The Archaeology of Early Medieval Ireland*, (London, 1990); Mags. Mannion, 'An Examination of Glass Beads from Early Medieval Ireland', in *Making Histories Proceedings of the Sixth International Conference on Insular Art*, ed. Jane Hawkes (Donington, 2013), pp.121-33.;

⁶¹ Briggs, 'The Discovery and Origins of Some Bronze Age Amber Beads from Ballycurrin Demense, Co. Mayo', 113.; Stephen Briggs, 'Amber in Ireland, some Geological Notes' 81-85 in E. Kelly 'A prehistoric amber find from Ballylin, Co. Offaly', *Eile: Journal of the Roscrea Heritage Society*, 2 (1983-4), 67-85 ;C. Beck and S. Shennan, *Amber in Prehistoric Britain*, (Oxford, Oxbow Books, 1991), Oxbow Monograph 8, pp. 26-7; Dáibhí Ó Cróinín, *Early Medieval Ireland 400-1200*, ed. Steven G Ellis, Longman History of Ireland (London and NewYork, 1995), p.251; A. L. Meaney, 'Amber: Saxon Amulets and Curing Stones' BAR British Series, 96 (1981); Seán P.Ó Riordáin, 'Excavations of a Large Earthen Ring-fort, Garranes, Co. Cork', *Proceedings of the Royal Irish Academy*, 47C, (1942),121; Fraquet, *Amber*, p.149.

studs which appear 'generally' similar but are not, and evidence of manipulating the material in small but with subtly different levels of skill were of particular interest.

Recreations in glass were not attempted by this author as enough evidence was present to demonstrate technique employed and while the main benefit would have been to develop and hone the fine-motor skills of this maker, there would have been little added benefit for this study. This approach would also have taken up significant time and financial resources to achieve. However, the intention is to undertake such work on the completion of this study. Where a technical ambiguity arose simple simulations made with soft clay, fimo, resins, tin foil, wet plaster, paper and acrylic or powdered 'ready-mix' paint at the point they were employed to form studs.

In addition to vitreous materials this approach was also taken with amber. An assessment of existing literature on amber all exclusively point to amber being ground down or cut and polished. All contemporary material working manuals and guides point to small scale jewellers using reductive grinding and polishing of amber inlays, implying that heat forming is beyond hand-working and associated with much later industrial approaches. This hypothesis was further supported by a search of jewellery forums and blogs online which also pointed to the unsuitability of amber for heat forming outside of the industrial realm.⁶² This evidence and the difficulty in working amber using heat and pressure initially suggested that reductive processes must have been employed in the early medieval Irish context. However, the empirical evidence gathered from the primary examinations of amber studs and inlays within their immediate settings, cross-applied with this researcher's knowledge of metalworking and setting stones particularly a soft one such as amber, emphatically suggested otherwise and is one of the major findings of this study.

In order to counter the difficulties associated with understanding the approaches to amber small experiments were made trying to heat and form amber and in forming amber studs in the traditional manner using reductive techniques. Heat-forming was first carried out with a small hand held gas torch to heat the material to simply see what would occur and to develop and understanding of the material and how it responds to various levels of heat. The second approach was to heat the amber in a wax pot used to for batik work, however the temperatures were not hot enough nor

⁶² 'How to work with amber' by Doug Lundberg at www.ambericawest.com accessed 20/01/2008, site updated in 2016 re-accessed 23-07-2016; 'How to work with amber by Nickolas Jewellery at www.amberway.co.uk accessed 20/01/2008.; see also Amber (working) with Knivesby.com (page created 11/03/2003) accessed 12/10/2010.; Fraquet, *Amber*, (1987); Niamh Whitfield, "More Like the Work of Fairies Than of Human Beings": The Filigree on the 'Tara' Brooch, a Masterpiece of Late Celtic Metalwork.,' *ArchéoSciences* 33(2009).235-41

was the equipment suitable to apply the pressure required at low temperature. While metalworking and enamelling are associated with greater health and safety requirements than most crafts, heating amber in hot wax, oil or fat and using pressure would require specialist equipment which protects the hands and face from hot oil without compromising finger dexterity. While this author has not as yet recreated the approached used by Early Christian Craftsmen, the physical evidence on the studs and inlays demonstrates this author's hypothesis.

It was clear from preliminary tests, that learning to manipulate amber in this manner without a demonstration from a currently practicing artist or explicit technical guide would prove to be an enormous undertaking in its own right. It would require much time to developing an innate understanding of the material's characteristics at different temperatures and lot of amber will be lost in the process. It is likely that specialist equipment would be need to be developed or adapted through trial and error, and more importantly, the skills of this maker would have to be significantly developed on a full time basis in order to achieve this. It is also likely to require an in depth examination of current industrial amber pressing processes as carried out on an industrial scale in the Baltic region.⁶³

Preliminary experiments with amber were informed by referencing personal technical notes, technical publications on goldsmithing and the Medieval treatise of the twelfth-century German goldsmith Theophilus *De diversis artibus*. The high resolution photographs of the studs and the larger artefacts to which they are attached were also consulted.⁶⁴ In tandem this researcher continued to develop her own skills to better understand the primary and secondary materials of interest and how they were utilised in the Insular context and metalworking atelier.

Chapter three outlines the fundamental techniques employed to form glass and amber studs, and for the first time outlines a representative selection of the individual approaches and modifications to these techniques developed by craftsmen on various artefacts. This chapter will demonstrate that both amber and glass studs were developed from the prior knowledge associated with *champlevé* enamelling and

⁶³ See for example www.amber-lori.com a company based in Lithuania which industrially reconstitutes amber fragments into larger pieces for the jewellery trade.

⁶⁴ Theophilus, *On Divers Arts*. Trans. John Hawthorn and Cyril Stanley Smith, (New York, 1979); Brephol, Erhard, *The Theory and Practice of Goldsmithing*, (Maine, 2nd ed. 2001); Ian Panter, 'Amber Working Tools and Techniques', in *Craft Industry and Everyday Life: Finds from Anglo-Saxon York, Vol.17: The Small Finds*, Fasc. 14 eds. A.J.Mainman and N.S.H. Rogers (York, 2000) pp.2501-19.; Paul Craddock, 'Metalworking Techniques' in *The Work of Angels*, ed. Susan Youngs (London, 1989),pp.170-213.

evidence similar problem solving approaches in their construction derived from metalworking practice.

Chapter four- analysis of Insular stud-making

This chapter will explore the questions regarding dating, chronology, authorship, workshop practice and the potential connections between the studs produced between the Early Christian and later eleventh century. While general similar characteristics between studs of similar technique are to be expected as a matter of course, it does not follow that similar studs on comparable objects were necessarily formed by the same hand or in the same workshop tradition. Other studies by Kelly, Ryan, Youngs and Murray have focused on common material use, general technical similarities and ornamental features to suggest potential common workshop connections.⁶⁵ Murray points to the similar use of red and yellow enamels on mounts and in two cases finds identified within relative proximity of the workshop that produced the Cross of Cong as probable evidence of common workshop origin.⁶⁶

While these comparisons are useful and may indeed be evidence of a common workshop, they may also be simply evidence of an overall common metalworking process, style or the availability of materials. In the case of Champlévé enamelling or the relatively common red and blue glass with silver grilles, this may be evidence of imitation of the work of a more prestigious workshop tradition. Although broadly similar they do not necessarily indicate a common workshop, more in-depth scrutiny is required.

Authorship

In order to examine authorship for the first time, this study looked much deeper into the physicality of the stud itself. By looking beyond common techniques or materials to evidence of individual handiwork within each stud, revealing the unique characteristic qualities of the maker. Within studs we have an ideal subject as they capture, much like a hand-written poem, the individual signature of each author's creative character in their use of different materials their resolution of different stages

⁶⁵ Youngs proposes that the comparable shape, slight curvature and angular design of the Lough Gara buckle and one from Melton Mowbray, Leicestershire and the shared use of an unusual opaque green enamel suggest that these items were made in the same workshop tradition. Susan Youngs, 'Recent finds of Insular enamelled buckles', in *The Insular Tradition*, eds. C. Karkov, R. Farrell, M. Ryan (New York, 1997), pp.196-7.; Eamon P. Kelly, suggests that proximity and similar ornament and materials may be indicators of a common workshop for the Tullylough Cross and Lough Kinale bookshrine, see 'The Tullylough Cross' *Archaeology Ireland* 17, no. 2 (2003), 10

⁶⁶ Murray, *Cross of Cong*, pp.138, 284-5.

in the stud making process. These characteristics can be found within the hand-composed high relief surfaces and recessed patterns and in the patterns and motifs of silver grilles as composed by the makers.

Previous authors such as Ryan and O'Kelly have made general comparisons between the studs on the Derrynaflan paten rim and the Moylough beltshrine respectively, with those on the bowl girdle of the Ardagh chalice.⁶⁷ However, no direct, in depth stud to stud comparison has been made prior to this study. Due to the large number of studs involved an initial survey was made to identify a selection of studs with similar patterns and comparable technical approaches. Particular working styles and signatures were compared to others to show differences in approaches to the cutting of grilles, applying enamel and casting which indicated different hands at work. The examples chosen are in good condition and in most cases do not display subsequent damage, however, where it does occur it is outlined in the text. The studs chosen from the Ardagh chalice are found on the bowl girdle, handles, handle escutcheon, medallion and underfoot mount. Those on the Derrynaflan paten were drawn from both the top surface and the side, while those from the ring are found on the only decorated zone the side.

It was during this aspect of the research that the greatest advantages of working with high resolution images revealed itself. It lay in the ability to position two or more enlarged stud images side by side, from the same or different artefacts. This permitted side by side scrutiny where, for the first time, detailed examples of the cut marks specific to each hand within the silver grilles could be compared. In addition, features and foibles specific to the application of red glass and backings of blue glass could be identified which helped build up a profile of the skill of the maker of each stud. This information also facilitated the opportunity to analyse potential information on authorship, specifically whether different or the same hands were at work within and across artefacts.

Issues such as spatial awareness, ability to gauge volume, shape and form, predictive skills indicating the ability to determine the temperature of a material and how it will react in different circumstances are in evidence. How to compensate for different factors such as rapidly cooling glass are also recorded. The ability to automatically and accurately time each movement and apply the correct amount of pressure to achieve the desired outcome is also demonstrated. Hand eye co-ordination

⁶⁷ Ryan, *The Derrynaflan Hoard I*, pp.36, 37; M. J. O'Kelly, 'Belt-Shrine from Moylough,'.174-5, 184.

and finger dexterity are visible within the formation and fusing of the enamelled inlays, as are the form of yellow and red glass additions to polychrome studs with silver grilles, and the application of silver grilles to backgrounds of glass. Attention to detail is found within the formation of the grilles, application of inlays and the removal of surplus material and a successful final cleaning.

Of particular use to this study was an in depth examination of the cut marks used to form silver grilles. Some makers used one sweeping movement while others employed three cuts to form the same shape, thus indicating that although they may look generally similar, they were formed by different hands. When we include an analysis of the application of additional elements we can begin to build up a profile of the maker. By scrutinising these additional features it provides a fuller picture of the skills of a maker and it is easier to isolate one-off mistakes, such as an unfortunate crater caused by an air bubble exposed during cleaning in an otherwise pristine stud. Indeed it was interesting to note similar issues regarding skill and predictive ability arising at each stage in the making process throughout some polychrome studs.

During the scrutiny of these features this researcher drew upon experience with glass working, enamelling and silver-smithing to interpret the material results, but as noted earlier, also seventeen years as a trained art teacher working in a post-primary environment with groups of student carrying out similar creative tasks. In this environment the ability to successfully identify and resolve technical problems and issues with fine motor-coordination are requisite and also lead to the ability to recognise the characteristics of different makers through observation and scrutiny of their individual handiwork.

Workshop tradition

Due to the large number of studs available a selection was taken from three objects often grouped together, by other scholars, the Ardagh chalice, the Derrynaflan paten and ring.⁶⁸ This selection was made due to the good condition of the studs and the fact that they demonstrated evidence which suggests a number of different artists making studs for an object. The Ardagh chalice studs were chosen from different regions of the artefact; three studs with silver grilles from the bowl-girdle, four studs with silver

⁶⁸ Ryan, *The Derrynaflan Hoard I*, pp.28, 29, 37, 38; Ryan states that it would be quite unscientific to assert that the paten and chalice were made by the same man or for the same communion set, but that they may be regarded as effectively contemporary and part of the same 'workshop tradition'. Michael Ryan, 'Some Aspects of Sequence and Style in the Metalwork of Eighth-and Ninth-Century Ireland,' in *Ireland and Insular Art AD500-1200*, ed. Michael Ryan (Dublin, 1987), p.68.

grilles from the handle, and a stud from both the handle-escutcheon and medallion mounts. Two studs with enamelled ornament were chosen from the handles. The final studs was selected from the underfoot mount and ornamented with gold filigree and a plain blue stud from the medallion mount. Amber inlays from the handle escutcheons and underfoot mount and the settings which originally contained amber from the

A broader selection of techniques was available on the Derrynaflan paten and the examples chosen include studs with silver grilles, enamelled studs and studs with relief ornament. These were chosen from two ornamented zones the upper ornamental rim and the side of the paten. The Derrynaflan ring contains two types of decorated studs enamelled studs and those with silver grilles, these are found on the only decorated zone, the outside of the ring. By comparing the cut-marks and other manufacturing features outlined previously a profile of some of the stud makers on each artefact was created and compared.

Workshop practice

Workshop practice was deciphered by scrutinising where the artefact's studs were drawn from, the materials employed on each, the level of complexity achieved, the design of the motif, the types of settings used and the ornamental features immediate to the studs. This evidence was cross-applied with information regarding the different levels of goldsmith and the status of materials recorded in contemporary law-tracts to determine issues regarding workshop practice, hierarchies within the same, training and the availability of materials- suggesting different levels of stud makers worked on the production of these artefacts.

Evidence regarding common authorship of studs was determined by initially visually skimming the artefacts for common features which may have suggested potential matches. Two from the bowl girdle of the Ardagh chalice and an example from the ornamental rim of the paten which bear strikingly similar patterns, were chosen to demonstrate although generally very alike, when other factors are considered, the handwork suggests that they are not by the same author. Two studs from the Derrynaflan paten rim and the side of the Derrynaflan ring were also chosen and compared to determine whether a common hand created both studs.

Dating and chronology

In order to determine issues regarding the chronology of artefacts the findings on authorship and technique were scrutinised. A comparison of the methods used to form both amber on the Ardagh chalice and glass are used to show that both materials

are found side by side on single artefacts and across artefacts using comparable approaches and connection methods, which suggests that they were worked concurrently rather than glass giving way to amber as suggested in the current dating system questioned by Nees, Raftery, Murray and Netzer.⁶⁹

The eleventh century revival

To determine the relationship between the studs made in the early Christian period and those of the eleventh century, the techniques employed to make the studs on the reverse of the Cross of Cong were compared to the technique employed to make enamelled glass studs during the Early Christian Period. Henry's suggestions that earlier enamels are formed using red against a yellow background, while later examples are yellow against red are examined.⁷⁰ While Murray's proposal that this cannot be used to ascertain a later or earlier date is also explored.⁷¹ Similarly the so-called '*millefiori*' fused glass discs on the crook of the Lismore crozier are compared to the *millefiori* also associated with *champlevé* enamelling during the earlier period. Henry writes that although there is a dearth of polychrome enamelled material from the tenth century period, there must be a link with the earlier period. The technical evidence and patterns pertaining to the use of materials is analysed to determine what this link may be.

⁶⁹Lawrence Nees, 'Trends in Dating of Works of Art' in *Insular and Anglo-Saxon Art, Art and Thought in the Early Medieval Period*, ed. Colum Hourihane (Princeton, 2011), p.30; Joseph Raftery, 'Concerning Chronology,' in *Irish Antiquity: Essays and Studies Presented to Professor M.J. O'Kelly*, ed. D Ó Córráin (Cork, 1981), pp.82-90; Nancy Netzer, 'The Narrative on Insular Gospel Books,' in *Insular and Anglo-Saxon; Art and Thought in the Early Medieval Period*, ed. Colum Hourihane (Princeton, 2011), pp.3-13. ;Griffin Murray, 'Stud of Amber and Glass from Decorative Pieces of Early Christian (Early Medieval) Metalwork' in *Excavations at Knowth 5*, ed. George Eoghan (Dublin, 2012), pp.544-50.

⁷⁰ Henry, *Irish Art in the Romanesque Period*, p.78

⁷¹ Murray, *Cross of Cong*, p.138

Chapter One: The character of Insular metalwork

The aim of this chapter is to provide a general introduction to Insular metalwork; the background to its development, its materials, techniques, design, dating and the status of the goldsmith responsible for its creation. It will outline the contribution of Germanic, La Tène and Late Roman influences to Irish metalwork and demonstrate the intrinsic importance of the goldsmith as an active participant involved in all aspects of Insular metalwork. This will provide the context within in which the more detailed study of one of the characteristic features of much Insular metalwork, the glass and amber stud, can be considered in more detail.

1.1, The impact of Christianity on Irish metalwork

With the introduction of Christianity from the fifth century, Ireland gradually became part of the Christian world focused on the Mediterranean, with Rome as its spiritual centre. (appendix 1) As one of the many consequences of this, Insular craftsmen developed new equipment based on the requirements of Christian rituals and practices.

The seventh-century lives of St. Patrick describe the saint as bringing across the Shannon 'fifty bells, fifty patens, fifty chalices, altar stones, books of the law, Books of the Gospels' and leaving them in 'new places'.⁷² The importance of using appropriate equipment for its rituals is recorded in the eighth-century text the *Rule of St Patrick* which states that 'for the church which has not its proper equipment is not entitled to the dues of God's church'.⁷³

While the information contained in any hagiography must be treated with some caution, certainly the first missionaries must have carried with them liturgical instruments from their homelands to minister to their congregations.⁷⁴ As Christian missions to Ireland originated in Gaul and Britain in the fifth century it is probable that Late Roman metalwork and decoration provided exemplars for native goldsmiths to copy.⁷⁵

By the late seventh or early eighth century, elaborate Eucharistic altar vessels were being manufactured in Ireland, which derived, in part, from Late Roman and

⁷² Ryan, 'Eucharistic Vessels. Architecture and Liturgical Celebration,' pp.122-23.

⁷³ J.G. O' Keeffe, 'The Rule of St. Patrick' *Ériu* 1 (1904), 223.

⁷⁴ Michael Ryan, 'Some Archaeological Comments on the Occurrence and Use of Silver in Pre-Viking Ireland' in *Studies in Medieval Irish Metalwork*, (London, 1982), pp.1-15.

⁷⁵ Michael Ryan, 'Church Metalwork in the Eighth and Ninth Centuries' in *The Work of Angels*, ed. Susan Youngs (London, 1989), pp.125-30.

Byzantine types, and were clearly related to those jewelled types employed throughout the Christian world.⁷⁶ For example, Ní Chatháin has pointed to the use of a strainer and chalice in the Roman liturgy as comparable to the strainer found at Derrynaflan in Ireland and Eucharistic chalices illustrated in the pages of the Book of Kells on folio 32v.⁷⁷ (figs. 1 and 2) The liturgical text preserved in the ninth-century Stowe Missal refers to a dove suspended above the altar during the consecration of the host,⁷⁸ which suggests comparison with a hollow silver dove found as part of a hoard of Eucharistic vessels at Attarouthi, Syria.⁷⁹ Similar, also to those suspended from jewelled votive corona employed over altars from Constantinople to Visigothic Spain.⁸⁰ Cogitosus' Life of St Brigid makes reference to jewelled coronas suspended over the tombs of St Conleod and Brigid in the church at Kildare, and it has also been suggested that the so-called Derrynaflan 'stand' or ring is in fact the Insular response to such jewelled hanging crowns.⁸¹ (fig. 1) Although none has survived, Eucharistic flabella derived from types used in warmer climates to keep insects away from the consecrated host are depicted in on folio 129v in the Book of Kells, in stone at Carndonagh Co. Donegal and are referred to in hagiographical texts.⁸² (figs. 3 and 4) (appendix 3)

Aside from Eucharistic vessels, knowledge of developments in fine metalwork on the continent are reflected in other types of object made for the Church. For example, the buckle design of the eighth-century Moylough beltshrine,⁸³ emulates Frankish exemplars, suggesting the emulation of a model procured from overseas. (figs. 5, 6)

⁷⁶ Ryan, *Early Irish Communion Vessels, Church Treasures of the Golden Age* (Dublin, 1985); idem, 'Some Aspects of Sequence and Style in the Metalwork of Eighth-and Ninth-Century Ireland', pp.67-74.

⁷⁷ Próinséas Ní Chatháin, 'The Liturgical Background of the Derrynaflan Altar Service', *Journal of the Royal Society of Antiquaries Ireland* 110 (1980), 136.

⁷⁸ *The Stowe Missal. Ms. D. li 3 in the Library of the R.I.A. Dublin* ed. George F. Warner, 2 vols. (London, 1915), ii, p.37.

⁷⁹ Helen C. Evans, 'The Arts of Byzantium', *The Metropolitan Museum of Art Bulletin* 58, no. 4 (2001), 38.

⁸⁰ For Anthony of Novrogod's later description of a hanging crown with an attached pendant cross and golden dove in St. Sophia's Constantinople see S. Khitrovo, *Itinéraires Russes En Orient* (Geneva, 1889), 96. The '*Liber Pontificalis*' records the donation of a hanging crown to St. Peter's in Rome. Louise Ropes Loomis, *The Book of the Popes (Liber Pontificalis)* (New York, 1916), pp.130-31. For the hoard of numerous votive crowns uncovered at Guarrazar in Spain see Alicia Perea (ed.), *El Tesoro Visigodo De Guarrazar* (Madrid, 2001).

⁸¹ 'Cogitosus: Life of Saint Brigid', eds Sean Connolly and Jean-Michele Picard, *Journal of the Royal Society of Antiquaries of Ireland*, 117 (1987), 11-27 at 25. Jennifer Gleeson, 'The crowning glory of Insular art' in *Islands in a Global Context*, C. Newman (ed.) forthcoming.

⁸² Hilary Richardson, 'Remarks on the Liturgical Fan, Flabellum or Rhipidion' in *The Age of Migrating Ideas*, eds R. Michael Spearman and John Higgitt, (Edinburgh and Stroud, 1993), pp.27-34, figs.3.1, 3.2.

⁸³ Ragnall Ó Floinn, 'The Moylough Beltshrine' in *Lost and Found: Discovering Ireland's Past*, ed. Joseph Fenwick (Bray, 2003), reprinted (Dublin, 2008), p.12

Awareness of the growing cult of the Cross, in particular promoted during the reign of the Emperor Charlemagne, manifested itself in Ireland with fine metalwork crosses such as the Tullylough cross and their skeuomorphs in stone, as at Ahenny.⁸⁴ (appendix 3)

1.2, Connections and influences outside Ireland

Such ideas and trends were brought to Irish shores most likely in a variety of ways; through contact with foreign craftsmen at home and abroad, the importation of foreign vessels, whether by gift or trade. The Irish monk, St Columbanus from Bangor Co. Down was given land to found his monastery at Bobbio c. 614, by King Agilulf of Lombardy, who along with his wife queen Theodelinda, donated many Christian treasures to adorn Monza Cathedral. The monasteries founded by Columbanus at Luxeuil, and at Bobbio and by a disciple of Columbanus at St. Gall, all acted as staging posts on the journey to Rome for Irish pilgrims and hence facilitated the exchange of ideas. (appendix 1) For example, in 631 AD a delegation of Irish ecclesiastics from the south of Ireland visited Rome for a ruling on the correct method of calculating the date of Easter consistent with current Church practice. This led Ó Carragáin to suggest that the Irish were aware that the ceremony of the mass was frequently changing and therefore relatively frequent visits to Rome were required to remain informed.⁸⁵

The portability of objects such as manuscripts also facilitated this exchange. This is demonstrated by the relatively numerous manuscripts that were preserved in Irish houses on the continent, such as the *Antiphonary of Bangor* preserved at Bobbio and the Irish gospel book at St Gallen, Stiftsbibliothek, Cod. Sang. 51, which presumably was one of the thirty '*libri Scottice scripti*' (books written in Irish script) referred to in the St Gallen library catalogue of c. 850.⁸⁶ Equally, manuscripts produced at European centres, such as the *Codex Usserianus Primus* made their way to Ireland, where they doubtless provided exemplars of both text and image for Irish scribes.⁸⁷ (appendix 1)

Certainly it is likely that Christian networks played an important role in the development of fine metalworking styles. For example, Irish missionaries operated in Anglo-Saxon England where they founded a centre at Cnobheresberg in East-Anglia and

⁸⁴ Rachel Moss, 'Altar, Processional and Reliquary Crosses', in *Art and Architecture of Ireland, Vol. 1 Medieval c. 400-1600AD*, ed. Rachel Moss, (Dublin, New Haven and London, 2014), pp.266-68.

⁸⁵ Éamonn Ó Carragáin, *The City of Rome and World of Bede*. Jarow Lecture (Jarrow, 1994), pp.1-2.

⁸⁶ Rachel Moss, 'Irish Art and Artists Abroad', in *Art and Architecture of Ireland, Vol. 1 Medieval c. 400-1600AD*, ed. Rachel Moss, (Dublin, New Haven and London, 2014), p.20.

⁸⁷ Kathleen Hughes, *The Church in Early Irish Society* (London, 1966), p.93; Henry, *Irish Art in the Early Christian Period*, p.62.

Malmesbury in Wiltshire, before turning their attention to Francia.⁸⁸ (appendix 1)

Ongoing and culturally significant connections with Scotland and northern England were made by the aristocratic St Colmcille of the Cénel Conaill branch of the northern Uí Neill. He set sail from Derry in 521 AD, to convert the Picts of Scotland and was received at Dunadd by the Gaelic speaking king of the kingdom of Dál Riata. (appendix 2) He founded the monastery of Iona, in Scotland which became the principal foundation among the Columban *paruchia*, which ultimately included monasteries at Derry, Durrow and Kells.⁸⁹ The monastery at Lindisfarne was also part of the Columbian *paruchia*, founded in 634 AD by St Aidan, a successor of Columcille. It is noteworthy that the Columban *paruchia* is associated in particular with artistic creativity, including three of the finest illuminated Gospels from this period, the Book of Durrow, the Book of Kells and the Lindisfarne Gospels and some of the finest examples of stone high crosses. (appendix 2)

At the Northumbrian court Irish visitors would also have come in contact with Germanic jewellery worn by Anglo-Saxon allies and high status royalty such as the spouse of the Northumbrian King Oswiu (642-70 AD). Niamh Whitfield has suggested that the Irish ecclesiastics would have seen great disc brooches on the cloaks of their Anglo-Saxon and Continental royal sponsors, which led to the evolution of simpler penannular brooches into elaborate pseudo-pennanular forms, with larger fields for display such as the 'Tara' and Hunterston examples.⁹⁰ (figs. 7, 8) Analogues for these can be seen in the great disc brooches of the Anglo-Saxon world such as the Kingston Down disc brooch, and in Continental disc brooches. (figs. 9, 10)

Although initially derived from Continental forms, as Insular fine metalwork developed, it moved in a different direction to its Continental counterparts. For example, by the early eighth-century Irish chalices were characterised by large semi-spherical bowls and broad feet in comparison to the narrower forms adopted on the Continent, seen, for example, in the Tassilo chalice.⁹¹ Irish croziers demonstrate a distinctively shaped crook with a straight drop unlike the curved forms of Continental types. While disc brooches became the favoured form of high status personal wear in

⁸⁸ For monasteries in England with Irish connections, including Glastonbury, see James Campbell, 'The Debt of the Early English Church to Ireland', in *Ireland and Christendom: The Bible and the Missions*, eds Próinséas Ní Chatháin and Michael Richter (Stuttgart, 1987), pp.332-46.

⁸⁹ Ibid.

⁹⁰ For the link between the development of Insular jewelled brooches based upon exemplars employed elsewhere see Niamh Whitfield, 'The 'Tara' Brooch: An Irish Emblem of Status in Its European Context' in *From Ireland Coming, Irish Art from the Early Christian to the Late Gothic Period and Its European Context*, ed. Colum Hourihane (Princeton, 2001), p.216.

⁹¹ Ryan, 'The Derrynaflan Hoard and Early Irish Art,' p.55; idem, 'Eucharistic Vessels, Architecture and Liturgical Celebration,' pp.125-45.

Anglo-Saxon England and on the Continent, in contrast in Ireland and Scotland the penannular and pseudo-penannular forms persisted.

By the twelfth century, adoption of Continental-style reliquaries and equipment such as the Cross of Cong, shrine of St. Lachtin's arm and curved ivory crozier head from Aghadoe, Co. Kerry, are evidence of the influence of church equipment created by English and continental craftsmen, on the forms of later Irish metalwork.⁹² Aubrey Gwynn notes that the eleventh century saw frequent pilgrimages to Rome, which necessitated stops at various ecclesiastical centres along the way.⁹³ It follows that Irish pilgrims witnessed the antique gem encrusted reliquaries and vessels, such as the Coffret of Teuderic and Cup of St. Martin, as they travelled to Rome, thus creating a demand for the same in Ireland.

The eleventh century was a period of political upheaval in Ireland due to competing dynasties struggling for supremacy and the arrival of the Anglo-Normans in 1172. The Gregorian church reforms similarly saw ecclesiastical centres vying for episcopal status at this time. Rivalling dynastic patrons, as a form of self-promotion, became involved in sponsoring church building and the creation of metalwork. Scribes became involved in the recording of saints' 'lives' in order to bolster the status of established monastic foundations in search of episcopal status. Murray identifies a Roscommon workshop under the directorship of Máel Ísu, the source of the Cross of Cong, as a centre of significant production, and is associated with red and yellow enamelled glass ornament.⁹⁴ This use of coloured glass alongside cast open work mounts, gold filigree and niello were created to emulate Irish metalwork of the earlier eighth century period.⁹⁵ Thus similar to the re-use of Roman gemstones and vessels by later continental goldsmiths, eleventh century Irish craftsmen created revivalist metalwork by using *millefiori* and opaque red and yellow enamels, which lent a character of authority and permanency to later high-status metalwork.

1.3, Materials, techniques and design in Anglo-Saxon and Frankish metalwork

It is clear then, that there was both the opportunity and receptiveness on the part of the Irish to adopt art forms both from its nearest neighbours in England, and from further afield. However, while comparison between the overall form of metalwork

⁹² Griffin Murray, 'The arm-shaped Reliquary of St. Lachtin', in *Irish Art Historical Studies in Honour of Peter Harbison*, ed. Colm Hourihane, (Dublin, 2004) p.158; Murray, *Cross of Cong*, p. 213

⁹³ Aubrey Gwynn, *The Irish Church in the Eleventh and Twelfth Centuries*, (Dublin, 1992), pp. 34-49.

⁹⁴ Murray, *Cross of Cong*, p.211.

⁹⁵ *Ibid.* pp. 141-2.

made in the Insular and Continental traditions yield some good parallels, there are also many differences, the key ones being the materials selected, and by extension manufacturing techniques, and ornamental design.

1.4, Anglo-Saxon metalwork

One of the key characteristics of sixth- and seventh-century high status Anglo-Saxon metalwork is the extensive use of garnet. It is clear from broader studies of continental metalwork that the Anglo-Saxons were, in turn, taking their lead from garnet *cloisonné* found on Merovingian metalwork.⁹⁶ Arrhenius suggests that the garnets used in Merovingian jewellery came from gem-quality deposits in Bohemia, and it is possible that Anglo-Saxon garnets also came from this source.⁹⁷ Several sources point to the creation of gold and garnet *cloisonné* in production at Northumbrian sites,⁹⁸ where it was used together with mother of pearl and carefully formed miniature 'mosaic' glass produced in sheets using rods of blue, white and red glass.⁹⁹ Together, these polychrome elements were set onto the surface of objects such as brooches and sword hilts using gold to form the framework of often complex designs in *cloisonné* inlay.

In order to create *cloisonné* ornament, gold ribbon was set on edge and hand-formed using a tweezers into the required pattern. Once this was achieved the garnet, glass and mother of pearl were shaped to match the form of their receiving cells. Foils of hatched gold were laid behind them to provide a reflective backing. Anglo-Saxon goldsmiths employed reductive lapidary techniques to shape the material into form, similar to the approaches used to shape hardstone gems using emery, a technique that had already been in existence for hundreds of years.¹⁰⁰ Mavis Bimson of the British Museum has demonstrated that garnet and mosaic glass panels of '*millefiori*' could be cut relatively quickly using early medieval methods and that this process could be speeded up by cutting several garnets at once.¹⁰¹ Polychrome inlays were backed with

⁹⁶ Merovingian metalwork was made by Frankish goldsmiths in a region which included parts of Belgium, the Rhine Valley and northern France between the 5th and 8th century AD. It is decorated using the polychrome *cloisonné* inlay technique, believed to have originated with the Gothic tribes of southern Russia and transmitted throughout Europe.

⁹⁷ Birgit Arrhenius, *Merovingian Garnet Jewellery. Emergence and Social Implications* (Stockholm, 1985), p.144.

⁹⁸ Rupert L.S. Bruce- Mitford, 'The Pectoral Cross' in *The Relics of St. Cuthbert*, ed. C.F. Battiscombe (London, 1956), pp.322-25; Ewan Campbell and Alan Lane, 'Celtic and German Interaction in Dalriada' in *The Age of Migrating Ideas, Early Medieval Art in Northern Britain and Ireland.*, eds R. Michael Spearman and John Higgitt (Edinburgh and Stroud, 1993), pp.52-63.

⁹⁹ Mavis Bimson, 'Coloured Glass and *Millefiori* in the Sutton Hoo Ship Burial,' pp.427-33.

¹⁰⁰ Pliny, *Natural History with an English Translation*, ed. and trans. D.E. Eichholz (London and Cambridge MA, 1962), pp. 42-43.

¹⁰¹ Mavis Bimson, 'Dark-Age Garnet Cutting', *Anglo-Saxon Studies in Archaeology and History* 4 (1985), p.125.

hatched gold foils to increase reflective qualities and secured in place using jewellers teeth gouged out of the cell wall to form a hook, the wall was slightly bent over to form a collet.

The Kingston Down disc brooch is a particularly fine example of personal wear created for a member of the Kentish Anglo-Saxon elite during the early seventh century.¹⁰² (fig. 9) Typical of Anglo-Saxon jewellery of the period, the 8.55cm diameter brooch demonstrates densely packed ornament carefully arranged into a coherent plan.¹⁰³ The obverse of the brooch is divided into five zones of concentric ornament arranged around a raised central boss, which is further sub-divided into zones of ornament surrounded by an annular zone. Four circular fields of ornament punctuate the concentric zones of the brooch. At equal points between the circular zones four radiating fields are punctuated with lozenge forms. The use of geometry is clear within the composition of the design and compasses were used to plan the design.¹⁰⁴ The control afforded to the goldsmith in cutting and shaping the garnet and glass elements of the brooch led to a further enhancement of the geometric form. These design elements that are common to most high-status Anglo-Saxon metalwork of the sixth and seventh centuries. (appendix 2) In addition to the polychrome elements of Anglo-Saxon metalwork, cast ornament and gold filigree was used to great effect. Both cast designs, gold foil, beaded wire and granules of gold were employed to make gold filigree panels, most typically forming interlace of both abstract and zoomorphic form. (figs.9-10)

1.5, Merovingian metalwork

Similar techniques are seen in use across the fine metalwork produced in Francia during the sixth and seventh centuries. Disc brooches and fibulae demonstrate the engagement of similar techniques that allowed the goldsmith to shape thin panels of garnet, glass and mother of pearl to fit the *cloisonné* surfaces of objects of status. In contrast with the Anglo-Saxon approach to ornament, Continental goldsmiths had greater and much more varied access to precious materials. Thus, what sets the two apart is the continental concern with setting and displaying precious and semi-precious gemstones, antique cameos and other precious pieces of spolia in prominent positions on their objects. (figs.10-12)

¹⁰² National Museums and Galleries on Merseyside, Liverpool museum; no. 6226.

¹⁰³ Coatsworth and Pinder, *The Art of the Anglo-Saxon Goldsmith*, p.164.

¹⁰⁴ Ibid.

The early seventh century Coffret of Teuderic, is a reliquary casket of south-western German manufacture.¹⁰⁵ (fig.11) It is formed from wooden panels overlaid with gold sheet. The sides and front (H. 12.5cm, L. 19cm, D. 6.5cm) are entirely covered with a frieze of garnet and blue and green glass cloisonné inlay, but the planning of the Kingston Down layout is missing. Rather, the decoration of the coffret is a celebration of materiality, with pearls, and different shaped classical polychrome intaglios and cabochons such as cornaline, chalcedony, onyx and antique red glass taking centre stage. A large 33mm classical cameo made from white and black glass occupies a central position within the scheme, and was likely donated by a patron.¹⁰⁶ The stones are arranged along symmetrical lines on the front of the casket, with the settings for the gems uneven in size, and therefore clearly, specifically formed for each. Thus, in contrast to the use of polychrome materials by the Anglo-Saxon goldsmith, where garnet and glass were cut down to fit the tightly controlled design, here the goldsmith's design is primarily guided by the form of the material as it was received.

This is evidenced on other artefacts from the period too. The Cup of St. Martin, from the Abbey of St. Denis is a vase assembled from a first century classical onyx vessel reputedly carved with a scene depicting Aphrodite.¹⁰⁷ (fig.12) Seventh-century work to the object includes a gold collar and foot inlaid with pearls from the east, emeralds from Egypt, cordorite, sapphires from the Auvergne and garnets. The classical onyx spolia vase, cut by an earlier craftsman, determines the principal element of the form. Filigree work is diminished to a thin beaded wire while the garnet is cut into simple shapes determined by the spaces between the other stones and set within gold. In this case the goldsmith has become an assembler of precious materials. The pieces are crudely connected and the maker has had limited engagement with the materials. This is evident in the simply shaped garnets on the foot which are the only stones the maker has cut. Here the design skills of the maker are subordinate to the materials. In a number of places the connecting elements are formed from gold, or spaces between stones are gold and are simply polished but not finished, the maker is relying primarily on the effects of the materials. It would appear that in some cases with the rise in availability of high status material we find the diminished role of the goldsmith. This is not to say

¹⁰⁵ P. A. Mariaux, 'Coffret Reliquaire De Teudéric' in *Le Trésor De L'abbaye De Saint-Maurice D'Agaune*, ed. Élisabeth Antoine-König (Paris, 2014), p.52.

¹⁰⁶ Provision of precious gemstones by patrons is well attested in European metalwork. The Reliquary of St. Servatius was refurbished reputedly using an antique relief amethyst head of Dionysus donated by the Ottonian empress Theophanu. Eliza Garrison, 'A Curious Commission: The Reliquary of St. Servatius in Quedlinburg,' *Gesta* 49, no. 1 (2010), 18.

¹⁰⁷ P.A. Mariaux, 'Vase De St. Martin' in *Le Trésor De L'abbaye De Saint-Maurice D'Agaune*, ed. Élisabeth Antoine-König (Paris, 2014), pp.48-50.

that outstanding work was not produced, or cloisonné enamels of great complexity are not to be found. But with the ample availability of hardstones and the constant recycling of material and importation of new stone from the east, the emphasis on materiality overshadowed the role of the maker.

1.6, Insular metalwork, materials and techniques

Unlike the Anglo-Saxon and continental goldsmiths' work, which included significant amounts of gold and hardstone gems, only one Irish brooch of pure gold has survived from the ninth century.¹⁰⁸ This has given rise to the belief that precious metals were not in abundant supply, although given the importance of the material it is possible other examples existed but have been recycled over time.¹⁰⁹ It has been noted that high status Insular artefacts such as the Derrynaflan paten display significant amounts of tinned-copper alloy or silver alloyed with copper, which Ryan notes give the impression that the luxury materials were not freely available.¹¹⁰ (fig.1) Instead, copper-alloy was the most prevalent material used to form structural elements, or the entire artefact, in Insular metalwork. For example, the Derrynaflan strainer-ladle was formed entirely from copper-alloy, enhanced with small amounts of embossed silver foil on the ladle flange. (fig.13) On parts of other artefacts, such as the stem of the Ardagh chalice, copper-alloy was plated with gold to imitate the effects of that material. (fig.14)

In some examples of penannular and pseudo-pennanular brooches large amounts of silver were employed to form the structure of the artefacts, such as the high status 'Tara' brooch, and then gilded to look like gold. Other approaches to creating the effect of large quantities of precious metal were also employed. On the Derrynaflan ring large recessed fields were filled with embossed silver foils creating the sense that the artefact is formed primarily of silver. (fig.15) Comparable embossed silver panels on the paten were gilt to create the same luxurious effects in gold.¹¹¹ (fig.16) Where silver was employed in significant volumes, the ratio of silver to other alloys has led scholars to

¹⁰⁸ A small gold brooch from Loughan, Co. Derry, eighth century, ring d. 5.2cm, see Patrick Wallace and Ragnall Ó Floinn, *Treasures of the National Museum Irish Antiquities* (Dublin, 2002), no 5.20 p.184.

¹⁰⁹ Michael Ryan, *Metal Craftsmanship in Early Ireland* (Dublin, 1993), p.15; Organ, 'Examination of the Ardagh Chalice; a Case History,' pp.262-63; Dáibhí Ó Cróinín, 'Ireland and the Celtic Kingdoms of Britain' in *The Work of Angels*, ed. Susan Youngs (London, 1989), p.13; Ragnall Ó Floinn, 'Secular Metalwork in the Eighth and Ninth Centuries' in *The Work of Angels' Masterpieces of Celtic Metalwork, 6th-9th Centuries AD*, ed. Susan Youngs (London, 1989), pp.17.

¹¹⁰ Ryan, 'The Derrynaflan Hoard and Early Irish Art,' *Speculum* 72, no. 4 (1997), 42; idem., 'The Derrynaflan Hoard and Early Irish Art,' p.547; Ó Floinn, 'Secular Metalwork in the Eighth and Centuries', p.72; Ryan, 'The Derrynaflan Hoard and Early Irish Art,' p.43.

¹¹¹ It is interesting that the designer did not use pure copper to form the embossed foils, copper examples noted at Dunadd. See Alan Lane, 'Celtic and German Interaction in Dalriada,' pp.52-63.

suggest that the material was significantly debased to stretch the material.¹¹² Similarly, riveting on the Ardagh chalice demonstrates that while the visible head is of silver the shank is of copper-alloy to conserve the precious material.¹¹³ (fig. 17) On the Emly house-shaped shrine an intricate lead-tin alloy grille was embedded into a core of yew wood to imitate silver.¹¹⁴ (fig.18)

1.7, Polychromy in Insular metalwork

In addition to the sparing use of precious metals, a further notable feature of Irish Early Christian metalwork is the distinct lack of semi-precious hardstones. This has been highlighted by Michael Ryan, who states that 'semi-precious stones of any kind are exceedingly rare on Insular pre-Viking metalwork'.¹¹⁵ Instead, Insular polychrome inlays attributed to the eighth century are typically comprised of amber and a range of vitreous materials, including opaque red, yellow, white, blue, some green glass and *millefiori* employed using the *champlevé* enamelling technique. Often punctuated with *millefiori* platelets commonly in blue and white, but other colours are in evidence. (figs. 19 and 20)

1.8, Iron-Age and Romano-British sources for champlevé enamelling

Champlevé enamelling with opaque red glass had been in longstanding use in Ireland prior to the addition of polychrome elements and angular forms. Opaque red enamel was employed in reserved fields depicting curvilinear La Tène ornament or stud settings as found on a bronze fibula from Inchcleraun, Co. Longford. (fig. 21) Ragnall O'Floinn, points to the potential transmission of later fourth and fifth-century Roman-British enamelling influences associated with Ultimate La Tène ornament and brooch types, known as latchets, to Ireland from western Britain via missionary activity.¹¹⁶ (Fig. Dowris latchet) In the late fifth or sixth century, high quality *millefiori* was imported from the Mediterranean region and was displayed within *champlevé* enamelling against fields of opaque red enamel.¹¹⁷ (fig. 22) Judith Carroll in her study of *millefiori*, proposes the manufacture of *millefiori* in Ireland from the seventh century and the application of the ornament within rectilinear cells among polychrome enamels, during the eighth and

¹¹² Ryan, *The Derrynaflan Hoard I*, p.55.

¹¹³ Organ, 'Examination of the Ardagh Chalice,' pp.261-62.

¹¹⁴ Rachel Moss, 'St. Manchan's Shrine' in *Art and Architecture of Ireland, Vol. 1 Medieval c. 400-1600AD*, ed. Rachel Moss, (Dublin, New Haven and London, 2014), pp.290-91.

¹¹⁵ Ryan, *Metal Craftsmanship*, p.13; idem, 'The Roscrea Brooch' In *Studies in Medieval Irish Metalwork*, (London, 1982), pp.16-41.

¹¹⁶ O'Floinn, 'Patrons and Politics', in Mark Redknapp, et al (eds) *Pattern and Purpose in Insular Art* (Oxford, 2001), pp.7-8.

¹¹⁷ Judith Carroll, 'Millefiori in the Development of Early Irish Enamelling', in Cormac Bourke (ed.) *From the Isles of the North, Early Medieval Art in Ireland and Britain*, (Belfast,1995), p.55

ninth centuries as found on the Moylough beltshrine, Lough Gara buckle and Coolure Demense plaque.¹¹⁸ (figs. 5, 19 and 20)

Alongside the expansion of colour, introduction of *millefiori* inlays and preference for angular forms over earlier curvilinear ornament in *champlevé* enamelling; the late sixth-seventh century saw the development of cast glass studs, within metalwork. (figs. 13, 16, 17) These commonly blue and green glass studs developed into examples with indented or relief patterns, those enamelled with contrasting colour of glass and other cast with metallic grilles. (figs. 7-8, 17, 19, 20). Henry has connected the development of studs with silver grilles to earlier Iron-Age examples such as those found on the Battersea shield.¹¹⁹ (Fig. 23)

Amber was also employed within the Insular workshop and the Lough Gara buckle dated to the seventh to eighth century and the eighth-century 'Tara' brooch demonstrate the display of the material alongside cast glass studs and *champlevé* ornament. (Figs. 20 and 24) Significant amounts of the material are found on the Derrynaflan chalice, ascribed to a date in the ninth century. (Fig. 25)

Typically, it is not until the twelfth century and later medieval period that additions to reliquaries such as the Shrine of St Patrick's bell, display gems of glass and semi-precious stones, bone, amber and in some cases enormous quartz crystals.¹²⁰ (fig. 26) Significant amounts of amber, as found on the Derrynaflan chalice, 'Tara' brooch, (figs. 7, 24-5) and mica identified on the Ardagh chalice and Moylough beltshrine were also employed. There is some evidence of the early use of circular rock-crystal cabochons on three Insular artefacts, the foot of the Ardagh chalice the handle of the Derrynaflan strainer-ladle and a mount from Crieff, Perthshire.¹²¹ A later, twelfth-century, example is found on the Cross of Cong.¹²² C-shaped Garnet fragments are extant on the Kilmainham brooch, and circular examples on an Insular house-shaped shrine from Abbadia San Salvatore, and a small circular seventh-century Germanic garnet stud was found at Dunadd.¹²³ One later oval garnet survival is found on the

¹¹⁸ Carroll, 'Millefiori,' p.53

¹¹⁹ Henry refers to the Somerset Boss from Co. Galway, a copper-alloy grille impressed with red glass from the reverse, Henry, *Irish Art*, (1965) p.71 (Fig. 6).; In a second publication she refers to the similarities with the Battersea Shield bosses which were formed in the same manner. See Françoise Henry, 'Irish Enamels of the Dark Ages and Their Relation to the Cloisonné Techniques,' in *Dark Age Britain*, ed. D. B. Harden (London: 1956), p.109.

¹²⁰ Jennifer Gleeson, 'Gemstones and Ornamental studs' in *Art and Architecture of Ireland, Vol. 1 Medieval c. 400--1600AD*, ed. Rachel Moss, (Dublin, New Haven and London, 2014), pp.112-14.

¹²¹ Ryan, *Metal Craftsmanship*, p.13; Michael Spearman, 'Two Decorative Mounts' in *The Work of Angels*, ed. Susan Youngs (London, 1989), pp.119-20.

¹²² Murray, *Cross of Cong*, p.140.

¹²³ Lane and Campbell, *Dunadd*, p. 150-1, fig. 4.53, 4.54.

eleventh-century Soisceal Molaise. Due to survival patterns, in some cases only a single artefact remains with a particular technique or material, for instance only one twelfth-century crozier displays *cloisonné* enamelling or inlay and coral has been identified on just one surviving object by Françoise Henry.¹²⁴ Aside from this, there is little evidence for the application of hardstones for display on Insular metalwork until the fourteenth-century refurbishment of earlier shrines and reliquaries. (appendix 2 and 3)

In addition to the use of vitreous materials to create polychrome effects, there is some circumstantial evidence to suggest that wood within metalwork was also coloured or painted to imitate enamelling. A strainer-ladle comparable to the Derrynaflan hoard example was uncovered at Ballynapark, Co. Wicklow.¹²⁵ On the handle is a recessed channel originally completely filled with yew wood similar to the Emly house-shaped shrine. (fig. 18) Dr Paul Mullarkey of the conservation department, National Museum of Ireland has suggested that this may have been painted, perhaps in imitation of *champlevé* enamelling.¹²⁶ Similarly, the raw wood of the Emly and other shrines, may have been dyed or given a surface pigment which imitated vitreous inlays, much as gilding and tinning were surface applications creating the effect of other materials.

The style of Insular fine metalwork associated with the late sixth and seventh centuries also saw the application of panels of gold foil with complex filigree work learned from the Anglo-Saxons, to some of the finer artefacts.¹²⁷ (figs.7, 8) Niamh Whitfield records the use of 'Corinthian bronze' on the reverse of the 'Tara' brooch,¹²⁸ (fig.24) Inscribing onto silver also occurred on the bowl of the Ardagh chalice, (fig.14) and on the reverse of the hinged mount on the 'Tara' brooch. (fig.24) Trichinopoly was also applied to Irish metalwork following Anglo-Saxon examples, for example on the 'Tara' brooch, Derrynaflan paten and Ardagh chalice,¹²⁹ (figs. 24, 16 and 27) while on the early twelfth-century Clonmacnoise crozier we find the inlay of twisted brass and copper wires and silver wires and *niello* inlaid into pre-cast channels.¹³⁰(fig. 28)

¹²⁴ Henry, *Irish Art in the Romanesque Period*, p.78. Murray suggests that coral is found on an ecclesiastical staff known as the Kilkenny Tau crozier. Murray, *Cross of Cong*, p.140.

¹²⁵ Noel Dunne, 'An Early Medieval Copper-Alloy Ladle from Ballynapark, Co. Wicklow' in *Fragments of Lives Past*, eds Bernice Kelly, Niall Roycroft and Michael Stanley (Dublin, 2014), p.58.

¹²⁶ Dr. Paul Mullarkey pers. comm.

¹²⁷ Whitfield, 'Filigree Animal Ornament' pp.211-12; Susan Youngs, 'Decades of Change: Mid-Seventh-Early- Eighth Century' in *The Work of Angels*, ed. Susan Youngs (London, 1989), pp.52.

¹²⁸ Niamh Whitfield, 'Corinthian Bronze' and the 'Tara' Brooch?', *Archaeology Ireland* (Jan 1, 1997), 24-8.

¹²⁹ Coatsworth and Pinder, *The Art of the Anglo-Saxon Goldsmith*, pp.117, 29, 42.

¹³⁰ Ryan infers Roman influence regarding the adoption of *niello*. Ryan, *Metal Craftsmanship*, p.13.

1.9 Manufacturing techniques in Insular metalwork

Several approaches were employed to create Insular artefacts. Firstly, simple or small artefacts such as penannular brooches were formed by casting, a technique in longstanding use in Ireland. Vessels were generally raised from a flat circular sheet of metal, such as the bronze bowl, ladle and silver chalice bowl in the Derrynaflan hoard. (fig.1) In some cases such as the Clonmore shrine, the artefact was assembled from flat sheets of metal,¹³¹ or composed of multiple components pinned to a wooden armature, as in the case of some house-shaped shrines (fig. 18) and processional crosses.¹³² Similar wooden cores were employed on Continental metalwork, such as the aforementioned Coffret of Teuderic, while a single rivet secured the base and cup of the Tassilo chalice.¹³³ (figs.11 and 32)

In contrast, the most complex Insular artefacts were composed of multiple components mechanically assembled. In the cases of the Ardagh chalice, Derrynaflan paten and chalice over 200 carefully formed components were designed to interlink to form the vessels.¹³⁴ (figs. 29, 30 and 31) The stem on the Ardagh chalice is formed from three interconnected components disguising a bolt running from the bowl to the foot of the chalice. (fig.14).¹³⁵ By engineering the finest vessels in the complex manner outlined above, the Insular goldsmiths ensured that they achieved the most elegant and sophisticated forms and the ability to maintain and repair their product over time, without compromising the exterior design. In this they demonstrate not only best practice but demonstrate the intrinsic relationship between the maker and the artefact which did not end once the vessel was completed.

1.10, Design principles in Insular metalwork

Distinctive Insular features can also be identified in the composition of Insular ornament. Regardless of the material employed or technique chosen, Insular metalwork is symmetrical, with ordered and consistent ornament within each scheme. Robert Stevik has outlined the geometry behind the careful formation of the 'Tara' and Hunterston brooches, high-crosses, and earlier Irish metalwork.¹³⁶ (figs.7-8) It is also

¹³¹ Cormac Bourke, 'Clonmore and Bobbio; Two Seventh-century Shrines', *Dúiche Neill, Journal of the O'Neill Country Historical Society* 14 (2005), 24-26.

¹³² Kelly, 'Tully Lough Cross,' 3-5.; Murray, *Cross of Cong*, pp.67-9

¹³³ Webster and Backhouse, *Making of England*, pp.167-8.

¹³⁴ Ryan, 'Eucharistic Vessels, Architecture,' p.126.

¹³⁵ These have been variously described as 'over ambitious' and 'complex' by some sources with 'the technical range of the artificer being stretched to the limit to achieve the ambition of the patron or designer', Ryan, 'The Derrynaflan Hoard and Early Irish Art,' p.43.

¹³⁶ R. D. Stevik, 'The Form of the 'Tara' Brooch', *Journal of the Royal Society of Antiquaries Ireland* 128 (1998), 5-32; 'The Form of the Hunterston Brooch', *Medieval Archaeology* 47 (2003),

possible to perceive the traces of straight edge and compass applied to manuscript pages which assisted the scribe and illuminator in their craft.¹³⁷ (fig.33)

Similar to Anglo-Saxon models, Insular goldsmiths filled curved elements of design with arc-shaped ornament fitted in to appropriately shaped cells and angular forms. (figs. 13, 24, Henry attributed the appearance of angular forms in enamelling to influence from Germanic garnet cloisonné.¹³⁸ (fig.9). (figs. 7, 8, 17, 19, 27) However, unlike Anglo-Saxon forms, which demonstrate greater flexibility and freedom on the part of the maker, or continental metalwork which permitted oval and amorphous forms and beads set as gems, (figs. 10, 11, 12) extant Irish glass and amber studs and the vast majority of empty settings are highly regular and confined to a limited number of shapes.

In harmony with the overall design principles of Insular artefacts, Insular studs are essentially high relief constructs which are geometrical and symmetrical in form when viewed from the obverse and in profile. Most commonly they are circular,¹³⁹ however, rectangular,¹⁴⁰ square, T-shaped,¹⁴¹ lentoid,¹⁴² half-circle or D-shaped,¹⁴³ pear-shaped, trapezoidal and lozenge forms also survive.(figs. 7-8, 13, 15-18, 28, 30-1) Square studs are generally made of amber, but this may be as a result of find patterns rather than representing a true picture of what existed at that time. Square studs on the Derrynaflan chalice were set into diamond form on the stem, (fig. 25) a simpler approach than forming a true parallelogram, as created for the centre of the 'Tara' brooch.¹⁴⁴ (fig. 7) Lentoid forms also occur on the 'Tara' brooch, (fig.7) while rectangular studs were either set individually, as on the Derrynaflan paten, (fig. 16) or into continuous frames within *cloissons* on the 'Tara' brooch. (fig.7) The only potential exception to the geometrical concept underlying studs are found in two small anthropomorphic heads on the 'Tara' brooch.¹⁴⁵

21-40; 'High Cross Design' in *Pattern and Purpose in Insular Art*, eds Mark Redknapp et al (Oxford, 2001), pp.221-3; 'Primary Plans in Insular Designing: Their Very Deep Indigenous Roots' in *Making Histories, Proceedings of the Sixth International Conference on Insular Art*, ed. Jane Hawkes (Donington, 2013), pp.13-23.

¹³⁷ Janet Backhouse, *The Lindisfarne Gospels* (London, 1981), pp.27-32.

¹³⁸ Henry, *Irish Art to 800AD*, p.96

¹³⁹ See CAT. 1.1-23.

¹⁴⁰ See CAT. 1.24-36.

¹⁴¹ See CAT. 9.9-10.

¹⁴² See CAT. 16.25-5.

¹⁴³ See CAT. 16.6.

¹⁴⁴ See stud CAT. 4.4.

¹⁴⁵ See CAT. 4.5.

The largest extant Insular glass stud examples range from 17mm on the Derrynaflan paten, to 21mm in diameter on the Lagore *Crannóg* glass stud and as little as 4mm on the base of the Ardagh chalice.¹⁴⁶ Copper-alloy permitted the formation of larger forms such as the 33.44mm by 31.47mm for the Coolure Demense plaque.¹⁴⁷ (fig. 19) However in the hands of the finest craftsmen intricate discs, measuring as little as 9mm on the reverse of the 'Tara' brooch, could be achieved with this technique.¹⁴⁸ (fig.24)

1.11, Insular ornamental motifs

Ultimate La Tène motifs were rendered in embossed foils, incised and cast ornament to form patterns in metalwork. They are characterised by crescents, various types of spirals, in some cases interlinked into triple spiral or S-forms, peltae, trumpet scrolls, lentoid motif and circular forms. (figs.24, 34-5) Abstract animal forms have been noted on the terminals of pseudo-penannular brooches. In general, La Tène motifs are executed in low relief using hatching, cross-hatching, dotting and various repeated marks, material and colour contrasts, to render the motif.

Developing the theme of abstract animal ornament, Insular artists enthusiastically adopted animal and ribbon interlace from Germanic sources.¹⁴⁹ (figs. 16, 24) In metalworking, ribbon interlace is expressed in a variety of ways, through cast low-relief ornament, and cast into the surface of glass studs. Interlace was also rendered using *champlevé* enamelling.¹⁵⁰ On flat surfaces such as silver or tinned copper-alloy interlace is incised into the surface, while in the case of filigree panels, ribbon interlace is drawn onto an underlying surface of gold foil using various beaded and twisted wires and granules. (figs. 7-8)

Animal ornament was a subsidiary motif in earlier Iron Age metalwork.¹⁵¹ It was only during the course of the seventh century that increasingly elaborate programmes of entwined animals and birds motifs were developed. Profile quadrupeds with flowing joints and highly stylised eyes, jaws, beaks, hips and feet,¹⁵² occupy significant points

¹⁴⁶ See CAT. 6.1 the Lagore *Crannóg* stud.; Ardagh chalice stud CAT. 9.24.

¹⁴⁷ See CAT. 14.1.

¹⁴⁸ See CAT. 4.6.

¹⁴⁹ Ryan, 'Metalwork in Ireland from the Later Seventh to the Ninth Century: A Review', pp. 49.

¹⁵⁰ See for example the hanging bowl mount from Whitby Abbey in north Yorkshire, Susan Youngs, 'Medium and Motif: Polychrome Enamelling and Early Manuscript Decoration in Insular Art' in *From the Isles of the North: Early Medieval Art in Ireland and Britain*, ed. Cormac Bourke (Belfast, 1995), p.37, fig. f.

¹⁵¹ Susan Youngs, 'Fine Metalwork to c. AD 650' in *The Work of Angels*, ed. Susan Youngs (London, 1989), p.21.

¹⁵² Susan Youngs, 'Decades of Change: Mid-Seventh-Early- Eighth Century,' p.52.

within a design, as do repetitive patterns of birds. These all follow a clear sequence and spacing system in terms of the manner in which they are conceived, suggesting that they were not merely copied from other objects, but that their designers understood the underlying design concept. (figs. 34-5)

1.12, Patronage

Due to the almost total absence of Insular artefacts attributed to a particular patron or craftsman, there has been a tendency to consider Insular fine metalwork separate from its social context. However, the role of the patron and craftsman are of course key to understanding why the art of the period adopted the forms that it did.

The remarkable artistic achievements that occurred before and after the seventh century would not have been possible without the support of wealthy and influential patrons.¹⁵³ In an Irish context, works of art remain unattributed to patron or artist before the mid-ninth-century high cross at Kinnitty Co. Offaly, where an inscription links the creation of the cross to King Mael Sechnaill (r. 846-62).¹⁵⁴ Thus, for information regarding the association between fine metalworking and royal or ecclesiastical patronage before the ninth-century the most fruitful lines of enquiry are archaeological excavations and documentary evidence from scattered references to individual pieces.

Many secular settlements have revealed evidence of basic metalworking, and it is likely that a degree of self-sufficiency was practiced in the manufacture and maintenance of iron tools. However, evidence for the practice of fine metalworking is a different matter, and the discovery of high-grade material at royal sites including in Ballinderry (Co. Offaly), Lagore and Moynagh Lough (both Co. Meath) and within large ringforts at Clogher (Co. Tyrone), Garranes and Garryduff (both Co. Cork) and Dunadd in Scotland.¹⁵⁵ (appendix 3) The precise relationship between the metalworking activities and patronage has still to be clarified, however it seems clear that high-status sites accommodated skilled metalworkers, presumably engaged in creating objects for relatively local use. A similar situation appears to have existed at ecclesiastical sites where evidence for fine metalworking, for example at Nendrum, Co. Down, Iona,

¹⁵³ Dáibhí Ó Cróinín, 'Ireland and the Celtic Kingdoms of Britain,' p.11.

¹⁵⁴ Liam de Paor, 'The High Crosses of Tech Theille (Tihilly), Kinnitty, and Related Sculpture', in *Figures from the Past: Studies on Figurative Art in Ireland in Honour of Helen M. Roe*, ed. Etienne Rynne (Dublin, 1987), pp.131-58.

¹⁵⁵ Lane and Campbell, *Dunadd*; Hugh O'Neill Hencken, 'Lagore Crannóg,'; Hugh O'Neill Hencken, Liam Price, and Laura E. Start, 'Lagore Crannóg: An Irish Royal Residence of the 7th to 10th Centuries AD', *Proceedings of the Royal Irish Academy* 53C (1950), 1-248; Michael J. O'Kelly, 'The Excavations of Two Earthen Ringforts at Garryduff, Co. Cork', *Proceedings of the Royal Irish Academy* 63C (1963), 17-150; Seán P. Ó Riordáin, 'The Excavation of a Large Earthen Ring Fort at Garranes, Co. Cork', *Proceedings of the Royal Irish Academy* 47C (1942), 77-150.

Scotland and Clonmacnoise, Co. Offaly suggests craft working activity on the periphery of the ecclesiastical settlement, presumably serving the community that were living and working there.¹⁵⁶ (appendix 1 and 3)

Certainly, more than many other crafts, proximity to market appears to have been a concern, as indicated by the urban pattern of metalworking that began to develop with the Viking settlements in Ireland. Excavations in Viking Dublin, for example, have yielded evidence of the manufacture of brooches, and by the late twelfth century it appears that the focus of most metalworking activities had shifted towards urban centres.¹⁵⁷

A majority of early documentary references to metalwork are found in hagiographies, where they are typically concerned with linking specific objects to a particular saint, in reference to theft or destruction, particularly in the context of the Viking raids. One of the earliest explicit references to an act of commissioning metalwork is found in the early eleventh century, when the *Chronicum Scotorum*, and annals written at Clonmacnoise, recorded that Máel Sechnaill mac Domnaill (r. 980–1002, 1014–22) donated a golden altar frontal (*enclair*) to the altar of St Ciaran at Clonmacnoise. In order to do this he levied a hide from every fort in Meath.¹⁵⁸ As Ó Floinn has noted, this was most likely a gold antependium of the type common across Europe at the time, and the extensive fundraising required to acquire it, perhaps suggesting that it may even have been imported. It is of note that the same king is also recorded as having donated another ‘exotic’ metalwork object to the altar, described as the *Carracan* or model of Solomon’s Temple.¹⁵⁹ It is uncertain exactly what this was, but it may have been a relic from the Holy Land. Either way these two examples of patronage suggest a desire to look beyond the locality to import fashionable or well-made objects.¹⁶⁰

Certainly by the twelfth century it is clear that probably the majority of high-status metalwork in the church treasury represented gifts from high status secular or

¹⁵⁶ James Graham Campbell, ‘The Bell and the Moulds’, in *Excavations in Iona 1964-1974*, ed. R. Reece (London, 1981), 23-25; Heather A. King, ‘The Economy and Industry of Early Medieval Clonmacnoise: A Preliminary View’ in *The Archaeology of the Early Medieval Celtic Churches*, ed. Nancy Edwards (Leeds, 2009), pp.333-49.

¹⁵⁷ Ó Floinn, ‘Schools of Metalworking,’ pp.179-80.

¹⁵⁸ *Chronicum Scotorum: A Chronicle of Irish Affairs*, p.211.

¹⁵⁹ Cormac Bourke, ‘Cairrecan Tempuill Solman’ *Peritia* 16 (2002), 474–477.

¹⁶⁰ Ó Floinn, ‘Clonmacnoise: Art and Patronage,’ pp.251–60

ecclesiastical patrons. Records of a theft from the altar at Clonmacnoise in 1129 seem to confirm this.¹⁶¹ Each item stolen was listed, together with a note of who the patron had been. These were both male and female, and were primarily noble members of dynasties. All were secular, with the exception of Cellach, abbot and bishop of Armagh (d. 1129), who presented a silver cup. Not all of the vessels described were Eucharistic, suggesting that even though it was displayed on the altar, it may not have been intended for liturgical use, but rather was a means of financial endowment, a diplomatic gift or commemoration of a particular event.

By this time too, metalwork was also regularly inscribed with the name of the patron, almost invariably a member of secular nobility.¹⁶² While it is not certain that this represents a continuation of a long-established trend, it makes sense that high-status objects such as the Ardagh chalice and Derrynaflan paten would also have been funded in this way, although the level of involvement of the patron is likely to remain a mystery.

1.13, The Goldsmith in Insular society

As seen in the case of Máel Sechnaill mac Domnaill and his exotic commissions for Clonmacnoise, it is clear that patrons were widely travelled, and on occasion wished this to be reflected in the art work that they commissioned. The specific techniques directly adapted from Anglo-Saxon metalwork outlined above demonstrate the role of the goldsmith in the development of the new style of metalworking in Ireland. The adoption of gold filigree working, embossing and trichinopoly demonstrate many technical similarities with the established techniques and design thinking found in earlier Irish metalwork. However, the apparent rejection of other techniques, such as garnet and glass cloisonné perhaps demonstrate not only the scarcity of imported hardstones but also the importance of the *cerd* as an original designer in Insular society. Designers responding to the requirements of their patrons in a way which combined the material and visual language of La Tène Ireland with new developments adopted from Anglo-Saxon metalwork. While it is clear that not all Insular metalworkers were of the calibre evident in the work of the 'Tara' brooch, (figs. 7, 24) even the less well executed

¹⁶¹ *Annála Ríoghachta Éireann: Annals of the Kingdom of Ireland by the Four Masters from the Earliest Period to the Year 1616*, ed. and trans. J. O'Donovan, 7 vols (Dublin, 1851; repr. New York, 1966), ii, p.1033; *Chronicum Scotorum*, p.52.

¹⁶² Pirette E. Michelli, 'The Inscriptions on Pre-Norman Reliquaries', *Proceedings of the Royal Irish Academy*, 96:C (1996), 1–48.

examples such as the Roscrea brooch demonstrate metalworkers taking control of the form of their artefact and engaging directly with the applied ornament. (fig. 36)

Cerd is the term associated with fine metalworkers in early Insular literature. However, aside from referring to a goldsmith and silversmith it was also employed as a more general term to referring to a 'craftsman'.¹⁶³ The law text the *Uraicecht Becc* records that the *cerd* had the same honour-price as an *Umaige* (coppersmith), *gobae* (blacksmith) and the *sáer* (wright).¹⁶⁴ It suggests that the *sáer* was skilled in church-building, mill construction, boat building or creating artefacts from yew wood. The importance of attaining a wide ranging technical expertise among Insular artists, designers and craftsmen is suggested by the fact that the honour-price associated with the *sáer* rose depending on the number of skills he possessed. While the basic honour-price was 7 *sét*, this increased to 10 *sét* if he possessed up to three of these skills and 15 *sét* if he had all four.¹⁶⁵ Murray notes that if 'the wright [*sáer*] had further qualifications, he might be classed as a 'chief wright expert' (*ollam suad saírsi*) with an honour price of 20 *sét*, which was greater than that of the highest grade of lawyer (*brithem*), significantly being equal to that of a high lord (*aire ard*).'¹⁶⁶ The *Uraicecht Becc* was glossed by a later author to include fine metal workers and blacksmiths indicating that the honour price of a gold or silversmith increased relative to the development of their technical expertise.¹⁶⁷

While some specialisms were associated with men, in the absence of male children a daughter could carry on the practice of the father, thus preserving the family practice, knowledge and technical acumen.¹⁶⁸ Evidence of the hereditary nature of the craft is further preserved in the inscription on the shrine of St Patrick's Bell, which records that the work was carried out by Cúdulig Ua Inmainén with his sons.¹⁶⁹ Evidence for contemporary attitudes to artists during the period, beyond their legal standing is scant, and does not appear to have been comparable to the modern cult of the artist. One ninth-century poem does refer to an Irish scribe; 'Among the early monks whom Athelwulf honoured was an Irish scribe, Ultán, whose skill with the pen were such that it was evident that 'the lord had taken control of his fingers and had directed his

¹⁶³ E. G. Quinn, *Dictionary of the Irish Language; Based Mainly on Old and Middle Irish Materials, Compact Edition* (Dublin, 1983), p.109.

¹⁶⁴ Kelly, *Early Irish Law*, p.63.

¹⁶⁵ A *sét* was worth three milch cows.

¹⁶⁶ Murray, 'The Makers of Church Metalwork' p.163.

¹⁶⁷ *Ibid.*, p.163.

¹⁶⁸ Kelly refers to records noting the existence of female wrights known as *bansaér*. Kelly, *Early Irish Law*, p.91.

¹⁶⁹ Cormac Bourke, 'Shrine of St Patrick's Bell' in *Art and Architecture of Ireland, Vol. 1 Medieval*, ed. Rachel Moss (Dublin New Haven London: 2014), pp.307-08.

mind to the heavens'.¹⁷⁰ Michelle Brown identified a small inscription hidden under ornament on the Derrynaflan paten that may be a concealed hymn or devotional inscription, pointing to the similar devotional aspect of the goldsmith's craft.¹⁷¹ The small damaged inscription, potentially CIAROD[UI]RMC[.R], is translated as asking for a prayer for the owner, suggesting the apotropaic as well as social function of fine metalwork.¹⁷² Murray notes that 'on the basis of the inscriptions alone, where prayers are requested for craftsmen alongside kings and abbots, it can be concluded that these individuals were held in very high esteem by the Church and that their work was seen as a service to God for which they would be perpetually remembered. Therefore their creations should not be seen as merely commercial acts, but as works of devotion, in the same manner as illuminated manuscripts'.¹⁷³

Not only was technical skill valued, but the medium in which the maker worked was of significant cultural importance in Ireland. The ninth-century *Senchus mhór* records that the sons of the kings of Ireland and the provinces should wear gold brooches with crystal or glass studs. While the sons of lesser kings wore silver.¹⁷⁴ In contrast to the status accorded the specialist *cerd*, who worked in gold and silver, Neil McLeod notes that the commentary to the *Bretha Étgid* records 'that one would not expect to find items of gold or silver in the blacksmiths forge'.¹⁷⁵ This suggests that the trades of the blacksmith and of the *cerd* were usually distinct and the disparate social value associated with each based on number and level of skills in particular materials. It also points to further social points of contact between the aristocracy and elite goldsmiths.

1.14, Organisation of the Goldsmith's training

Kelly suggests that craftsmen probably learned their trade from their fathers and gained further experience from a master craftsman.¹⁷⁶ Murray points out the

¹⁷⁰ Nicola Brooks, 'The Church in Northumbria' in *The Making of England; Anglo-Saxon Art and Culture*, eds Leslie Webster and Janet Backhouse (London, 1991), p.109.

¹⁷¹ Michelle P. Brown, 'Paten and Purpose: The Derrynaflan Inscriptions', in *Pattern and Purpose in Insular Art*, eds M. Redknapp et al (Oxford, 2001), pp.162-67.

¹⁷² Niamh Whitfield and Elizabeth Okasha, 'The Killamery Brooch: Its Stamped Ornament and Inscription,' *The Journal of Irish Archaeology* 6 (1991-2), 59.

¹⁷³ Murray, 'The Makers of Church Metalwork', p.172.

¹⁷⁴ 'Ocus deilge óir ocus glaini do beth indte ac macuibh rígh Érenn ocus rígh cóicidh, ocus delge airget do macuibh rígh túaithe ocus mórhú aithe...' Colmán Etchingham and Catherine Swift, 'English and Pictish Terms for Brooch in an Eighth-Century Irish Law-Text,' *Medieval Archaeology* 48 (2004), 47.

¹⁷⁵ McLeod, 'Metalworking Tradition', p.103.

¹⁷⁶ Kelly, *Early Irish Law*, p.91.

usefulness of this arrangement in exposing the pupil to different skills and techniques.¹⁷⁷ Later glosses on the *Uaicecht Becc* record that as part of his duties the master-craftsman (*fíthidir*) provided food, clothing and tuition to his apprentice (*felmac*). For their part, the apprentice granted their initial payments from their own commissioned work after leaving the master, and provision in their old age.¹⁷⁸ From this arrangement it is clear that the master-goldsmith had a clear self-interest in providing the best education possible to an apprentice. In terms of the practical organisation of the craft, Michael Ryan suggests that peripatetic craftsmen moved between sites on an *ad hoc* basis thus spreading metalworking styles.¹⁷⁹ While excavation at some high status secular sites such as Moynagh Lough and ecclesiastic sites suggest more fixed operations,¹⁸⁰ it is clear that apprentices travelled to learn from master craftsmen, distances which precluded a daily commute and thus they required board as specified in the law tracts. However, beyond this, we know little about day to day workshop practice or the organisation of the craft.

Given the association between high status fine metalworking, royal patrons and important ecclesiastical sites such as Derry, Clonmacnoise, Derrynaflan and Iona one must speculate that apprentices may have been working or visiting these sites via the *paruchia* network. Within this context they would have been exposed to a rich visual culture which naturally informed and influenced their own work. Sumptuous Eucharistic vessels on the high altar of a church, as found in the hoards at Derrynaflan and Ardagh,¹⁸¹ (figs. 1 and 30) painted stone crosses and wood carvings, little of which survive and illuminated manuscripts under production within the scriptorium at ecclesiastical sites similar to the Books of Durrow and Kells are what remains of the visual culture of the time. (figs. 2 and 3) Given the homogeneous nature of much Insular art we can assume that such places had a pervasive and powerful impact on visual designers at this time. Not only in terms of exposure to motif and colour, but

¹⁷⁷ Murray, 'Makers of Church Metalwork', p.163.

¹⁷⁸ Douglas Mac Lean, 'The Status of the Sculptor in Old Irish Law and the Evidence of the Crosses,' *Peritia* 9 (1995), p.130.

¹⁷⁹ Michael Ryan, 'Some Aspects of Sequence and Style in the Metalwork of Eighth-and Ninth-Century Ireland' in *Ireland and Insular Art AD500-1200*, ed. Michael Ryan (Dublin, 1987), p.67.

¹⁸⁰ John Bradley, 'Excavations at Moynagh Lough, Co. Meath' *Journal of the Royal Society of Antiquaries Ireland* 121 (1991), 25-26; idem, 'Moynagh Lough: An Insular Workshop' in *The Age of Migrating Ideas*, eds R. Michael Spearman and John Higgitt, (Edinburgh and Stroud, 1993), p.80. Michael Ryan proposes that the Derrynaflan Paten was made within a monastic milieu, and that great monasteries maintained a goldsmith's atelier much as they did scriptoria during the eighth and ninth-centuries. Ryan, 'Aspects of Sequence and Style', p.67. This point will be dealt with in a later section.

¹⁸¹ For discussion on value accorded treasures in early medieval monasteries see James Campbell, 'The Debt of the Early English Church to Ireland', in *Ireland and Christendom: The Bible and the Missions*, eds Próinséas Ní Chatháin and Michael Richter (Stuttgart, 1987), pp.334-5.

techniques, problem-solving and material knowledge associated with other metalworking and other disciplines, which would naturally enrich their existing abilities.

While little remains of relatively fragile artefacts such as painted icons or furnished interiors, the description of the church of Brigid at Kildare and manuscript folios give us some idea of the type of high status milieu associated with the work of a master goldsmith and the visual environment in which they worked and trained. (fig. 37)

There repose the glorious bodies of both the Archbishop Conled and the noble virgin Brigid in their sarcophagi, the one to the right and the one to the left of a beautifully adorned altar. These sarcophagi are richly decorated with gold, silver and multi-coloured precious stones; they have also pictorial representations in relief and in colours, and are surmounted by crowns of gold and silver.Its ground plan is large, and it rises to dizzying height. It is adorned with painted tablets....One wall, covered with linen curtains and decorated with paintings traverses the eastern part of the church from one side to the other.¹⁸²

Haseloff suggests that the uniformity in design between Irish and Northumbrian art is as a result of the 'strong discourse' between Ireland and Northumbria documented by the missions of the Irish and Anglo-Saxons going to Ireland,¹⁸³ while Ewan Campbell and Alan Lane note the 'probable mobility of artisans, whether secular or religious'.¹⁸⁴ It is likely therefore that travel formed part of the master goldsmith's duties, perhaps to undertake significant commissions, deliver completed work and perhaps service and repair significant artefacts from previous commissions. Travel to significant sites such as Iona, Clonmacnoise and perhaps even Northumbria or Lindisfarne, thus encouraging the development of the master-goldsmith's skills and the dissemination of styles in general. Whitfield points out that the art of the goldsmith is 'too technical a craft to learn at second hand' and that Irish goldsmiths must have met foreign goldsmiths who passed on their skill.¹⁸⁵ She points to the great Frankish goldsmith Eligius who was deeply involved in the monastic movement founded by Columbanus'.¹⁸⁶ This elite social and ecclesiastical context provided metalworkers with the support and resources

¹⁸² Bieler, *Ireland: Harbinger of the Middle Ages*, p.28.

¹⁸³ Gunther Haseloff, 'Insular Animal Styles', in *Ireland and Insular Art AD 500-1200*, ed. Michael Ryan, (Dublin, 1987), p.51.

¹⁸⁴ Campbell and Lane, 'Celtic and German Interaction in Dalriada,' p.54.

¹⁸⁵ Whitfield, 'The "Tara" Brooch: An Irish Emblem of Status,' p.217.

¹⁸⁶ Ibid.; For the connection between Columban *paruchia* and Eligius see I. Wood, *The Merovingian Kingdom, 450-751* (London and New York, 1994), p.151.

to develop new forms in local art forms which permeated manuscript illumination, stone carving and of most concern here, goldsmithing and stud-craft from the sixth century.

1.15, Status and Identity of the Goldsmith beyond Ireland

Far more information is available regarding the status and identity of goldsmiths beyond Ireland during the early medieval period. Of note is the number of references to craftsmen who were accomplished in more than one art, and who were members of religious communities. In Anglo-Saxon England, the Abbot of Abingdon, Spearfahoc, was recorded as being 'outstanding in painting, gold- engraving and goldsmithing', while the abbot of Evesham, Mannig was an accomplished calligrapher, painter and goldsmith.¹⁸⁷ Beyond the British Isles, Theophilus, believed by some to be Roger of Helmarshausen, a Benedictine monk, was the author of a medieval treatise on metalworking, glass working and painting.¹⁸⁸ The manner in which the text is written suggests an individual with first-hand knowledge of nearly all of the arts of the period, with the exception of stone carving.

While the Irish law tracts and archaeological evidence suggest a different pattern in Ireland, there are one or two suggestions that some clerics may have practiced more than one art. If one compares for example, the inscriptions on two eleventh-century book shrines, the shrine of the Cathach and the shrine of the Stowe Missal, differences in the quality of the script are immediately evident: the inscription which records that the Cathach shrine was made by Sittriuc mac meic aeda comprises poorly executed letter forms and spelling, which there has been some attempt to correct.¹⁸⁹ This contrasts sharply with the assured hand that engraved the inscription on the shrine of the Stowe Missal, identified as 'Dunnchad ua Taccain of the company of Cluain [Clonmacnoise]' [*Dunchad Hu Taccain do Muintir Cluana*], presumably a cleric who had also received scribal training.¹⁹⁰ In addition, the Life of St Ciaran of Saigher refers to a former bishop of Iniskeen, Daigh (d. 588), as a 'smith, artist and choice scribe' who was responsible for making 'bells, shrines reliquaries, crosses, chalices and sixty gospels'.¹⁹¹ Even if this description is somewhat exaggerated it does suggest that a clerical artist working in several mediums was not exceptional in an Irish context.

¹⁸⁷ Dodwell, *Anglo-Saxon Art*, p.55; Coatsworth and Pinder, *Art of the Anglo-Saxon Goldsmith*, pp.208-9.

¹⁸⁸ Theophilus, *On Divers Arts*.

¹⁸⁹ R.A.S Macalister (ed.), *Corpus inscriptionum insularium Celticarum*, 2 vols (Dublin, 1949), II, p.38.

¹⁹⁰ Macalister (ed.), *Corpus inscriptionum insularium Celticarum*, p.105.

¹⁹¹ W.W. Heist (ed.), *Vitae Sanctorum Hiberniae* (Brussels, 1965), pp.388-89; D.B. Mulcahy, *Life of St Ciaran of Saigher* (Dublin, 1897), p.67.

1.16, Dating issues in Insular art

Just as the determining of authorship is problematic for Insular art, so too is the dating of objects.¹⁹² Unfortunately, no extant metalwork from the seventh to ninth centuries survives with an inscription noting the goldsmith, patron or saint that can be employed to identify a secure date for artefacts.¹⁹³ It is not until the early eleventh-century that dedicatory inscriptions are found on high-status metal artefacts which can be securely dated.¹⁹⁴ The lack of coinage and secure archaeological contexts associated with most Insular finds also precludes accurate dating, and thus concrete evidence of the chronology and development of Insular arts. There is no scientific, stratigraphic information regarding the archaeological context for the 'Tara' brooch or Ardagh chalice,¹⁹⁵ while that of the Derrynaflan hoard is inconclusive. Thus, dates given to Insular artefacts often range over centuries. For example, dates for glass stud and clay mould finds from Lagore *Crannóg* range from the seventh to ninth centuries.¹⁹⁶ (appendix 3)

In pre-Christian Britain, seventh-century Anglo-Saxon metalwork grave goods incorporate some studs evidently re-used as spolia, thus suggesting a *terminus post quem* for stud manufacture. Viking graves in Scandinavia which contained looted Irish metalwork are broadly dateable by coins, although the age of artefacts or coins at burial may distort the picture, as Irish metalwork may have been of some age when interred.¹⁹⁷ For instance votive objects such as high status Eucharistic vessels displayed on the altar at Derrynaflan and Ardagh may display little wear and tear despite their age. (fig.1) While other artefacts such as a shrine or personal brooch may display much more evidence of use and repairs based upon greater handling. The lack of evidence of use or the repurposing of some elements may or may not be evidence of age but point to the function or manner in which the artefact was employed. For this reason, the relative chronologies of Insular artefacts are usually based on stylistic comparisons of ornament

¹⁹² Nees, 'Recent Trends in Dating Works of Insular Art,' pp.14-30; Ryan, 'Some Aspects of Sequence and Style,' pp.67-74.

¹⁹³ Written records suggest that metalwork was inscribed in the late ninth and tenth-centuries. Roderick O'Flaherty, recorded that the now lost shrine of the Book of Durrow once contained an inscription which requested a prayer for the patron King Flann Sinna (r.879-916). E. Lhuyd, *Archaeologia Britannica* (Oxford, 1707), p.432.

¹⁹⁴ Murray, 'Makers of Church Metalwork,' pp.162-73; Pirette Michelli, 'The Inscriptions on Pre-Norman Reliquaries', *Proceedings of the Royal Irish Academy*, 96:C (1996), 1-48

¹⁹⁵ Etienne Rynne, 'The Date of the Ardagh Chalice' in *Ireland and Insular Art AD 500- 1200*, ed. Michael Ryan (Dublin, 1987), pp.93-95.

¹⁹⁶ O'Neill Hencken, et al., 'Lagore *Crannóg*: An Irish Royal Residence', 130.

¹⁹⁷ Youngs, 'Fine Metalwork to c. AD 650,' p.20.

between artefacts in all mediums, and by association in metalwork on the presence of polychrome studs or of amber, the latter usually associated with the Viking invasions.¹⁹⁸ Within this time-line the Lindisfarne Gospels has traditionally been the definitive datable point, based upon a mid-tenth-century colophon which records that the manuscript was illuminated by Eadfrith, Bishop of Lindisfarne in 698 and bound by Aethilwald who succeeded him in 721.¹⁹⁹ In spite of there being difficulties, the Lindisfarne colophon has been described by Janet Backhouse as 'a touchstone for all other decorative work of the period'.²⁰⁰ However, stylistic comparison fails to account for many variables such as skill, fashion, regionalism or revivalism, and therefore may be misleading in terms of indicating common dates for artefacts. Increasingly traditional dating methods are being called into question.²⁰¹ This method of dating does not take into account disparate levels of technical and creative ability among craftsmen, nor the availability of materials at the point in time an artefact was constructed, or the deliberate choice of amber or glass for a particular commission. Neither does it take into account regional preferences, nor does it account for the quite different creative, material and technical responses to similar visual stimuli by original designers and lesser craftsmen. Critics of this approach have included Joseph Raftery, who noted that the eighth century 'has become some sort of miraculous cauldron into which every decorated metal object is dropped with relief' and little justification.²⁰² While Griffin Murray has questioned this approach and noted that amber is found in significant quantities on earlier artefacts, which predate the Viking invasions, and thus its presence as an indicator of date is also open to question.²⁰³

Alongside this system of stylistic comparisons, metalwork objects have been drawn into a system of dating which has the following material chronology. Opaque red enamel with floating *millefiori* is interpreted as an indicator of a fifth to late sixth-

¹⁹⁸ Ryan, 'Some Aspects of Sequence and Style,' pp.67-74.

¹⁹⁹ A completion date of 698 AD or 721 AD based on whether a Bishop would have time to complete such an undertaking has been suggested. See Françoise Henry, 'The Lindisfarne Gospels,' *Antiquity* 37 (1963), 103.; Michelle Brown suggests that the making of the manuscript was a long term project of many years left unfinished at his death in 721, with later additions. Michelle P. Brown, *The Lindisfarne Gospels, Society, Spirituality and Scribe* (London, 2003), p.84, 93, 144; Lawrence Nees proposes a date in the second quarter of the eighth century. Nees, 'Trends in Dating of Works of Art,' p.22.

²⁰⁰ Janet Backhouse, 'The Lindisfarne Gospels,' in *The Making of England; Anglo-Saxon Art and Culture*, eds Leslie Webster and Janet Backhouse (London, 1991), p.111. So pervasive was this view, that Lawrence Nees recounts how Ernst Kitzinger noted in graduate seminars 'that thank heavens we have the Lindisfarne Gospels as a firmly dated and localized work of art, for nothing else provides a fixed point. Nees, 'Trends in Dating of Works of Art,' p.14.

²⁰¹ Ibid, p.30; Raftery, 'Concerning Chronology,' pp.82-90; Netzer, 'The Narrative on Insular Gospel Books,' pp.3-13.

²⁰² Raftery, 'Concerning Chronology,' p.82.

²⁰³ Murray, 'Stud of Amber and Glass,' pp.544-50

century metalwork.²⁰⁴ Artefacts which display polychromy through the use of ornate glass studs with grilles and enamelled ornament, *champlevé* enamelling, *millefiori*, amber and well executed filigree are assigned to a date ranging from the late seventh or eighth century.²⁰⁵ This is seen as an apogee in Insular metalwork.²⁰⁶ The increase in amber and silver use is attributed to greater contact with the Vikings during the ninth century, thus leading to the attribution of objects that make heavy use of these materials to that century.²⁰⁷ The allocation of artefacts to particular periods has perhaps erroneously led to the belief that the ninth century saw a decline in the creation of polychrome metalwork as amber replaced the use of *millefiori* and enamel.²⁰⁸ Thus scholars assign an artefact to a ninth century date based upon exclusive amber inlays and greater amount of silver and 'a lack of polychromy'.²⁰⁹

This approach has led to comparable artefacts being assigned to different dates, despite similarities, which using a different system might place the artefacts closer together, or reverse the accepted chronological sequence. The Ardagh chalice, which contains glass, amber, filigree and other ornament is placed in the eighth-century while the similarly shaped and ornamented Derrynaflan chalice with less accomplished filigree and amber ornament throughout is assigned to the later ninth-century.²¹⁰ (figs. 30, 25) The Lough Kinale bookshrine (fig.38) and Tullylough cross (fig. 39) ²¹¹ are assigned to a late eighth- or ninth-century date, as are a number of larger silver brooches with amber studs.²¹² (fig.36) The luxurious Derrynaflan paten (fig.31) with its panels of filigree and polychrome studs is seen as eighth-century artefact, while the Derrynaflan ring is

²⁰⁴ Carroll proposes that the pristine patterns but 'hap-hazard' placement suggests *millefiori* was made and transmitted from the Mediterranean region. 'Millefiori,' p.55.

²⁰⁵ Henry, *Irish Art in the Early Christian Period*, pp.92-3.

²⁰⁶ Rynne, 'The Date of the Ardagh Chalice,' p.89.; Stevenson assigns the Westness brooch pin to the second quarter or middle of the eighth-century in part due to the similarities with the 'Tara' Brooch. R.B.K. Stevenson, 'Brooches and Pins: Some Seventh- to Ninth-Century Problems.' in *Ireland and Insular Art AD 500- 1200*, ed. Michael Ryan (Dublin, 1987), p.91; Ryan, 'Church Metalwork,' pp.125-26; The Derrynaflan paten and ring are assigned to a late eighth early ninth-century date. Ryan, *The Derrynaflan Hoard I*, pp.37-8.

²⁰⁷ Henry, *Irish Art During the Viking Invasions*, pp.11, 112; Ryan, 'The Derrynaflan Hoard and Early Irish Art', p.37; James Graham-Campbell, 'The Initial Impact of the Vikings on Irish Art,' *Saga-book* 20, no. 1-2 (1979), 42-8.

²⁰⁸ Michelle Comber, *The Economy of the Ring Fort and Contemporary Settlement in Early Medieval Ireland* (Oxford, 2008), pp.134-35; Ryan, 'The Derrynaflan Hoard and Early Irish Art,' p.53.

²⁰⁹ Ibid.

²¹⁰ Ryan, *The Derrynaflan Hoard I*, pp.3-16.

²¹¹ Kelly, 'The Tully Lough Cross', 9-10; Michael Ryan, 'The Roscrea Brooch,' pp.16-41.

²¹² James Graham- Campbell, 'Two Groups of Ninth-Century Brooches,' *Journal of the Royal Society of Antiquaries Ireland* 102 (1972), 113-28.

ascribed to a later date in part due to the lack of elaborate gold filigree and less impressive glass studs.²¹³ (fig.15)

Few examples of fine metalwork are dated to the tenth century period.²¹⁴ While there appears to be a fall-off in amber and glass use at this time, this may be as a result of inaccurate dates assigned to metalwork rather than reflective of metalwork manufacturing during this period. The survival of many fine examples dated by inscription to the eleventh-century and twelfth-centuries suggest a 'revival' in metalworking. The Lismore and Clonmacnoise croziers (figs. 28, 40) and later twelfth-century Cross of Cong, (fig. 41) Shrine of St. Lachtain's arm and St. Manchan's shrine are among many artefacts remaining from the Romanesque period.²¹⁵ Constructional differences with the earlier metalwork are noted, as is the continuous use of *champlevé* enamelling on the Cross of Cong, noted by several sources.²¹⁶ Henry points to the technical differences in using red and yellow enamel and *millefiori* on the Lismore crozier and interprets these as indicating the continuous use of enamelling and *millefiori* from the earlier period despite the losses of the Viking period.²¹⁷

1.17 Discussion

In summary, with the introduction of Christianity to Ireland in the fifth century, new forms of equipment were required to practice the new religion and associated equipment. The forms were derived from Roman silver ware combined with earlier *La Tène* ornament and techniques and motif adapted from Anglo-Saxon metalwork. In contrast with Anglo-Saxon and Continental metalwork there are few examples of hardstones or gratuitous use of precious materials on Insular Irish metalwork. The structure of an artefact is composed along geometric lines and all applied ornament is carefully measured and shaped to fit harmoniously into this scheme. Where gold is employed it is utilised for its working properties to make filigree or gilt over copper-alloy to form a highly textured mount which harnesses the benefits of both materials. This approach to materials use and the highly structured organisation of the design required significant input, skill and material knowledge into the design and formation of an artefact. Similarly the finer Irish Eucharistic vessels such as the Ardagh chalice and the

²¹³ Ryan, *The Derrynaflan Hoard I*, pp.37-8.

²¹⁴ Johnson, 'Mind the Gap: The supposed Hiatus in Irish Art' pp. 57-8; Henry, *Irish Art in the Romanesque Period*, pp.74.

²¹⁵ Françoise Henry, *Irish Art in the Romanesque Period*, pp.74. See also Crawford, 'A Descriptive List of Irish Shrines and Reliquaries,' 151-76.

²¹⁶ Henry, *Irish Art in the Romanesque Period*, p.78; Murray, *Cross of Cong*, p.138.

²¹⁷ Cormac Bourke, 'Lismore Crozier,' p.315; Ó Floinn, 'Lismore Crozier,' pp.170-1; Henry, *Irish Art in the Romanesque Period*, p.78.

Derrynaflan paten and chalice are assembled from over two-hundred pieces and engineered into a form which permitted elegant forms and the later servicing and maintenance of the artefact. In contrast, some examples of Continental metalwork a goldsmith was reduced to assembling and connecting precious materials of various provenances, forms and sizes as found on the Cup of St. Martin. Irish literary sources suggest that the goldsmith held a position of reasonably high status in Irish society which was associated with the number of skills the craftsman could practice.

The dating of artefacts is problematic due to the lack of inscriptions and archaeological context, this has led to comparisons with manuscripts. Similar to metalwork, the dating of manuscripts is not dated based on a scientific or archaeological data due to a lack of context or the limits of current technology to decipher accurate dates; but dated according to art historical comparisons with the Lindisfarne Gospels and the inscription pointing to the late seventh-early eighth century. Items which are abundant in polychrome glass are assigned to the eighth-century and amber to the ninth century. Some artefacts are ascribed to the same workshop tradition based upon general ornamental comparisons. Prior to the eleventh-century inscriptions on artefacts, there is little information regarding authorship or workshop practice.

Chapter Two: Materials and Colour in Insular metalwork

Having examined the broader context of Insular metalwork, the aim of this chapter is to outline the materials employed specifically as polychrome inlays on Insular metalwork between the late sixth and twelfth centuries and how they were manipulated by Insular craftsmen.

As highlighted in chapter one, one of the distinctive features of Insular fine metalwork is its use of glass and amber, often shaped into rigidly geometric forms. This chapter will examine in greater detail the range of materials used. It will start by examining the different colours and types of glass used, before moving on to look at the use of amber and gemstones. The different materials used to enhance or complement polychrome studs will then be examined.

Contemporary legal and exegetical texts indicate that the Insular understanding of colour was more than simply aesthetic. Various sources will be explored in an attempt to see how the colour ranges adopted or created by Insular craftsmen fit into these interpretations. As it seems unlikely that Insular goldsmiths worked in isolation from artists in other mediums, a comparison will then be made with the pigments used in manuscript illumination.

2.1, Primary structural materials employed to make studs and inlays

The most prevalent materials manipulated into studs and polychrome inlays in Insular metalwork were glass and amber. Glass is found in the form of *millefiori* or cast studs, and with copper-alloy to form *champlevé* enamels. (fig.19) Amber was employed in the form of inlays and studs. (figs.7, 20)

2.2, The historical use of glass in Ireland

The use of glass by Insular craftsmen was not new, and there was already a relatively long history of glass use in Ireland prior to the arrival of Christianity. Barry Raftery notes that glass beads were an important means of personal adornment throughout the Iron Age and early historic periods, with bead production undertaken in native workshops and a great variety of bead types produced.²¹⁸ Small blue glass beads of a few millimetres in diameter were among the most prevalent beads discovered with Iron Age burials at Knowth, Co. Meath, Oranbeg, Co. Galway, and Loughrey, Co. Down

²¹⁸ Barry Raftery *La Tene in Ireland; Problems of Origin and Chronology* (Marburg 1984), pp.198-9.

among many other sites.²¹⁹ In addition to the prevalent blue glass type, an Ultimate La Tène colourless translucent glass example from Hawk Hill, Kildare demonstrates a series of thin thread-like inlays of bright yellow opaque glass as surface decoration. (fig.42) This bead is of Irish manufacture mimicking similar examples made on the Continent and imported into Ireland.²²⁰ The historical use of opaque red enamel within copper-alloy *champlevé* cells, is evident throughout the Iron Age on fibulae, equipment, and with *millefiori* on sixth to seventh century penannular brooches²²¹. (figs.21, 43) It was in use until the twelfth-century AD. Examination of the range of surviving Insular studs suggests continuity in the use of some glass colours and types, but also some innovation.

2.3, Vitreous materials associated with stud-making

Two types of glass were employed in Insular metalwork; a soda-lime-silica glass and a glass formed through other processes. The basic glass employed to form the majority of polychrome inlays was made by fritting soda-lime-silica or lead oxide-soda-lime-silica constituents together in two phases. Silica, often sourced from quartz rich sand, was partly melted with an alkali at a reasonably low temperature of approximately 650-750°C.²²² This greyish sugar-like material dissolves in water and was washed and ground into a grain-like substance. To create the final glass product temperatures ranging from 1100-1400°C were required and contributed to the production of a high quality vitreous material.²²³ If coloured glass was required, mineral colourants and opacifying materials would have been added to the glass.²²⁴ Glass could be worked and coloured at source and turned into finished products such as vessels, tiles or mosaic or traded as a commodity in block form to secondary sites where the finished products were made.

2.4, Blue glass in Insular metalwork

The blue glass found in Insular fine metalwork occurs in a variety of hues. On the Ardagh chalice, for example, there are three blues ranging from opaque dark navy,²²⁵

²¹⁹ Michael J. O' Kelly and Claire O'Kelly, *Early Ireland: An Introduction to Irish Prehistory* (Cambridge, 1989), pp.280, 340.

²²⁰ Barry Raftery, 'Late La Tène Glass Beads from Ireland,' *Journal of the Royal Society of Antiquaries Ireland* 102, no. 1 (1972): 14, 15, 17-8.

²²¹ See for example the bronze fibula from Inchcleraun, Lough Ree, first century AD L.62.06mm by W.25.89mm. NMI E499.23.

²²² Julian Henderson, 'The Production Technology of Irish Early Christian Glass with Specific Reference to Beads and Enamels,' in *The Glass in Britain and Ireland AD 350-1100*, ed. Price (London: British Museum Occasional Paper, 2000), p.144.

²²³ Ibid.

²²⁴ Julian Henderson, 'The Raw Materials of Early Glass Production', *Oxford Journal of Archaeology* 4, no. 3 (1985), 267-91.

²²⁵ CAT. 9.9-10.

(fig.44) to transparent deep blue-black,²²⁶ to a translucent light blue.²²⁷ (fig.45-6) Similarly, on the Derrynaflan paten an opaque blue²²⁸ (fig.47) and a lighter translucent mid blue tone are in use.²²⁹ (fig.48) Blue glass was made from soda lime silica glass and coloured using cobalt and to a lesser extent copper, with greater amounts producing the distinctive blue-black of the Ardagh chalice escutcheon studs.²³⁰ (fig. 49) Henderson suggests that cobalt-rich material was added to a glass batch 'deliberately and at controlled levels', most likely as a small measurement of the mineral or as a densely coloured glass block.²³¹ In this way the craftsmen could achieve varying strengths of blue colour according to their requirements. Further variation was achieved by creating opaque dark blue using tin oxide as an opacifying agent, evident in studs on both the Derrynaflan paten and Ardagh chalice.²³² However, extant finds suggest that only the darkest blues contained opacifying materials. All mid- and lighter blue glasses are translucent or transparent.

Deep blue/black is also associated with *champlevé* enamelling and is found as a secondary ornamental material on the small *champlevé* studs on the reverse of the 'Tara' brooch.²³³ (fig.24) It has a high melting point, approximately 800- 900°C,²³⁴ which suggests that when used as an enamel it was the first colour applied to *champlevé* cells. Cobalt colouring is stable and can resist multiple firings and re-workings, it can also be easily recycled with surplus or unused material added back into the melt pot for later use. Dark blue glass is associated with opaque red and yellow enamel and with white enamel. (figs. 18-20, 24)

2.5, Green glass in Insular metalwork

The largest concentration of green glass is found on the Derrynaflan ring on three remaining studs of an original group of four.²³⁵ (fig.50) These examples represent the deepest examples of this colour of glass, the Lagore *Crannóg* stud is a mid-green version²³⁶ (fig.51) and stud from a hinged shrine mount displays the lightest green.²³⁷ (fig.52) Colour was created by applying varying amounts of iron oxide to the glass

²²⁶ CAT. 9.2.

²²⁷ CAT.9.13-4.

²²⁸ CAT.1.14.

²²⁹ CAT.1.6.

²³⁰ Henderson, 'Production Technology,' p.148.

²³¹ Ibid., 149.

²³² Ibid., 154.

²³³ CAT. 4.6.

²³⁴ Bimson and Werner, 'Scientific Examination of Ancient Glass,' p.205.

²³⁵ CAT. 2.2.

²³⁶ CAT. 6.1.

²³⁷ CAT. 5.1.

batch.²³⁸ This colour of glass does not appear to have been treated with tin oxide, and extant examples suggest it was favoured in its transparent state. The varying strength in colour between the Lagore stud and Derrynaflan ring studs suggests that, like blue, the maker had a degree of control over the density of the final colour. Similar to cobalt blue, the colour is stable lending itself to multiple heating cycles, and the recycling of unused material. This glass is typically associated with opaque red and yellow enamelling.

2.6, Turquoise glass in Insular metalwork

Transparent turquoise glass is found on some of the smaller, 4mm, studs on the escutcheons of the Ardagh chalice mixed with blue examples.²³⁹ (fig.53) The similarity of the tones to the blues and greens identified suggest that it may have been made by mixing transparent blue and green glass together to create this mid-tone.²⁴⁰ Henderson notes that cupric oxide was employed in turquoise glass.²⁴¹ Similar to green glass, this type of glass does not appear to have been treated with opacifiers to create an opaque version, however, this may be as a result of survival patterns. The examples on the Ardagh chalice demonstrate particularly high quality glass which is evident from the clarity of the vitreous material and the highly reflective surface which does not display pitting or other inclusions.

2.7, Transparent yellow- orange and brown glass in Insular metalwork

These colours are found on penannular brooches, the Killamery brooch demonstrates the lightest shade of transparent yellow,²⁴² the Ervey brooch a transparent orange²⁴³ while the 'Tara' brooch example displays golden brown glass.²⁴⁴ (figs. 54-5) The minerals employed to colour these materials are unknown to this author and at present the glass has not been scientifically analysed. The significance of the colour and the manner in which it is used will be discussed in a later section.

2.8, Dark-brown, black glass in Insular metalwork

Extant examples of dark brown glass are confined to the small studs on the corners of stud mounts on the Derrynaflan ring.²⁴⁵ Two extant opaque black studs are found on the decorative rim of the Derrynaflan paten.²⁴⁶ Due to a lack of scientific

²³⁸ Henderson, 'Raw Materials of Early Glass,' 286.

²³⁹ CAT. 9.18 (3)

²⁴⁰ CAT. 9.18 (3)

²⁴¹ Henderson, 'Production Technology,' p.148-9.

²⁴² CAT. 11.1

²⁴³ CAT.10.1

²⁴⁴ CAT. 4.2

²⁴⁵ CAT. 2.8.

²⁴⁶ CAT. 1.5.

analysis of the glass on the paten, the materials employed to colour these glass materials are unknown. The black studs on the paten were fused with both opaque yellow and red enamel. (fig.56)

2.9, Purple glass in Insular metalwork

Two unique transparent purple glass studs are extant on the 'Tara' brooch, Henderson records that this colour was achieved using manganese in transparent purple glasses.²⁴⁷ (fig.7)

2.10, Opaque yellow glass employed in enamelled glass studs and *champlevé* enamelling

Chemical analysis of the opaque yellow glass employed in Insular contexts shows that the material is a lead oxide-soda-lime-silica mix and that the opacity and strong primary colour is due to lead-tin oxide crystals.²⁴⁸ Henderson notes that under relatively low temperatures the lead-rich glass becomes fluid, thus making it suitable to act as an enamel. Opaque yellow glass was often used alongside opaque red glass as a secondary ornamental material within enamelled studs (figs. 16, 47, 50 and 56) and *champlevé* enamels. (figs.18, 20) Small fragments of yellow enamel were excavated from Moyagh Lough, Co. Meath measuring 25mm x 23mm x 14mm.²⁴⁹ Yellow enamel, unlike red enamel, contains working properties that allow it fuse securely with a tin-bronze surface.²⁵⁰ Despite its relatively low melting point, it does not appear to have been employed to 'glue' platelets of blue and white *millefiori* into place like red glass. (fig.19) This suggests that the melting point of opaque red was lower than that of yellow, with yellow applied to an artefact in a prior step. Unlike red glass, there are no instances of its use as a primary structural material in stud making, although this may be as a result of survival patterns. It is similar in composition to Anglo-Saxon opaque yellow glass beads in terms of high lead content and it has been suggested that its use was predominant in Irish metalwork for approximately two centuries,²⁵¹ before apparently falling out of use during the nadir in metalworking during the tenth century and coming back into style in the eleventh and twelfth century revival.²⁵²

²⁴⁷ Henderson, 'Production Technology,' pp.148. CAT. 4.5

²⁴⁸ Ibid., p.144.

²⁴⁹ National Museum of Ireland NMI ML1987:416.

²⁵⁰ John Bradley and Susan Youngs, 'Enamel Block ' in *The Work of Angels*, ed. Susan Youngs (London: 1989), p.201, no. 197.

²⁵¹ Ibid.

²⁵² Cormac Bourke, 'An Enamelled Iron Object from Rathmullan County Down,' *Ulster Journal of Archaeology* 48(1985), 135.

2.11, Opaque White glass employed within champlevé enamelling, glass cables and millefiori.

Opaque white glass was generally used as a secondary ornamental material for *champlevé* enamelling most often within *millefiori* and is also found as an inlay on the blue studs of the Cross of Cong.²⁵³ (fig. 57) It was not generally used to form the structure of a stud, although technically it was suitable for this application and cannot be ruled out. It was also employed within bi-chrome cables, bead and *millefiori* work along-side cobalt blue glasses. (figs. 19, 20, 35 and 40) During the Early Christian period, the white colour was formed by adding the mineral cassiterite to glass.²⁵⁴ Similar to opaque yellow enamel, white glass employed as an enamel fused readily and securely with bronze and tin-bronze surfaces.²⁵⁵

2.12, Opaque 'liverish red' glass associated with millefiori and Iron Age 'Celtic' and Roman enamelling

Two types of opaque red glass were employed in Insular metalworking. The first, a soda-lime-silica variety, was associated only with *millefiori*. (fig.58) It has been identified by Henderson as a red glass consistent with that used within Iron Age within *champlevé* enamels and the large block of 'sealing wax red' glass found at Kilmessen Co. Meath.²⁵⁶ (figs. 21, 23) This type of glass was introduced into Britain around the first-century AD and used alongside the second later type of high lead reds associated with later *champlevé* enamelling.²⁵⁷ It was formed from a soda-lime-silica glass recipe coloured using copper and iron oxides,²⁵⁸ which probably originated outside the British Isles.²⁵⁹ Extant evidence suggests that this type of opaque red glass was reserved for the red glass employed within *millefiori* glass canes.²⁶⁰ (fig,58) This is logically due to physical compatibility with other soda-lime-silica glasses and the fact that this form of red permitted multiple re-heating and cooling without altering the colour of the glass. Furthermore, this type of glass can 'flow', it can be pulled into fine canes to form *millefiori* if required or scrap reconstituted back into the melting pot for recycling.

²⁵³ CAT.12.1

²⁵⁴ Henderson, 'Production Technology,' p.150.

²⁵⁵ Bradley and Youngs, 'Enamel Block ' p.201, no. 197.

²⁵⁶ Enamel block, opaque red, L.16.6cm, W. 14.5cm, H. 11.1cm, NMI 1887:149a; V. Ball and M. Stokes, 'On a Block of Red Enamel Said to Have Been Found on Tara Hill, with Observations on the Use of Red Enamel in Ireland.,' *Transactions of the Royal Irish Academy* 30(1893).

²⁵⁷ Stapleton, et al, 'Composition and Origin,'913.

²⁵⁸ Henderson, 'Production Technology,' p.149.

²⁵⁹ Stapleton, et al, 'Composition and Origin,' 915.

²⁶⁰ Henderson, 'Production Technology,' p.150.

2.13, Millefiori

Millefiori rods have been identified at Dunmisk, Co. Tyrone,²⁶¹ and blue and white *millefiori* glass cane was found at Lagore *Crannóg*, Co. Meath.²⁶² Lagore also yielded small rods of plain blue glass including one which is lentoid in form, typical of the vitreous building blocks of *millefiori*.²⁶³ At Garranes, Co. Cork a small cut plaque of *millefiori* dated to the sixth to seventh-centuries was excavated.²⁶⁴ *Millefiori* platelets were employed within the red glass studs of the Derrynaflan strainer-ladle, and a typically Irish blue and white *millefiori* is found on the Moylough beltshrine and Coolure Demense plaque. (figs. 19, 35) *Millefiori* is found in some artefacts from the end of the period, including an example in the drop of the early twelfth-century Lismore crozier. The crozier drop displays plaques of true *millefiori* fused in place with opaque red glass. (fig.59) Thus, *millefiori* was used as a primary and secondary ornamental vitreous material within metalworking. (appendix 3)

2.14, Non-soda-lime-silica opaque red 'sealing-wax' red glass

The second type of vitreous material employed in Insular metalwork and stud-making as a primary structural material was an opaque red glass commonly referred to as 'sealing wax' red.²⁶⁵ (figs. 19, 24 and 45) It is now known that this opaque red glass employed as an enamel on Insular artefacts and the red glass employed as an enamel during the Roman Iron Age and in *millefiori*, are two different types of opaque red glass.²⁶⁶ Unlike the other vitreous materials outlined, there is no soda-lime-silica component to 'sealing-wax' red glass or enamel, nor is it fashioned in the same glass-making environment.²⁶⁷ This enamel is the product of metallurgical processes and the recycling of a metallurgical slag carried out within the Insular atelier. This material is in striking contrast to the opaque red soda-lime-silica glass employed in *millefiori* as previously outlined. (fig. 58) It has been suggested that this red glass could have been made in the workshops that produced the finished artefacts,²⁶⁸ thus giving the enameller and stud maker potential control over the production and use of the material.

²⁶¹ Julian Henderson and R. Ivens, 'Dunmisk and Glass-Making in Early Christian Ireland' *Antiquity* 66(1992): .55, fig. 4, 7, 9-10.

²⁶² O'Neill. Hencken, 'Lagore *Crannóg*,' 8.

²⁶³ Raghnall Ó Floinn, 'Two Glass Rods,' p.203 no.201a, b.

²⁶⁴ Raghnall Ó Floinn, '*Millefiori* Plaque,' p.202, no. 199.

²⁶⁵ CAT. 9.16-7.

²⁶⁶ Stapleton, et al, 'Composition and Origin,' 919.

²⁶⁷ Ibid., 916.

²⁶⁸ Ibid., 919-20.

'Sealing wax' red was used as the primary structural material within the small rectangular studs on the Ardagh chalice handles and two examples on the Derrynaflan strainer-ladle.²⁶⁹ (fig.13) It was also used as a secondary ornamental material, often found in conjunction within studs with dark blue glass on the Ardagh chalice, (figs.44-5) and Derrynaflan paten. (figs. 16, 47 and 56) The glass is quite fragile and prone to decay and loss of colour over time. Close analysis of studs as part of this study revealed that the red degraded to various shades of orange, pink, light-blue and even white. These weathering colours and patterns are confirmed in scientific analysis of Insular red glass in the British Museum collection.²⁷⁰

The bright primary red colour is due to the suspension of copper-based dendritic crystals and much higher lead oxide composition than that found in soda-lime-silica glasses.²⁷¹ The large amount of lead within the composition significantly reduces the heating point of this glass, making it a suitable secondary ornamental material. However, due to the heat sensitivity of the dendritic crystals which give the glass its bright red colour, this glass requires reducing condition and much skill and quick reaction times on the part of the stud maker if heat is used in its formation. The colour is easily damaged by heat and transforms into a dull brown or khaki green if over-heated or heated for too long. To mitigate these working properties fragments were largely pre-formed before use and only heated to a viscous state to preserve the colour.²⁷² It is worked at temperatures around 210°C, well below those of the soda-lime-silica transparent or opaque glasses. When used as an enamel, it was the very last material placed *in situ* and heated, as it was only receptive to one firing. Due to the fact that it is worked in a viscous state rather than a molten state, true fusion which occurs between glass and metal in other enamelling contexts does not occur in this case. Sealing wax red glass requires a recess to enclose the material and keys (imperfections such as grooves and protruding irregularities which are deliberately applied to grip an overlying material) within the cell to facilitate mechanically securing it in place. For this reason, much red glass which has degraded overtime has lost traction with the surrounding collet and been lost. (figs.20, 36, 44 and 52) The much lower melting point was also utilised in *champlevé* enamelling where opaque red glass was employed to connect elements with higher melting points such as soda-lime-silica *millefiori* platelets into copper-alloy cells. (fig. 19) Stapleton *et al.* write that

²⁶⁹ CAT.3.2

²⁷⁰ Stapleton, et al, 'Composition and Origin,' 914.

²⁷¹ Henderson, 'Production Technology,' p.150.

²⁷² Bimson, 'Coloured Glass in the Sutton Hoo Grave Deposit,' p.941.

‘It is something of an irony that the widely acclaimed opaque red enamel, decorating what are considered to be masterpieces of the Celtic metalworkers’ repertoire, is not a prestigious purpose-made glass, but derived from slag. Even so, the technical accomplishment required to work this material is likely to have been no less than for any other cuprite glass’.²⁷³

Julian Henderson noted that in comparison with later medieval glass production ‘it seems that Roman and Early Medieval glass artisans were more in control of glass coloration’.²⁷⁴ In relation to Insular glass, he drew attention to its fabrication at high status sites, both ecclesiastical and secular demonstrating ‘that it was employed in most levels of a strongly hierarchical society’.²⁷⁵

Hints of this hierarchy are seen too in patterns of material use. For example, despite the use of *millefiori* within Anglo-Saxon and Viking beads, the same material is not a feature in Irish-made beads.²⁷⁶ Could its use have been hierarchically governed, similar to the colours of clothing reserved for different ranks of society? In an Irish context, *millefiori* glass appears to have been the preserve of the enameller. In addition to a lack of *millefiori*, Irish bead workers did not employ red glass within their beads, while locally made cuprite glass is simply incompatible with lampworking techniques employed to make studs.²⁷⁷ The soda-lime-silica liverish red glass could have been employed successfully in this way. However, this material also appears to have been reserved for the creators of *millefiori* and fine enamels. While this may be the result of survival patterns it may also point to practices which reserved the use of red glass and *millefiori* to fine metalworkers over other vitreous crafts. It is evident that the primary materials employed to make or manipulate glass studs, and amber were an important part of Insular society and had cultural significance.

In terms of sourcing vitreous materials, the evidence points to significant control over the entire manufacturing process. In the case of opaque yellow glass, it may have been made from constituent soda-lime-silica parts, as at Dunmisk, Co. Tyrone, while opaque red ‘sealing wax’ enamel may have been a locally made product created within

²⁷³ Stapleton, et al., ‘Composition and Origin,’ 919-20.

²⁷⁴ Henderson, ‘Production Technology,’ p.148.

²⁷⁵ Ibid., p.147.

²⁷⁶ Ibid., 145. One *millefiori* glass bead was recovered from Lagore *Crannóg*, Co. Meath. Dr. Margaret Mannion pers. comm.

²⁷⁷ Lampworking is fast-moving and involves constant heat and rotation to achieve the intricate patterns which are applied by overlaying fine trails onto the bead structure. As noted red glass is largely cut to shape worked in viscous form at low temperatures and does not lend itself to prolonged heating.

the metalworking atelier. Thus demonstrating the Insular stud makers' engagement with materials throughout the whole stud making process.

In addition to the potential to control colour and opacity, all primary structural materials permit the recovery, reconstitution and future reworking of material. The only exception to this rule is found in opaque red glass. However, the potential historical and cultural importance of the material and the fact that the makers had some control over production appears to have mitigated the negative working aspects.

2.15, Potential methods of shaping glass

Glass has the potential of being cut using lapidary techniques. It was cut by the Anglo-Saxons, while amber also formed in this manner using reductive techniques. Relatively little has been written about working glass into inlays and studs. Ó Floinn suggested that a small *millefiori* plaque found at Garranes was cut from a cane and bevelled to be set as a gem within a *cloison*.²⁷⁸ (fig.58) Similarly, it has been inferred that the blue glass cane of lentoid cross-section from Lagore *Crannóg*, Co. Meath could have been cut down to set within *cloisons* on brooches or brooch-pins.²⁷⁹ Craddock notes that 'very often pieces of glass either plain, coloured or *millefiori* were cut and set as stone'²⁸⁰, but he does not refer to specific examples. Certainly this reductive technique was employed in the medieval period. Writing in the twelfth century Theophilus, in his account of lapidary techniques says 'Rub [the gemstone] with both hands on a hard sandstone moistened with water until it takes on the shape you want to give it; then on another stone of the same kind which is finer and smoother until it becomes completely smooth'.²⁸¹ This appears to have been approach taken with Anglo-Saxon garnet and glass cloisonné inlay, and an example of a roughly circular disc cut and grozed (roughly clipped into shape around the edge with a pliers) from a vessel is known from Whitby.²⁸² To make glass beads and bangles, hot lampworking techniques were employed to heat and pull glass into canes and form these by hand into *reticella* trailed glass.²⁸³ Polychrome beads were formed by gathering a globule of glass onto a rod and forming it into shape while molten and, where desired, applying dots and trails of contrasting white and blue or white and green *reticella* glass. (fig.60)

²⁷⁸ Ó Floinn, 'Millefiori Plaque,' p.202.

²⁷⁹ O'Floinn, 'Two Glass Rods,' p.202, no. 01 a and b.

²⁸⁰ Paul Craddock, 'Metal-Working Techniques,' p.173.

²⁸¹ Theophilus, *Book 95, the Various Arts*, trans. C. R. Dodwell (London 1961), p.168-9.

²⁸² Vera Evison et al., *Catalogue of Anglo-Saxon Glass in the British Museum* (London, 2008), p.71, no. 211, colour plate 8.

²⁸³ Reticella glass was formed from blue canes of glass, with white glass trails applied while rotating the blue cane.

2.16, Sources for soda-lime-silica glasses in Insular Ireland

Excavations at Hadera, a coastal region in Israel, uncovered sixteen colossal tank furnaces capable of processing up to eight tons of glass in one firing each.²⁸⁴ This site is one among many in the eastern Mediterranean region producing glass at this time. It is from this area that most of the glass from ancient to early medieval Europe was created and transmitted in vessel form, *millefiori canes*, raw chunks to points as far away as Britain and Ireland.²⁸⁵ Henderson reports that the results from chemical analyses of 160 translucent and opaque glasses from Dunmisk, Co. Tyrone suggest that the glasses are a soda-lime-silica mix, consistent with a 'Roman' recipe. The range of calcium oxide identified in the Dunmisk glass is comparable to similar glass from Jalame, a late fourth-century Roman glass working site in Palestine.²⁸⁶ Glass was also manufactured in the Cologne region and Bordeaux in fifth to seventh-centuries AD. Evidence suggests Bordeaux-made vessels were imported into Ireland certainly during the late sixth and early seventh centuries AD, perhaps in association with the wine trade.²⁸⁷ Therefore we have evidence of soda-lime-silica glasses transmitted from the Mediterranean and Continent to Ireland. (appendix 1)

The use of vessel or recycled glass beads in creating ornamental studs is suggested by the use of *reticella* and brown glass to make studs on the Lough Gara buckle, CAT.8.1 (fig. 61) and 'Tara' brooch, CAT.4.2. (fig. 55) Vessel glass is known in Ireland from several high-status secular sites.²⁸⁸ Writing in the context of finds at Lagore Crannog, Hencken proposed that scrap glass from vessels was re-used as insets in jewellery, and this would certainly have extended the colours available to Irish craftsmen.²⁸⁹ Aside from the Lough Gara example, a further example was identified at Garranes, Co. Cork, where a disc was cut from the wall of a glass vessel.²⁹⁰ Other

²⁸⁴ Mavis Bimson and I. C. Freestone, 'Analysis of Some Glass from Anglo-Saxon Jewellery,' in *Glass in Britain and Ireland A.D. 350-1100*, ed. J. Price (London: British Museum Occasional Paper, 2000), p.133.

²⁸⁵ Evison et al., *Catalogue of Anglo-Saxon Glass*, p.29.

²⁸⁶ Henderson, 'Production Technology,' p.142.

²⁸⁷ Ewan Campbell, 'The Archaeological Evidence for External Contacts: Imports, Trade and Economy in Celtic Britain Ad 400-800,' in *External Contacts and the Economy of Late Roman and Post-Roman Britain*, ed. K. R. Dark (Woodbridge: 1996); E. Campbell, 'A Review of Glass Vessels in Western Britain and Ireland Ad 400-800,' in *Glass in Britain and Ireland Ad 350-1100*, ed. J. Price (London: British Museum Occasional Paper, 2000), p.37.

²⁸⁸ E Bourke, 'Glass Vessels of the First to Ninth Centuries AD in Ireland,' *Journal of the Royal Society of Antiquaries Ireland* 124(1994): fig. 51.

²⁸⁹ Hencken, 'Lagore Crannóg: An Irish Royal Residence,' 33.

²⁹⁰ Garranes no. 325 is circular in form 1mm thick, nine millimetres in diameter. Ó Riordáin remarks that the circular form has been carefully achieved by grinding the edges and thus preparing the glass for setting within metalwork. Seán P. Ó Riordáin, 'The Excavation of a Large Earthen Ring Fort at Garranes, Co. Cork,' *Proceedings of the Royal Irish Academy* 47c(1942): 42, Fig.14

imported forms of glass include a little eastern Mediterranean glass gold leaf tesserae similar to those used on Byzantine mosaics, found in an Insular context at Dunadd.²⁹¹

However, aside from recycling pre-coloured vessel glass, Henderson has suggested that the 'specialised procurement of opacifying materials and other mineralogically-based colorants may have occurred in Ireland; some addition of colourants and opacifiers to glass melts certainly occurred there'.²⁹² This suggests that in the case of transparent blue, green, opaque white and yellow and opaque 'liverish' red the specialist Irish glass worker had a degree of control over the colour and opacity of the material and may have chosen the intensity or opacity of some colours. Iron cobalt and manganese, for example, are available at Howth (Co. Dublin) and in other regions of Ireland.²⁹³

The creation of vitreous materials from constituent parts within Insular Ireland points to significant control over material from initial creation and colouring to manipulation into finished artefacts. In the case of opaque red glass associated with enamelling by the metalworkers who perhaps formed and created the very artefacts on which it was employed. Stapleton *et al.* note that the results for two Irish brooch enamels are comparable with the main body of lead isotope data for lead ore sources from Ireland, thus demonstrating a strong possibility that the brooch enamels were produced in Ireland.²⁹⁴ In addition to opaque red glass, Henderson notes that opaque yellow glass employed in enamelling may also have been formed from constituent parts in Ireland based on evidence found at Dunmisk, Co. Tyrone.²⁹⁵

2.16, Glass stud production sites

While many Insular sites revealed glass which may have been employed to make *champlevé* enamels or beads, eight Insular sites in Ireland and western Scotland demonstrate direct evidence of glass stud production. This occurred at, Iona Dunadd, and Tarbatness in Scotland, Dunmisk, Co. Tyrone, Lagore *Crannóg*, and Knowth in Co. Meath, Ballinderry, Co. Offaly and Garryduff in Co. Cork.²⁹⁶ (appendix 4)

²⁹¹ Lane and Campbell, 'Dunadd,' p.173.

²⁹² Henderson, 'Production Technology,' p.154-5.

²⁹³ John O'Reardon, 'Minerals and Gems of Ireland; Varieties: Literary and Scientific,' *The National Magazine* 2, no. 3 (1831): 365.

²⁹⁴ Stapleton, et al. Freestone, and Bowman, 'Composition and Origin,' 915.

²⁹⁵ Henderson and Ivens, 'Dunmisk and Glass-Making' 63-4.

²⁹⁶ Iona and Dunadd in the Irish Kingdom of Dálriada extended from Northern eastern Ireland into western Scotland. The Sites were also connected to Ireland via the Columban *paruchia*. (appendix 2) For Iona see James, Graham-Campbell, 'The Bell and the Moulds', in R. Reece, *Excavations at Iona*, (London, 1981), p.24; for Dunadd see, Lane and Campbell, *Dunadd*, pp.174-5; for Tarbatness, see M. Carver, 'An Iona of the East, The Early Medieval Monastery at Portmahomack,

2.17, The historical use of amber in Ireland

Like glass, amber use was already well-established in Ireland before the coming of Christianity. Necklaces attributed to a Bronze Age date demonstrate large collections of the material, such as the example from Tooradoo Co. Limerick.²⁹⁷ (fig. 62) Even at this stage there appears to be an association between amber and gold demonstrated by a necklace from Croghtencrough, Co. Kilkenny with gold spacer beads, and an amber bead with an inset of gold from Milmoraine Co. Cork.²⁹⁸ Mary Cahill notes the adaption of forms associated with large amber beads to hollow spherical gold beads.²⁹⁹ In her study of prehistoric amber, Lisa Moloney points out that the high point for the use of amber in Ireland has generally been ascribed to the Bronze Age, but that some of these amber finds may infact have been deposited during the Irish Iron Age 300BC-400AD. This research gives amber greater continuity than was commonly accepted and its sartorial display alongside *champlevé* enamels and glass beads an established heritage during the transmission of Christianity to Ireland.³⁰⁰

This opens up the possibility of the continuous use of amber in Ireland with established customs and local importance associated with the material. In support of this theory, Aidan O'Sullivan *et al.* record that some amber finds on Irish medieval sites predate the arrival of the Vikings.³⁰¹ For example, amber bead fragments from Garranes have been dated to the late fifth or early sixth-centuries, and those at Ballycatteen, Co. Cork, also point to early use of the material in a sartorial context in Ireland, while Hencken notes the discovery of a small, finely made, lathe turned amber bead during the early phases at Lagore *Crannóg*.³⁰² An amber bead was identified at Garryduff dated

Tarbatness,' *Medieval Archaeology*, Vol. LXXIII, 2004, p.16; for Dunmisk see, J. Henderson, 'The Nature of the Irish Glass Industry in Ireland', *Ulster Journal of Archaeology* 1988, 115.; for Lagore *Crannóg* see Hugh O'Neill. Hencken, 'Lagore *Crannóg*,' 10.; for Knowth, Co. Meath see Murray, 'Stud of Amber and Glass', pp.544-50; for Ballinderry *Crannóg*, see Hencken, O' Neill, 'Ballinderry *Crannóg*, no. 2,' *Proceedings of the Royal Irish Academy*, 47c. 1941, 58.; For Garryduff, Co. Cork, see O'Kelly, 'Two Ring-forts at Garryduff, Co. Cork, *Proceedings of the Royal Irish Academy* 63 (1962), 74-5.

²⁹⁷ George Eogan, 'From Skåne to Scotstown: Some Notes on Amber in Bronze Age Ireland. ,' in *Experiment and Design, Archaeological Studies in Honour of John Coles*, ed. A.F. Harding (Oxford and Oakville, 1999), p.75.

²⁹⁸ National Museum of Ireland, NMI W.G. 34-47. E. Mac White, 'Amber in the Irish Bronze Age,' *Journal of the Cork Historical and Archaeological Society* 49(1944): 123.

²⁹⁹ Mary Cahill, 'The Gold Beads from Tumna Co. Roscommon,' in *From Megaliths to Metal*, ed. Helen Roche, et al. (Oxford: Oxbow books, 2004), p.105.

³⁰⁰ Lisa Moloney, 'Amber in Prehistoric Ireland,' *Archaeology Ireland* 27, no. 103 (2013): 14-5.

³⁰¹ Aidan O'Sullivan et al., *Early Medieval Dwellings and Settlements in Ireland, AD400-1100*, vol. 1:Text, Early Medieval Archaeology Project (Irish National Strategic Archaeological Research (INSTAR) programme 2010 2010), p.179, fig. 8.14.

³⁰² Ó Riordáin, 'Large Earthen Ring Fort at Garranes, Co. Cork,' 121, fig. 14, 210; S.P. Sean P. Ó Riordáin and P.J. Hartnett, 'The Excavations of Ballycatteen Fort,, Co. Cork,' *Proceedings of the Royal Irish Academy* 49C(1943), 27; Hugh O'Neill. Hencken, 'Lagore *Crannóg*,' 10.

to the seventh century.³⁰³ Similar to glass, amber from these sites had been worked into beads, rings and pendants for personal adornment, and there is no evidence of the manufacture of associated amber studs at these sites.³⁰⁴

2.19, Amber

Alongside glass, amber is the most significant material employed to make studs in Insular metalworking. Amber is defined as an amorphous polymeric glass made up of polymers of cyclic hydrocarbons termed terpenes. It is formed from the resin exuded from several types of conifer and flowering tree, which undergoes a fossilisation process within soils and sediments over thousands to millions of years. It comes in many forms, colours and ranges from clear to opaque. Common colours of amber include pale yellow, golden yellow, orange, sherry red, cognac browns to black and even naturally occurring green.³⁰⁵ Almost colourless transparent types termed 'water clear' also exist. The opacity of the material is determined by the number of air bubbles present, the more intense the opacity the greater the number of bubbles. Amber is not homogenous and within one sample the colour can range from pale yellow to orange and opaque to transparent. The number of air-bubbles and internal flaws result in a material which is naturally inconsistent in physical hardness and resistance to the application of pressure and heat during working. Amber has a specific gravity of 1.04-1.10, is quite buoyant in sea water and naturally breaks with a conchoidal fracture.³⁰⁶

The amber samples examined as part of this study demonstrate a broadly similar yellow to 'cognac' colour range, due to age and exposure to the elements. (figs. 63-4) Amber tends to darken and fragment from the surface on contact with air and UV light and has a tendency to dehydrate and shrink. For this reason the amber on a number of extant Insular artefacts is much degraded, as in the case of a few remaining fragments on the Ardagh chalice.³⁰⁷ (fig.65) While the original amber colour remains unknown, we can logically determine that as the material darkens with age, thus amber studs were much lighter than is seen now. Similarly tiny fractures in the surface of amber studs examined by this writer with magnification from a jewellers eye piece,

³⁰³ O'Kelly, 'Ringforts at Garryduff,' 77-8, fig. 13, no. 284.

³⁰⁴ Ballinderry *Crannóg* 2, Co. Offaly, Amber ring fragment width 6mm, D-shaped in cross section, perhaps originally 30mm in diameter employed as a finger ring or pendant, eighth-ninth-centuries, National Museum of Ireland. Ragnall Ó Floinn, 'Amber Ring Fragment' in *The Work of Angels*, ed. Susan Youngs (London, 1989), p. 208. A similar fragment was found at Lagore *Crannóg* Hencken, 'Lagore *Crannóg*,' 660, fig. 74.

³⁰⁵ Andrew Ross, *Amber; the Natural Time Capsule*, vol. 1 (London: Natural History Museum, 2009), 7-9, 21.; Fraquet, *Amber*, pp.1-4.

³⁰⁶ Ross, *Amber*, pp.1, 9.

³⁰⁷ See also the Roscrea brooch fig, 36.

suggest that the interiors are transparent. Thus we can ascertain that transparent amber was originally favoured. This is supported by the careful placement of hatched gold foils underneath the 'Tara' brooch studs and gilding and malachite under the examples on the Ardagh chalice. (fig.65) It also suggests that there were attempts to alter the colour of amber by layering the materials into 'doublet' inlays.

2.20, Potential methods of shaping amber

All sources without exception, identified by this author record that, prior to the nineteenth century, amber was worked by hand by removing surface material and then drilling, lathe turning, grinding or carving amber into shape using sharp implements. This approach was employed to form amber beads, pendants rings and small statuettes.³⁰⁸

Due to internal bubbles, fractures and flaws, much loss can occur during this cold working reductive process, resulting in hundreds of waste fragments. These internal factors, alongside exposure to the air which causes dehydration and UV light which causes the surface to begin to disintegrate all affect the resistance and thus working properties of the material. It is the experience of this researcher that within a single nugget the application of uniform levels of pressure or heat during working will create different results in different regions easily resulting in overworking of a particular area. Ian Panter noted that to overcome these difficulties, a bead shape was roughed out to the basic shape required using a file or saw, which ultimately clogged up with amber dust. Generally, beads were drilled from both sides, meeting in the middle.³⁰⁹ This reductive method resulted in striations along the interior wall of the perforation.³¹⁰ Lathe turned rings have been found as part of the Viking excavations at York. According to Panter, producing this type of form 'appears to have been very risky, as suggested by the number of broken rejects recovered from Clifford Street'.³¹¹ As amber begins to soften above 150°C, and if heated unevenly or cooled too rapidly will fracture, cold water may have been poured over the amber in order to maintain a low temperature.

A further method of perforating amber was to heat up a pointed iron and gently push it through the amber bead, however, no direct evidence of this method has been found at York or in other ninth- and tenth-century Viking contexts.³¹² Amber fragments

³⁰⁸ 'Amber (II),' in *Grove Art Online* (Oxford Art Online, 2008).; Ross, *Amber*, pp.9-11.; Fraquet, *Amber*, pp.60-72.; Patty C. Rice, *Amber, Golden Gem of the Ages*, 4 ed., (Milton Keynes, 2006) p.97

³⁰⁹ I. Panter, 'Amber Working Tools and Techniques,' (2000), pp.2501-2.

³¹⁰ *Ibid.*, 2503.

³¹¹ *Ibid.*, 2503

³¹² *Ibid.*, 2503.

in significant numbers and a range of colours from opaque white to various shades of light to golden yellow and orange were uncovered during the excavations of Viking Dublin at Fishamble St., pointing to the existence of an amber workshop specialising in drilled beads and carved pendants.³¹³ (fig. 66) At Scotch St. Armagh hundreds of chips were discovered.³¹⁴ However, these are associated with bead, ring and pendant making rather than stud making.

Opaque or cloudy amber with multiple bubbles, can be clarified and softened by heating in vegetable oil, pigs' fat, paraffin or bees wax, and can be surface darkened to orange, red or red brown tones in this manner too. Pliny noted that amber could be used to imitate translucent precious stones such as amethyst by dyeing it purple and dyed red with the root of the *Anchusa tinctoria* or root of alkanet, a Mediterranean plant.³¹⁵ While there is no extant evidence of the Insular dyeing of amber as described by Pliny, fabric dyeing occurred in Ireland where the roots of the local plant madder or *rubia peregrine* were utilised to achieve the purple colour of which Pliny spoke.³¹⁶

Amber dust can also be used as a flux for gold soldering.³¹⁷ Similar to glass conservation, fragments of amber can be recovered and reconstituted by rubbing with oil, heating to around temperatures from as low as 150 up to 250°C and pressing samples together leaving no visible join in ambers of similar colour. Many variations of this approach were developed and in 1881 Spiller amber or 'ambroid' was released. This method involved hydraulically pressing small chips of amber through a sieve within a steel mould, and applying steam to soften the amber. The amber block produced could then be cut into pipe mouth pieces and cigarette holders. Uniform amber beads and amber cabochon inlays were similarly processed to make necklaces of geometrically formed beads and amber gemstones for setting within jewellery.³¹⁸ It must be noted that amber formed in this way is still very much seen as a second class form of the material with less intrinsic value than original unadulterated amber. Reconstitution, and the creation of imitation amber from copal, resin and plastics and the mass production heat forming techniques were developed in the late nineteenth and twentieth centuries

³¹³ Patrick F Wallace, 'The Economy and Commerce of Viking Age Dublin' in *Der Handel Der Karolinger-Und Wikingerzeit: Bericht Über Die Kolloquien Der Kommission Für Die Altertumskunde Mittel- Und Noerdeuropas in Den Jahren 1980 Bis 1983* ed. Klaus Düwel (Göttingen/Zürich: Vandenhoech & Ruprecht, 1987), pp.215-6.

³¹⁴ C. J. Lynn, 'Excavations at 46-48 Scotch Street Armagh 1979-80,' *Ulster Journal of Archaeology* 51(1988).

³¹⁵ John Bostock and H. T. Riley, *Pliny, the Natural History*, (London, 1855-7), pp.402-3.

³¹⁶ S. P. Ó Ríordáin, *Antiquities of the Irish Countryside*, 5 ed. (London, Methuen, 1979), 30.

³¹⁷ T. Follet, 'Amber in Goldworking,' *Archaeology* 38, no. 2 (1985): 64-5.

³¹⁸ Fraquet, *Amber*, pp.66-7.

and are not associated with earlier periods such as pre-historic, classical or medieval use.³¹⁹

2.21, Sources for amber

The Baltic region and the North Sea area are the most well-known sources of amber dating from the Tertiary Period within Northern Europe.³²⁰ (appendix 1) Other primary geological deposits of amber within Europe are also found in Romania, Poland, Germany, Holland, Hungary, Sicily and the Isle of Wight among others.³²¹ Baltic amber is termed 'succinite' due to the presence of succinic acid in small quantities. Infra-red spectrometry has been used to identify 'Baltic' succinite ambers and differentiate between these and other similar fossilised resins. However, it has been shown that amber from the same North-European deposits may or may not contain succinic acid or varying levels of the substance.³²² As 'Baltic' amber can be carried by the action of the tides and trade far from the original geological source, and be repurposed over time, this method is not without its critics and limitations.³²³ Furthermore, due to the movement of glaciers overtime amber which was formed within the Baltic region migrated and was redistributed in regions beneath the North Sea Dogger Bank, Poland, Germany, and as far away as Holland.³²⁴ It is now also accepted that the forests in which amber originated once stretched out into the Atlantic Ocean, suggesting that potential deposits exist here also. Thus tests for succinite may be an unsafe method of identifying amber, discounting other fossil resins of such as copal, resinite, rumanite and retinite, which share similar physical properties, environmental and geological origins.³²⁵

Unfortunately to date no scientific examination has been carried out to determine the source of Irish amber employed during the Early Christian Period. Although a limited study by Beck and Sennan demonstrated that some amber beads of Irish provenance were made from amber which originated in the Baltic region, but as we

³¹⁹ 'Amber (II),' in *Grove Art Online* (Oxford Art Online, 2008).; Ross, *Amber*, pp.9-11.; Fraquet, *Amber*, pp.70-83, 130-141.

³²⁰ Ross, *Amber*, pp.1, 20.

³²¹ Fraquet, *Amber*, pp.102,110.; The amber found on the Isle of Wight dates from the Cretaceous period rather than the Tertiary period associated with Baltic amber. Ross, *Amber*, p.19; Briggs, 'The Discovery and Origins of Some Bronze Age Amber Beads from Ballycurrin Demense, Co. Mayo,' 110-1.

³²² Rice, *Amber*, p.14; Traditionally succinic acid is associated with medicinal properties and is used to enhance the prestige and marketability of 'Baltic' material.

³²³ Ibid. pp.110-1; Fraquet, *Amber*, p.149.

³²⁴ Ibid.

³²⁵ Briggs, 'Some Bronze Age Amber Beads', 110.

have seen this may be unsafe.³²⁶ With this in mind the following sections will attempt to outline sources of amber potentially available in Early Christian Ireland.

2.22, North Sea coast of England and Scotland, sources for amber

Deposits within the North Sea Dogger Bank are often released during storms and washed ashore along the East coast of Britain from East Anglia to as far north as Scotland. Amber necklaces made from flat discoidal beads are found extensively in Anglo-Saxon graves dated from the mid to late sixth century.³²⁷ It is possible that locally gathered samples were mixed with imported Baltic nuggets and formed into necklaces, while the seventh century Ripon jewel and gold pendants in the British Museum collection demonstrate amber employed within cloisonné in the manner usually associated with Anglo-Saxon garnet.

This suggests the Anglo-Saxons and other communities of the east coast of Britain such as the Northumbrians and Picts, may have had the resources to convey amber acquired from the North Sea coastline to Ireland through established trade and ecclesiastical links as early as the sixth and seventh century. (appendix 2) Indeed, an amber bead of a shape and type associated with the Anglo-Saxon origins was found in two fragments at Garranes ring fort in County Cork.³²⁸ A second roughly-made bead was also uncovered at the site which is associated with glass bead making, *millefiori* and metal casting.³²⁹ Thus, prior to the Viking settlements in Ireland, amber may have been traded into Ireland through Anglo-Saxon middle-men either sourced along the British North Sea coastline or from Anglo-Saxon trade with the Baltic region.

2.23, Viking sources for amber

The traditional source of amber is attributed to trade with the Vikings in the ninth century AD based on the large amount of waste material found at sites such as Fishamble St, Dublin dated to the tenth century. Dáibhí Ó Cróinín has noted that the first phase of contact with the Vikings, involved 'hit and run' raids on high value sites along the coast of the Ireland from 795 AD, with Iona attacked in 802 and 806 AD.³³⁰ The aim being to acquire clerics for ransom and artefacts of value, many of which have been

³²⁶ Beck and Shennan, *Amber in Prehistoric Britain*, pp.26-7

³²⁷ Meaney, 'Amber: Saxon Amulets and Curing Stones'.

³²⁸ The fragmented amber bead has a diameter of 15mm approximately. Mr Beck noted that the '... bead is of the rough type usually associated with Anglo-Saxon amber. The pre-Roman amber is generally much more carefully made.' Ó Riordáin, 'Earthen Ring-fort, Garranes, Co. Cork', 121

³²⁹ Ibid. 116,118, 120,121-2

³³⁰ Ó Cróinín, *Early Medieval Ireland*, p.235

uncovered in Viking graves in Scandinavia.³³¹ The second phase of Viking contact, appears to be a more likely source of amber, it involved the establishment of the *longphort* or naval camps at sites such as Dublin and Linns, Co. Louth.³³² This change in emphasis from raiding to trading suggests direct Viking trade as a source of amber from the second phase dating from the 840s. This is much later than the sixth century ecclesiastical and political links with the east coast of England and Scotland set up by Ss Columba and Fursa outlined in chapter one, or the identification of amber on seventh to eighth-century artefacts such as the Lough Gara buckle or eighth-century 'Tara' and Hunterston brooches. (figs.20, 24, 7, 8)

2.24, Sources for amber in Ireland

However aside from accessing amber from the British coast of the North Sea or directly from the Baltic region via the Vikings. Several sources have suggested that amber resins occur naturally in Ireland in many sites such as on Rathlin Island and other sources in Co. Antrim.³³³ Stephen Briggs points to other potential sources within lignite beds found in Co. Derry, where small lumps of the material were recorded in the nineteenth century.³³⁴ Lough Neagh and Howth, Co. Dublin, also have also presented evidence which suggests amber is available in Ireland.³³⁵ Briggs also points to potential amber repositories within Tertiary lignite beds beneath the seas surrounding Ireland which may have the potential to discharge fragments during winter storms. In fact amber is found along the coast of Co. Cork and as far west as Co. Galway where it was gathered by locals along the shoreline and used to make amber rosary beads as a cottage industry in the nineteenth century.³³⁶ It may have been conveyed by the tides to the south coast and gathered along the shore line at Kinsale according to Joseph

³³¹ Ibid., p.237

³³² Ibid., p.238

³³³ Briggs, 'Bronze Age Amber Beads,' 113; C. Stephen Briggs, 'Amber in Ireland, some Geological Notes' 81-85 in E. Kelly 'A prehistoric amber find from Ballylin, Co. Offaly', *Eile: Journal of the Roscrea Heritage Society*, 2 (1983-4), 67-85 ; Beck and Shennan, *Amber*, pp.26-7

³³⁴ J.E. Portlock, 'Report on the Geology of the County of Londonderry and of parts of Tyrone and Fermanagh', (Dublin, H.M.S.O., 1843), pp.112-3

³³⁵ Briggs, 'Discovery and Origins,' 113.

³³⁶ Briggs points to G.H. Kinahan's record from 1884 which relays that pieces of amber were known to have been washed up on the shores of counties Galway and Clare, at one point it was common to fashion rosaries from this flotsam in Hier Connaught, West Galway and the Barony of Burren, Clare. See G.H. Kinahan and J. Nolan, 'Memoir of the Geological Survey: Explanation of Sheet 95. The Country around Headford and Oughterard, (H.M.S.O. Dublin) in the *Journal of the Royal Society of Antiquaries Ireland*, 15, p.538; Fraquet points to nineteenth century folklore cures in Ireland pertaining to amber. see *Amber*, p.57.

(1997), 114; I am grateful to Margaret Mc Glynn originally from Co. Limerick who shared information about family heirloom, an amber rosary belonging to her mother believed to date from the late nineteenth century. The local use of this material within Ireland over the centuries, is a topic worth further investigation.

Raftery.³³⁷ Stephen Briggs has called for scientific analysis to determine both the type and source of both Viking and pre-historic amber resins employed in Ireland, and outlined the difficulties associated with the interpretation of the findings.³³⁸

It is possible that primary and secondary sources of amber were intermingled and used to supplement workshop stock. As has been noted, even small fragments of amber and other fossil resins can be 'fused' into larger pieces as required thus 'amberoid' from diverse sources may have been utilised to make Insular studs. Furthermore as large nuggets were not required by the Irish goldsmiths to produce studs even small samples of the material would have been useful. As amber beads were a popular form of personal adornment during the Bronze Age and Iron Age, caches of these were also theoretically available. (fig. 62) Michelle Comber has observed that Bronze Age gold may have been re-used in the Early Christian period, suggesting that it is highly possible that amber from earlier periods was utilised to make studs alongside, or even combined with, indigenous varieties and imported amber. In support of recycling from local sources for materials, Ó Cróinín recounts that the prehistoric tumuli of Knowth, Dowth and Brú na Boinné were ransacked by Amláib, Ivarr and a third Norse king Auisle.³³⁹ This may be evidence that the sites contained material of interest to ninth-century pillagers.

2.25, Amber stud production sites in Ireland

Only three metalworking sites demonstrate evidence of the production of loose amber studs, examples in an unfinished state were recovered at Lagore, Co. Meath and Ballinderry *Crannóg*, Co. Offaly. In Knowth, Co. Meath, finished loose studs were found in a metalworking context alongside glass studs³⁴⁰. At 46-8 Scotch St., Armagh, un-worked amber fragments were revealed alongside glass materials in a high status metal workshop. This perhaps indicates the intention to apply them to metalwork rather than as bead or for ring making.³⁴¹ (appendix 5)

³³⁷ Joseph Raftery, *Prehistoric Ireland*, (London, 1951), p.204, Raftery's comments are noted by Briggs, 'Discovery and Origins,' 11.

³³⁸ Briggs, 'A Neglected Viking Burial with String-Beads from Kilmainham, discovered in 1847,' *Medieval Archaeology*, 29, 94-108.; Briggs, 'Discovery and Origins,' 117-8.

³³⁹ Ó Cróinín, *Early Medieval Ireland*, p.251.

³⁴⁰ For Amber studs at Lagore *Crannóg* see Hencken, 'Lagore *Crannóg*,' 151, figs. 74, 776. For Ballinderry *Crannóg* see Hencken, 'Ballinderry *Crannóg*, No.2' 51, figs. 21, 75.; for Knowth, Co. Meath, see Murray, 'Stud of Amber and Glass', pp.544-50.

³⁴¹ C. Lynn, Excavations at Scotch St. Armagh, 1979-80, *Ulster Journal of Archaeology* 51, 69-84. See also Susan Youngs, 'Fragments of Amber,' in Youngs S. (eds.) *Work of Angels*, p.208, no. 216.

2.26, Secondary ornamental materials associated with stud-making.

The various colours of glass and amber discussed above were used by Insular craftsmen to form the main body of stud settings. However, for many, this was just the start of the process and a range of other materials were used to create further embellishment. The secondary materials associated with glass stud-making include, silver, gold, lead-tin alloy, opaque red, white and yellow glass, *millefiori*, orpiment and gypsum. Extant examples of amber studs incorporate gold and gilt copper-alloy, lead-tin and malachite to enhance the primary material.

2.27, Silver

Silver was used to enhance glass studs in a number of ways. In conjunction with translucent blue studs, for example on the Ardagh chalice, embossed silver foils were set behind studs to reflect light back at the viewer. (fig.27) Silver inlays are also associated with opaque and transparent blue glass and opaque red glass studs on several artefacts.³⁴² (fig. 46) It has a light whitish colour and exceeds all other metals in its ability to take a polish and produce a reflective mirror-like surface. Pure silver is too soft for most technical applications and therefore is generally used in alloyed form to increase tensile strength. Brephol notes that 'centuries of experimentation have determined that the most suitable alloys contain an addition of 7.5% to 20% copper'.³⁴³ In addition, the melting point of silver is 960°C, by alloying with copper which melts at 1083°C, the working properties of silver could be altered slightly and the material rendered more suitable for gilding. Ryan reports that the silver on the Derrynaflan paten and chalice were alloyed with about 30% copper, thus demonstrating that Irish smiths were stretching precious materials. However, as we have seen this mixing was also necessary to improve the working properties of the material and the durability of the final artefact.³⁴⁴

2.27, Gold

Similar to silver, gold was used to enhance the backs of transparent studs such as the small Ervey brooch studs (CAT.10.1), the front of the small studs on the base of the Ardagh chalice (CAT.9.24) and the larger blue studs on the Derrynaflan paten. (CAT.1.20) (fig.67)

³⁴² See CAT. 11.1, CAT.9.13 and CAT. 9.15.

³⁴³ Erhard Brephol, *The Theory and Practice of Goldsmithing*, trans. Charles Lewton-Brain, (Maine, 2 ed., 2001), p.10.

³⁴⁴ Michael Ryan, *The Derrynaflan Hoard I*, p.61.; idem, 'The Derrynaflan Hoard and Early Irish Art,' p.42.

Gold is the only metallic element with a highly reflective yellow colour when polished that does not tarnish.³⁴⁵ It is highly malleable and particularly easy to form into fine hair-like wires which can be manipulated by hand. The flexibility of the material is demonstrated by the fact that gold foil can be made so thin that a single stack of 10,000 foil leaves of only 1mm in thickness can be achieved.³⁴⁶ The melting point of gold is 1063°C making it a suitable material to act as a substrate for cloisonné enamelling. It has been regularly alloyed with other metals, particularly copper and silver. The alloying of the material with other metals is generally interpreted to be an attempt to extend the material. However, this does not take into account the working properties of the material. From a technical viewpoint, alloying gold is undertaken to both increase the tensile strength of the gold being worked and, crucially, to lower the melting point of the material.³⁴⁷ By lowering the melting point of gold the artificer increases the ability to fuse it thoroughly to other materials, such as glass, which have lower melting points.

2.29, Copper

Copper is the only base metal which is reddish in colour. It can be polished to a relatively high finish, but tarnishes with exposure to air. On exposure copper begins to form a red oxide layer, followed by a blackish layer. Over time a greenish patina develops as a result of copper interacting with sulfates and salts, this forms the typical green colour associated with aged copper roofing.³⁴⁸ When annealed, copper is highly flexible, it has a high melting point at 1083°C. Aside from alloying copper with silver and gold, copper was also alloyed with tin to create bronze.

2.30, Tin

Tin is silver white in colour and resembles silver, in that it can take a high shine and is relatively unreactive in air. It has low tensile strength, is very ductile and melts at only 231.9°C.³⁴⁹ Old tin tends to disintegrate due to structural changes in the material that occur over time below 180°C,³⁵⁰ therefore its use in pure form is limited. Due to its silver colour and lack of tarnish, tin has been alloyed with both copper and lead to form useful alloys.

³⁴⁵ Brephol, *Theory and Practice of Goldsmithing*, p.15.

³⁴⁶ *Ibid.*, p.8.

³⁴⁷ *Ibid.*

³⁴⁸ *Ibid.*, p.11.

³⁴⁹ *Ibid.*, pp.9, 11

³⁵⁰ *Ibid.*, p.11.

2.31, Copper-alloy

Copper-alloy grilles were used as metallic inlays on studs, such as the red and blue glass examples on the Derrynaflan strainer-ladle, CAT.3.1. (fig. 13) Copper-alloy does not appear to have been associated with transparent glasses, but this may simply be as a result of surviving examples rather than a reflection of use. Similar to *champlevé* enamelling, it is associated with opaque blue and red glass. Bronze is formed by alloying copper and tin to produce a metal with both the strength and the ability to form a highly reflective surface.³⁵¹ Copper-alloy is the only metal which was employed as a primary structural material within studs, as found on the small *champlevé* discs on the reverse of the 'Tara' brooch, CATS. 4.7. (fig. 24)

2.32, Lead-tin alloy

On the Lough Kinale bookshrine stud, CAT.17.5, grilles of lead-tin alloy were embedded into the surface of the amber circular studs. (fig.64) Lead is a bluish white metal which is extremely dense and quickly forms a dull grey coating in air. It is very soft and can be cut with a knife. Lead is often alloyed with tin to form bright silver solders used with copper. It has limited use with precious metals as it can cause brittleness and render them un-useable.³⁵² Particular care has to be taken with lead within a workshop, as even minute amounts which come in contact with gold or silver can cause irreparable damage to artefacts. When heated to soldering temperatures, lead, even in amounts undetectable to the naked eye, will dissolve the region to which it has come in contact. To avoid this, any work involving lead is typically carried out in a different location to work which involves precious metals.

Lead tin alloy was formed by mixing molten lead with tin to produce a metal-alloy with a relatively low working temperature and the appearance of silver. Lead was also added to copper-tin alloys to produce a 'gun metal' type alloy with improved casting qualities.³⁵³ Lead isotopes analysed within two enamelled brooches matched lead ore data for Ireland, suggesting that local sources were employed during the early medieval period.³⁵⁴

2.33, Mercury

Mercury was employed in fire-gilding used, for example, on the stem of the Ardagh chalice. (fig. 14) It is silvery white and expands proportionately in response to

³⁵¹ Ibid.

³⁵² Ibid.

³⁵³ Edwards, *Archaeology*, p.90.

³⁵⁴ Stapleton, et al., 'Composition and Origin,' 915.

temperature increases. Mercury must be stored in sealed vessels as it is fluid and gives off toxic fumes at room temperature. Mercury forms amalgams with both silver and gold.

2.34, Sources for metals in Ireland

Copper mining is known from Ross Island in Co. Kerry as well as a number of other places.³⁵⁵ While hoards of Roman silver such as that from Balline, are known from earlier in the millennia, by the ninth century the primary source of raw silver is attributed to Viking trade.³⁵⁶ Viking silver hoards, including a hoard of silver ingots weighing 31 kilograms from Carrick, Co. Westmeath and further example from Dysert dated to the ninth and tenth-centuries demonstrate the large amount of silver in circulation in Viking Age Ireland.³⁵⁷

Cornwall is rich in tin, copper and gold and Michelle Comber points to these sites as potential sources, however she suggests that indigenous sources played the greater role in supply.³⁵⁸ Similar to amber, the re-use of Bronze Age gold dress fasteners, lunulae and gorgets may have supplied some of the material used in later periods.³⁵⁹ Roman gemstones and jewellery now in the British Museum were left as votive offerings at Newgrange.³⁶⁰ As noted, Ó Cróinín recounts that the prehistoric tumuli of the Boyne vallery were ransacked by Amláib, Ivarr and a third Norse king Ausle.³⁶¹ This may be evidence that the sites contained material of interest to ninth-century pillagers. The Shanmullagh hoard certainly demonstrates the breaking down and reserving of more contemporary scrap materials in hoards for later reuse.³⁶² Murray suggests the

³⁵⁵ W O'Brien, *Ross Island: Mining, Metal and Society in Early Ireland*, Bronze Age Studies (Galway, 2004).

³⁵⁶ J. D. Bateson, 'Roman Material from Ireland: A Reconsideration,' *Proceedings of the Royal Irish Academy* 73C(1973). 21-97; Eamonn P. Kelly and Maeve Sikora *The Treasury, Celtic & Early Christian Ireland* (Dublin, 2011) p.45.; Ryan, *Studies in Medieval Irish Metalwork*, p.5.

³⁵⁷ John Sheehan, 'Early Viking Age Silver Hoards from Ireland and their Scandinavian Elements', in H. B. Clarke, M. Ní Mhaonaigh and R. Ó Floinn (eds), *Ireland and Scandinavia in the Early Viking Age* (Dublin, 1998), pp.166–202; Kelly and Sikora *The Treasury*, p.45.

³⁵⁸ Comber, 'Lagore Crannog and Non-Ferrous Metalworking,' *Journal of Irish Archaeology* 8 (1997): 105-6.

³⁵⁹ *Ibid.*, 105.

³⁶⁰ Twenty-five Roman coins and two disc brooches were found outside the entrance or at the base of standing stones. The deposition of artefacts in groups or singly suggests the ongoing sanctity of the site over some time. R. A. G. Carson and C. O'Kelly, 'A Catalogue of the Roman Coins from Newgrange Co. Meath and Notes on the Coin Related Finds ' *Proceedings of the Royal Irish Academy* 77c(1976).

³⁶¹ Ó Cróinín, *Early Medieval Ireland*, p.251.

³⁶² Cormac Bourke, 'Fine Metalwork from the River Blackwater,' *Archaeology Ireland* 12, no. 3 (1998): 30.

importation of mercury and glass through Dublin in the eleventh century.³⁶³ Thus we can surmise that metals were likely sourced from primary raw materials mined in Ireland, recycled older secondary material which had gone out of fashion or was beyond use, supplemented with imports.

2.35, Cold pigments associated with stud ornamentation

On the escutcheons of the Ardagh chalice, green paste described as malachite was laid into the recesses presumably as a backing for the amber.³⁶⁴ (figs. 65, 53) Highly poisonous arsenic trisulphide, better known as orpiment, was employed to draw a stepped pattern onto the transparent light green studs on an enamelled hinged mount.³⁶⁵ A fragment was found at Dunadd, a site which also revealed significant evidence of metalworking.³⁶⁶ On the enamelled hinge mount, a backing of gypsum further reflected light back through transparent studs, thus enhancing the colour. (fig. 52) The use of pigments played a crucial role in enhancing the appearance of the stud and transparent materials. This was particularly evident during an examination of the green studs on the Derrynaflan ring where the light backing enhanced the colour of the studs. (fig.50) Mineral pigments were often ground up and mixed with a medium such as egg white prior to painting. In the case of backing material it is possible that gypsum was applied in a wet state and hardened *in situ* before a stud was set above it. In the case of malachite or copper-oxide it may have been mixed with beeswax, a traditional backing for amber. (appendix 2)

2.36, Sources for pigments

Gypsum is a highly water soluble material with local sources in Ireland.³⁶⁷ Orpiment was imported from the Mediterranean region. Small malachite deposits are found at Tynagh, Co. Galway. However, it is possible to make a comparable copper-green patina which is generally associated with exposed copper roofing. This can be deliberately formed using heat and acids in a short amount of time, scrapped off and

³⁶³ Murray, *Cross of Cong*, p.120.

³⁶⁴ Organ, 'Examination of the Ardagh Chalice,' p.266.

³⁶⁵ Fig. 53, unfortunately this feature is extremely difficult to photograph. See CAT. 5, Orpiment was employed within manuscripts. See figure 34.

³⁶⁶ Helen Muller, *Jet*, ed. Peter G. Read, Butterworths Gem Books (London, 1987), pp.25-6. Fragment of orpiment from Dunadd, Argyll, Scotland, National Museum of Scotland, Museum no. 1997:289; Campbell and Lane, 'Celtic & German Interaction in Dalriada,' p.62; Lane and Campbell, 'Dunadd: An Early Dalriadic Capital.'

³⁶⁷ John O'Reardon, 'Minerals and Gems of Ireland; Varieties: Literary and Scientific.'

stored for future use. These could have been scrapped off the surface of the metal and mixed with a ground such as bees-wax or egg-white.³⁶⁸

2.37, Other semi-precious gemstones

A small number of examples of the use of other semi-precious gemstones as mounts on Insular metalwork have survived. Perhaps the most impressive is the rock crystal mounted into the base of the Ardagh chalice. (fig.34) Rock-crystal develops as a single crystal with hexagonal prismatic form it is a hard material measuring 7 on the mohs scale and occurs in almost all rock types and countries, making it a common material.³⁶⁹ It ranges from white to milky and 'water clear' and breaks with a conchoidal fracture.

Coloured quartzes are found in Ireland, such as smoky quartz in the Mourne Mountains, beryl and pink feldspar and amethyst in the West of Ireland around Kerry and Achill.³⁷⁰ Rock crystal is associated with the Killarney lakes and can be gathered on the shores of Co. Kerry around Dingle and Ballyheige beach perhaps giving rise to the name 'Irish Diamonds' or 'Kerry Diamonds' in the nineteenth century.³⁷¹ Given the availability of rock crystal and coloured quartzes in Ireland, it is surprising that so few examples show up in the archaeological record prior to the fourteenth century refurbishment of shrines.³⁷² Instead, it has been noted that this material was probably imported for use in Irish metalwork.³⁷³ Rock crystal on Anglo-Saxon metalwork from the early medieval period, such as the Alfred Jewel and spherical crystal balls within suspension loops, have been shown to be Roman spolia or imports, thus implying that the Anglo-Saxons also were not carving rock-crystal despite the local availability of raw materials.³⁷⁴ The high conical shape of the Ardagh crystal suggests that it was formed by a Romano-British craftsman, while the transparency and convex form point to a manufacturing date between the first and second century.³⁷⁵ It may have been traded to Ireland through Anglo-Saxon or ecclesiastical connections.

³⁶⁸ Robert Fuchs and Doris Oltrogge, 'Colour material and Painting Technique in the Book of Kells' in *The Book of Kells: Proceedings of a Conference at Trinity College Dublin 6-9 September 1992*, ed. Felicity O'Mahony (Ashgate, 1994), pp.133-171.

³⁶⁹ Michael O' Donoghue, *Quartz*, ed. Peter G. Read, 10 vols., vol. 4, Butterworth Gem Books (London, 1987), p.ix.

³⁷⁰ Pers. comm. Stephen Callaghan.

³⁷¹ O'Reardon, 'Minerals and Gems of Ireland,' 365 *ibid*.

³⁷² *Ibid.*, 364-5.; The Shrine of the Book of Moling contains a quartz crystal five inches in length. Crawford, 'A Descriptive List of Irish Shrines and Reliquaries'. II, 152.

³⁷³ Ryan, *Metal Craftsmanship*, p.13.

³⁷⁴ Kornbluth, 'The Alfred Jewel' 32-7.

³⁷⁵ Catherine Johns, *The Jewellery of Roman Britain, Celtic and Classical Traditions* (London, 1996), pp.77-8.

Small pieces of mica survive mounted behind openwork grilles on the Moylough belt-shrine and Ardagh chalice. Mica is also a common material in Ireland. It is a silicate mineral forms in hexagonal plaques within granite. It is extremely friable and breaks easily into highly reflective transparent flakes which are heat resistant. It can be sourced within granite deposits but can be found released from bed rock within streams and rivers.

Although found only in very small quantities, circular garnets were used for the eyes of beasts on the Abbadia San Salvatore shrine, Kilmainham brooch and a small number of other objects. Garnet is a silica and commonly occur as crystals with twelve or twenty-four sides it fractures into flat panels which can be highly polished. Although garnet was likely sourced from outside Ireland, local deposits do exist almandine garnets are found in the Ox mountains in Co. Sligo and in Co. Donegal.³⁷⁶ As noted previously, it was employed by the Anglo-Saxons on high status metalwork, it is likely that this was the source of the garnet spolia found on Irish metalwork.

2.39, The symbolic significance of glass

In chapter One, it was noted that brooches of gold, silver and copper-alloy with studs were associated with the status of the wearer in a highly stratified society. Copper-alloy, tin, lead, silver and gold, were employed in the production of high status Insular artefacts.³⁷⁷ Similar to studs, the use of blue, green, turquoise and colourless glass with white or opaque yellow ornament appear in contemporary bead making.³⁷⁸ Beads may have been strung into necklaces, stitched to clothing or worn in the hair. (fig.60) In some cases ornate glass beads were attached to bronze and iron pins perhaps as apotropaic devices.³⁷⁹ (figs. 42, 60) From the seventh century, glass bangles including blue and white cabled variety were made in Ireland, perhaps used as pendants or hair rings.³⁸⁰

³⁷⁶ C.V. Mac Dermott, C. B. Long, and S. J. Harney, 'Geology of Sligo-Leitrim: A Geological Description of Sligo, Leitrim and Adjoining Parts of Cavan, Fermanagh, Mayo and Roscommon to Accompany the Bedrock Geology 1:100,000 ' in *Scale Map Series, Sheet 7, Sligo-Leitrim* (Dublin,1996), p.26.

³⁷⁷ Thomas Kerr et al., 'The Archaeology of Industrial Activity on Secular Sites in Early Medieval Ireland, Ad 400-1100 ' in *The Early Medieval Archaeology Project (EMAP 2) Report 6.1* (Irish National Strategic Archaeological Research (INSTAR) programme 2012, 2012), p.42.

³⁷⁸ Mags Mannion, 'An Examination of Glass Beads from Early Medieval Ireland,' in *Making Histories, Proceedings of the Sixth International Conference on Insular Art* ed. Jane Hawkes (York: Shaun Tyas, 2013), p.125, table 1.

³⁷⁹ E. C. H. R. Armstrong, 'Irish Bronze Pins of the Christian Period ' *Archaeologia* 72(1921-2): 75.

³⁸⁰ Judith Carroll, 'Glass Bangles as a Regional Development in Early Ireland,' in *Pattern and Purpose in Insular Art*, ed. Mark Redknapp, et al. (Oxford2001), pp.102-3, 9.

According to Bede, 'glass ... is the pellucid fount of Baptism which is consecrated with the Holy Ghost.'³⁸¹ In this description Bede implies that glass was a symbolically significant material, and therefore appropriate for Eucharistic vessels, liturgical equipment and symbols of status. Although no glass chalices have survived, hagiographical sources refer to the gift of a glass chalice by St Finbar and the visit of St Brendan to an island on which the chalices were made of crystal.³⁸² The blue wash used to depict drinking vessels (or chalices?) in the Book of Kells, for example on folio 32v (fig. 2) and 202v in the hand of Christ, (fig. 37) also suggest that this was considered a high status, or sacred material.

In the saga the *Tochmarc Becfhola*, the protagonist, Flann, is described as having a *cennbar du ór agus argut agus glaine ima ceann* – a helmet of gold, silver and crystal (*glaine*) on his head.³⁸³ As noted by Niamh Whitfield '*glaine*' can also be translated as 'clearness', so she suggests that it might also refer to a clear stud, or transparent glass. Bede also associates rock crystal with the grace of baptism 'which is formed of water, congealed into a precious stone'.³⁸⁴ It suggests that while the difference between glass and crystal are recognised, there is less distinction in value between the two materials and certain degree of interchangeability taking place between glass and crystal.

Another type of gem that is referenced quite extensively in Early and Middle Irish texts is the *carmocol*. For example, in the *Togail Bruidne Da Derga* (the Destruction of Da Derga's Hostel), Étain is said to be washing from a 'silver vessel with four gold birds on it, and on its rim bright tiny gems [*carmocol*] of purple'.³⁸⁵ In the *Fled Bricrend* (The Feast of Briciu), King Conchubar's couch is set with gems of *carmocol* – a description reminiscent of the jewel encrusted throne depicted on folio 7v of the Book of Kells.³⁸⁶ (fig. 68)

Examining the etymology of the term, in conjunction with the types of gem most commonly in use in early medieval Ireland, Niamh Whitfield has suggested that the term

³⁸¹ Bede, *The Explanation of the Apocalypse by Venerable Bede*, trans. Edward Marshall (Oxford and London 1878), BK.III CH. XV, p.106 § 2.

³⁸² *Bethada Náem nÉrenn: Lives of the Irish Saints*, ed. C. Plummer, 2 vols (Oxford, 1922), i, pp.27, 58; ii, 15, 56.

³⁸³ Máire Bhreathnach, 'A New Edition of *Tochmarc Becfhola*,' *Ériu* 35(1984), 82, 85.

³⁸⁴ Niamh Whitfield, 'Dress and Accessories in the Early Irish Tale 'the Wooing of Becfhola',' in *Medieval Clothing and Textiles*, ed. Robin Netherton and Gale R. Owen-Crocker (Woodbridge: Boydell Press, 2006), pp.28-9. Bede, *The Explanation of the Apocalypse by Venerable Bede*, BK.I CH. IV, p.31 § 6.

³⁸⁵ 'The Destruction of Da Derga's Hostel', in *Early Irish Myths and Sagas*, trans and ed. Jeffrey Gantz, (Harmondsworth 1981), p.62.

³⁸⁶ *Fled Bricrend* trans and ed. George Henderson (London, 1899), pp.2-5.

carmocol may refer to cut glass gemstones.³⁸⁷ If this was the case then the occurrence of the term most frequently as means of adding ‘lavish opulence’ to a scene, further suggests that these were seen as objects of wealth and beauty, and not necessarily as a second-rate substitute for precious or semi-precious gemstones. Irish ‘gems’ or studs also appear to have enjoyed some reputation outside Ireland, as the account in the *Nuzhat-al-Mushtaq*, compiled c. 1154 by an Arab geographer in the court of Roger of Sicily, singles out for mention trade in ‘coloured stones and amber’ in three un-named Irish towns, another indication that these were far from low-status objects.³⁸⁸

2.39, The symbolic significance of amber

Amber has been viewed by many societies since prehistoric times as an exotic material with potent magical and apotropaic qualities, often employed in conjunction with, or substituted for gold.³⁸⁹ Amber both floats in water and can be burned, releasing a pleasant smell. It is also electrostatic, drawing small, light objects towards itself. These qualities cannot have gone unrecognised. The transformative properties and colour from yellow (fig. 64) through orange to brown and red (fig. 63) must also have been noted over time, and, as noted above, there is also the potential to colour the material purple or reddish hues through heat or dye, so that it may have been also harnessed to create a or ‘blood’-like material.³⁹⁰ It may even have been used to create transparent purple in imitation of amethyst, or red ‘like clear blood’, similar to sardonyx, one of the four red stones of the Apocalypse noted in the Old English Lapidary.³⁹¹ The potential longstanding use of amber in Ireland, (fig.62) and the employment of coloured glasses in three brooches which emulate different shades of amber, suggest that it was a significant symbolic material worthy of high-status use.³⁹² (figs. 54-5) Whitfield links the reference to ‘*da gem do lic lóghmar*’ translated as ‘two gems of precious stone’ to

³⁸⁷ Niamh Whitfield, ‘Carmocol – an Imitation Garnet?’ in *A Grand Gallimaufry*, eds Mary Davies, Una McConville and Gabriel Cooney (Bray, 2010), pp.55–60.

³⁸⁸ David James, ‘Two Medieval Arabic Accounts of Ireland’, *Journal of the Royal Society of Antiquaries of Ireland* 108 (1978), 5.

³⁸⁹ Cahill, ‘The Gold Beads from Tumna Co. Roscommon,’ pp.103,105.

³⁹⁰ *Rubia perigrina* is an evergreen perennial, the roots contain alizarin a red dye pigment used in Anglo-Saxon textiles. It is native to the British Isles and can be employed in a cold dye bath suited to amber. Jenny Jenny Dean, *A Heritage of Colour, Natural Dyes Past and Present* (Tunbridge Wells: Search Press, 2014), pp.116, 118.

³⁹¹ Peter Kitson, ‘Lapidary Traditions in Anglo-Saxon England: Part II, Bede’s Explanatio Apocalypsis and Related Works,’ *Anglo-Saxon England* 12(1983), pp.32-3.

³⁹² See CAT, 10.1, 11.1 and 4.2.

stones made in nature rather than glass and perhaps references to amber studs.³⁹³ In Ezekiel 8:2 the vision of God is described as '*dath omra*' or 'the colour of amber'.³⁹⁴

2.39, Colour symbolism in early Christian Ireland

Together with material, colour was an important indicator of social rank in Early Christian Ireland. The law tracts, for example, determined the colours to be worn by children of different ranks. Children from royal families were assigned purple and blue, those from noble families were to wear red, green and brown, while yellow, bay-coloured, black and white were the colours associated with free-born children.³⁹⁵ Naturally too, colour symbolism was not restricted to the secular world. For example, a late eighth-century tract, which survives in two separate Irish sources, on how to paint the apostles 'in the Roman fashion' notes that the twelve wore white albs and tunics of varied colours — honey-coloured or blue or purple.³⁹⁶ It is notable that there are many visual similarities between honey and amber.

Heather Pulliam has drawn attention to the significant effort evident in the mixing of colours in manuscript illumination, and has argued that it is unlikely that the choice of colour selected, in particular in association with holy figures, was left to chance.³⁹⁷ Contrary to J.J. G. Alexander, who used colour analysis in Anglo-Saxon manuscripts to suggest mere copying of other traditions,³⁹⁸ in her analysis of the Lindisfarne Gospels, Pulliam highlights how the depictions of the Evangelists apparently demonstrate knowledge of Bede's work, *Explanation of the Apocalypse*, in which he explains the symbolic properties of the twelve stones of the walls of the Holy City (Revelation 21:19).³⁹⁹ Thus, the tunic colours of the Evangelists mimic the colours of the first four stones; Matthew in jasper, Mark in sapphire, Luke in chalcedony and John in emerald.

Bede's work, probably composed between 703 and 709, was an innovative departure from previous commentaries on the Apocalypse which seldom went into such detail on the symbolism of the individual stones of the Heavenly City.⁴⁰⁰ It was

³⁹³ Whitfield, 'Dress and Accessories,' p. 8.

³⁹⁴ <http://www.dil.ie/search?q=dath+omra>. Accessed 01.02.16.

³⁹⁵ Niamh Ní Chonaill, 'Fosterage: Child-Rearing in Medieval Ireland,' *History Ireland* 5, no. 1: 29.;

³⁹⁶ Caecilia Davis-Weyer, *Early Medieval Art, 300-1150* (New Jersey, 1971), pp.78-79.

³⁹⁷ Heather Pulliam, 'Eyes of Light: Colour in the Lindisfarne Gospels' in *Newcastle and Northumberland*, ed. J. Ashbee and J. M. Luxford, *BAA Conference Transactions XXXVI* (Leeds, 2013), pp.54-72.

³⁹⁸ J.J. G. Alexander, 'Some Aesthetic principles in the Use of Colour in Anglo-Saxon Art', *Anglo-Saxon England*, 4 (1975), pp.145-154.

³⁹⁹ Pulliam, 'Eyes of Light,' pp.56-60.

⁴⁰⁰ Peter Kitson, 'Lapidary Traditions in Anglo-Saxon England:Part II, Bede's *Explanatio Apocalypsis* and Related Works.' pp.74-76.

apparently disseminated widely from soon after its making, with a dozen manuscript copies of it surviving from the late eighth and ninth centuries.⁴⁰¹ It is of note that the timing of its production seems to coincide with a more developed use of colour in both Insular fine metalwork and manuscript illumination

Although it is not possible to state with absolute certainty how an insular audience may have perceived or understood the colours of gemstones that they had never seen, it is nonetheless informative to look at what Bede had to say about the stones whose colours or opacities most closely relate to the materials used by Insular fine metalworkers outlined above.

Regarding the baptismal association of glass cited above, Bede also writes that 'because it [glass] pertains to the nature of fire, in that it is made red by martyrdom'.⁴⁰² Thus linking red with martyrdom and sacrifice. Sard is linked with the blood of Christ and the sixth day of the week, the crucifixion and thus linked to Christ's human aspect and sacrifice.⁴⁰³ The association between Christ and the colour red is also depicted within the Book of Kells, where the three dot motif used to ornament robes is yellow or white on other figures, (fig.68) but is consistently red on the robes of Christ.⁴⁰⁴ (figs. 2 and 38) Pulliam has seen this as a reference to Revelation 19:13 where Christ is described as 'clothed with a garment sprinkled with blood'.⁴⁰⁵ It is of note that elsewhere Bede glossed the word *purpura* (purple) in Exodus, where it is used to describe the veils of the Tabernacle. He says that *purpura* is the colour of blood, adding that 'real purple is died with the blood of shell fish'.⁴⁰⁶ Of the amethyst he says it is a reminder of the 'heavenly kingdom in the mind of the humble'.⁴⁰⁷ As noted Pliny recounts that amber can be dyed purple similar to the stone amethyst.

The colour blue is found in Bede's *sapphirus*, and linked to the heavens. In his discussion of sapphires, Bede makes reference to Exodus 24:10 and Ezekiel 10:1–4, in which the glory of God is described as having the likeness of a sapphire, saying that 'the

⁴⁰¹ Ibid., p.74, n. 6.

⁴⁰² Bede, *The Explanation*, BK.III, CH. XV, p.2 §2.

⁴⁰³ Ibid., BK.III CH. XXI, p.154.;Kitson, 'Lapidary Traditions,' p.88.

⁴⁰⁴ Michael J. O' Kelly and Claire O'Kelly, *Early Ireland: An Introduction to Irish Prehistory* (Cambridge, 1989), pp.263-64.

⁴⁰⁵ Heather Pulliam, 'Looking to Byzantium: Light, Color and Cloth in Insular Art' in *Insular and Anglo-Saxon Thought in the Early Medieval Period*, ed. Colum Hourihane (University Park, Pennsylvania, 2011), pp.65.

⁴⁰⁶ George Henderson, 'The Colour Purple: A Late Antique Phenomenon and its Anglo-Saxon Reflexes' in *Vision and Image in Early Christian England* (Cambridge, 1999), p.126.

⁴⁰⁷ Bede, *The Explanation of the Apocalypse*, BK III CH.XXI, pp.161-2.

glory of the Lord consists of this colour, which bears the image of the super celestial'.⁴⁰⁸ Bede links the azure blue 'jacinth' found in Ethiopia with the sky and a 'cloudy' version of this stone with souls given up to heavenly contemplation.⁴⁰⁹

The emerald was associated with the radiance of the enthroned Christ due to the description in Revelation 4:3, 'And there was a rainbow [*iris*] surrounding the throne, in aspect similar to an emerald'. Green stones such as 'smargus' or emerald, green quartzes or glass in Byzantine cloisonné inlay were associated the leaves of the vine.

Bede associates the colour white with 'the Church which is made whiter than snow by grace',⁴¹⁰ and 'the joy of souls itself may be represented by white robes'.⁴¹¹ White is also associated with truth and purity,⁴¹² and associated with 'Christ the precious stone' which like jasper from the whiteness of virtues and crystal from the inner purity of the mind and faith.⁴¹³

2.41, Discussion

In common with Pulliam's comments regarding the choices of colours made by manuscript illuminators, it is clear from the examination of the range of different colours and varying opacities in Insular metalwork, that Irish fine metalworkers deliberately manipulated glass and colourants to form particular colour densities and opacities. Certain colours were used in an opaque form, while others, such as green and turquoise, were employed in their transparent form, as for example on the Ardagh chalice and Derrynaflan ring. (figs. 53 and 50) This interest in saturation and intensity of hue finds parallels in the contemporary language used to describe colour, both in Anglo-Saxon and Old Irish Literature, reinforcing the idea that Insular craftsmen deliberately sought greater depth and character in the colours that they produced.⁴¹⁴

Perhaps similar to a painter choosing particular colours, Irish stud makers appear to have been creating and colouring glass in specific ways to achieve certain

⁴⁰⁸ Exodus 24:10: 'And they saw the God of Israel. And under his feet was something like a work of sapphire stone, or like the sky, when it is serene'; Ezekiel 10:1: 'And I saw, and behold, in the firmament that was over the heads of the cherubim, there appeared above them something like the sapphire stone, with the sight of the likeness of a throne'.

⁴⁰⁹ Bede, 'Apocalypse', BK.III CH. XXI., p.159.

⁴¹⁰ Ibid., BK.I CH. VI, p.38 §2.

⁴¹¹ Ibid, BK.I CH. VI., p.41 §11.

⁴¹² Ibid. BK.III CH.XIX, p.130 §11.; See also BK.III CH.XIX, p.131 §13.

⁴¹³ Ibid, BK.III CH. XIX, p.145 §11.

⁴¹⁴ N. Barley, 'Old English Colour Classification: Where do matters stand?', *Anglo-Saxon England*, 3 (1974), 15-28; H.A. Lazar-Meyn 'Colour terms in Táin Bó Cúailnge' in *Ulaide, Proceedings of the First International Conference on the Ulster Cycle of Tales*, eds J.P. Mallory and G. Stockman (Belfast and Emain Macha, 1994), pp.201-05.

colours. This extended to altering colours by layering transparent materials over complimentary materials. It is possible that amber workers within the goldsmith's atelier were heat-clarifying or dyeing amber using contemporary textile technology and fabric dyeing expertise to suit their specific requirements. If this occurred, it was not the only adaption from the fabric industry. Trichinopoly found on the Ardagh chalice and Derrynaflan paten demonstrate panels of woven copper and silver wire set as ornament. The complexity of the weaves and patterns point to a dialogue taking place between the experts in both fields. (figs. 16, 24 and 27) Additionally it demonstrates the connection between the makers of Irish metalwork and each step in the process of manufacturing a stud and artefact in general.

This cross-application is also evident in the visual similarities and actual cross-over in materials between the scriptorium and the goldsmith's atelier; where materials such as gypsum, orpiment and malachite were adapted to enhance studs.⁴¹⁵ Aside from the sharing of materials between the goldsmith's atelier and the scriptorium, textile artists and the illuminators also shared material knowledge including oak gall inks and woad as colourants for manuscripts. (fig. 33)

The use of orpiment in place of yellow enamel or golden yellow glasses for amber suggests substitution of similar materials for one another was acceptable. This can be seen to follow the employment of gilding and tinning in place of gold and silver and orpiment for yellow enamel. In general it suggests that the Insular metalworker aimed for an illustrative use of materials. Similarly this aligns with connections between the comparable meanings and significance accorded to glass and crystal in the writings of Bede both of which are linked to the sacrament of baptism,⁴¹⁶ and to the term '*glaine*' which is interpreted as meaning both 'crystal' and also 'clearness' and thus linked with Bede's assertion that glass is '...in which nothing else appears on the outside than that which it has within'.⁴¹⁷

Given the potential for glass, and indeed amber, to take on any colour, the fact that only a small range of colours was used by Insular craftsmen to make studs is significant. The majority of these colours have analogues in manuscript illumination and sartorial display and could be linked to Bede's commentary on the stones of the Holy City. This, in tandem with their contemporary and historical use, points to materials with significant cultural meaning and significance in Insular Ireland. It suggests a deliberate

⁴¹⁵ See CAT. 5, fig. 52 and CAT. 15.1, fig. 65.

⁴¹⁶ Bede, *Apocalypse*, BK.III CH. XV, p.106 § 2.

⁴¹⁷ Ibid.

and specific attempt to manipulate glass and amber to achieve these outcomes. Where Continental craftsmen imported exotic stones from the east, Irish craftsmen employed familiar and available materials and drew upon the approaches within other indigenous disciplines to enhance them. The significant preliminary steps which occurred prior to stud making point to the subjugation of the materials to the design rather than the materials determining the outcome. The approach in which they were manipulated to achieve these colours suggests a contrasting innovative approach in the goldsmith's atelier. While we do not have evidence of dying amber purple or red, this may be as a result of find patterns or the general fragility of the material. There is, however, evidence of modifying the colour of amber by using a green back malachite background on the Ardagh chalice. Scientific examination of amber should prove useful in that it can be employed to determine whether the colour was manipulated by dying with pigments or perhaps heating.

The use of three shades of yellow, orange and golden brown glass respectively, on the Killamery brooch, Ervey brooch and 'Tara' brooch to create studs demonstrate glass colours which display the various light yellow to orange tones found in amber. (figs. 54-5) This suggests attempts to recreate the effect of amber with glass and may point to the scarcity of the material or the working limits of the material and thus the substitution of glass to overcome these issues. The purple glass of the 'Tara' studs approximates amethyst, while tin was used to imitate silver grilles on the Lough Kinale bookshrine studs.⁴¹⁸ (figs. 7, 64)

Blue glass was employed extensively in Insular stud making and bead making. Blue pigment extracted from the *Isatis tinctoria* plant species, commonly known as woad, was employed to dye fabric and as a pigment throughout the Book of Kells and other Insular manuscripts.⁴¹⁹ (fig.2) It was found in pots at Deerpark Farms, Co. Antrim.⁴²⁰ Similar to the ranges of dark blue and light blue create in glass. Some examples of blue within the Book of Kells demonstrate that gypsum was mixed with the indigo dye, presumably to create a lighter perhaps opaque form of the material.⁴²¹ Comparable to the use of sealing wax red glass, opaque red lead was employed in

⁴¹⁸ Bimson and Werner, 'Scientific Examination of Ancient Glass,' p.206.

⁴¹⁹ Fuchs, Robert and Doris Oltrogge, 'Colour material and Painting Technique in the Book of Kells' in *The Book of Kells: Proceedings of a Conference at Trinity College Dublin 6-9 September 1992*, ed. Felicity O'Mahony (Ashgate, 1994), pp.139, 170-71.

⁴²⁰ C. J. Lynn, 'Deer Park Farms; a Visit to an Early Christian Settlement,' *Current Archaeology* 113 (1989), 197.

⁴²¹ Susan Bioletti et al., 'The Examination of the Book of Kells Using Micro-Raman Spectroscopy,' *Journal of Raman Spectroscopy* 40(2009), 1044.

manuscripts. Madder root is associated with red dye and traces of cultivated madder were identified in a pot at Teeshan *Crannóg*.⁴²²

Opaque yellow glass and orpiment are quite visually similar, as demonstrated by examples of orpiment employed to mimic the effects of enamelled yellow glass in two studs. Susan Bioletti et al have identified translucent brown yellow colours in the Book of Kells, comparable to the employment of lighter transparent yellow, darker orange and brown colours of glass, although the material from which the pigment was made has yet to be securely identified.⁴²³ Green glass can be compared to green/turquoise pigment vergaut a mixture of orpiment and woad,⁴²⁴ and to the copper-acetate that was used to create the verdigris green on the Book of Durrow. Pure gypsum, utilised for its white colour has been identified in the Book of Kells, Book of Armagh and Garland of Howth, and was also employed on the reverse of transparent studs.⁴²⁵ It also shares much in common white glass in terms of colour and opacity.

Black glass as been identified in two studs in this study for the first time. (fig. 71) The dark brown black studs on the Derrynaflan ring are comparable to the carbon black and oak gall inks used extensively in Insular calligraphy.⁴²⁶ While carbon black is easily made locally from burnt charcoal, oak gall is also a dye associated with dark brown or black fabric.⁴²⁷ Purple glass on the small heads of the 'Tara' brooch have counterparts in the purple manuscript pigment orcein sourced from indigenous lichen *Rocella tinctoria*.⁴²⁸ In coastal areas a reddish-purple colour was derived from a shell fish known as dog whelk to dye fabric.⁴²⁹

It is significant that the materials employed to make studs are not unique to this oeuvre, but drawn from other disciplines and utilised in other ornamental contexts and hold colour or material symbolism within Insular culture. Glass was also extensively utilised in *champlevé* and bead making, amber from bead making and pigments from illumination and potentially colourants from fabric dying. In addition, glass and amber in particular, are significant in that they permit the maker significant control over the

⁴²² Seán P. Ó Ríordáin, *Antiquities of the Irish Countryside* (London, 1979), p.30.

⁴²³ Susan Bioletti et al., 'Examination of the Book of Kells,' 1045.

⁴²⁴ Ibid., 1044.

⁴²⁵ Fuchs and Oltrogge, 'Colour, Material and Painting Technique,' p.171.

⁴²⁶ Susan Bioletti et al., 'Examination of the Book of Kells,' 1046-7.

⁴²⁷ Jenny Dean, *A Heritage of Colour, Natural Dyes Past and Present* (Tunbridge Wells, 2014), p.107.

⁴²⁸ Susan Bioletti et al., 'Examination of the Book of Kells,' 1047.

⁴²⁹ Edwards, *Archaeology*, p.82.

colour and form of the outcome and are technically versatile allowing a significant degree of experimentation.

Eight sites in Ireland and western Scotland have revealed specific evidence of glass stud making, in the form of clay moulds, both unfinished and finished studs. (appendix 4) Both amber and glass studs have been identified within a metalworking context on three high status metalworking sites in Ireland, including Ballinderry *Crannóg* Co. Offaly, Lagore *Crannóg* and Knowth, Co. Meath. Furthermore, a fourth metal workshop uncovered at 46-8 Scotch St. Armagh uncovered samples of both unworked raw glass and amber, suggesting the potential availability of the material to make studs and the requisite metalworking skills within the Armagh workshop also.⁴³⁰ Appendix 4 and 5)

In terms of determining the sources of amber, scientific evaluation using infra-red spectrometry of extant examples and potential sources of amber identified by Briggs will be required to determine the types of amber surviving on Insular metalwork and potential geological origin of the material. However as noted, determining the source is fraught with difficulty as amber could have been transported to Ireland by many means both by man and nature and recycled overtime. However until such a study is carried out we cannot assume that all amber is only of Baltic origin or only brought here by the Vikings. As we have seen Ó Cronín associates the trading phase of Viking activity with the 840s but there are examples of amber found on metalwork dated to earlier periods.

As we have seen the Baltic variety is available along the east coast of Britain. Lindisfarne monastery on the North Sea coast was linked to Iona, Kells and Derry among other sites in Ireland as part of the Columban *paruchia* or network of monasteries, this ecclesiastical network could have provided the material. Anglo-Saxon middlemen also possessed the resources to collect local samples and to trade them to Ireland through trade links. Similarly trade through the Anglo-Saxon middlemen potentially may have brought Baltic amber harvested and traded by the Vikings to Ireland. It is also possible that amber was recovered from pre-historical sources or mixed with non-Baltic fossilised resins which have their geological origin in Ireland. Briggs has shown that local deposits were harnessed in the nineteenth century along the west coast of Ireland, therefore it is possible that these were accessed to some degree in the Early Christian Period. Given

⁴³⁰ For Amber studs at Lagore *Crannóg* see Hencken, 'Lagore *Crannóg*,' 151, figs. 74, 776. For Ballinderry *Crannóg* see Hencken, 'Ballinderry *Crannóg*, No.2' figs. 21, 75. For glass see page 58; for glass and amber at Knowth, Co. Meath, see Murray, 'Stud of Amber and Glass', pp.544-50. C. Lynn, Excavations at Scotch St, 69-84 and also Susan Youngs, 'Fragments of Amber', p.208, no. 216. For glass and amber at 46-8 Scotch St. Armagh.

these facts we cannot conclude beyond doubt that all amber employed in Early Christian Ireland was solely of Scandinavian origin.

Chapter Three: Techniques employed to make Insular glass and amber studs

3.1, Introduction

Having examined the materials and colours favoured by Insular craftsmen in the formation of polychrome studs, this chapter will outline and discuss some of the key techniques employed to make glass and amber studs on Insular metalwork. Despite the loss of studs, evident for example from the empty collets on the twelfth-century Lismore crozier and lost central mounts on the eighth- to ninth-century large silver paten and bronze basin from the Derrynaflan hoard, a tremendous amount of information remains. This can be employed to give an insight into the techniques, design thinking and manner in which materials were utilised in the production of studs. Much experimentation and cross-application of skills and materials knowledge is evident in complex glass and amber inlay and stud making. This reflects the vitality of fine metalworking during the Insular period and into the later twelfth century.

In chapter two, the three materials which formed the basic structure for man-made Insular studs were outlined. These were copper-alloy, glass and amber.

Four different types of cast glass studs have been identified; those cast plain or with patterns in relief or indented, (fig. 67) those with enamel applied to a recessed pattern, (fig.16) those with elements cast into their surface, such as metallic grilles or millefiori plaques, (fig. 13) and miniature *champlevé* discs. (fig.24) Some sources suggest that glass was cut and polished, in the manner of gemstones, and set onto artefacts⁴³¹ other sources point to either plain, coloured or *millefiori* plaques cut and set as a stone sometimes in combination with enamel.⁴³²

While glass studs are generally described according to technique, such as studs with 'enamelled glass studs', 'studs with silver grilles', and 'studs with relief or recessed channels', or '*champlevé*' there is evidence to suggest that these basic stud techniques were further developed by more skilled artificers. In some cases, due to the combination of more than one technique or approach to form a single complex stud, it is difficult to neatly assign it to a particular technical category. Studs of apparently similar type were often achieved by different means, further confusing technical categorisation. This chapter is not an attempt to categorise stud outcomes into typological groups but to

⁴³¹ Craddock, 'Metal-Working Techniques,' p.173.

⁴³² Ibid.; O'Floinn, '*Millefiori* Plaque,' p.202, no. 199.; idem, 'Two Glass Rods,' p.203, no. 01 a and b.

determine the various technical approaches and processes undertaken. For example, studs described as 'blue and red studs' Henry, found on the 'Tara' brooch, Moylough Beltshrine and Ardagh chalice were made using at least three different processes.⁴³³ (Figs. 7, 29, 35) If Similarly the circular amber studs with gold filigree centre found on the 'Tara' brooch, Ardagh chalice escutcheon mount and Hunterston brooch form a further distinct category of stud. (fig. 69) However, this form of categorisation will require a future dedicated study where the focus will be on examining in detail the form, materials, colours and motif employed and the pattern which emerges from this examined in the context of Bede's lapidary to determine symbolic meaning or. This chapter explicitly aims to simply present and examine the range and variation of techniques employed to make glass and amber studs.

In many of these cases basic techniques have been misidentified with authors mistaking enamelled studs *champlevé*,⁴³⁴ or *champlevé* for those with grilles,⁴³⁵ with the technical processes misunderstood, or features misidentified.⁴³⁶ Often this is the result of a lack of understanding of working limits of the material, resulting in the misidentification of techniques.⁴³⁷ This chapter will attempt to rectify inconsistencies and misidentifications where possible. It will show that glass and amber studs were conceived and constructed using a range of skills drawn from indigenous metalworking techniques and knowledge associated with artefact formation and other disciplines, rather than produced using the reductive methods such as cutting and polishing more typical to Anglo-Saxon and Continental metalworking traditions.

As with the materials employed to form studs, it is possible to divide the techniques employed to make studs into two stages; the primary technique employed to shape the structure and geometrical form of the stud and the secondary techniques employed to add ornamentation to the stud. In most cases the secondary ornament was positioned on the surface of the stud, but where transparent materials were employed the reverse was also often enhanced in some manner, through the use of backing materials such as malachite and gypsum and ornamented foils. On some of the finer

⁴³³ Henry, *Irish Art*, p.96.

⁴³⁴ Griffin Murray identifies the discs on the reverse of the Cross of Cong as *champlevé* when in fact they are enamelled studs. Murray, *Cross of Cong*, p.138.; Youngs, 'Enamelling in Early Medieval Ireland,' 51.

⁴³⁵ Françoise Henry identifies blue and red studs on the 'Tara' Brooch as having grilles in them, when in fact both are not constructed using this method, but are in fact *champlevé*. Henry, *Irish Art in the Romanesque Period*, p.78.

⁴³⁶ In places where the grille has lifted and the resulting shallow imprint made visible, this has led some authors to believe that cast channels were inlaid with matching grilles.

⁴³⁷ Griffin Murray suggests that the channels in the enamelled glass were created by chasing, prior to enamelling. Due to the brittle nature of glass this approach is highly unlikely.

artefacts ornament was also applied directly to the side of the stud to form a pseudo setting, (CAT.16.1) (fig. 69) or the settings were enhanced in various ways to promote the central stud, as on the stud surrounds and projected settings on the ornamental border of the Derrynaflan paten. (figs. 47, 48, 67, 70, 71)

Hundreds of extant Insular studs were identified as part of this study, and space precludes a study of all. Rather, this chapter will present the variations of basic techniques identified, through a comparison of examples on key artefacts that carry a representative cross section of the techniques employed. This approach will give the reader a sense of some of the different approaches to handling amber and glass by different goldsmiths and an insight into the creativity and experimentation within the Insular arts in general.

The chapter will first give a brief synopsis of the key fine metalworking techniques known to Insular craftsmen, in order to provide an overview of key characteristics such as mass production (for example through casting and stamping), fixing techniques etc. This overview is significant in the context of the following section, which examines in greater detail the methods used to make copper-alloy and glass studs, and in the final section, which examines the manipulation and shaping of amber studs.

3.2, Design phase in Insular metalworking

It is evident from the carefully controlled symmetrical proportions of Insular metalwork, that free hand modelling of visible structural elements was not common, pointing to a careful system of measuring and proportion during the design phase. For example, Whitfield has shown that the geometry underlying Anglo-Saxon disc brooches, namely a circle within a square divided by a cross; each arm of the cross is equal in length to the diameter of the circle and sides of the square; was also applied to create the form of the 'Tara' and Hunterston brooches.⁴³⁸ (figs. 7-9) It is evident that a compass was integral to the design of the Derrynaflan paten and the under-foot mount of the Ardagh chalice, and as highlighted in chapter one, this use of structured forms created by underlying measurement and geometry has also been identified within manuscripts and stone.⁴³⁹ (fig.33) Designs may have been initially worked out in sketches on wax

⁴³⁸ Whitfield, 'The 'Tara' Brooch: An Irish Emblem of Status,' pp.233-37.; idem, 'Design and Units of Measure on the Hunterston Brooch,' in *Northumbria's Golden Age*, ed. Jane Hawkes and S. Mills (Stroud: 1999), pp.296-314.

⁴³⁹ For compass lines and rules on the reverse of Lindisfarne folios see Rupert Bruce-Mitford, 'Decoration and Miniatures' in *Evangelium Quattuor Codex Lindisfarnensis*, ed. T. D. Kendrick, et al. (Olten and Lausanne: 1960), pp.250-8.; D. Kelly, 'A Sense of Proportion: The Metrical and

tablets or stone as evidenced by brooch designs on a stone from Dunadd Fort Argyll.⁴⁴⁰ Examination of stud forms demonstrated that similar principles underlay the creation of the wide variety of forms that survive today, although, as yet, trial pieces that relate directly to stud design have yet to be discovered.

3.3, Casting copper alloy mounts and pseudo chip carved ornament

One of the most significant techniques to contribute to stud formation was metal casting, carried out using a clay mould. It is clear from the remarkable fineness of cast detail of Insular metalwork that casting technology was particularly well developed. (fig.24) It is likely that several approaches including lost wax, two piece, open clay and stone moulds were utilised based upon the form and complexity of the end result and also perhaps the skill of the metalworker in question. It must be noted, that the approach was modified to suit different requirements. For example, lost wax or lead dies dipped in successive layers of fine grained liquid clay were employed to produce three-dimensional items such as the stem of the Ardagh chalice. (fig. 14) Two piece moulds were used to produce other less complex brooches with ornament restricted to the obverse and reverse, or flat mounts with underlying tangs protruding from the obverse. Open clay moulds were employed for artefacts with ornament on one side and stone moulds for simpler forms such as axe heads or ingots.⁴⁴¹ (fig. 72) For the purposes of this section a generic approach to casting a mount will be outlined to illustrate the basic skill.

Prior to creating the mould it was necessary to create a die or model of the intended artefact. Beeswax, lead and copper-alloy have been proposed as possible materials.⁴⁴² It is clear from the markings on the gilded copper-alloy frames which make up the ornamental border of the Derrynaflan paten, that the primary dies were formed from a soft material such as wax with the pattern carved and inscribed out of the soft material. (fig.73) This soft copy was then cast in lead or copper-alloy to form a more

Design Characteristics of Some Columban High Crosses. , *Journal of the Royal Society of Antiquaries Ireland* 126(1996), 108-46.

⁴⁴⁰ R. Michael Spearman and Ragnall Ó Floinn, 'Motif Piece with Brooch,' in *The Work of Angels*, ed. Susan Youngs (London: 1989), p.177, no. 55.

⁴⁴¹ Ewan Campbell, 'Brooch Mould,' in *The Work of Angels* ed. Susan Youngs (London: 1989), p.191, no. 81.; Ragnall Ó Floinn, 'Ingot and Mould Fragment,' in *The Work of Angels*, ed. Susan Youngs (London: 1989), p.174, no. 50. The nature of the casting process results in the fragmentation of complex moulds. Coatsworth and Pinder, *The Art of the Anglo-Saxon Goldsmith*, p.37.

⁴⁴² Copper-alloy die 28mm by 20mm, found at Louth, Lincolnshire, potentially Northumbrian dated to the 7th or 8th century. Susan Youngs, 'Die,' in *The Work of Angels*, ed. British Museum (London: 1989), p.192, no.84.; Potential circular lead die or motif piece, 50mm in diameter, with *La Tène* motif, found at Birsay, Orkney. Susan Youngs, 'Decorated Disc,' in *The Work of Angels*, ed. The British Museum (London, 1989), p.192 no.83.

durable master-copy suitable for making multiple finished cast artefacts. The level of pristine detail found on the reverse of the 'Tara' brooch and key marks on clay moulds, suggest re-useable dies of copper-alloy or lead were created for repeated use, as does the ability to produce such fine and outstanding detail. On the 'Tara' brooch, for example, this was used to great effect in the creation of minute entwined quadrupeds and birds. (fig.24)

Cast ornament found in Insular metalwork is created in false relief, as on the obverse of the 'Tara' brooch and high relief as on the escutcheon mounts of the Ardagh chalice. (figs. 24, 50) This included carefully positioning stud settings, recesses and channels at various levels to allow for the addition of applied ornament on what are ultimately two-dimensional structures. (figs. 49, 65) Generally when casting, it is best practice if the die is brought as close as possible to the final finish. This saves time and effort on the final copies, which are generally formed from a harder less responsive material. It is clear from surviving clay moulds that a significant amount of detail could be captured by the clay, leaving minimal requirement for reworking on the final casts.

Once the die was ready for copying, two balls of soft clay were imprinted at the centre with the model. (fig. 72) A funnel shape connected to an appropriate point on the artefact was also applied to the clay, to allow the application of molten metal to the mould. Key marks were then applied to the clay to facilitate the connection with the other side. The pieces were slowly air dried. The keys which allowed the opening and reclosing of the moulds suggest that quality dies, presumably of copper alloy or lead, were created for casting and employed as part of a multiple production. Once the mould was fitted together again, molten copper-alloy or silver were poured into the opening in the clay mould. Once the metal had cooled the cast was released from the mould and examined to ensure the metal had run into all areas resulting in a pristine relief pattern.

Typically, two levels of relief were created in Insular casting. High relief was used to create the form of an artefact or mount with a flat backing for attachment to a wooden core or metal backing. The hemispherical copper-alloy mounts attached to the Lough Kinale bookshrine and Tullylough cross demonstrate this type of high relief. (figs. 38, 39) The second type in evidence is false-relief, where the pattern is formed by removing the background material and creating the effect of low-relief ornament. The height of the ornament never extends beyond the original level of the material from which it was cast. This type of ornament is found throughout the back of the 'Tara' brooch. (fig. 24) This approach could also be adapted to cast complex openwork panels.

(figs. 73, 74) Robert Organ noted, during his examination of the Ardagh chalice, that both handles were cast from the same die, pointing to the suitability of this technique to form multiple accurate copies of complex forms.⁴⁴³ (fig.17)

3.4, Insular *champlevé* enamelling

The sophistication of metal casting allowed the metalworker to create a, typically patterned, copper alloy matrix into which brightly coloured opaque enamels could be fused. (figs. 18-20, 35) The vast majority of extant enamelled fields are flat or slightly convex. Insular *champlevé* enamelling utilises casting to form copper-alloy into the background structure with recessed cells. Opaque glass was specifically reserved for *champlevé* to disguise the rough background of the cells that was required to act as a key to secure the glass. Commonly opaque red, yellow and blue glass were fused into these recesses with the top of the cell wall forming a bronze outline separating the different glasses and forming a pattern. (figs. 19.20)

As noted in chapter two, blue glass fuses readily and securely with silver, gold and copper-alloy at high temperatures. Whereas opaque red glass had to be chipped into the shape of the intended cell, placed in the preheated cell and heated carefully to 210 °C. Once it began to soften it was pressed into place. Opaque red glass forms a much less secure connection with metals, and primarily relies upon the softened glass forming around keys in the copper-alloy backing before cooling takes place. The poor working characteristic of the glass, in conjunction with the tendency of the material to degrade in acidic conditions, has resulted in the much loss. However, as outlined in more detail below, the solutions developed to connect red glass to *champlevé* cells benefited other materials.

Plaques of blue and white *millefiori* glass were routinely arranged into a pattern and set into recesses within copper-alloy cells. (figs. 19, 35) Less reported, but important additions include strips of silver wire set on edge which were formed into curvilinear motifs such as peltae and wave forms.⁴⁴⁴ The Sutton Hoo hanging bowl mounts also incorporate unusual dark blue glass peltae pointing to the creativity and experimentation taking place within this oeuvre.⁴⁴⁵ These additions were fused in place

⁴⁴³ Organ, 'Examination of the Ardagh Chalice,' p.242.

⁴⁴⁴ Susan Youngs, 'Recent Finds of Insular Enamelled Buckles,' in *The Insular Tradition*, ed. Catherine Karkov, Robert T. Farrell, and Michael Ryan (New York: State University of New York Press, 1997), p.193, pl.10.2.

⁴⁴⁵ Youngs, 'Enamelling in Early Medieval Ireland,' 48.

with opaque red glass and broadened the effects and materials possible with *champlevé* enamelling.

3.5, Millefiori

From the seventh century *millefiori* was made in Irish workshops, by bundling together coloured rods of white and blue glass and occasionally liverish red.⁴⁴⁶ (fig. 58) These were arranged to form a pattern on their cross section. This bundle was fused and drawn out reducing the diameter of the rod and resulted in a smaller more detailed motif. Often several rods would be recombined and fused to make a more detailed pattern.⁴⁴⁷ *Millefiori* was cut into platelets and fused into place using opaque red glass as a mastic. (figs. 19, 35, 59)

3.6, Embossed silver foils

Embossed silver foils were made by stamping a thin foil of silver with a die of the intended form.⁴⁴⁸ This technique is also known as *pressblech*. It is described by Theophilus, who advises the use of lead to force the foil into the die.⁴⁴⁹ Whether embossing foil, paper or other materials, negative dies result in the ability to create more detailed and sharper ornament and a better finish overall compared to the result achieved from embossing with positive forms. Some high relief detail on the silver foils originally located on the base of the Derrynaflan paten suggests that negative dies perhaps in copper-alloy were employed. Comparable to casting, embossing results in multiple high quality patterned foils imprinted from a singular die. On the sides of the Derrynaflan paten and large sheets of embossed gilt-silver foil were displayed within recessed spaces, and in the context of stud manufacture, embossed foils were sometimes placed at the base of translucent forms. (figs.13, 26, 35)

3.7, Gold filigree

Insular filigree was created using various types of beaded, textured or twisted wire, set on edge, together with granulation set on gold foils. The fine foils were made by hammering out gold sheet. In some cases a base was pierced and embossed into a raised form to elevate the motif. Beaded wire was made using a tool with the appropriately sized grooves in negative form, which allowed the relatively quick preparation of lengths of gold wire into evenly spaced and formed beaded wire. This

⁴⁴⁶ Carroll, 'Millefiori,' p.55.

⁴⁴⁷ Ibid., p.49.

⁴⁴⁸ Coatsworth and Pinder, *The Art of the Anglo-Saxon Goldsmith*, pp.109-10.

⁴⁴⁹ Theophilus. *On Divers Arts.*, pp.153-56.

was sometimes set on gold strips to elevate sections while twisted gold wires were placed side by side to create the effect of plaited wires.⁴⁵⁰ Fusing and soldering were employed to connect the elements together. Gold filigree panels were fixed into recessed cells using mechanical methods such as burring over the edges of the surrounding recesses, jeweller's stitches, scoring a small hooks of gold out of the surrounding wall to hold the panel in place and rarely by riveting.⁴⁵¹ Minute panels of filigree were used to decorate the surfaces and sides of studs on high status objects such as the 'Tara' brooch and Derrynaflan paten. (figs.7, 31)

3.8, Niello

Similar to *champlevé* casting, recesses for ornament were cast into copper-alloy mounts, or grooves were cut into silver pins. *Niello* is a dense black paste mixed from copper and silver sulphide material which was inlaid into the prepared recesses, heated to approximately 680°C and fused in place.⁴⁵² It was introduced to the west by the Romans and employed extensively by the Anglo-Saxons.⁴⁵³ In the twelfth-century manifestation of this technique, *niello* was employed on the Cross of Cong and Clonmacnoise crozier alongside inlays of copper and silver wire. (fig. 28)

3.9, Corinthian bronze

This form of ornament is found on the back of the 'Tara' brooch. Here, a bronze backing foil was stamped or embossed with a *La Tène* pattern in relief. The sharp outline of the pattern suggests that this imprinting was carried out using a die or embossing tool with a negative imprint of the required pattern rather than a positive form. The recessed background was flooded with hard silver solder to the level of the relief bronze pattern. This was gently ground down to a level surface and polished.⁴⁵⁴ (fig.24)

3.10, Mica inlays

To overcome the fragility of mica without losing the reflective qualities of the material, cast openwork panels were created to hold panels of the material in place. On the upper flange of the Ardagh chalice mica was secured into precast recesses with a mastic, possibly beeswax, and overlaid with two-dimensional openwork panels of gilt copper-alloy. These panels were formed by casting, potentially in open moulds given

⁴⁵⁰ Niamh Whitfield, 'Filigree,' in *Medieval C.400-1600 Art and Architecture of Ireland* ed. Rachel Moss (Dublin New Haven London: 2014), pp.111-2.

⁴⁵¹ Paul Craddock, 'Metal-Working Techniques,' p.173.

⁴⁵² Coatsworth and Pinder, *The Art of the Anglo-Saxon Goldsmith*, pp.116-7.

⁴⁵³ Paul Craddock, 'Metalworking Techniques,' p.173.

⁴⁵⁴ Niamh Whitfield, 'Corinthian Bronze,' 25-27.

their size and form, and gilt to enhance their appearance prior to setting. The openings within the panels allowed the mica light reflect back at the viewer.⁴⁵⁵ (fig. 74)

3.11, Tinning and gilding

Tinning was employed to cover copper-alloy and create the impression of silver; true 'silvering' or silver plating was not employed. Tinning was achieved by wiping a heated stick of tin over the heated copper-alloy surface or immersing the copper-alloy object in molten tin. Craddock notes that some pieces were carefully heated which created the circumstances where the overlying tinning could fuse into the copper-alloy beneath. This created a high tin bronze 'inter-metallic compound at the surface' which has a silvery appearance and takes a high polish.⁴⁵⁶ Mercury gilding was used to cover fields of copper-alloy on the stem of the Ardagh chalice or silver on the 'Tara' brooch to imitate the effects of gold. Gold was mixed with mercury to form 'butter of gold'. Both the *Mappae Clavicula* and Theophilus describe using fine gold foil ground into mercury.⁴⁵⁷ The solution was applied to a fully finished and cleaned metal surface. Craddock notes that heat in the region of 350°C was required to drive off the mercury and bond the gold into the underlying silver or copper-alloy.⁴⁵⁸ (figs. 14, 24)

3.12, Connecting elements within Insular metalwork

One of the most interesting aspects of Insular metalwork is the methods used to connected various elements and ornament together. Soldering and fusing are used to form permanent, but rigid, joins in an artefact. These are classified as 'hot connections' as they use heat in their creation. Connections which do not use heat, but mechanical joins are termed 'cold-connections'. These include folding, wedging, riveting and they are generally reversible, less rigid and ultimately stronger than hot connections. On the reverse of the 'Tara' brooch the panel of Corinthian bronze is perforated at a central location in the design. An ornamental gold pin made from a granule of gold surrounded by beaded wire are employed to secure it within the recessed setting. (fig. 24) In the empty filigree setting on the obverse of the hoop it is possible to see the flat open head of the hidden end of the pin. (fig. 7) The Derrynaflan paten demonstrates a similar use of

⁴⁵⁵ Edwin Dunraven, 'On an Ancient Chalice and Brooches, Lately Found at Ardagh in the County of Limerick,' *Transactions of the Royal Irish Academy* 24(1874), 438.

⁴⁵⁶ Craddock, 'Metalworking Techniques,' p.173; see also N. Meeks, 'Tin-Rich Surfaces on Bronze,' *Archaeometry* 28, no. 2 (1986), 133-62; Coatsworth and Pinder, *Art of the Anglo-Saxon Goldsmith*, pp.129-30.

⁴⁵⁷ C.S. Smith and J.G. Hawthorne, '*Mappae Clavicula*', 36, 60; Theophilus. *On Divers Arts.*, pp.110-4.

⁴⁵⁸ Craddock, 'Metalworking Techniques,' p.173; see also W. A. Oddy, 'Gilding and Tinning in Anglo-Saxon England,' in *Aspects of Early Metallurgy* ed. W.A. Oddy (London, 1980), pp.129-30.

rivets capped with studs which extend within the paten from the upper surface to the base, their heads originally covered by silver foils. A similar approach was adopted on the Moylough belt shrine, where stud-capped rivets secured the *champlevé* mount on the obverse and wedges jammed into an opening on the base of the rivet secured the other reverse. Both approaches forming a secure pressure-fitted join.

The base of the Ardagh chalice demonstrates one of the most elaborate surviving examples of ornament in Insular metalwork and will be referred to later in terms of the construction of studs. It is a disc with extensive false-relief ornament organised into concentric zones including three annular recessed channels. It was cast from copper-alloy and gilt before inlays of malachite, amber and filigree were applied to the smaller annular channels; the largest was set with a ring of gold filigree. Five collets were cast to hold blue glass studs. The centre of the disc is plain and contains a perforation. This mount was set into a circular recess within the silver sub-conical base of the Ardagh chalice. A bolt hidden under a domed cap within the bowl, ran through the stem and the perforation in the base mount connecting all elements together. Similar to the ornamental covers used to disguise or enhance rivets employed elsewhere, in this case an elaborate collar-mount and conical rock-crystal were connected to the terminus of the bolt holding the artefact together.⁴⁵⁹ (figs. 34, 75)

3.13, Basic copper-alloy and glass forming techniques applied to stud-making

The geometry and measurement underlying metalwork and artefacts in other media which utilised ruler and compasses, were also employed to create the dies for studs. All studs, without exception, are geometrical in form, pointing to the careful consideration given to forming them. All examples demonstrate perfect symmetry created from carefully worked-out geometrical lines. Shapes include circular cabochons and discs created using a compass, squares often set in diamond formation, lentoid, trapezoidal and rectangular forms, one example of a true lozenge and two heads. This approach must also have been applied to form the composition of decorative motifs applied to the surface of studs, which can be broken into four main types. For the first time it is noted that stud motif can be broken down into four basic stud compositions. Type (a) motifs based on a concentric plan formed using a compass, CAT.1.20 (fig. 67) and CAT.16.1 (fig.69). Type (b) a radial plan made up of a circle divided into three, four, six or eight equal segments, CAT. 1.5 (fig.56) and CAT.1.4 (fig.70). Type (c) is a combination of concentric and radial, CAT.9.20 (fig.76). Type (d) is generally associated

⁴⁵⁹ Organ, 'Examination of the Ardagh Chalice,' pp.248-50.

with square or rectangular studs where a grid is used to determine the layout of the ornament, CAT.2.2, (fig. 50).

3.14, Creating copper-alloy based *champlevé* studs and inlays

It is clear to see that in the case of the *champlevé* studs on the reverse of the 'Tara' brooch that the maker employed the same process and materials used to make larger *champlevé* mounts, (fig. 19) albeit here on a much smaller scale, in line with his superior skill.⁴⁶⁰ (figs. 77) Given the scale of the 'Tara' brooch discs, it follows that the maker employed a master die 9mm in diameter, made of copper-alloy with key marks within the recesses to connect in particular to the red glass inlays. Due to the higher melting point and durability of the dark blue glass these *cloisons*, were filled first and fused in place. In the central triangle a small circular recess was created by pushing a sharp, pointed implement into the viscous glass during cooling, thus creating a circular recess. During the application of red glass to the remaining *cloisons* the remaining recesses were filled with opaque red glass which had been shaped to approximate the intended recesses. These red glass elements were then carefully heated and pushed into place within the recesses to ensure they connected with the key marks therein. (Appendix 4)

A second, much simpler form of *champlevé*-based technique is indicated on the eighth-century Monymusk reliquary. In this case, simple copper-alloy circular and square cells were filled with viscous red enamel in imitation of a setting filled with a simple monochrome glass stud. (fig. 13) It is possible to see that the bases of the Monymusk 'settings' are wider than the setting aperture, thus the glass had to be applied in a viscous state and once cooled the red enamel was mechanically secured within the setting. (figs.78, 79) From these examples we can see that the basic Insular technique of *champlevé* was employed to imitate the effect of a plaque-like or disc-shaped monochrome red glass stud held within a setting.

3.15, Casting in an open clay mould

A glass stud still within a clay mould was excavated at Lagore *Crannóg*, Co. Meath pointing to the casting process used to form glass into studs.⁴⁶¹ In common with the techniques used in metal casting outlined above, the mould was made from equal

⁴⁶⁰ Due to their fine execution and similarity with grille studs, Henry mistakes these for examples of studs with copper-alloy grilles rather than *champlevé*. Henry, *Irish Art in the Early Christian Period*, p.95.

⁴⁶¹ O'Neill Hencken, 'Lagore *Crannóg*,' 130.

volumes of clay and sand.⁴⁶² The sand was employed due to the high quartz content which gives the mould its refractory properties. The design was possibly achieved using a prepared copper-alloy stamp.⁴⁶³ Clay moulds were fired at a temperature circa 1000°C and given a straight upper surface by grinding down the top surface with an abrasive.⁴⁶⁴ Once the mould was created to make a stud, the heated glass was applied and pressed into place. Unfinished studs often display a seam of extra glass around the base which is a result of over filling the mould with glass to ensure full coverage and stamping down to ensure that glass has filled all negative spaces within the mould, CAT.6.1-2 (Fig.51) What is particularly striking about the Lagore stud is the quality of the finish on the surface of the glass when removed from the mould. It is evident that a highly polished surface could be achieved by this technique, requiring very little working post casting to improve the polish on the glass or the quality of the transparency. Aside from the removal of surplus material from the reverse, it is likely that little beyond a surface clean and a 'buff' polish was required for the obverse.⁴⁶⁵ This suggests that glass casting using clay was a highly efficient and appropriate method of processing the glass into studs.

3.16, Creating a simple glass stud

The Lagore stud and mould suggests that simple monochrome glass cabochons were made by imprinting the intended form into a clay mould using a pre-made die of copper-alloy. Molten glass was applied from the reverse and pressed into place. (figs.80) Once cooled and the excess material removed these were set within collets. The simplest of the examples include those found on the medallions (fig. 80) and escutcheons of the Ardagh chalice (figs. 49, 53) and Derrynaflan ring. This approach would result in multiple accurate copies of glass studs and could be applied to any colour of glass. With the Derrynaflan ring both dark brown and blue glass studs were produced, and on the Ardagh chalice blue and turquoise cabochons. (figs. 81,76)

3.17, Other methods proposed to make studs

⁴⁶² Bimson and Werner, 'Scientific Examination of Ancient Glass,' pp.205.

⁴⁶³ The fine detail found on the reverse of the 'Tara' Brooch and the stem of the Ardagh Chalice demonstrates the ability of the Insular maker to form fine detail in bronze, a relatively hard alloy, it follows that this highly suitable material would be employed to form important tools intended for multiple use.

⁴⁶⁴ Ibid.

⁴⁶⁵ Theophilus describes using a soft cloth with soft abrasives such as ground charcoal followed by 'chalk' rubbed with a linen cloth for polishing silver and emery for rock crystal. Theophilus. *On Divers Arts*. pp. 153, 58, 91.

It has been proposed that glass studs were cut and polished into shape using techniques similar to those associated with shaping crystal and other gem stones.⁴⁶⁶ However, the production of copies of small monochrome studs, as for example on the Ardagh chalice handle-escutcheons and medallions, and the technical methods generally favoured in Insular metalwork, suggest otherwise. (figs. 82) During the course of this study no glass studs displaying evidence of cutting or grinding into shape were identified on any object surveyed whether included or not. Similarly, while 'lamp-working' techniques were used to make beads and stud-like coloured glass counters, (figs.42, 60, 83) the irregular characteristics of these are simply unlike those of geometrical studs which occur in identical sets. (fig. 82)

Two points rule out the likelihood of these approaches. Firstly, glass cabochons produced by this method are not perfectly circular, and often retain the irregularities of the original shape of the glass shard from which they were formed. With smaller examples of studs, such as those found on the Ardagh chalice and Derrynaflan ring of 4-5mm, it might have been possible to achieve a near perfectly circular form, but once this approach was applied to larger studs the irregularities would become more apparent. In addition, it is a feature of Insular art that stud settings are fixed in size, specific to a preconceived design. Any irregularly formed 'stud' therefore would not be a suitable match. Secondly, glass studs are often set in multiples; there are four identically sized and shaped small blue studs on the escutcheons of the Ardagh chalice,⁴⁶⁷ (fig. 49) and originally thirty-two on the Derrynaflan ring. (fig. 81) When forming a counter from a shard of glass it is almost impossible to ensure that all examples are formed from the same volume of glass. Discrepancies naturally occur which, among multiples would result in cabochons of different sizes. A Germanic brooch from the Metropolitan Museum in New York demonstrates this point. (fig.10) Although it is clear that glass cabochons of similar size and colour were the intention, the degree of detail and symmetry achieved on a brooch such as the 'Tara' brooch has not been achieved. (fig. 7) As we have seen, irregularity is of no use in a design system which demands a high degree of symmetry and identical stud-clones within a series.

With reductive techniques such as cutting and polishing, it is very easy to over-work a section, ruining the geometry of the form, particularly at this small scale. In terms of shaping a crystal Theophilus suggests 'Rub it with both hands on a hard sandstone moistened with water until it takes on the shape you want to give it; then on

⁴⁶⁶ Ó Floinn, 'Glass Rods,' p.203; idem, 'Millefiori Plaque,' p.202; O'Kelly, 'Ringforts at Garryduff,' 74-75.

⁴⁶⁷ See CAT. 9.18

another stone of the same kind, which is finer and smoother, until it becomes completely smooth'.⁴⁶⁸ Using this approach, it is almost impossible to ensure that all samples are of identical form and size, particularly if several individuals are tasked. Firstly, ensuring that identical volumes are created among a series is difficult. In addition, materials such as glass with internal fractures and weaknesses can result in harder and softer areas which hand working naturally exposes. This can result in fractures and a less-than-even outcome. Similarly, when grinding material into form using reductive techniques, particularly at this scale, it is difficult to produce multiple identical clones without evidence of over or underworking the material. While it could be argued that examples of similar size are grouped together the issues of irregular form and mismatches to the setting still occur. In terms of the simple studs on the Ardagh chalice and Derrynaflan ring it is possible to see that they are regular and symmetrical and could be reset within their scheme without affecting the design. (figs. 76, 81) They do not display the features one would expect to find if hand-working using reductive techniques outlined by Theophilus had been employed⁴⁶⁹.

The utilisation of techniques that facilitate the production of high quality clones are in evidence across Insular metalwork, from the production of eight embossed silver foils on the Derrynaflan ring, (fig. 15) to the creation of two handles and escutcheon mounts by casting on the Ardagh chalice. (fig. 30) The identical *champlevé* mounts on the Emly and Monymusk shrines, (figs.18, 78) evidence this repeat production application to *champlevé* enamelling. The development of casting to such a sophisticated degree in Insular metalwork suggests that this was the common basic skill adapted to make all types of glass stud within the Insular atelier. Unless an example comes to light with evidence that challenges this hypothesis, we must recognise that the treatise of Theophilus, and reductive techniques described in *Mappae Clavicula* did not apply in Ireland to the production of Insular glass studs as they did elsewhere.

3.18, Enhancements applied to simple geometric studs

In the case of studs formed from transparent glass, evidence suggests that several enhancements could be applied. For example, an enamelled mount in the National Museum of Ireland demonstrates that a reflective white gypsum paste backing could be used, while the surface of some semi-circular studs have stepped motif drawn on with orpiment. (Fig.52) The studs on the base of the Ardagh chalice were laid over

⁴⁶⁸ Theophilus. *On Divers Arts.*, p.189.

⁴⁶⁹ Ibid. pp. 153, 58, 91.

embossed silver foils, while amber on the 'Tara' brooch was laid over hatched gold foils. (figs. 27, 69, 84)

3.19, Casting studs with relief or recessed ornament

Just as detail was cast into copper-alloy on artefacts as on the Ardagh chalice, the same principles were applied to open clay moulds and the creation of textured studs. Similar relief designs in glass studs were cast with three types of textured pattern. High relief forms are found in the central lozenge and 'marigolds studs' on the obverse of the 'Tara' brooch. (fig. 85) Low-relief interlace and beading are found on the large blue and gold studs of the Derrynaflan paten, (fig.67) while a blue glass stud with stepped cross motif set as *spolia* within an Anglo-Saxon pin-suite, demonstrates cell walls in blue glass and recessed background.⁴⁷⁰ (fig.86)

The Lagore *Crannóg* stud demonstrates the process employed to form a glass stud with recessed pattern indented into the surface of the stud. (fig.51) Although no examples of stud dies have survived, a similar type lead die potentially for embossing foils does survive from Lincolnshire.⁴⁷¹ Given the outstanding levels of detail achieved in copper-alloy casting, this material was most likely employed to form stud dies with negative patterns. Several other points support this hypothesis. Technically, the high polish evident on the glass of the Lagore *Crannóg* stud demonstrates that the original die must have achieved this finish in order to transfer it to the clay mould and on to the glass stud.⁴⁷² Although the process of create an ornamented stud is similar to that of a plain stud, the addition of a pattern and fine detail likely resulted in greater loss and miscasts, as the glass may not have run into the minute detail, particularly with difficult-to-work materials such as red glass.⁴⁷³ It is perhaps for this reason that the majority of studs with relief or indented patterns are formed from blue and green glass, which can be heated to higher temperatures, thus allowing the glass to achieve a more liquid state, (figs. 47, 50) which would allow it to flow into more complex forms. The reverse of the Lagore *Crannóg* stud demonstrates rows of tool marks, presumably where the stud maker ensured the glass permeated the whole pattern by repeatedly pushing the glass into the mould from the reverse. The effort to ensure that there was enough glass to fill

⁴⁷⁰ Susan Youngs, 'Pin Suite,' pp.53-4.

⁴⁷¹ Youngs, 'Die,' p.192.

⁴⁷² It is possible that an initial die of wax was made, with as much detail applied as permitted by the material. This was cast in copper alloy and finished to a much higher degree to form the 'master' copy, which was used to make other copper-alloy stud dies and perhaps to form other soft wax copied which were modified.

⁴⁷³ Failed glass studs of similar type were found at Garryduff, Co. Cork. O'Kelly, 'Ringforts at Garryduff,' 74-75. I would like to thank glass artist Róisín de Buitléar for discussing the creation of cast glass studs and the associated difficulties with me.

the mould is evidenced in the extra glass over hanging the edge of the stud. Once cooled this excess material was removed by grozing or clipping. From transparent examples, such as the studs on the base of the Ardagh chalice, it is evident that some at least were perfectly cast or had excess material removed to ensure full transparency. (fig. 27)

Although it is likely that in some cases the indented motif functioned as the ornament in its own right, similar to intaglio gemstones, the deep channels and step sides of the Lagore *Crannóg* stud, CAT.6.1, suggest that it may have been intended for enamelling, as pointed out elsewhere.⁴⁷⁴ (fig.51) Other scholars have suggested that these channels may have been intended to accommodate metal grilles, however, as outlined below, it is highly unlikely, for technical reasons, that matching grilles were set into recesses in the glass.⁴⁷⁵

3.20, Creating an enamelled glass stud

Extant examples of enamelled studs suggest that tiny pieces of red or yellow glass and in some cases white glass, were broken into appropriately minute shards, which were then positioned into the pre-cast channels within green, blue, and in one case, black glass. CAT.2.2 (fig. 50) In some of the enamelled studs on the Derrynaflan paten it is possible to see the minute levels of detail and complex patterns made possible in the hands of master stud-makers. (figs. 47, 56) Once the appropriate colours of glass were applied to the relevant channels, the stud was heated to fuse the materials together.⁴⁷⁶ In the case of studs with inlays of both opaque yellow and red glass it is likely that the colours were applied in two stages, firstly the yellow enamel was applied and fired and secondly the red. Due to the fact that red glass tends to darken or discolour when heated, it is likely that the 'red' channels were over filled to protect underlying red glass from the heat.⁴⁷⁷ This discoloured material could be removed by careful polishing with a soft grit revealing brightly coloured glass at the surface level of the yellow glass. A comparison of the enamelled studs on the Derrynaflan paten and ring demonstrates the importance of this finishing step in enamelled studs. In the case of the paten, a pristine, well defined pattern is in evidence throughout all matching studs. While an example from the ring demonstrates less pristine pattern due to the removal of too little material. (figs.50, 56)

⁴⁷⁴ Ó Floinn, 'Stud and Mould,' p.205.

⁴⁷⁵ Ibid.

⁴⁷⁶ Bimson and Werner, 'Scientific Examination of Ancient Glass,' p.204.

⁴⁷⁷ By over filling the channel with red glass when the glass was heated the 'over fill' protected the underlying red glass within the channels from discolouring. When the over filled glass was removed pristine opaque red glass was revealed underneath.

3.21, Enamelled glass studs with silver foil ribbon

Two blue, yellow and red studs on the Derrynaflan paten had minute ribbons of silver foil carefully applied to outline the channels of the central pattern, thus separating the opaque red from the background of blue glass. (fig. 47) To form this type of stud, blue glass was cast with various recessed channels intended to hold the relevant colours. It is likely that the Greek key pattern was filled with yellow enamel and fused in a first firing to avoid overworking the red glass.⁴⁷⁸ The remaining central channels were then lined with silver foil cut into ribbons and set on edge. It is possible to see that the edges were overlapped to join the ribbons into continuous silver lines. This feature suggests that without the blue glass structure, these foils could not stand up-right or maintain their position. Minute fragments of red glass appear to have been pushed into place to pressure-fit the silver ribbon against the adjacent blue glass walls of the channels. It would appear that a second firing took place at this point partially fusing the various surface elements together. However, unlike the seamless yellow glass within the Greek key pattern, and elsewhere on other examples of red glass in enamelled studs, it is possible to see that the red glass is made up of small fragments lined up within the channel. (fig.87) This suggests that the maker was particularly conscious of over-heating the stud and destroying the work. For this reason the opaque red inlay was cautiously heated as little as possible to the degree that we can still make out the individual fragments within the red enamel.⁴⁷⁹

3.22, Opaque red glass enamelled into a yellow background within a copper-alloy support

This technique differs from traditional *champlevé* where the yellow and red glass are employed in adjacent cells divided by copper-alloy walls. In this case a thin layer of red is fused into shallow channels in the yellow. (fig. 88) Enamelled inlays in opaque red and yellow glass are a feature found on the reverse of the Cross of Cong. Described as being *champlevé*, they are in fact different to earlier examples as the colours are not separated by copper-alloy walls but formed within a copper tray just visible in figure 88.⁴⁸⁰ The interpretation as *champlevé* arose as at the lines where the

⁴⁷⁸ CAT.1.14

⁴⁷⁹ Bimson outlines this technique in relation to studs on the Ardagh chalice see Bimson and Werner, 'Scientific Examination of Ancient Glass', pp.206-7

⁴⁸⁰ Both Griffin Murray and Susan Youngs identify the studs on the reverse of the cross as *champlevé* see Murray, *Cross of Cong*, p.138; Youngs, 'Enamelling in Early Medieval Ireland,' 48.; Henry correctly recognises that the glass red applied to yellow, however she also identifies them as enamelling as practiced in the earlier period and discusses them alongside examples referred to as *champlevé*. Therefore, also inferring that these examples are *champlevé*. Françoise Henry, *Irish Art in the Romanesque Period*, p.78.

glasses meet a vitreous material brownish in colour developed. This could easily be mistaken for oxidised copper-alloy. (fig. 88) (appendix 7, diag.1)

In fact, in this enamelled stud type two opaque low melting point glasses are layered within a copper-alloy backing rather than juxtaposed within adjacent cells separated by copper-alloy walls. As yellow glass has a slightly higher melting point, it had to be used as the primary structural material within the design. Secondly, as noted in chapter two, this glass was suitable for this function as it can form a successful bond to the copper-alloy tray. The yellow glass was cast into a disc with the intended pattern in high relief. Once formed it was placed into the circular copper-alloy tray for support during heating. Unlike enamelling into blue or green glass, the melting point of yellow is too close to the heating point of red and thus it could not maintain its form without support. Red glass was then applied to the recessed areas of the design, once cooled a certain amount of cleaning and finishing was required. The fine layer of red on the studs and its tendency to embed into imperfections in the surface of the yellow suggest that unlike enamelling carried out in the earlier period where opaque red glass in fragment form was infused into recesses, that in this form opaque red glass in a powdered state was used. This would have reduced the levels of heat required to melt the glass and helped preserve the underlying intricate form of the yellow glass base. In terms of connecting to the artefact, the use of a copper-alloy setting was secured within the brass settings on the cross. (fig. 88)

3.23, Mosaic glass panels on the Lismore crozier

The two-colour studs on the crook of the Lismore crozier have traditionally been identified as *millefiori* discs,⁴⁸¹ Henry suggested that the *millefiori* was shallow on the studs and simply a veneer backed by blue glass, while the frame of the drop was true *millefiori*.⁴⁸² The evidence from damaged studs suggests that Henry was correct, these studs have a polychrome veneer 0.52mm-1.1mm in thickness, with a backing of blue glass. The studs were potentially manufactured in a number of ways

- 1 Slices from a *millefiori* rod (composed of white lentoids arranged into an X formation surrounded by blue glass) were set at the base of a mould with matching cobalt blue glass applied from the reverse. On CAT.13.2 (fig.89) it is evident that much distortion has taken place and that the white lentoids are quite wispy and irregular, perhaps suggesting that the rod from which it was made had been drawn down to the point that the detail was fading and

⁴⁸¹ Bourke, 'Lismore Crozier,' pp.315.

⁴⁸² Henry, *Irish Art in the Romanesque Period*, p.78.

diminishing. In contrast, the detail on CAT. 13.3 (fig.90) is regular and well-spaced despite the pronounced curve in the glass. This suggests that *millefiori* platelets approximately 1.2m thick were carefully arranged at the base and around the edges of the mould. The continuation of the pattern under the collet suggests that the *millefiori* may have extended to the edge of the mould at least. The mould and glass was heated to begin fusing the elements together. Matching blue glass was applied to the reverse. (appendix 7, diag.2)

- 2 On stud CAT.13.4 (fig.91) the pattern suggests that the approach described above was applied to similar blue and white *millefiori* on a flat or slightly curved surface of perhaps a rectangular mould. The distortion of the red within the pattern suggests that holes or recesses were drilled or heat pressed into the glass at the points the red glass occur, these were filled with opaque red glass and fused using heat. Essentially, a combination of mosaic glass and enamelled glass. This also represents one of the few examples where a reductive technique was utilised in Insular stud making. (appendix 7, diag.3)
- 3 A similar fused plaque was prepared to form stud CAT.13.5 on the crook, (fig. 92) Irregularities suggest that square and sub-square white plaques were arranged into a chequered pattern panel and fused with blue glass. The absence of white glass ornament at the edges suggests that an irregular shard was broken off and placed at the bottom of a mould with blue glass applied from the reverse. (appendix 7, diag.4)
- 4 A second pattern demonstrates the same painstaking approach of arranging alternating lines of white and red squared to make a chequered patterned glass panel, which was not quite as wide as the stud mould to which it was applied. The remaining areas along the sides are filled with blue glass. This is found on CAT.13.6. (fig. 93)

3.24, Casting a monochrome soda-lime-silica glass stud with metallic grille

This description pertains to studs formed from common soda-lime-silica glass and silver, gold or copper-alloy grilles only. In the simplest versions a silver or gold foil was marked in some way with the intended pattern of the grille. The cut marks evident under magnification suggest that a sharp scalpel-like implement was used to cut the grilles on the studs on the Derrynaflan paten ornamental border. Once pierced this

openwork foil was annealed and centred at the base of a clay mould. Viscous semi-molten glass was applied from the reverse. (appendix 7, diag.5) The glass flowed over the foil and bonded with the metal; in examples where the foil has lifted slightly it is possible to see an imprint of the foil. (fig.94) Once cooled, successful studs were cleaned and finished using the steps outlined for previous stud castings. As essentially all glasses except opaque red glass bond well with metal, thin foils could be employed allowing efficient use of expensive materials such as silver and gold.

The formation of this type of stud has caused some confusion, with some commentators suggesting that the studs with an indented motif in the surface of the glass were set with matching grilles.⁴⁸³ This is highly unlikely, as creating fixed grilles to match the indents on precast studs would add unnecessary steps and complication to the process, particularly as molten glass can fuse to any type of metallic ornament placed at the bottom of a clay mould. In addition, by producing indents of a particular depth, the maker is confined to only using grilles of that thickness. If the foil is too thin it will buckle within the channels; if it is not cut exactly to match the indented pattern, gaps will be obvious; if it is too thick and protrudes from the stud a significant amount of reductive work is required to complete the stud. All of these issues are avoided and multiple well-made copies formed if the process outlined above is followed.

3.25, Casting a monochrome opaque red stud with metallic grille

Few monochrome opaque red glass studs with grilles have survived. Those that do contain thick grilles of copper-alloy or silver, as for example, the studs on the Derrynaflan strainer-ladle, CAT.3.1,(fig. 13) Unlike the metallic grilles set within the aforementioned studs, the red glass variety stand out for the thickness of the grilles employed. The thickness of the grille increased the surface area of the metallic component and provided extra 'grip' for the opaque red glass. CAT.3.1 (fig. 95) On a damaged section of a stud on the Derrynaflan strainer-ladle it is possible to see the grille extends down one millimetre into the stud.⁴⁸⁴ This thickness and the use of *millefiori* result in this stud closely resembling the effects of *champlevé* plaques found on the reverse of the 'Tara' brooch, CAT.4.7 and the Coolure Demense plaque CAT.14.1. (figs.77, 19)

⁴⁸³ Ó Floinn, 'Stud and Mould,' p.205; Ó Floinn, ' Lismore Crozier,' pp.170-71.

⁴⁸⁴ As noted earlier Françoise Henry misidentified a *champlevé* stud as this very type due to the similarities in the outcomes and similar materials. Henry, *Irish Art in the Early Christian Period*, p.95.

3.26, Casting a polychrome glass stud with metallic grille

Polychrome glass studs with silver and copper-alloy grilles are a noted feature of Insular metalwork appearing extensively on the Derrynaflan paten. They are typically blue and red, CAT.2.8,(fig. 81) but opaque yellow was also employed on the side of the paten on CAT.1.33. Mavis Bimson of the British Museum scientifically examined the studs on the Ardagh chalice and was involved in the recreation of a polychrome glass with silver grille example, CAT.9.19.⁴⁸⁵ (fig. 65) She reported the following facts during this process:

A fragment of high quality silver foil was formed into a dome using the die which formed the stud mould. The openwork pattern was created using a chisel to cut the pattern. A similarly sized copper-alloy foil vessel was created to protect and support the silver grille during subsequent working. Thin fragments of opaque red glass were made by covering a piece of glass in a cloth before striking it with a mallet. An appropriately sized and shaped piece was chosen for further working. It was held with a tweezers and formed into the shape of the opening in the silver grille using a finger nail. This process was repeated until the correct number of red fragments was achieved. The silver foil was positioned within the copper support and the prepared fragment of the red glass placed into the appropriate silver foil cell. A dilute adhesive was employed to secure the flake to the grille while heating took place with a miniature blowpipe.

Bimson notes that the burning adhesive facilitated a reducing atmosphere within the copper foil, thus somewhat preventing the oxidation of the red glass. This part of the sequence was particularly difficult and much care was needed not to over-heat the silver foil. Once the red glass began to soften the heat was removed and the glass pressed into place against the grille with a copper rod. Once all cells were filled with opaque red glass the silver grille was placed at the bottom the clay mould standing on a hot plate. A fragment of blue glass in excess of the volume required was heated on the end of a copper-alloy spatula. This was heated until molten and dropped into the clay mould, at this point the glass was pressed down hard with a piece of cold metal. After cooling slowly on the hot plate the stud was removed from the mould and the base ground down to the required thickness. Bimson notes that in the recreation, the upper surface was finished with rottenstone. The central medallion studs on the Ardagh chalice are among the finest examples of this type of stud due to the complexity of the pattern and minute fragments of red glass set into the silver grille.⁴⁸⁶ (CAT. 15.1) (fig. 65)

⁴⁸⁵ Bimson and Werner, 'Scientific Examination of Ancient Glass,' pp.205-06

⁴⁸⁶ Ibid.

3.27, Variations within monochrome and polychrome glass studs with metallic ornament

Aside from using silver grille foils to make a metallic motif on glass studs, a second approach was to use a thicker gauge silver ribbon on edge. Unlike the use of silver foil, which allows the creation of sharp angles or the creation of lattice like interlace, this approach is limited to simpler curved shapes such as peltae. These were formed by curling the ends of a strip of silver around a cylindrical rod or tweezer ends. On an example found on the Moylough beltshrine, CAT.7.1, three peltae were set back to back at the bottom of a clay mould and blue glass was applied from the reverse. (fig.35) Opaque red glass was also fused to the circular terminals of the peltae and the central triangular form in order to make blue, red and silver forms of this stud type. Examples are found on the Moylough beltshrine, CAT.7.1 and the Ardagh chalice, CAT.9.24, where the maker varied this approach by using peltae made from beaded gold wire against dark blue glass. (figs.35 and 96)

3.28, Gold filigree ornamental insets within Insular glass studs

Gold filigree or granulated insets were combined with all stud making techniques through either fusing them *in-situ* during casting, or casting a cylindrical recess and cold-connecting the filigree ornament after the glass component had been adequately finished. In general, the use of gold on a stud is an indicator of a particularly fine example of a stud type and one which has been accorded a prominent position on an artefact or group of studs. There is evidence for the use of gold work applied to studs with relief ornament, enamelled ornament and studs with silver grilles. Only *champlevé* stud types are not embellished with gold. Given the enormous variation in evidence within the basic stud techniques, a small number of case studies of the various insets applied to various stud types will be outlined.

3.29, Beaded gold wire, granulation and filigree panels fused in-situ

Examples of beaded gold wire formed into three peltae were applied to the monochrome blue studs on the base of the Ardagh chalice, as demonstrated above. (appendix 7, diag. 6) On the blue, red and silver grille studs on the handle escutcheons of the Ardagh chalice discs of gold were included in the design, CAT.9.20.(fig.76) In this case, the maker used a sub-conical rather than flat or slightly dished mould and formed purpose-made grilles with an enlarged central aperture which matched the form of the mould. A miniature disc of gold was set behind the silver foil aperture. This disc had over one hundred gold granules fused within a space measuring 4mm in diameter. Opaque red glass was cut into stepped fragments and fused to stepped openings within the

grille. Finally a backing of blue glass was added to fill remaining spaces within the stud background. (appendix. 7, diag.7)

The glass lozenge at the centre of the 'Tara' brooch, CAT.4.4, contains a central gold filigree panel applied to the stud at the casting stage. (fig.85) This small tray was formed from gold foil and beaded wire wound into whorls and set in a cruciform arrangement. This small tray was placed into the centre of the clay mould prior to the application of glass to the mould to form the stud. This stud demonstrates particularly fine skills as the maker has managed to make the glass flow around the inset into undercut edges and into the relief ornament without over heating or damaging the fragile panel. The complexity of this assembly and the ability to form a stud in this manner suggests much experimentation and trials to achieve this combination in this manner. (appendix. 7, diag.8)

3.30, Filigree insets cold connected to the stud

The second technique employed to apply complex gold filigree ornament to a glass stud appears on the Derrynaflan paten. A stud die was formed with a central circular recess designed to receive the gold filigree ornament. Markings in the central recess of CAT.1.6 suggest that a perforation was created in the stud at the casting stage. (fig. 48) This implies that a perforation was located on the die, or perhaps as a protrusion applied to the centre of the mould, to result in this form. Once the stud was cast, it was removed from the mould and finished. The inset is composed of small tray of gold foil ornament beaded wire and seven whorls of beaded gold wire as found on CAT.1.20. (fig. 67) The back of the tray contained a stem which was used to thread through the perforation in the stud. Niamh Whitfield has shown that in similar examples on the 'Tara' brooch, the base of the stem was cut lengthways several times and the individual pieces folded out into a radial formation against the obverse of the stud, thus forming a secure cold connection. The stud was then set within a collet.⁴⁸⁷ (appendix 7.9)

3.31, Techniques employed to form amber studs and inlays

3.32, Forming a simple loose amber stud

Like glass studs, it is a feature of amber studs that they are always geometrical and formed to precise measurements that match their fixed settings. As with glass, they

⁴⁸⁷ Whitfield, "More Like the Work of Fairies," 235-41.

are also typically displayed in schemes of identically shaped studs within an artefact. (fig.63)

Traditionally, it has been suggested that amber studs were shaped using reductive techniques.⁴⁸⁸ This view has most likely arisen through comparison with other Bronze Age or Viking artefacts fashioned from amber in this way. (figs.62, 66) The generally smoothed irregular forms associated with amber beads and carved pendants, suggest that reductive techniques were certainly employed, and as outlined in chapter two, there is much evidence of scrap from excavated sites where the manufacture of amber goods was carried out, as for example at Scotch Street, Armagh and Fishamble Street, Dublin, suggesting that this was the default technique employed to shape the material outside of the goldsmith's milieu.

As an organic material, amber naturally has many interior bubbles and fractures, which tend to hamper efforts to shape the material into a regular form. Fragments chip off and cracks in the material emerge at different points during working. As noted with glass, hand-working a soft material into a perfectly symmetrical form is difficult, as overworking can easily occur on a section, ruining the symmetry. These difficulties are magnified due to the softness of amber and the internal weaknesses, It is for these reasons that hand-worked beads are somewhat amorphous in form, as this is the best that can be achieved by hand.⁴⁸⁹ (fig. 62) The use of this reductive technique for stud manufacture would have been at odds with the efficient processes developed to work other materials and form high quality multiples of ornament such as foils and glass studs in Insular metalwork. Preliminary experiments with raw amber carried out as part of this study, suggest that a reductive approach was highly unlikely to achieve the results required. Furthermore metalworking tools such as files became easily clogged with amber dust and un-useable without repeated clogging.⁴⁹⁰ This made the production of

⁴⁸⁸ Ó Floinn, 'Amber Stud,' p.208 ; Ó Floinn, 'Amber Ring Fragment,' p.208; Ryan, *The Derrynaflan Hoard I*, p.13.

⁴⁸⁹ Unlike studs forming beads points to the importance of conserving the volume of the amber which is bound up with the intrinsic value of the bead. Therefore we can see that in terms of beadwork the size and volume of the material is paramount. Whereas, in the case of studs it is the complexity and design which is important.

⁴⁹⁰ A small fragment approximately 12mm in diameter was formed by drawing the shape on a nodule of amber and removing material. The size proved quite difficult to handle, even though this writer has small hands. During the removal of material by file or file wrapped in sandpaper it quickly becomes apparent that this is not the most efficient method of producing a small perfectly formed stud. The softness and irregular hardness of the material means calculated pressure must be applied and care taken with areas of softer material where less is required. When polishing using a fine gauge paper the same issues arise. Progress is relatively slow and this inefficiency of this method is marked when one realises multiple accurate copies are required. A further problem with this method is the significant loss of material, as we have seen polychrome materials were used sparingly and recycled where possible.

one perfect stud laborious using reductive techniques. It is also at odds with the widespread technical approaches discussed earlier which favoured variations of 'imprinting' and casting to produce accurate modular elements. This suggests other methods of working. As Ryan has noted amber can be pressed, and the evidence gathered from a selection of Insular artefacts suggests that this process, involving heat to soften the amber and pressure applied with a stamp, may have been the definitive method employed to create amber studs.⁴⁹¹

Aside from rough or loose amber studs, no small amber offcuts or waste survives from rural metalworking sites although raw nugget have been identified within a metalworking context at Scotch St. Armagh. This may be as a result of poor survival patterns, or the fact that amber may also have been used as a flux for gold soldering or due to significant recycling and conservation of the material. As amber fragments can be combined and fused together to form what is today termed reconstituted amber, it is possible that fragments from bead-working and ring making were also reused by the Insular goldsmith alongside raw nuggets. The reuse of amber fragments fused together is suggested by the fragmentation pattern of amber studs from the Lough Kinale bookshrine on stud CAT.17.5.(figs.97) Although fusing separate fragments together results into a solid piece of amber, nugget cracks or imperfections in the surface may have succumbed to external interference and caused the joins to open and fracture. It is notable that these fracture patterns are completely different to those caused by normal exposure to air and ultra-violet light which causes the amber surface to discolour, crack and finally to disintegrate. (fig. 36) In this case the whole stud has essentially expanded apart. Furthermore, aside from being an efficient use of recycling otherwise un-useable material, amber fragments could be employed to fill more complex shapes such as the corners within lentoid studs and spaces with lead-tin openwork grilles.

We have seen that clay moulds were used to form glass and imprint a pattern on the surface of glass. The principles of this imprinting approach were adapted to amber. Similar to the use of a copper-alloy stamps and pressure to emboss leather and silver foils and form stud dies, it is probable that copper-alloy stamp-moulds were developed to press amber into stud forms. Despite searching the archaeological record, so far, no surviving stamping tool with the potential to form amber has been identified. However, these may have been recycled to recover the material once amber working fell out of fashion. Two separate elements were required, a flat lower section which at its simplest may have been a flat-based dish of copper-alloy set against a heavier flat surface for

⁴⁹¹ Ryan, *Metal Craftsmanship*, p.13.

support. Secondly, a copper-alloy stamp-mould cast with a negative recess to mould the amber into the required shape. The correct volume of amber was required, plus extra to ensure all areas filled. As with the Lagore *Crannóg* and Ballinderry *Crannóg* II amber, it is possible that in some cases a raw nugget was worked into the approximate shape prior to stamping.⁴⁹² This would involve less work and stress to the material to shape the final form of the amber stud. (appendix 7, diag.10) The amber material was either rubbed with or heated in oil, beeswax or fat. Once the appropriate heat was achieved, the amber began to soften and several pieces were combined and pressed with the stamp to form the shape. Similar to the lip of glass found on the edge of the cast glass Lagore *Crannóg* stud, (fig. 51) a lip also occurs on oval stud, CAT.17.1, from the Lough Kinale bookshrine, suggesting a comparable processing of imprinting onto a softened material took place. (fig. 98) (appendix 7, diag.11) This excess amber lip may have been expelled from the junction of the stamp and setting when pressure was applied. It is likely that several versions of this technique were in use as this principle was adapted to suit the requirements of individual artefacts and settings. Using this method, or an approximation of it, a series of accurate amber duplicates could be achieved. Once the stamp was removed the formed amber stud needed to be cooled slowly to avoid sun spangles and internal fractures. This could have occurred in a warm bath of oil or set over a warm stone which would slowly release heat until the amber studs were at room temperature. While no evidence of pig fat or oil remains on amber there is evidence for beeswax on the reverse of some studs on the Lough Kinale bookshrine.⁴⁹³ This material has a long history of use as a protective polish and may have also been employed in place of oil as a flux during combining, forming and setting as well as applied to the front of studs during maintenance of the artefact. Once completed, these studs could have been set. This technique could have been used to recombine amber fragments and off-cuts into geometrical forms or perhaps rods or ingots similar to glass canes or metal, for later reworking.

⁴⁹² Ó Floinn, 'Amber Stud,' p.208 ; Ó Floinn, 'Amber Ring,' p.208.

⁴⁹³ Dr Paul Mullarkey pers. comm.

3.33, Flat amber studs formed within a setting.

Small lentoid studs, CAT.16.2, are located on the obverse of the 'Tara' brooch, positioned within fixed gilt silver collets cast into the body of the brooch.⁴⁹⁴ Much of the amber has degraded to the surface of the collet rather than the sides pointing to the airtight environment within the collet between the amber and the gilt silver collet. (fig.99) The exterior form of the fixed collets on the 'Tara' brooch suggests that the base is slightly wider on the interior than the opening of the collet. This implies that the amber must have been infused in a viscous state into the collet, much as opaque red glass was fused into *champlevé* cells on the Monymusk house-shaped shrine. (figs.78-9) (appendix 7, diag.12) It is probable that a backing flux of beeswax was applied to the cell to facilitate the amber to flow into small areas such as corners. A fragment of amber generally shaped to the dimensions required was placed into the cell and heated gently with the beeswax. If a flat finish was required a flat tool could be pressed against the surface of the amber to force it into the under-cut regions of the setting and create a flat stud within the setting.

3.34, High-relief amber stud formed within a setting

The recessed channel along the side of the loose lentoid amber stud, CAT.17.1 on the Lough Kinale bookshrine suggest it was stamped *in-situ* within a cell with a wide base and smaller aperture to anchor the stud into the setting. (fig. 98) The channel is a result of the setting side embedding into the amber stud. (fig.38) (appendix 7, diag.11) The advantage of this technique is that it had the potential to accurately form the other examples on this artefact.⁴⁹⁵

3.35, Amber stud with metallic grille

Originally, five disc-shaped amber studs with cruciform lead-tin alloy grilles occupied the obverse of the Lough Kinale bookshrine.⁴⁹⁶ (fig. 97) The general similarities with glass studs with silver foil grilles are notable, particularly examples of yellow and brown glass which mimic forms of amber. However, unlike glass and metal, amber does not readily bond or fuse with other materials. To mitigate this aspect of amber, the lead-tin alloy grilles employed on the studs are one millimetre thick and the openwork

⁴⁹⁴ The uppermost part of these fixed settings are in contrast with the malleable gold foil settings encompassing glass studs on the bowl girdle of the Ardagh chalice or silver examples on the Derrynaflan Paten. The features of the cast 'Tara' examples suggest that they were not folded or formed around the amber whereas the Ardagh chalice and Derrynaflan paten foil examples were clearly thinner and created to fold over the edge of the studs.

⁴⁹⁵ It is possible that the 'Tara' examples were originally formed in this way and the high relief tops have come away.

⁴⁹⁶ See CAT. 17.5

pattern is divided into four quadrants. The thickness of the grille increases the surface area of the metal allowing the amber to key into minute irregularities in the grille. In addition, the complexity of the pattern, in particular the four open segments, provides multiple points around which the compressed amber could pressure fit. This created a sufficiently strong mechanical connection to form between the two materials. Similar to the lentoid examples, it is possible that the studs were formed *in-situ*. (fig.38) The following approach is suggested: Sufficient amber fragments or a piece reduced to the appropriate size was placed within the setting lined with beeswax. The material was heated until viscous and the fragments softened and began to merge. At this point the heated lead grille was positioned and pushed into place forcing the viscous amber to enclose the circular frame and rise into the openwork segments. (appendix 7, diagram 13)

3.36, Forming loose circular amber stud with central recess

This type of stud occurs on three of the finest Insular metalwork artefacts, the Hunterston brooch, (fig. 8) and the 'Tara' brooch. (figs. 7) The examples on the 'Tara' brooch were described by Niamh Whitfield whereby the perforation at the centre of the amber stud was formed by drilling a central perforation.⁴⁹⁷ (fig. 69) The gold filigree cap measuring 3.25mm was fitted with a stem formed from gold foil which was in turn threaded through a perforated circular foil with hatched gold ornament. The stem was then cut lengthways with the ends folded out radially to secure them in place. These studs were also ornamented with borders of gold filigree enclosing the side of the stud within ornamental gold settings. As there are five matching domed studs measuring 7mm in diameter in the sequence, this implies a process which produced multiple high quality reproductions. As we have seen, casting and stamping gave rise to these outcomes rather than reductive techniques. The form of this particular stud indicates that a stud stamp-mould with the negative form of the stud was created and several samples made. A central perforation was required to receive the tang attached to the gold cap. While it is possible that the perforation was drilled, the use of a gold stem implies that the inner wall of the perforation was transparent (otherwise surely a more base metal would have been used). Drilling amber (for example to thread beads) can often result in fracturing the material due to friction and uneven heating of the material. In addition, the finish of the hole can be whitish and matt as a result of the process. On the 'Tara' examples, it is more likely that the amber was gently heated and a heated

⁴⁹⁷ Whitfield, 'More Like the Work of Fairies,' 236-39.

copper-alloy pin of suitable thickness was pressed into the amber to form the perforation. (appendix 7, diag.14)

3.37, Amber 'enamelling' on the Ardagh chalice escutcheon mount

Perhaps some of the most compelling pieces of evidence for heat working amber comes from the Ardagh chalice handle escutcheons and the base surrounding the rock-crystal mount. On the escutcheon mounts of the Ardagh chalice the highest point is a setting for sub conical blue and red glass studs.⁴⁹⁸ (fig.65) The point of interest to this study of amber is the annular frame, CAT.15.1, divided into eight arcs which surround the bases of these studs.⁴⁹⁹ The base of these arc-shaped settings is filled with a malachite paste much as beeswax or a base of gypsum was applied to the base of typical glass and amber studs.⁵⁰⁰ Although much degraded, a fragment of amber remains attached to one region pointing to amber originally occupying a place above the malachite paste. While the general assumption is that this was cut and set, other possibilities exist. It is possible that the amber was heated and pressed into place much as glass is cut to shape and applied in *champlevé* enamelling. In order to determine the probable technique one must look at other similarly formed ornament on the chalice.

3.38, Inlaid amber surrounding the rock-crystal mount on the Ardagh chalice.

Further information which points to the use of amber in this manner is found on comparable annular settings adjacent to the central rock-crystal on the underside of the chalice foot. (fig.100) Within this channel are the remains of a significant portion of the original amber, CAT.13.5, set in a gilt silver channel with fragments of malachite located on the base.⁵⁰¹ (fig.101) While some smaller pieces have fractured, the presence of an almost 20mm intact arc 2.3mm thick and adjacent fragments where the surface forms match, suggests that originally this was a continuous annular amber form.⁵⁰² Due to the fragility of the material and the dimensions of the amber ring, it would be impossible to form an amber ring of this diameter using reductive methods. The large number of lathe

⁴⁹⁸ CAT. 15.1

⁴⁹⁹ Dunraven describes it as 'Round the enamels was a circle of amber, divided into eight spaces by pieces of bronze'. Dunraven, 'On an Ancient Chalice and Brooches,' 437.

⁵⁰⁰ Organ, 'Examination of the Ardagh Chalice,' p.266.

⁵⁰¹ Ibid., p.249.

⁵⁰² Dunraven describes this 'a circular crystal round which there has been a circle of amber, divided into twelve tablets, with a bronze division between each tablet.' Dunraven, 'On an Ancient Chalice and Brooches,' 438. This description applied to the amber on the handle escutcheons but not to under-foot mount section. He also describes the outer circle as having amber tablets but these have fallen out. However, there is no evidence of dividers within this channel similar to those outlined by Organ on the handle escutcheons. Organ, 'Examination of the Ardagh Chalice,' p.266. It would appear that any amber in this outer ring was applied in the same manner as the amber to the inner ring.

turned rings and failed beads from various sites attest to this. Therefore using amber in its heated viscous form is the logical process followed. A silver foil collet was applied to the outside edge of the channel and slightly encloses the amber providing some security. This evidence suggests that the maker of the Ardagh chalice could shape amber using heat, and suggests that the escutcheon amber, and the larger, now empty, channel on the base had amber applied in the same manner.

When we look further afield we can directly find this approach in the context of *Champlevé* enamelling on the Lough Gara buckle, where two small amber studs are found embedded into a background of copper-alloy similar to the adjacent recesses with red, green and yellow glass. (fig.20)

3.39, Discussion

3.40, Principles of metalworking and applying ornament

The processes used to form components and applied ornament in Insular fine metalwork tend to follow a system which involves imprinting a form and pattern onto a material to achieve a finished shape. Both metal casting and embossing silver foils follow this principle, where a die or stamp is used to imprint relief patterns and form onto metal. This process gives the maker full control over the form and shape of the final piece. An advantage of these processes is that multiple, accurate copies can be made from a single carefully prepared die.⁵⁰³ This method was used to cast elements such as the under foot mount of the Ardagh chalice with minute high relief detail and settings and channels to receive studs and amber inlays. (fig. 100)

The technique of *champlevé* enamelling, demonstrates a development of metal casting whereby the forming of metal is used to create recessed and high relief regions; recessed areas in a design are filled with glass. Typically in Insular metalwork, ornament was applied to pre-made recesses, such as filigree, embossed silver panels, amber inlays and polychrome opaque enamel. This addition of material to a pre-formed recess can be seen as the second principle of Insular ornament. Aside from *champlevé* enamelling the same principle was employed to create *niello* work and Corinthian bronze ornament.⁵⁰⁴ (fig. 24)

⁵⁰³ This process was so successful that it also crossed disciplines to leather working and was employed to form the ornament on the leather cover of the Stowe-missal.

⁵⁰⁴ The embossed Shrine of the Stowe missal also contains orpiment applied to the recesses in the same manner.

The addition of viscous material to a pre-formed recess or channel was further developed by adding additional ornament. In the case of *champlevé* and *niello*, silver wire was added to create different effects. While in the case of *champlevé*, *millefiori* and *peltae* forms in contrasting glass were added in to the surface. (figs. 19, 20,)

The final principle was the layering of materials, for example on the Ardagh chalice mica was laid underneath cast openwork panels with relief ornament. Malachite paste under amber, gypsum under glass and gold and silver foils under transparent materials. (figs. 74, 76, 84) Gilding, and tinning were employed to enhance underlying materials, while orpiment was painted onto the surface. (figs.14, 15, 52)

In terms of connecting ornament to an artefact, there is a reliance on mechanical means, such as pinning, riveting, pressure-fitting, and overlaying separate elements within openwork grilles. Embossed foils are over laid at their edges with frames which secure them into place. The formation of mounts such as the underfoot mount on the Ardagh chalice with the relief ornament, amber inlaid recesses and cold-connected rock-crystal and gold mount threaded through the central perforation (fig. 100) can be seen to have a direct relationship to the techniques and methods employed to form relief and enamelled glass and amber studs on the Derrynaflan paten and 'Tara' brooch. (figs.67, 69, 71)

3.41, Discussion of the cross-application of techniques between glass and amber

As we have seen, there is a significant amount of evidence which supports the use of hot working and imprinting methods to manipulate both amber and glass into geometrical studs. Forming glass into circular cabochons by heating fragments until surface tension created a rounded circular form has also been ruled out as a method of production. Approaches based upon casting and press-moulding were the predominant method of forming glass and amber studs respectively rather than the use of reductive methods. The same technical processes and problem solving principles were employed to connect both amber and opaque red glass to metallic grilles, to apply them into pre-cast cells with wide bases and smaller apertures, to 'enamel' them into cells or channels, to mould them into loose studs, and form them both into perforated studs threaded with gold caps. There is evidence to suggest that both glass and amber were used in transparent form and laid over ornamented foils or pigments to enhance their colour or appearance.

3.42, Glass and amber stud technical processes

Glass studs can be divided into six technical categories with sub groups.

Technique 1 champlevé, copper-alloy and glass studs

Studs based upon *champlevé* principles can be broken into two types:

- (a) *Champlevé* discs, set into a collet within an artefact.
- (b) Glass fused into a precast recess formed with a base wider than the setting aperture. This was designed to imitate a collet and create the effect of glass stud set into an artefact.

In advanced *champlevé* examples, indents were formed within opaque blue glass inlays, these were filled with opaque red glass.

Technique 2 geometrical monochrome glass studs

Monochrome geometrical glass studs formed by casting. Advanced examples may have metallic ornament cold connected to the stud after casting, or pigments drawn onto the surface. Additions applied to the reverse include gypsum or embossed or hatched foils of gold or silver.

Glass technique 3 glass studs with relief or indented motif cast into the surface

- (a) Studs with high relief,
- (b) false relief or
- (c) indented patterns.

Advanced examples may have metallic ornament connected to the stud post casting using cold mechanical connections only.

Technique 4 monochrome and polychrome glass studs with metallic and additional vitreous components combined during casting phase.

- (a) Glass studs with a metallic openwork inlays applied during the casting process. These are generally monochrome, but two tones of glass can be employed. The use of silver wire set on edge or beaded gold wire is a variation of the use of silver foils or cast openwork grilles.
- (b) Glass studs formed with at least two but up to three different coloured glasses and a central motif formed from metal. This can be formed from wire on edge or an openwork foil.

Additions such as gold granulation or filigree are applied during the casting process or cold connected using mechanical means post-casting.

Technique 5 enamelled glass studs

- (a) Enamelled glass studs usually green or blue glass, cast with an indented design and enamelled with opaque glass usually yellow, red or white. Additions such as gold granulation or filigree are applied during the casting process or cold connected using mechanical means post-casting.
- (b) Enamelled glass stud in blue or black glass which incorporates fine silver foil ribbon set on edge and employed to line the walls of the recessed pattern within the stud.
- (c) Enamelled glass stud formed from cast yellow glass with relief ornament, placed within a copper-alloy support, recesses enamelled with opaque red glass powder.

Technique 6 mosaic glass plaques

- (a) *Millefiori* platelets arranged within the *en-cabochon* recess of a clay mould, molten glass is applied from the reverse to form the high relief backing of glass.
- (b) *Millefiori* platelets arranged into fused glass plaques arranged in a mould and fused to a backing of glass. Recesses made in the glass were filled with opaque red enamel.
- (c) White slices of white square glass cane fused with blue glass to form mosaic glass. This was cut and set in the base of a mould and fused to a backing of blue glass.
- (d) Coloured red and white slices from canes of square glass arranged into a chequered pattern and fused with a backing of blue glass.

Amber studs can be divided into three types:

Technical process 1 amber inlay formed within a metallic setting

- (a) Simple amber studs formed by pressing the viscous amber into a fixed premade collet. The collet base is often wider than the setting aperture, thus connecting the amber in place.
- (b) Amber inlaid into channels in a heated state. This can occur within channels which have been gilded or filled with malachite paste to enhance the appearance of the amber.
- (c) Amber studs with high relief obverse form created by stamp-moulding amber into fixed collets. This form is a combination of type a and b.

Technical process 2 amber studs formed outside of the setting

- (a) Amber stud individually formed into a relief geometrical form using a stamp-mould and set after casting.
- (b) Amber studs pressed moulded with a circular recess and cold connected to gold filigree ornament post-casting.

Advanced examples may be combined with a backing of hatched gold foils and collar of gold filigree imitating a bezel.

Class 3 amber stud embedded with a metallic grille

Amber stud with a thick metallic openwork motif mechanically fixed into the surface while the amber was in a softened state and a result of heat, in the manner of opaque red glass with metallic inlays.

3.43, Discussion

Existing material knowledge and the two most basic Insular metalworking techniques, metal casting used to make relief ornament and mounts and secondly *champlevé* enamelling were employed to make the primary structure of both glass and amber studs. Furthermore the principles of these techniques were adapted to add ornament and virtuosity to the glass or amber stud forms. From two basic techniques metal casting and enamelling into pre-cast recesses in metal as evidenced in *champlevé* enamelling, we find much complexity developed by cross applying the techniques to other materials and by combining them in a multitude of different ways. Both amber and glass were worked in the same manner with techniques derived from within the goldsmith's atelier to make studs of similar form, technique and type. The only difference between the two is the lack of 'enamelled' amber whereby an amber matrix is formed with a patterned recess which is filled with a contrasting material. As it is not possible to 'enamel' onto amber as with glass we must look to other materials identified in chapter two that could simulate enamel. It is possible that orpiment could have been employed to simulate yellow glass, gypsum white enamel inlays, malachite paste as found under amber on the Ardagh chalice for green or red lead for red enamel. While no examples of recessed amber studs are extant, within Hiberno-Norse context we have a small crucifix with dot-in-circle recesses, suggesting that a broad simple pattern is possible. Furthermore a similar pendant crucifixes in jet identified at Coppergate, York once contained orpiment within similarly designed recesses.⁵⁰⁵ This suggests that amber

⁵⁰⁵ A.J. Mainman and N.S.H. Rogers, *Craft Industry and Everyday Life: Finds from Anglo-Scandinavian York. Vol 17: The Small Finds, Fasc. 14.* (York, 2000), p.2590.

had to potential to be 'cold enamelled' with alternate material much as contemporary enamellers use resins to imitate the effects of enamel on jewellery and historically how cobalt and red lead were used within delicate gold filigree to simulate enamel. Given the fragile nature of amber, already outline in chapter two it is highly likely that any complex studs of this type may have lost their ornamental applications and degraded. However given the finds from waterlogged environments such as Lough Kinale *Crannóg*, it is possible that a yet- to-be discovered stud of this type may exist. Equally scientific analysis of a newly found recessed amber stud may reveal such inlays as orpiment, red lead, gypsum or malachite were employed. While this may seem speculative, the adherence of insular metalwork to comparable methods and problem solving across media and techniques, outlined here for the first time, suggest that there is the potential that this combination occurred.

Other secondary ornamental applications also demonstrate comparable techniques such as the construction of glass and amber studs with filigree elements cold connected to the underlying structure. These demonstrate the adaptation of processes used to form complex mounts such as the elaborate example from the base of the Ardagh chalice. The amber and filigree inlaid recesses, the use of an annular composition and the enhancement of the centre with a crystal has compositional similarities with amber and glass studs on the Derrynaflan paten and 'Tara' brooch. These similarities are also found in the central ornament, quartz in the case of the Ardagh mount and gold filigree within the studs, which are attached to pins which fit through a central purpose made perforation and cold-connected on the reverse. These points suggest that the prior knowledge associated with metalworking was applied to both glass and amber. In addition we find this approach across artefacts and within artefacts suggesting that the creative thinking behind these methods was part of a circular system. There is some evidence to suggest that layering techniques associated with painting and illumination were shared and applied to enhance amber and glass studs through the creation of 'doublets' using gypsum, malachite paste and ornament painted onto the obverse with orpiment. While there is no evidence pointing to an amber and orpiment combination in Insular stud craft, it is known from an Anglo-Saxon context and we do have amber used alongside malachite on the Ardagh chalice. This suggests that mixing amber with other materials such as orpiment or even red lead may have occurred.

Chapter Four-Analysis

4.1, Introduction

As outlined in Chapter one, polychrome glass and amber studs have frequently been used as a means of dating on the basis of general comparisons between objects which incorporate them. Some have even gone so far as to suggest that similarities between the materials, techniques, colour and motifs found on studs are suggestive of their origin in a common workshop. However as we have seen in chapter two and three, a small number of materials were in use in Insular metalworking in general and these were also applied to stud-making. In chapter three we saw that the techniques developed to form amber and glass were derived from pre-existing metalworking techniques such as the production of relief castings and *champlevé* enamelling, while the connections are similar to those used to form mounts and to apply ornament. Based on this evidence, generally similar characteristics are to be expected as a matter of course. However despite these common points a detailed analysis of the individual formation or comparison of studs on these artefacts has not been undertaken.

The lack of examination of this aspect of studs, the methods that were used to produce them, has overlooked an important avenue into workshop practice. As has been demonstrated, some techniques require high levels of skill, knowledge of how different materials reacted to heat, and to one another, together with more basic physical requirements, such as good eyesight, strong fine motor skills and predictive ability. Others were clearly less difficult, and available to individuals who were perhaps attempting to achieve similar effects, but without the benefit of the same knowledge or skill.

Due to the enormous variety of technical adaptations and patterns there are too many studs to discuss individually. For this reason, three artefacts have been selected for detailed study, based on the number of studs that they incorporate and the variety of techniques used. By looking at these in detail it is hoped to establish what relationships existed between artefacts that have traditionally been grouped together by date and workshop tradition.

This chapter will explore the skill levels, technical range and materials based on a representative selection of studs from the Ardagh chalice, Derrynaflan paten and Derrynaflan ring. In order to examine the issues and difficulties of ascribing chronology and authorship based upon general similarities, a comparison will be made between a selection of silver grille studs on these artefacts, which have traditionally been linked. In

order to assess the relationship with later metalworking of the eleventh century an assessment of a selection of studs from the Cross of Cong and Lismore crozier will be outlined and compared to earlier examples.

4.2, The Ardagh chalice

The Ardagh chalice was discovered near a rath in Co. Limerick, and is an example of a *calix ministerialis*.⁵⁰⁶ It has traditionally been dated to c. 700 AD.⁵⁰⁷ Scientific examination of the object undertaken in 1970 by Robert Organ included detailed examination of the studs by Mavis Bimson, who established a numbering system for them, which has adopted in this study.⁵⁰⁸ The chalice has often been compared to the Derrynaflan paten in terms of the ornament and technical expertise.⁵⁰⁹ While the studs of the two objects are often compared in terms of material and design, no detailed comparative analysis of the two objects has been undertaken to determine whether a concrete connection between their studs exists, beyond general aesthetic similarities.⁵¹⁰

The key ornamental features of the chalice are the bowl-girdle, the bowl medallions, the handles, the handle-escutcheons, the upper and lower flanges and the underfoot-mount. A selection of studs from the chalice handles, handle escutcheons, bowl-girdle, medallion and underfoot mount will be outlined. (appendix 8, diag.1)

4.3, Ardagh chalice bowl-girdle monochrome stud CAT. 9.1

CAT. 9.1 (fig.102) measures 9mm in diameter and is formed with a radial pattern based on a composition divided in to six segments with stepped motif. The inner corners of the central Y were formed in one cut by rotating the blade and resulting in softened corners rather than the sharp edges associated with performing two cuts to remove the foil from the grille. The maker of the grille continues this method when forming the curved sections, they are made up of two to three angular cuts rather than a continuous arc-like motion. The thickest section of the grille measures approximately 0.5mm in width and there is a discrepancy between the wider and finer parts of the grille. The grille of this stud extends to the end of the stud and joins the setting.

⁵⁰⁶ Dunraven, 'On an Ancient Chalice and Brooches,' 433-4 ; Ryan, *Early Irish Communion Vessels*, pp.15-16.

⁵⁰⁷ Rynne, 'Date of the Ardagh Chalice,' pp.85-95.

⁵⁰⁸ Organ, 'Examination of the Ardagh Chalice,' ;Bimson and Werner, 'Scientific Examination of Ancient Glass,'.pp.201-11.

⁵⁰⁹ Ryan, *Derrynaflan Hoard I*, p.38.

⁵¹⁰ Ryan generally compares the studs on the paten ring to the Ardagh chalice, but does not analyse the patterns or other features.

The blue glass is uniform in colour and adheres well to all areas of the grille, suggesting that the maker heated the glass and grille sufficiently to allow both to bond together entirely without causing damage to the grille. Expert ability to control heat and understanding of the materials is also suggested by the uniformity of the glass, which was cooled at the correct rate, thus preventing the glass from fracturing.

4.4, Ardagh chalice bowl-girdle bi-chrome stud CAT.9.3

CAT.9.3 (fig. 103) is formed from a circle divided into eight segments, it measures 9mm in diameter and the grill extends to the edge of the stud. The grille demonstrates slightly poorer handling than CAT.9.1; (fig.102) although the radiating straight lines are well cut, smaller, more detailed areas demonstrate several approaches to the removal of material with varying success. The central squares and cross grille are noticeably uneven compared to CAT.9.1(fig. 102).

In terms of the casting phase, the forming and fusing of red glass to the grilles added a further level of complexity not found in monochrome studs such as CAT.9.1. (fig.102). Each of the five, fragments of opaque red glass are appropriately formed to the shape of their respective cells and do not encroach beyond the grilles. The reverse of the stud was formed from dark blue glass which flowed behind the opaque red glass and into the adjoining empty cells. In general most regions demonstrate blue glass fused to the silver grille except for one point on the grille, the lower right-hand corner of the stepped ornament. (fig. 103)

4.5, Ardagh chalice bowl-girdle bi-chrome studs CAT.9.2

Within CAT. 9.2 (fig. 45) the lines of the silver grille are straighter and evenly formed throughout than either CAT. 9.1 or CAT. 9.3. The lines demonstrate some curving as a result of the individual handling of the tool during cutting, but not to the extent seen on the other two studs CAT. 9.1 and CAT. 9.3. The correct volumes of opaque red glass were estimated and formed to shape resulting in glass which has not migrated into adjoining blue fields.

Similar to CAT. 9.3, dark blue glass was employed, however, in this case the blue glass appears to project slightly beyond the level of the cell grille. This suggests that, unlike CAT.9.1 and CAT.9.3, the maker applied significant pressure to the reverse of the stud while the blue glass was still molten. It also suggests that the maker either worked the glass at a slightly hotter temperature, was able to maintain a higher temperature for longer or was much quicker at working.

4.6, Ardaqh chalice left handle, studs with silver grilles CAT.9.7 and CAT.9.8

CAT. 9.7 and 9.8 are small rectangular studs on the handle of the chalice. Opaque red glass was used with a silver grille to form these studs, the glass is in good condition, the colour has not altered significantly although it is slightly rougher in texture than other examples on the chalice handle escutcheons. The level of the opaque red glass is also slightly lower than that of the grille. This feature and the minute gaps between the glass and the grille, indicate that unlike the previous examples outlined these studs were formed from thicker silver sheet, rather than foil. (fig. 104) Despite the small size of the studs and the simple angular forms which require simple straight cuts, the grilles are uneven at the corners and lines are positioned off-centre. On CAT. 9.8 it would appear that the grille was too small for the mould, resulting in the grille not meeting the edge of the collet. (fig.104) The arms of the central cross are uneven in width and lines intended to be straight are curved on CAT.9.8. (fig.104) The use of the thicker grille to help embed the silver grille mechanically into the red glass recalls the approach employed on the copper-alloy and red glass studs on the Derrynaflan strainer-ladle (fig.95) and the approach with lead-tin alloy and amber on the Lough Kinale Bookshrine composite studs. (fig. 97)

4.7, Ardaqh chalice right-handles, studs with silver grilles CAT. 9.13 and 9.14

CAT. 9.13 and 9.14_ are T-shaped and formed from silver foil and light blue glass which is of uneven colour and opacity. The pattern on the stud is based upon a grid of three squares across, four high. (fig. 46) The lines of this pattern are basic angular shapes that are simple to form and thus, are quite regular and well executed. Each line appears to have been cut from silver foil individually, resulting in sharp edges. There is no evidence of blade rotation at the corners, which tends to softens the angles. The grille runs to the edge of the stud and meets the setting.

The glass applied to the reverse of the stud contains a significant amount of air bubbles compared to other examples on the chalice made from similar glass such as CAT. 9.1. The glass is also mottled and varies from the mid blue employed on the bowl-girdle to a light translucent sky blue caused by fracturing within the glass. This may have been as a result of uneven cooling of the glass after casting which resulted in the fracturing and colour range within the stud. It is likely that the stud did not fragment as a result of the silver grille.

4.8, Ardaqh chalice left-handle, enamelled studs CAT.9.9 and 9.10

Studs CAT.9.9 and 9.10 (fig. 44) on the Ardaqh chalice handle are T-shaped and formed from a backing of opaque dark blue glass with recessed channels to accommodate opaque red enamel. The design was formed by breaking the form of the stud into a grid to create an angular stepped pattern. It is evident that the edges of the stud and pattern are somewhat mal-formed and irregular compared to the pristine effects created in similar studs on the Derrynaflan paten such as, CAT. 1.5. (fig.56) Compared to CAT. 2.2 (fig. 50) it appears that the border of glass was formed too thin and the channels too large to provide adequate grip for the red enamel. Aside from structural design issues, estimating and remaining within the correct temperature range appears to have been a particular problem for this maker. The sharp angular points on the base of opaque blue glass appear to have been overly softened during the application and fusing of opaque red glass. When the fragments of opaque red glass were fused into place the backing of blue glass was simply not thick enough to resist the temperatures involved and began to distort.

4.9, Ardaqh chalice, right handle escutcheon CAT.9.20

CAT.9.20 was formed from a grille with a radial composition based upon dividing the circle into eight stepped segments and overlaying this with an annular composition of four rings to form the inner circle, the edges of the steps and the over-all border. The grille measures 14mm in diameter and is quite simple in form, most likely for clarity due to all the other detail within the design. The grille is particularly regular, of even width and well-formed with few examples of over or under cutting. The grille is visibly thicker than most and measures approximately 0.5mm thick throughout. (fig.76)

A minute gold disc measuring approximately 4.5mm with over 100 granules of gold fused to the surface and a beaded wire border, was set behind the central aperture in the grille. The steps of the silver grille were fused with step-shaped opaque red glass and placed at the bottom of a mould. The form and position of the red glass and the gold disc correctly match their respective silver cells and did not slip out of alignment or encroach into adjoining cells. Molten dark blue glass was applied to the reverse and is well adhered to all areas of the grille. Despite the many components employed in the creation of the stud, no distortion occurred during casting, suggesting the blue glass was hot enough to run into the under-cut areas and uneven surfaces within the stud. A relatively hot liquid glass to form the body of the stud, is also suggested by the lack of

evidence for pressure applied to the stud from the reverse. There is no evidence that the glass was pushed into place which can cause the grille to slightly rotate. The silver setting meets the edge of the grille. (appendix 7, diag.7)

4.10, Ardagh chalice, right handle escutcheon, amber border CAT.15.1

Originally the silver channels surrounding the escutcheon studs were filled with amber, of which only fragments remain on the right handle surrounding escutcheon stud CAT.9.19 (fig. 65). This channel was first packed with a green malachite paste at the bottom and overlaid with viscous amber, which keyed into the eight keys placed at equal points along the annular channel. It is clear that the position of the dividing segments in the amber setting line up with the same points within the glass stud, suggesting the whole assembly was conceived and made to work in unison.

4.11, Ardagh chalice, medallion stud CAT. 9.21

CAT. 9.21 is 9mm in diameter and extremely finely made; the silver strips cut from the grille are under 0.4mm wide. (fig.105) In the corners of each section it is possible to see minute ragged edges suggesting that the maker used two cuts to form each sharp edge and corner. Occasionally these cut lines did not meet, resulting in the maker having to pull away the foil leaving a ragged edge only visible under magnification. At the edges of the stud the red glass can be seen to have extended under the grille into a compartment which should be blue. However, given the minute scale of the ornament and thickness of the grilles this stud is the most technically outstanding of the extant silver grille studs. The blue glass is similar to the deep cobalt blue used upon the escutcheon studs and adheres well to all parts of the silver grille. (fig.76)

4.12, Ardagh chalice, amber and blue glass studs on the medallion mount, CAT. 15.2 and CAT.9.25

The central studs on the medallion were originally flanked by four circular settings, two filled with amber, CAT 15.2 and two with blue glass studs CAT.9.25. (figs. 106, 30) The blue glass studs are still *in-situ* measuring 4mm in diameter (fig.80), but the lost amber settings have been replaced with amber-coloured wax. (fig. 106) The settings are typical of those associated with the small blue studs found on the chalice handles. The hollow settings were cast from silver, with a base which is wider than the top, forming a hollow sub-conical structure. The plain blue glass studs were cast in a clay mould and set within the collet over a base of gypsum. Tool-marks visible on both blue glass settings indicate that manual pressure was applied to the collet to close it around

the glass stud. (fig.80) In contrast, the amber settings are pristine, suggesting that, like the wax, the amber was applied in a softened viscous state which allowed it spread into the hollow sub-conical base and anchor the stud in place. (fig.106) While still in a viscous state the top of the stud may have been 'stamped' to form it into a cabochon form which imitated the form of the similarly sized blue glass studs.

4.13, Ardaqh chalice, underfoot mount stud with gold beaded wire CAT. 9.24

Originally five, 4mm in diameter studs, CAT. 9.24 were positioned on the base of the chalice. (fig.96) These were formed by first shaping three beaded gold wires into peltae and positioning them back to back at the bottom of a mould. A backing of molten blue glass was applied to the reverse. Cutting curved forms in foil of this size is extremely difficult and few extant examples of intricately made motif exist such as CAT. 9.21. (fig.105) It is likely that the maker chose to overcome the difficulties associated with forming this type of pattern by using malleable beaded gold wire to form the curved ends with a tweezers. The texture of the beaded wire was more reflective and attractive but also increased the surface area of the gold and facilitated the connection with the background blue glass. The fact that the beaded wire and peltae are so small suggests that blue glass in a highly liquid form was required to penetrate into the open spaces of the design, such as the central triangle, the spiral terminals and the regions between the beaded sections of the wire.

4.14, Ardaqh chalice stud settings

The mounts associated with the escutcheon studs CAT. 9.19 and CAT. 9.20 display several levels of relief and incorporate collets of gold, beaded gold wire, silver trichinopoly and amber coronas modified with malachite backing. (figs. 49, 65, 76, 82) Beaded gold wire and gilding set into an ornate gilt bronze background in the case of the small blue studs on the under foot mount (figs.96, 100) The settings on the bowl girdle and medallion mount are protruding, and made from silver beaded wire and twisted wires imitating plaits in order to enhance the studs. (fig.105) The small amber studs on the medallions (figs. 80, 106) and blue glass on the handle escutcheons (fig.76) were set within precast hollow settings sub-conical in form, with a base wider than the top of the stud. The settings on the handles are formed from silver sheet wrapped around the stud. This was cut at the corner and splayed out behind the stud aperture on the handle to secure the stud in place mechanically. (figs. 44, 46) The corners were pinched in some cases for added security. (figs. 46, 104)

4.15, The Derrynaflan paten

The Derrynaflan paten was discovered in 1980 as part of a hoard of Eucharistic vessels. Its discovery was of particular significance, as it is the only paten of its scale (368mm in diameter by 30mm high) and form to have been discovered in the British Isles.⁵¹¹ (fig.32) The paten comprises a circular silver plate surrounded by an annular decorative border on its upper surface. The border is decorated with an alternating pattern of filigree panels and studs set into decorative collets. Originally, there were twenty-four studs on the upper surface, of which twenty-three remain. A perforation in the centre of the paten suggests that a central ornament was once attached to this artefact and is now lost. The side of the paten is decorated with an alternating pattern of die stamped foils and twelve rectangular studs. These were assigned a numbering system in the preliminary account of the artefact by Michael Ryan and Ragnall Ó Floinn published in 1983, prior to the reassembly of the paten in the British Museum.⁵¹² The circular studs on the upper surface ornamental border are divided into smaller rivet studs measuring between 9mm and 12mm numbering RVS 1-11. These are set into mounts that protrude from the surface of the paten and are set over structural rivets which help support and hold various elements of the paten together. The larger ornamental studs alternate with the former type and are set into collets secured against the surface of the paten. These studs are labelled ORN 1-12 measuring between 11mm and 17mm.⁵¹³ However, as many studs were loose when they came into the possession of the National Museum of Ireland and labelled prior to the reassembly of the paten; the studs on the surface as they are now positioned do not match the labelling system used in the preliminary report. To deal with this issue the studs will be labelled here as CAT. 1.1 to 1.24 as they are positioned currently on the paten. This labelling system begins with CAT.1.1 (the modern) replacement stud and proceeds clockwise around the paten as the studs are currently positioned. The twelve rectangular studs on the side of the paten are labelled CAT. 1.25 to CAT.1.36 (Fig.107) (appendix 8, diagram 2)

4.16, Dating of the Derrynaflan paten

Based on the use of polychrome glass in decorating the Derrynaflan paten is dated by Ryan to the mid-eighth century.⁵¹⁴ On the basis of the filigree ornament on the paten the date has been extended by Whitfield up to the later eighth or early ninth

⁵¹¹Ryan, *The Derrynaflan Hoard I*, 1, 17; idem, 'The Derrynaflan Hoard and Early Irish Art,' 37.

⁵¹² Ryan and Ó Floinn, 'The Paten and Stand,' 17.

⁵¹³ Ibid., 22-5.

⁵¹⁴ Ryan notes that the range of colours used on the paten conforms to the well-known examples from other examples of eighth-century metalwork *ibid.*, 37; idem, 'Church Metalwork,' 131.

century.⁵¹⁵ These dates have been arrived at through comparison of the polychrome glass studs, stamped silver panels and filigree with objects such as the Ardagh chalice and the 'Tara' brooch, both of which are dated to c. 700 AD based upon comparisons with ornament in the Lindisfarne Gospels.⁵¹⁶ (figs. 30, 24, 7) Due to the similarities in ornament, technique and design, Ryan has gone so far as to suggest that the Ardagh chalice and Derrynaflan paten originate from the same workshop tradition.⁵¹⁷ (figs. 30, 31)

As there is a significant amount of evidence suggesting individual technical variation on the Derrynaflan paten rim, a representative selection of studs will be outlined, grouped according to technique. This group has been chosen as they demonstrate evidence which suggests different individuals were creating studs. Due to the technical similarities between monochrome studs with silver grilles and polychrome studs with silver grilles, these shall be dealt with together. Several variations of enamelled studs occur on the Derrynaflan paten rim and these will be dealt with as a group followed by the single type of glass stud with cast relief ornament. This will be followed by an outline of a selection of studs from the paten side for comparison. The sample outlined will similarly be grouped according to technique, with both monochrome and polychrome silver grille studs and enamelled glass studs represented. This description will be followed by a description of the studs on the Derrynaflan ring, categorised in the same manner according to technique. A second comparison between the studs on the paten and the ring will be made to determine what this can tell us about authorship, chronology or workshop practice.

4.17, Derrynaflan Paten rim monochrome blue glass studs CAT. 1.7 and CAT.1.3

There are two types of stud with metallic grille on the paten rim. Monochrome blue glass studs and blue and opaque red glass studs. Monochrome blue studs CAT. 1.7 and stud CAT.1.3 will be outlined. (figs. 108, 109, 110) The glass used to make these studs appears to be a translucent mid blue colour, although it is difficult to tell due to the presence of the grilles which block light. These studs were made by planning and cutting a grille pattern from silver foil, annealing the grille and positioning it at the base of a clay mould. A backing of blue glass was then applied to the reverse which fused to

⁵¹⁵ Niamh Whitfield, 'Filigree Animal Ornament from Ireland and Scotland of the Late-Seventh to Ninth Centuries; Its Origins and Development,' in *The Insular Tradition*, eds Catherine Karkov, Robert T. Farrell, and Michael Ryan (New York, 1997), 231.

⁵¹⁶ Ryan and Ó Flionn, 'Paten and Stand,' 30, 37; Wilson, *Anglo-Saxon Art*, 120; Rynne, 'Date of the Ardagh Chalice,' 85.

⁵¹⁷ Ryan states that it would be quite unscientific to assert that they were made by the same man or for the same communion set, but that they may be regarded as effectively contemporary. Ryan, 'Aspects of Sequence and Style,' 68.

the grille, thus incorporating it securely into what would become the surface of the glass stud.

4.18, Derry-naflan paten rim stud CAT.1.7

CAT. 1.7 on the paten ornamental rim measures 9mm in diameter with a grille of 7.6mm in diameter. (fig.108) The composition is radial, based on an underlying structure of a circle divided into six equal segments. The central triangle divided into three sections with the lines terminating in stepped forms. (fig.111) CAT.1.7 is particularly well made, with even spaces and a grille perfectly centred within the stud. The individual who cut the grille handled the blade in a manner which left the outlines of the silver strips with slight bi-concave form. A grille of this size must have been cut by beginning in the middle and working outward by forming the centre lines dividing the triangle first. Each cut was formed by pressing the blade into the grille and pulling it gently toward the goldsmith. Once each strip was completed, the craftsman rotated the foil and moved onto the next line to be cut. As a result of the individual way in which the goldsmith handled the blade it would appear that lines were cut with an arc-shaped motion. (Fig.110) Resulting in curved sections, bi-concave on long lines and a tendency towards bi-convex on some of the shorter lengths. The silver grille is centred within the stud resulting in a small corona of blue glass measuring approximately 1.4mm in width separating the grille from the silver collet. The grille is well fused to the backing of glass and a small air bubble is apparent under magnification. The small lines and the crater from the bubble evidence a polishing stage was applied to finish this stud. Despite the lone air bubble, the majority of features associated with this stud from the clarity of the grille design to the formation and casting of the stud suggest an experienced stud maker.

4.19, Derry-naflan paten rim stud CAT.1.3

The challenges associated with stud making on this scale can be seen in the reticulation beginning to appear in the surface of the grille on CAT.1.3 (fig. 109) as the silver heated almost to melting point.⁵¹⁸ (fig.110) The complexity of the device on CAT.1.3, suggests that particularly strong fine-motor skills and sharp scalpel-like cutting tools were involved in the manufacture of this piece.⁵¹⁹ The uniform width of the silver lines throughout is particularly difficult to achieve, in addition to cutting pronounced

⁵¹⁸ The loss of glass under one of the spirals suggests an impact which smashed the glass but left the grille intact.

⁵¹⁹ In this context fine motor skills refers to dexterity and the coordination of movements that occur between the eyes and the wrists, hands and fingers to produce extremely detailed patterns on a minute scale.

curves rather than the straight lines or arcs found in CAT.1.7, which require much less skill. Furthermore, where CAT.1.7 has only one centre point, CAT.1.3 has four curvilinear triple-spirals, which would necessitate the rotation of the foil or the blade as the cut is carried out. (figs. 109-10) Similar to the execution of CAT.1.7, the cutting of the foil for this stud must have been begun in the centre. Where the maker of the grille on CAT.1.7 uses corners and angular points to conclude motif and devices, (fig.111) this maker favours terminating his channels with flat edges or curved ends. (fig.112) A tiny protrusion emanating from the grille border at 3 o'clock may be a section missed by the artist. However, given the attention to detail demonstrated elsewhere on the stud it may also be evidence that this grille may have been part of a larger foil and that the grille was cut down and modified for use on this stud. (fig.113) The damage to the grille appears to have been caused by an ancient impact rather than during casting process. The complexity of the pattern and the narrow channels suggest that fusing the grille and glass was a more difficult process than one associated with a more open symmetrical pattern found on CAT.1.7. (fig. 108) In this case the glass needed to be as molten as possible to allow it flow into the narrow channels and corners. The reticulation on CAT.1.3 suggests that the silver grille was almost at melting point during casting to achieve this result. It is evident under magnification that while fusion was achieved, shadows within the centre spiral suggest that the glass did not adequately run into all of these corners. (fig. 110) However, given the complex structure of the Ultimate *La Tène* style composition with narrow parallel curved channels and spirals, it is unlikely that these issues could have been completely avoided. The molten glass was simply not fluid enough to get into these regions. It is probable that the maker opted for channels ending in flat points or curved ends to increase the possibility of the glass adhering to certain points and thus, facilitating narrower less secure patterns elsewhere. The fragility of the connection is also implied by the reticulation on the surface of the silver grille. In normal circumstances this would be polished away as on CAT.1.7 (fig.111), however in this case polishing the surface would likely have torn the grille from the glass backing. It is probable that this step was omitted to preserve the stud.

In terms of the complexity of the pattern composed at this scale, the ability to cut such fined channels and lack of distortion of the grille during casting suggests a highly experienced stud maker. It also suggests one who had experimented to an enormous degree to refine the Ultimate *La Tène* style design and stud making process until a functional stud could be produced. It is in contrast with the approach take on CAT.1.7 where a much more traditional openwork design was executed. On the Ardagh

chalice beaded gold wire was employed to create a similar diminutive highly curved pattern, rather than attempt to form the motif from foil. (fig.96)

4.20, Derry-naflan paten rim polychrome studs CAT. 1.4, CAT.1.11 and CAT.1.23

There are nine opaque red and blue glass studs with silver grilles on the surface rim of the Derry-naflan paten. Three studs will be considered, CAT. 1.4 (fig.114) – an ornamental stud measuring 12.2mm. Unique studs CAT.1.11 (fig.115) and CAT.1.23 (fig.116) are both 9mm.

These studs were created in the following manner. A grille was cut from silver foil to the required pattern. Opaque red glass was formed into the required shape and fused to the correct cells within the silver grille. The grille and glass was centrally positioned on the base of a clay mould and blue glass was applied from the reverse. When cooled the stud was cleaned and set.

4.21, Derry-naflan paten rim CAT.1.4

The grilles on CAT. 1.4 (fig. 114) demonstrate finely made long lines which are slightly bi-concave in formation. When cutting the inside edge of corners, two cuts were used which resulted in sharp edges to corners. The stud-maker favoured a thicker border surrounding the grille. The design of CAT. 1.4 required the maker to create difficult V-shaped forms in opaque red glass within the design, all of which are expertly cut. Despite the pressure and high temperatures required to ensure the blue glass backing could run into the small triangles on the front, the opaque red glass has not distorted or been forced into adjoining cells. In terms of composition, this stud has much in common with monochrome stud CAT. 1.7, (fig.108) this stud is larger and the extra space has been employed to display red glass and the four blue triangles integrated into the design. The cut marks on the grille, the composition of the pattern and the perfect casting are very similar to CAT. 1.7. These features imply that this stud CAT. 1.4 (fig.114) and CAT. 1.7 (fig. 108) may have been made by the same hand.

4.22, Derry-naflan paten rim stud CAT.1.11

The grille on CAT.1.11 (fig. 115) is well formed; the lines are even in thickness throughout, all areas of red glass are restricted to their own cell. The grille is centrally positioned on the stud. However, unlike other similar sized studs, the design demonstrates much less complexity than the others on the paten such as monochrome CAT.1.7 (fig.108), CAT.1.3 (fig. 109) or CAT.1.4 (fig. 114). Larger blocks of opaque red and blue are formed into less pronounced angular forms compared to the V-shapes

within CAT. 1.4, (fig.114). Although damaged, CAT.1.9 (fig. 116) demonstrates a similar composition. However, the maker created more detail by dividing the step into two L-shapes and rendered these elements in opaque red glass divided by a panel of blue.⁵²⁰ The use of a blue stepped motif rather than opaque red glass on CAT. 1.11 (fig.117) is unusual and is the only example extant. Although the size is small and the stud is well formed, the technical ability is not matched by the design acumen displayed on other studs. The tiny space is not perhaps used as well as it could be and the maker has perhaps inadvertently coloured the stepped forms blue instead of the typical red colour found elsewhere in Insular metalwork. The stud maker has clearly attempted to compose a unique design. However the graphic element falls short of the expertise demonstrated within the other studs already outlined.⁵²¹

4.23, Derrynaflan paten rim stud CAT.1.23

The lines of the grille on CAT.1.23 appear relatively well formed throughout. (fig. 117) However, on the bottom right quadrant of the grille two features stand out. (fig.118) The inner W-form demonstrates that a less than perfect cut was made to the grille, resulting in an irregular corner. On the outer W it is evident that the corner was cut in one motion by cutting a curve rather than using two cuts to form a point. The red glass is for the most part within the correct cells, only in two regions is it possible to see that the glass extends into the adjoining cells and over the grille in one area. There is a noticeable distortion in the form of the grille which suggests that when the blue glass was applied and pressed down to fill the empty L and W-forms the pressure caused the entire grille to rotate slightly. At seven o'clock on the grille it is apparent that an off-cut of silver grille fell in behind the grille prior to the application of the blue glass. Further issues at the casting stage include the poor adhesion of the stud to the grille from seven to ten o'clock. This writer suspects that this feature is a defect which occurred when the glass was applied to the clay mould. Firstly, the glass was not sufficiently hot or the maker worked too slowly during this stage. Secondly not enough was added the first time and the backing had to be topped up with a second application which resulted in this seam. Although the stud grille appears off centre in the images this may be because the stud has slipped slightly within the setting rather than poorly applied to the stud. It is evident that the difficulties for this maker appear to have occurred largely at the casting stage where red glass, the application of the blue glass and the excessive pressure distorted the silver grille. The mismanaged steps in casting in conjunction with the silver

⁵²⁰ CAT. 1.9. This stud forms a pair with CAT.1.13.

⁵²¹ See also CAT. 1.3, fig. 109, and CAT.9.21 fig. 105 on the Ardagh chalice.

foil inclusion suggest that this was the work of a competent but less skilled stud maker compared to the makers of the other studs.

4.24, Derrynaflan paten rim enamelled stud CAT.1.2

There is evidence for three different variations of enamelled stud on the Derrynaflan paten ornamental rim. One example from each group will be outlined. These studs were made by casting a glass stud from a clay mould with the required pattern in relief, as illustrated by the well-known stud and mould from Lagore *Crannóg* Co. Meath. In the simplest of cases the entire recessed pattern could be filled with monochrome opaque yellow, white or red glass. However, within the Derrynaflan paten rim this technique was significantly developed.

CAT.1.2 (fig. 119) is representative of sets of two and three identical studs, the first technique is found on studs, CAT. 1.12, CAT.1.16 and CAT.1.2. a set of three identical studs. (fig.119) Alternate sections of red and yellow glass were enamelled directly into a continuous swastika pattern set against a dark blue background. It is evident that the appropriate colours of glass were carefully measured and applied to each section of the swastika and do not infringe upon the following segment of the design, essentially 'drawing' the pattern in colour. Opaque navy was chosen as the base colour to form the structure of this stud. The secondary ornamental materials employed were created using opaque yellow and red glass.

4.25, Derrynaflan paten rim enamelled stud CAT.1.14

The second approach, found on CAT.1.14, was to form distinct patterns enamelled in different colours. In the case of the yellow pattern the motif is a continuous Greek key, which encompasses the border of the stud and in the case of the red glass the pattern is a radial pattern encompassing three zones of stepped motif arranged around a central triangle. (figs. 47, 87) On stud CAT. 1.8 an extra level of virtuosity was added by applying bands of silver foil ribbon to the walls of the recessed patterns prior to the application of opaque red enamel. This was an extremely delicate operation given the complexities of the patterns involved and multiple materials in use. In this case an outer pattern of Greek Key was filled with opaque yellow glass. (fig.87)

4.26, Derrynaflan paten rim enamelled stud CAT.1.5

A third variation of this technique, found on CAT.1.5 (fig. 56), created two distinct recessed patterns which were overlapped. In this case a radial stepped cross and

corona are overlapped by a red interlace pattern which can be read as both a lozenge and the arms of a cross. At the four points where the patterns intersect, a minute piece of rectangular red glass the same width (less than one millimetre) as the interlace was inserted between adjoining fragments of yellow to create the illusion that the red pattern overlaid the yellow. This demonstrates evidence of creating rudimentary perspective with studs. This is a new observation, the significance of which will be discussed in a later section.

4.27, Derrynaflan paten rim relief pattern stud CAT.1.20

CAT.1.20 (fig.67) is representative of this type. It measures 17mm in diameter and has a central cylindrical recess 6mm across. The annular inset is approximately 5.5mm wide and ornamented with two interconnected rows of single strand interlace, the inner edge contains pseudo-beading in glass. The central recess contains a circular panel of gold bordered with beaded gold wire and seven cones formed from beaded gold wire, typical of a six point cross arrangement. The motif on relief studs was applied at the casting stage. A detailed die, probably copper-alloy, matching the specifications and form of the stud was prepared. The small cap of gold filigree was created with a tube of gold projecting from the base, which was threaded through the perforation within the stud. Once through, the excess was cut vertically forming several tendrils which were opened out against the reverse of the stud thus securing it in place. This type of stud does not occur on the side of the paten, or on the Ardagh chalice. However, the process and assembly method was also applied to the amber stud, (CAT. 16.1), on the 'Tara' brooch. (Fig. 69)

4.28, Derrynaflan paten rim stud settings

The monochrome studs and bi-chrome studs with silver grilles on the decorative border fall into the category of the smaller rivet studs identified by Ryan. These measure between 9mm and 10mm in diameter, unlike the larger ornamental studs which measure between 11mm and 17mm in diameter. Despite the discrepancy in size throughout, there is a sense of harmony achieved through the use of space and the specific setting assigned to individual stud groups.

Each stud, regardless of size, was assigned a circular field approximately 20mm in diameter, bordered by a beaded wire of gilt bronze. In the case of the larger studs, such as (CAT.1.2), these were set into the top of the paten in a lower-relief arrangement. (fig.119) In contrast, the smaller rivet studs are given ornate protruding settings which elevate them up to 4mm above the surface of the paten, providing contrasting high

relief to the low relief settings of the larger studs. In the case of CAT.1.23, (fig.120) the setting was ornamented with an upper and lower border of silver beaded wire and a central ribbon of intricate gold filigree. In addition, the annular field surrounding each rivet stud was filled with a larger corona of gold filigree ornament. Thus, in stud CAT.1.3 and CAT.1.9, (figs.109, 116) the central part is glass with an ornamental annular border of gold filigree. This was balanced by applying gold filigree centres to the largest ornamental studs. In contrast, CAT.1.20 and CAT.1.2 (figs.67, 119) demonstrate the opposite arrangement of a corona of glass surrounding a gold filigree circle. This contrasting use of material, space and high and low relief was employed to enhance and subdue the studs according to their size. Thus, creating a harmonious composition on the paten rim. (fig.31)

4.29, Derrynaflan paten side monochrome blue glass stud CAT.1.35

Two techniques occur on the paten side only. Studs with silver grilles and enamelled studs. The silver grilles employed on the Derrynaflan paten side form two openwork patterns. Variation was created by using various combinations of colours in various cells. Due to the range a selection of studs will be outlined.

CAT.1.35 (fig.121) is a stud from the paten side with an overall measurement of 10.01mm by 14mm and a grille measuring 9.02mm by 13.17mm.⁵²² The blue of this monochrome stud appears similar to the mid translucent blue used throughout the paten. The composition is based upon a rectangle which was quartered, each quarter was further divided in half creating eight equal sections. The rectangular outline of CAT.1.35 appears ill defined and slightly irregular in places throughout suggesting a poorly formed stud mould. (fig. 121) The choice of pattern on CAT.1.35 suggests less experience on the part of the maker as the angular lines within each square are not anchored to other parts of the openwork design. Unlike the fully symmetrical circular form of the silver grilles on the surface, with their evenly distributed weight, there is evidence that the rectangular composition of the silver grille on CAT.1.35 caused the craftsman difficulties during handling, positioning in the mould and fusing. This is evident in the over-all distortion of the pattern, and the somewhat diagonal lopsided appearance of the device. In addition, the grille failed to fuse adequately to the bottom left-hand corner and at some point was torn away leaving the imprint of the grille.

⁵²²CAT. 1.35. The preliminary account also identifies this stud as ES3 and records it as containing blue glass only, however this is incorrect as it contains a degraded red glass alongside blue glass. Ryan and Ó Floinn, 'Paten and Stand,' p.26.

Despite the relative simplicity of the straight lines of the border, it is an uneven width throughout, most likely due to the less accomplished fine-motor skills of the maker. The top right hand corner of the grille is thin and relatively even, while on the top left of the silver grille it is clear that extra material should have been removed. The dimensions of the silver grille were not a close match to the stud mould and moved during the casting phase.

4.30, Derrynaflan paten side polychrome glass studs with silver grilles, CAT. 1.31, CAT. 1.33

CAT. 1.31 (fig.1.22) the grille is even and well cut throughout and the ornament is centrally positioned within the stud. A single plaque of red glass of the correct proportions was made and fused to the silver grille, blue glass was applied from the reverse. The discolouration within the backing of blue glass suggests it was not applied in a uniform fashion and that cooling may have occurred too rapidly in this area.

CAT. 1.33 (fig.1.23) from the side demonstrates the uneven form prevalent on the side of the paten. The top of the stud measures 10.87mm while the base is 9.8mm wide suggesting an uneven mould. This grille is cut in a different manner to both CAT.1.35 (fig.1.21) and CAT.1.31 (fig.1.22) suggesting a separate hand. Within the top left hand corner of the grille the blade cuts did not meet at the point of the corner. When the foil cut out was removed from the grille at these two points a tear occurred leaving surplus material in place, which was not removed. (fig.1.24) Within this stud we can see that several errors occur. For example, on the top left quadrant red glass protrudes into a section intended for yellow. On the top right field the red glass obscures the arms of the swastika and again protrudes into the yellow glass area.

4.31, Derrynaflan paten side enamelled stud CAT. 1.36

CAT. 1.36 measures 16.78mm high by 9.43mm wide, the enamelled pattern occupies an area measuring 13.97mm by 7.78mm. (fig.1.25) It is made from an opaque navy glass and opaque yellow and red glass enamel. It is evident that compared to the similarly enamelled examples on the rim of the paten, CAT. 1.2,(fig.1.19) the stud-maker of CAT.36 (fig.1.25) had difficulty estimating the correct amounts of material for enamelled inlay. While it is possible to see that they attempted to fill particular areas with specific colours it is also evident that the colour over ran in places. On CAT. 1.36 areas of excess yellow enamel applied to the channel were not removed during finishing, thus distorting the pattern. The central cross, which displays a horizontal line of opaque yellow 'overlapping' the vertical line of red glass.

4.32, Settings on the side of the Derrynaflan paten

The settings found on all side mounts are a standard size with a ribbon of silver running around the stud acting as both a collet and filling space between the stud and opening on the mount. (fig. 122-3) A length of beaded wire was also applied to fill in any gaps and can be seen in some cases to obscure the inner ornament on the mounts. (fig. 122)

4.33, The Derrynaflan ring

The Derrynaflan ring is a hoop of copper-alloy formed from a single piece of metal raised into a 38.5mm high cylinder, 335mm in diameter.⁵²³ (figs.107, 15) The upper and lower edges of the cylinder were folded to form a flange. It has been proposed that it potentially functioned as a stand or foot for the paten.⁵²⁴ Elsewhere it has been argued that it was intended to function as a hanging corona, suspended over the Eucharistic vessels of the hoard.⁵²⁵ The outer surface is covered in eight embossed silver panels and eight bronze mounts originally set with eight central rectangular studs, one of which is now missing. The seven remaining rectangular studs on the ring are labelled CAT. 2.1 to CAT. 2.7. Two small circular cabochons selected for this study are labelled CAT. 2.8 to CAT. 2.9. (appendix 8, diagram 3)

4.34, Dating of the Derrynaflan ring

Based on the use of polychrome glass in decorating the Derrynaflan ring is dated by Ryan to the mid-eighth century.⁵²⁶ A link in terms of common ornament has been made by Ryan between glass stud CAT.1.4, (fig.126) on the Derrynaflan ring with double spiral motif and a similar gold filigree panel, no. 12 on the paten rim.⁵²⁷ Regarding chronology, the Derrynaflan paten has been placed first in the sequence with the Derrynaflan ring the last due to its simpler ornament and relationship to the paten.⁵²⁸ Writing about the ring, Ryan noted that;

“[The paten] is echoed on its outer aspect with applied silver-stamped ornaments and pseudo-cloisonné glass plaques, which echo the side of the paten in style and construction, but differ from it in their relative lack of elaboration. It seems plausible to

⁵²³ Ibid., p.28.

⁵²⁴ Ibid., pp.26, 28.

⁵²⁵ Gleeson, 'Crowning Glory,' .

⁵²⁶ Ryan notes that the range of colours used on the paten conforms to the well-known examples from other examples of eighth-century metalwork *ibid.*, p.37; *idem*, 'Church Metalwork,' p.131.

⁵²⁷ Ryan, *The Derrynaflan Hoard I*, p.38.

⁵²⁸ Mary Cahill, 'The Excavation,' in *The Derrynaflan Hoard I*, p.38.

suggest that it was made as an afterthought, although conceivably not long after the original creation of the piece".⁵²⁹

Elsewhere Ryan notes "that we cannot be certain however, whether it [the Ring] was made as an afterthought to the paten design or made by a different craftsman".⁵³⁰

The studs on the Derrynaflan ring are set along the outside of the ring structure. There are four studs with silver grilles on the Derrynaflan ring, CAT. 2.1, (fig.127); CAT. 2.3, (fig.126); CAT.2.5, (fig.129) and CAT 2.7, (fig.128).

4.35, Derrynaflan ring monochrome stud with curvilinear motif CAT. 2.3

CAT. 2.3 (fig. 126) is the only monochrome blue stud with silver grille on the Derrynaflan ring. The grille extends almost to the edge of the stud and measures 12.8mm by 7.26mm. It carries an Ultimate *La Tène* pattern made up of two large triple spirals flanked by two smaller double spiral motifs. It is an extremely complex pattern, but the stud-maker has been able to remove very fine strips of foil within the curvilinear pattern to make the design legible. Many of the channels left by the removal of strips of silver foil terminate in curved forms or abrupt flat edges. Trumpet patterns were formed by cutting the outside form and then removing the interior section. The regular rectangular form and the good quality of the casting throughout suggest the hand of an accomplished stud maker.

4.36, Derrynaflan ring bi-chrome studs with angular patterns CAT.2.1, CAT.2.7 and CAT. 2.5

CAT.2.1 and CAT.2.7 (figs. 127, 128) have matching grilles, formed using a quartered grid to create a cruciform pattern with stepped terminals and an X-form. On CAT.2.1, (fig. 127) the cross is in blue and the X-red and the CAT.2.7, (fig. 128) the colours are swapped. Despite the similarities in the patterns the grilles are different sizes. CAT.2.1, (fig. 127) measures 9.6mm high by 6.3mm wide, while CAT.2.7, (fig. 128) is 10.9mm high by 7mm wide. The pattern is quite simple and the lines are thin and relatively even throughout. The corners of the stepped motif which are generally sharp were cut in a manner which has left them with notably rounded corners. The rectangular grid on CAT.2.1, (fig.127) appears to bulge at the centre demonstrating distortion during the application of blue glass to the reverse of the stud. CAT.2.7

⁵²⁹ Ryan, 'The Derrynaflan Hoard and Early Irish Art,' p.44.

⁵³⁰ Ryan, *The Derrynaflan Hoard I*, p.38.

(fig.128) in comparison is more angular and demonstrates better casting overall but slight similar slight distortion to the right of the grille.

The third stud with silver grille is CAT. 2.5 (fig. 129) which measures 11.5mm by 8.02mm with a grille of 9.5mm by 6.3mm in width. This is a unique stud on the ring and is made up of a silver grille divided in four and set with four swastika patterns, one in each corner. While the grille is reasonably well executed, the opaque red glass is quite indistinct and runs into adjacent cells. This suggests two points, firstly the maker was unable to gauge the volume required and secondly mal-formed the opaque red glass prior to fusing to the grille.

4.37, Derry-naflan ring enamelled studs CAT.2.2 and CAT.2.4

Studs CAT.2.2 (fig.130) and CAT.2.4 (fig.131) were made from the same mould die measuring 9.9mm by 8.06mm. On the backing matrix of CAT.2.2, (fig.130) a minute fragment of opaque yellow glass became embedded within the backing of glass during the casting of the green glass. This suggests that the casting and enamelling phases were carried out in the same region of the workshop perhaps around the same time. The recessed channels of CAT.2.2, (fig.130) were filled with small fragments of opaque red and yellow glass in an alternating sequence. Although the red is degrading it is possible to see that the alternating colours are not evenly spaced and extend beyond the channel they were intended for. However the pattern could have been sharpened by removing the surplus enamel from the surface.

CAT.2.4, (fig.131) was filled with yellow enamel only, it is possible to see sections where opaque yellow enamel was not removed adequately suggesting underworking at the finishing stage. Similar to CAT.2.4, (fig.131) the stud is under finished, with too little enamelled yellow glass removed from the surface.

4.38, Derry-naflan ring, stud settings

The stud-settings on the Derry-naflan ring are uniform throughout. They are simple straight collets formed from the surrounding embossed copper-alloy sheet and moulded around the studs. On the bottom corners of CAT.2.2 (fig.130) the corners were 'pinched' to secure the studs in place similar to the approach on the Ardagh chalice handles.

4.39 Discussion

4.40, Comparison of studs and settings from different parts of the Ardagh chalice

Although both the central medallion stud CAT.9.21, (fig. 105), escutcheon studs CAT. 9.20, (fig. 76) and bowl-girdle studs CAT.9.2, CAT. 9.1 and CAT.9.3 (figs. 45, 102-3) on the Ardagh chalice appear on the surface to be particularly fine. An examination of the complexity of the design, execution and handling of the silver foils, the casting and employment of additional elements such as red glass, suggests subtle differences in terms of level of skill and approach to cutting grilles. The varying levels of skill evident between CAT.9.2, CAT.9.1 and CAT.9.3 (figs. 45, 102-3) suggest that at least three different stud-makers contributed studs to the bowl-girdle. Similarly the contrasting use of lines and cutting employed to forming the medallion stud CAT.9.21 (fig. 105) compared to escutcheon stud CAT.9.20 (fig.76) may point to two further experienced hands contributing silver grille studs to the chalice. The disparity in the formation of the grilles between CAT.9.7 and CAT.9.8 (fig. 104) and T-shaped studs CAT. 9.13 and CAT. 9.14 (fig. 46) suggests that two hands at least contributed studs to the handles. Thus, the silver grille studs suggest that there is evidence for potentially six craftsmen of varying skill contributing silver grille studs to the Ardagh chalice.

4.41, Silver grille stud-makers on the Ardagh chalice

- **Maker 1-** Contributed stud CAT.9.1 (fig.102) on the bowl girdle of the chalice. (Fig.102) The grille was formed by cutting the lines with a slight curve, resulting in bi-concave and bi-convex lines in places on the grille, however over all it is well cut and glass has permeated into all parts of the grille.
- **Maker 2-** The evidence suggests that this maker was responsible for CAT.9.2, (fig. 45) on the bowl girdle and escutcheon stud 9.20. (Fig. 76) These studs are expertly made and cut with similar thick angular lines which suggest that they may have been produced by the same hand. The red glass is well-cut and remains within the intended *cloisson*. The handling of the grille and each stage of the casting suggests that the maker inherently understand the materials and how to manipulate them.
- **Maker 3-** Maker three contributed CAT.9.3 bowl girdle (Fig. 103). The cutting of the grille suggests a maker still perfecting his craft as the lines of the grilles are uneven suggesting the maker is at the limits of their fine-motor skills and hand-eye co-ordination. The different vitreous elements of the stud suggest that this maker was accomplished at casting but one

section of the grille has not fused, again suggest more was practice required at this minute scale.

- **Maker 4-** The artist who produced the stud CAT. 9.21 (fig. 105) for the medallion was an expert maker who pushed the boundaries of their skill and ability to produce this stud. They consciously chose a more difficult to cut curved pattern and made things more difficult again by choosing to apply five shaped red glass pieces to highlight the complex pattern. Where thick lines will cover the borders between the coloured glass on a stud, this maker has given themselves very little room for error. The incursion of red glass into blue areas at the edge, suggests that the maker was not afraid to make mistakes, to push the boundaries of their craft and recognised that these small mistakes did not take from the overall effect.
- **Maker 5-** Studs CAT.9.7-8 are two small monochrome studs which suggest their maker was less practiced at the craft of forming grilles. (Fig.104) The maker is less spacially aware than other makers evident from the unevenness of the cells.
- **Maker 6-** CAT. 9.13-14 (fig. 46) The maker of these studs was able to produce well- formed grille although casting and fusing the various elements together was successful the fractures in the glass, if accidental, suggest the maker was inherently skilled but required more practice.

Due to the technical differences between the blue and gold studs on the underfoot mount CAT.9.24, (fig.96) and the silver grille studs, CAT. 9.1, CAT. 9.3 and CAT.9.7 and CAT. 9.8, (figs. 102- 105) it is not possible to determine if they were made by the same hand. Given the minute scale, complexity and use of materials it is possible that the work was carried out by an expert maker, perhaps either the medallion stud or the handle escutcheon artist. Similarly it is difficult to assess whether the maker of the enamelled handle-studs CAT. 9.9 and CAT. 9.10 (fig.44) contributed other stud types to the chalice. However it is evident that similar to the other studs on the handles the evidence suggests that the maker of CAT.9.7 and CAT.9.8 (fig. 104) and CAT.9.13 and CAT.9.14 (fig.46) were still developing their skills and understanding of materials and process. In contrast to the other studs groups the monochrome studs on the handles were formed from two materials only and only include silver as a metallic component. These features suggest less experienced craftsmanship was assigned to the handles.

4.42, Silver grille stud-makers on the Derrynaflan paten rim

In common with the Ardagh chalice, monochrome and bi-chrome studs on the rim of the Derrynaflan paten suggest that several individuals of disparate skill may have contributed to the silver grille stud scheme.

- **Maker 1** appears to have contributed only one curvilinear stud to the group of unique studs on the paten rim scheme CAT.1.3 (fig. 109). The design of the grille and the technical approach taken to cast and finish the stud suggests much experimentation to overcome several issues associated with fusing this less open pattern to glass. It suggests an accomplished maker designed and cut the grille and carried out the casting. The small protrusion suggests that the grille was cut down from a pre-existing larger piece of work.
- **Maker 2**, responsible for CAT.1.15 (fig.115) He appears to have been competent at cutting grilles and casting, although less experienced at composing motif at this small scale.
- **Maker 3** demonstrates different cutting technique and compositional understanding to maker 2 suggesting a different hand at work. Their casting technique is much less developed resulting in the poor adhesion to the grille at some points. The overall distortion on CAT. 1.23 (fig.117) and the scrap of foil caught behind the grille. Each step in the process of forming this stud points to an individual who is competent but still gaining experience at this scale of working.
- **Maker 4** may have been responsible for monochrome CAT.1.7 (fig.108) and bi-chrome CAT. 1.4. (fig. 114) Both demonstrate that the maker made two cuts to form the apex of a triangle and the lines are consistently fine throughout and there is evidence of the ability to cut continuous curved lines rather than stilted cuts. Both studs employ the same radial composition with triangular and stepped motif. The extra space afforded in the larger stud (10mm in diameter grille compared to 7mm) was employed to incorporate further detail in the form of four triangles applied to the centre and outer border between the stepped motif. The overall impression is one of a highly experienced maker.

Unlike comparisons made between studs with silver grilles, there are simply not enough common points to determine whether the same hand carried out the work on enamelled and relief studs on the paten. What can be stated with certainty, is that the makers of the silver grilles of the CAT.1.3, (fig.109) and CAT. 1.7, (fig.108) had strong

hand eye co-ordination and the ability to compose complex motif at this scale. Thus they had the potential to form similarly complex patterns in enamelling had they chosen to do so. Whether they produced the complex enamelled or relief studs on the paten will remain unknown. However the common use of fine-lines, similar form and scale, similar insets of gold and illustrative qualities of the enamelled and relief studs suggest that the similar higher level stud-makers may have carried out the work.

4.43, Comparison of the studs on the rim of the Derrynaflan paten to those on the side

In comparison to the rim of the paten, a reduced number of techniques and larger studs characterise the polychrome ornament of the side of the paten. All studs on the side are either enamelled or have silver grilles only. However, unlike the various grilles on the rim, the makers of the side studs chose or were restricted to just two patterns. These display larger motifs that required less skill to make. In some cases, the rectangular form of these studs is a little irregular and the grilles are noticeably misaligned, suggesting issues regarding the fusion of the glass to silver grille during the casting process. Within the silver grilles there is evidence of different levels of complexity. On CAT.131 (fig. 122) there is a basic bi-chrome approach, where a simple rectangle was formed to enhance the design. On CAT.1.33, (fig.123) both yellow and red were applied to create further variation within the same grille design. The lack of experience of the maker of CAT.1.33 is evident in the manner in which the glass has run into adjoining cells and overlapped the misaligned grille. The methods used to cut the grilles on these studs suggest at least three individuals may have been involved in making the silver grille studs for the side of the paten. The silver grilles sampled here suggest that three less experienced makers of varying skill contributed studs to the side of the paten. Thus in total there is evidence for at least seven stud makers of silver grilles on the paten.

4.44, Silver-grille stud-makers on the Derrynaflan paten side

- **Maker 1** CAT.1.31, (fig. 122) was capable of producing a thin grille and applying a well formed and fused backing of red glass. Apart from a misapplied patch of glass, this stud suggest the maker has the potential with practice.
- **Maker 2** CAT. 1.33, (fig.123) the grille cut-marks suggest that this maker was still learning their craft while the application of red and yellow glass suggests that this maker was developing their skill with polychrome materials. Although well fused the excess glass and overspill into other cells suggests an apprentice developing their skill.

Maker 3 CAT.1.35 (fig.121) suggests that the maker was a novice, the grille is irregular and did not fuse adequately to the glass during casting.

Similar to the studs with silver grilles, the enamelled examples are larger and simpler in motif and detail. The rendering of the ornament on CAT.1.36 (fig. 125) suggests less experience with materials and less attention to finishing the motif compared to comparable studs on the paten rim.

4.45, Derrynaflan ring comparison of the studs

Although studs CAT.2.1 and CAT.2.7 (figs.127-8) share a similar patterned grille these are of different sizes, the cut marks suggest that different craftsmen may have formed them. Given the distortion due to the uneven application of glass to CAT.2.5 (fig.129) it is difficult to tell whether the same person may have cut the grille. However, the less successful application of red glass to the composition suggests a third person was involved in making the studs for the ring. The fourth stud in the silver grille sequence is stud CAT.2.3 (fig.126) it is by far the finest stud in the Derrynaflan ring sequence and on a par with stud CAT.1.3 (fig.109) on the ornamental rim of the paten. Based on the evidence from the studs on the ring it is proposed that the studs with silver grilles on the ring may have been produced by up to four different craftsmen.

The enamelled studs on the Derrynaflan ring were all formed using the same pattern die, and the application of opaque yellow and red in alternating sequences. One person could be responsible for these studs, whether they also worked on the silver grille studs is impossible to determine.

4.46, Silver-grille Stud-makers on the Derrynaflan ring

- **Maker 1** CAT.2.3 (fig.126) was made by a highly accomplished stud-maker who was an expert at cutting difficult curved highly complex patterns from silver foil. This aspect of their work and the use of wide ended channels suggest an artist who significantly experimented to develop this type of patterned grille for use in glass studs.
- **Maker 2** The maker of CAT.2.1 (figs.127), was accomplished at combining the various elements together but the fractures in the glass and the distortion of the grille suggest too much pressure during the casting phase. These elements suggest that the maker was still perfecting their craft.

- **Maker 3** CAT.2.7 (figs.128) demonstrates a well-cut grille, and unlike CAT.2.1, excessive pressure was not applied during casting. It suggests a slightly more skilled craftsman.
- **Maker 4** The maker of CAT.2.5(fig.129) was competent at cutting grilles and produced a successful cast suggesting they had mastered the basic elements. The attempt at applying eight opaque red fragments, which underlap into adjoining cells, suggests that they were in the process of developing this aspect of their stud-making skills.

4.47, Workshop practice

From the artefacts included in this study it is clear that stud-makers of various levels of ability and experience were contributing studs for display on an artefact. On the chalice and paten they also appear to have been forming the settings and in some cases the associated mount-settings. On the Ardagh chalice, with its many zones of ornament, the more complex and well-made studs were separated from those that are less accomplished. The finest work is displayed in obvious, prominent positions such as the medallions and escutcheons and also on the underfoot mount, the simplest enamelled and monochrome silver grille were relegated to the handles and displayed in less complex settings. On the Derrynaflan ring there is a mixture of outstanding work, such as CAT.2.3, (fig.126) juxtaposed with CAT.2.5, (fig. 129) which is significantly less well made and on a par with the weaker work assigned to the side of the Derrynaflan paten.

On the Derrynaflan paten, with two key areas of decoration, there is also some apparent segregation of better and lesser quality studs. On the rim at least two places were given to the display of studs CAT.1.15, (fig.115) and CAT.1.23, (fig.117) which demonstrate features which suggest less experience. These were set among the better composed and made work of the maker of CAT.1.7, (fig.108) and the enamelled and high relief virtuosity work CAT.1.2 and CAT.1.20. (figs.119, 67) This mixing of disparate levels of silver grille studs is also found on the Ardagh chalice bowl-girdle where three similar 9mm in diameter studs of disparate skill, CAT.9.2, (fig. 45), CAT.9.3, (fig.103) and CAT.9.1, (fig.102) were juxtaposed.

This may be evidence of the deliberate display of more proficiently made studs in increasingly prominent, or possibly symbolically important places on an artefact. Based on the dimensions and features of the silver grille studs on the Derrynaflan paten rim and the Ardagh chalice bowl-girdle it implies that once a stud-maker could produce

a monochrome or bi-chrome stud with a well cut complex silver grille of approximately 9-10mm their work had achieved a certain benchmark and was assigned to a significant region. Thus separating their studs from the less accomplished examples on the handles and side, but still below the virtuosity levels of the finest studs. As noted in chapter one a goldsmith's status was based upon their ability to practice a number of skills and the fine material in which they worked.⁵³¹ The workmanship on the various zones of the Ardagh chalice and Derrynflan paten suggest that stud craft may have been similarly graded. By analysing the features from the various zones it may be possible to deduce a general idea of the skill levels, materials and training associated with different levels within a general hierarchy associated with these three objects.

4.48, Stud-makers of the Ardagh chalice handles and the Derrynaflan paten side

Elementary level studs are found on the handles of the Ardagh chalice and the side of the Derrynflan paten, they can roughly be broken into two levels, (a) which is simpler and (b) which is more complex.

4.49, Elementary studs level (a)

This work is found on the handles of the Ardagh chalice it is exemplified in studs CAT. 9.7 and CAT. 9.8 (fig.104) characterised by the use of a single colour of glass and simple angular shapes within the grilles. Within CAT.9.8 the inexperience of the stud-maker is evidence in the stud grille which was too small and the irregular lines of the angular grille. The use of an angular grille the same size as the mould prevents the grille misaligning during casting again simplifying the process. As the stud makers only employed one colour of glass this made the process easier to manage overall. This level suggests structured learning taking place and a focus on developing basic core material knowledge and understanding of fundamental techniques. The small size of the studs points to the emphasis on developing skill to work at small scale rather than the production of large complex inlays. The settings associated with these studs are basic and low relief with none of the complexity or elaboration afforded to studs in other regions of the Ardagh chalice.

4.50, Elementary studs level (b)

Enamelled studs on the chalice handles may have also formed part of this elementary group, although some features suggest that they are more developed and given more freedom to experiment. CAT.9.9 and CAT.9.10 (fig. 44) demonstrate opaque

⁵³¹ McLeod, 'Metalworking Tradition in Medieval Irish Law,' 103; Kelly, *Guide to Early Irish Law*,.

red glass applied to a background of blue, these studs are set in the most prominent part of the handle and this may imply a certain preferential treatment within the scheme. The channels for the opaque red glass are too wide, and the border of blue glass too thin. This resulted in distortion within the pattern during heating and the ultimate loss of the inlay as the opaque red glass did not have enough support.⁵³² In a development of the enamelled studs found on the Ardagh chalice handles CAT.9.9 and CAT.9.10 (fig. 44), the examples on the paten side CAT.1.36 (fig. 125) include both opaque yellow and red and the channels are much thinner and better formed. The enamelled variety on the Derrynaflan paten side demonstrate an attempt to imitate the use of alternating red and yellow glass found on the enamelled studs CAT. 1.5, (fig. 56) and CAT.1.2, (fig.119), on the rim.

On the sides of the Derrynaflan paten the less-accomplished stud-makers created more complex grilles and experimented with shaping and forming opaque red and yellow glass into forms appropriate for spaces within openwork grilles CAT.1.35, (fig.121); CAT.1.31, (fig.122) and CAT.1.33, (fig. 123). As the opaque red and yellow enamel are found beyond their intended cells in CAT.1.33, (fig. 124) this suggests that the junior stud-makers had not yet developed their material knowledge to the degree that they could estimate the correct volume to use, or predict how the material would respond to heat and pressure during casting. The grilles do not match the size of the mould and therefore casting was more difficult as the artificer had to try and apply the backing glass without moving the grille. The misshapen grilles and off centre grilles on the Derrynaflan ring and paten side suggest that in some cases too much pressure was applied when adding the backing of blue glass. The miscoloured area on CAT.1.31, (fig.122) may be as a result of the blue glass applied unevenly and not quickly enough and/or cooling too slowly.

The colour variations created by applying different colours to different cells suggest that the artificers were experimenting with colour and pattern combinations at this early stage. Evidence of this is also found in the enamelled studs on the paten side where it is clear that the less experienced stud makers were imitating effects created on the more sophisticated studs on the surface. CAT.1.36, (fig.125) demonstrates the use of two effects found on the surface studs, the centre cross evidences the effect of overlapping ribbons also found on stud CAT. 1.5. (fig. 56) While stud CAT.1.2 (fig. 119)

⁵³² See the thin channels in the Lagore *Crannóg* stud, CAT.6.1, with thicker edging which provides more structure to resist deforming occurring during heating and fusing. (fig. 51)

displays more complex approach to using alternating red and yellow glass within a continuous pattern.

Although larger than the comparable Derrynaflan paten rim studs, which are 9mm, the ornament was confined to recessed lattice work pattern 12.5mm by 8.4mm, CAT.1.36, (fig.125) and grilles measuring 13.17mm by 9.02mm on CAT.1.35, (fig. 121). Thus the polychrome detail being formed by the less-accomplished stud-makers was beginning to approach the smaller sizes associated with the studs on the Derrynaflan paten rim and the Ardagh chalice bowl-girdle. As the studs themselves measure approximately 14mm by 12mm it is possible that the junior stud makers may have started off working at this larger size and were in the process of honing their fine-motor skills and attempting to reduce the scale in which they worked.

On the Derrynaflan paten, studs of this type, such as CAT.1.33, (fig.123) were secured into identical gilt copper-alloy mounts using silver ribbon and a layer of beaded wire. This in conjunction with the silver foils on the studs themselves may indicate that training in rudimentary silver working such as forming beaded wire, casting and perhaps fire gilding was taking place. The simplicity of the paten mounts and the handling of the silver ribbon collet and surround of wire suggest the work of a novice. On the Derrynaflan ring the rectangular studs are housed in embossed copper-alloy sheet. It is evident that the embossed bronze sheet surrounding stud CAT.2.7 (fig. 128), is not centred and is at an angle. Overall, the execution was quite basic and suggests the development of basic skills rather than the pristine finish found on the adjoining silver foils on the ring. It suggests that the less experienced metalworkers were forming elements in copper-alloy before progressing to more precious materials.

The evidence from these examples suggests that elementary training included gaining material knowledge and the formation of basic techniques such as monochrome studs with silver grilles and later enamelled studs. Stud sizes were small in the basic monochrome variety but once additional complexity was added to the process the junior stud makers were given an increased area to work upon to hone their skill, before the dimensions were reduced. The use of common grilles suggests less design freedom but there was experimentation taking place with opaque red and yellow enamel. Junior stud makers also appear to have been involved in making their own stud settings. Based on the examples on the paten, chalice and ring forming embossed copper-alloy foils, an introduction to forming beaded wire and simple settings may have been undertaken at

this phase. The use of materials including blue glass, opaque red and yellow glass, copper-alloy and silver, in conjunction with the ability to form an enamelled glass stud imply that *champlevé* enamelling was part of the skill set of this level of craftsman. Indeed many extant *champlevé* castings are much larger and the levels of skill material and technical skill evident at this stage imply the ability to compose and create much a larger *champlevé* mount such as Cooloure Demense plaque CAT.14.1 (fig.19), or *champlevé* studs of the type found on the Monymusk Reliquary. (figs. 78-9)

4.51, Intermediate level studs on the bowl-girdle of the Ardagh chalice and Derrynaflan paten rim

This grade can be broken into two groups; the less experienced makers who produced the less well-designed and made examples, and those who were more experienced.

On the bowl girdle of the Ardagh chalice there are disparate studs with silver grilles, some are simple blue glass and others are red and blue glass. The grille on stud CAT.9.3 (fig.103) is much less well formed than either CAT.9.1 (fig.102) or CAT.9.2 (fig.45) that is almost on a par with the polychrome studs on the escutcheons. (fig.65) However, these studs are a significant development in terms of creating a grille and applying opaque red glass compared to the examples on the side of the Derrynaflan paten, CAT.1.31, (fig. 122) or the monochrome examples on the Ardagh chalice handles, CAT. 9.13-4, (fig. 46). The unique examples on the Derrynaflan paten rim suggest that the makers of these studs had more creative freedom and designed their own compositions, as evidenced by the unusual motif and a-typical colouring of stud features within stud CAT.1.15, (fig.115) and CAT.1.23, (fig.117), which are at the lower end of the intermediate scale. Similar to stud CAT.9.2, (fig. 45) enamelled stud CAT.1.5, (fig. 56), demonstrates design clarity and a minute detailed pattern which is designed to be read in different ways. It is possible that this maker was at the higher end of the intermediate scale or also associated with advanced metalworking.

The Ardagh chalice bowl-girdle studs were set within more intricate and elaborate settings that protrude from the artefact and were formed from different types of silver beaded and twisted wire. This may be evidence of the development of the initial training in beaded wire found with the studs on the chalice handle and at the side of the paten. It may also point to a practice of learning to form the filigree components in silver first, prior to transitioning to gold filigree. The structure and execution of the mounts on the bowl-girdle suggest that a highly skilled individual was at least closely

involved. It may be that the goldsmith who produced the adjacent gold filigree panels or the more accomplished studs on the bowl-girdle was involved and supervised the production of the silver stud mounts. Further evidence that craftsmen at this level may have been introduced to filigree during this stage is found on the mount of stud CAT.1.23, (fig.120) In this case, silver beaded wire was employed and a particularly finely made ribbon of gold filigree. The beaded silver wire and filigree ribbon has been cut slightly too short and a small gap is evident suggesting a less skilled individual carried out the work.⁵³³

Contemporary law tracts highlight that silver was next in importance to gold and a transition between the two materials in this manner may have been appropriate within a workshop setting.⁵³⁴ Just as there is evidence of rudimentary copper-alloy working alongside silver at the elementary stud making phase on the Derrynaflan ring, on the chalice there seems to be evidence of the introduction of filigree working, starting with the basic techniques of bead making and wire twisting in silver, incorporating finished ribbon to enhance the work. (fig.120) The expertise found in the finer silver grille studs from this category suggests that that they may have been simpler versions made by advanced stud makers. This expertise is implied by the outstanding levels of detail and handling of material found on studs such as CAT.1.7, (fig. 108) and CAT.1.5 (fig.56)

4.52, Advanced studs found on the rim of the Derrynaflan paten and Ardagh chalice medallion, escutcheon and underfoot mount

The rim of the Derrynaflan paten demonstrates some of the finest studs in Insular metalwork, matched only by the studs on the Ardagh chalice medallions stud CAT. 9.21, handle escutcheon mount stud CAT.9.20 and the underfoot mount stud CAT. 9.24. (figs. 105, 76, 96) The Derrynaflan paten studs demonstrate several common features. Firstly, they share basic techniques and materials. There are silver grilles, CAT.1.4, enamelled, CAT.1.2 and studs with relief ornament, CAT.1.20. (figs. 114, 119, 67) These studs are expertly made and are significantly developed in the hands of a master craftsman. Enamelled glass includes silver ribbon, CAT. 1.14 and the addition of complex gold filigree, CAT. 1.20. (figs. 48, 67) As with intermediate studs, the ability to produce small scale work is an important feature. While there are some studs that are

⁵³³ Compared to CAT.1.5, where the more experienced stud maker over lapped the ribbon to avoid a gap. (fig.56)

⁵³⁴ Colmán Etchingham and Catherine Swift, 'English and Pictish Terms for Brooch in an Eighth-Century Irish Law-Text,' *Medieval Archaeology* 48(2004), 47.

larger than 9mm – ranging from 14mm-17.2mm. (CAT. 1.20; CAT. 1.14; CAT. 1.2) – in these examples the extra space is always associated with the inclusion of additional complex detail. For instance the annular field on CAT.1.20 (fig. 67) is approximately 5mm in width and filled with four concentric rings of ornament. The emphasis on small size and detail within studs is further underlined by the creation of stud CAT. 9.24, (fig. 96), 4mm glass and gold studs on the base of the Ardagh chalice, made from four separate components fused together. The finer stud mounts on the escutcheons of the Ardagh chalice demonstrate particularly creative use of amber, gold filigree and trichinopoly settings on studs CAT. 9.20 and CAT.9.19. (figs.76, 65) This implies that these skills formed part of the stud-maker repertoire at this advanced stage and aligns with the multitude of skills expected of a senior goldsmith in the law tracts.⁵³⁵

While amber appears on the chalice in association with these studs, this cannot be taken as evidence that the material is associated with the higher grades of craftsman. As outlined in chapter three and above, technically amber shaping is closely related to working opaque red glass, therefore an elementary or intermediate stud worker had the potential to create basic amber studs CAT.17.1, and CAT.17.5, found on the Lough Kinale bookshrine. (figs.63-4) It is the application of amber of the Ardagh chalice, into the thin annular channels of the underfoot mount CAT.15.3, (fig. 101) and handle escutcheons over malachite, CAT.15.1, (fig.65) which mark it out as a superior technical examples of amber use.

4.53, Studs and illustration

In a development of the experimentation with colour and composition found at the intermediate stage on these artefacts, advanced studs demonstrate developed motifs and the ability to create compositions and integrated ornament which can be read in a number of ways. This is found in silver grilles on the central medallion stud of the Ardagh chalice, CAT.9.21, where triquetra interlace forming a cross and the inclusion of minute complex red glass elevate it from the simpler counterparts on the bowl-girdle, CAT.9.2. (figs.105, 45)

The similarities in the materials outlined in Chapter Two and use of common materials such as copper-acetate, gypsum and orpiment imply a dialogue was taking place between the goldsmith's atelier and the scriptorium or painters.⁵³⁶ But Irish stud-

⁵³⁵ McLeod, 'Metalworking Tradition,' p.103

⁵³⁶ Little remains of the interior furnishings of churches, what we are left with are the descriptions of Cogitosus and the depictions within the Book of Kells folio 202v, fig.38, to indicate

makers who practiced enamelling into glass in particular must have been influenced by more than just the materials employed by the illuminators. We have seen that the ability to render and illustrate complex motifs and the development of the aesthetic aptitude of the stud maker is found at early stages in their training. The use of illustrative methods within enamelled studs perhaps records deeper connections which ultimately led to sharing between the two disciplines.

4.54, Stud-makers borrowing from other disciplines

There is an attempt at basic perspective on stud CAT.1.15, (fig.56). Where the red glass extends between the knots, this creates the impression that the yellow glass is running underneath the red ribbon. This is similar to the approach employed to depict interlace on the Book of Durrow *folio* 85v, the Lindisfarne Gospels 94b and the Book of Kells *folio* 291v. (figs. 132-5) In CAT.1.14 (fig.47), the stud is broken into concentric zones similar to the central medallion on the Book of Durrow *folio* 85v, Lindisfarne Gospels *folio* 94b (figs.133-4) and the nimbus on *folio* 291v of the Book of Kells. (fig. 135) Further comparisons with the interlace on Durrow *folio* 85v are found in the lines of red interlace that have a white border, similar to the application of silver foil ribbon to the edge of the red ornament within stud CAT.1.14. (fig. 47) In stud CAT.1.2 (fig.119) each swastika is filled with alternating opaque yellow or red glass similar to the colouring of the interlaced annular border on the cross carpet page of the Lindisfarne Gospels *folio* 94b. (fig.134) In both cases, individual components of the design are rendered in different colours. In most enamelled studs, particularly CAT. 1.2 (fig.119), CAT.1.36 (fig.125) and CAT.1.5 (fig.56), the colours are presented against exceptionally dark backgrounds, which provide the maximum contrast for the opaque red and yellow enamel. This may have been drawn from the scriptorium practice of highlighting interlace against a carbon black or oak gall backgrounds, evident, for example in the Book of Durrow on *folio* 85v and Lindisfarne 94b. (figs.133-4) The aim of imitating the illuminators' work may also have resulted in the maker of identical studs CAT.1.5, (fig.56) and CAT.1.19, (fig.71) sourcing and using the only example of opaque black glass on the paten identified by this study. On the malachite and amber inlays of the Ardagh chalice, CAT.15.1,(fig.65) and the green glass studs with painted orpiment stepped motif, CAT.5.1,(fig.52) the maker layered colour and painted on detail much as the illuminators did to create effects within manuscripts. Within the green and yellow enamelled studs on the Derrynaflan ring, CAT.2.4, (fig. 131), we find the same effect

how they may have been ornamented. These suggest brightly coloured interiors potentially achieved by painting, perhaps using the same or similar materials and carried out by illuminators.

carried out entirely in enamelled glass. Comparable layering and application of detail in contrasting colours was carried out on the robes and nimbus of the Evangelist John on *folio 291v* of the Book of Kells. (fig. 135)

It is unlikely that the maker of enamelled studs was drawing inspiration solely from illumination, but also from other visual art forms within their environment as described by Cogitosus in his description of the church of Ss Brigid and Conlaed.⁵³⁷ Other more fragile art forms which may have acted as sources, such as painted carvings or wall paintings have not survived, leaving only manuscripts for comparison. However other features suggest two-dimensional crafts such as illumination, were sourced for illustrative methods. The typically flat enamelled surfaces employed over other surface forms point to the enamelled stud maker emulating two-dimensional representation rather than high relief art-forms. Furthermore if the stud-maker was emulating *champlevé* enamelling, surely they would have employed this technique or used copper-alloy grilles to separate colours similar to the studs on the Derrynaflan strainer-ladle. Perhaps just as manuscript designs were rendered in stone, these designs were also rendered in glass, harnessing the permanency and significance of the materials. What is certain is that the ability to compose and illustrate high quality motifs in glass was an important skill associated with advanced stud design and creation.

Working in ink would have permitted a flexibility and speed not available in enamelling and thus greater flexibility to develop the graphic element and to explore other designs and potential combinations. It is evident from illustrations of metalwork in Insular Gospels, that both disciplines were looking to the other for aesthetic considerations, but once certain highly skilled stud makers achieved fluency with their vitreous material it allowed much greater illustrative detail to be achieved in glass. Given the variation it is also possible that craftsmen were developing designs in two-dimensional form on wax tablets or whatever material was to hand, such as bone and translating this to stud-making.

As aesthetic ability was a clearly a component of the training within an atelier and a significant feature of advanced stud making skills, it follows that stud makers sought inspiration from other disciplines and were influenced by their environment. The interaction between stud-making and illumination could have taken place in two ways.

⁵³⁷ 'Cogitosus: Life of Saint Brigit', eds Sean Connolly and Jean-Michele Picard, *Journal of the Royal Society of Antiquaries of Ireland*, 117 (1987), 11-27 at 25.

The stud-maker may have scrutinised the forms and made a study of the design methods used in illumination or drawn inspiration from visits to churches and ecclesiastical sites as described by Cogitosus.⁵³⁸ The second approach is prompted by the dual role ascribed to goldsmiths outside of Ireland at this time. The Anglo-Saxons, Spearfahoc, Abbott Mannig and Theophilus practiced as painters and gold-smiths.⁵³⁹ It is possible that some elite stud-makers-goldsmiths also practiced as illuminators. By experimenting in red ink and yellow orpiment, woad based blue dye and carbon black the designer could have conceived ideas and worked at scales which would not have occurred to them if restricted to one material. Designs in ink may have created new avenues to explore and contributed to the outstanding skill and techniques evident in metalwork. As we have seen throughout this study of technique and material, Insular stud makers were actively adapting materials and cross-applying techniques from within the Insular milieu, it follows that illumination or painting was also sourced in some way. This is not to imply that all stud-makers or goldsmiths worked as illuminators, but to suggest that some key individuals did and passed their innovative approach into the metalworking milieu, either through instruction and the apprenticeship system or transmitted to unrelated craftsmen who attempted to imitate their work. Among the enamelled studs on the side of the Derrynaflan paten there is evidence of stud CAT.1.36, (fig.125) emulating the illustrative approach employed on the surface studs CAT.1.19 and CAT.1.2. (figs.71, 119)

The evidence from the Ardagh chalice and Derrynaflan paten suggest that the most accomplished grade of stud-makers were versed in a wide variety of materials techniques and skills and created both simpler and more complex examples which can be classed as expertly made intermediate or advanced studs. Gold was also associated with this group. However, it was not displayed gratuitously but harnessed for its flexible working properties and rendered into a stud design in an aesthetic way.⁵⁴⁰ It was used to display the technical virtuosity of the maker. This group had mastered the skills and material knowledge associated with elementary and intermediate copper-and silver smiths. In addition, they had developed the fine-motor skills and design acumen to differentiate their work from lower grades using scale, aesthetic and technical expertise.

⁵³⁸ 'Cogitosus: Life of Saint Brigit', eds. Connolly and Picard, 11-27 at 25

⁵³⁹ Dodwell, *Anglo-Saxon Art*, pp.208-9; see also the range of medieval artistic techniques within *Theophilus, on Divers Arts*.

⁵⁴⁰ This expert use of gold is in contrast to areas of gilt silver or poorer gold filigree associated with the Killamery or Roscrea brooches. (figs. 54, 36.)

While gold was used by this group the emphasis in elite stud making is on technical virtuosity and the production of graphic detail which invite scrutiny.

4.55, Workshop practice- implications

Analysis of a selection of studs from the Derrynaflan paten suggests the possibility that four intermediate/advanced stud makers contributed silver grille studs to the paten rim. Three apprentices worked on the silver grille studs on the paten side. The disparity in skills evident within the elementary and intermediate levels suggests a mixed ability setting with a number of highly trained stud makers working alongside and teaching apprentices. It would appear that the junior members were involved in preparing material such as beaded wire and embossing foil suggesting their involvement in many aspects of artefact making. The fact that there is evidence of elementary work on the same artefact as the advanced makers implies a workshop system which rewarded achievement and actively promoted the development of apprentices. While others may interpret this as conservation of precious material it is relatively easy to heat and separate silver foil from glass and recycle the material, if one is not happy with the result. Secondly, as Irish craftsmen had significant control over the supply of materials, technical virtuosity and aesthetics were the elements which brought value to studs. This fact is reinforced by the evidence which suggest the aim was to create minute detail and stud forms rather than produce large scale work. By setting the less accomplished work of the apprentice alongside the masters, they were encouraged to improve and reach the next milestone. Overall, the harmonious composition on these artefacts suggests a group who had much practice at working together and may also indicate a workshop master overseeing proceedings. Over all supervision may be suggested by the lettering system used to organise the studs and underlying plates into the correct position on the Derrynaflan paten.⁵⁴¹ While this group of artefacts suggest multiple hands. One cannot presume that all artefacts were formed in this manner, it is possible that each craftsman also worked or managed individual projects such as the 'Tara' brooch. (fig.7)

The fact that there was enough work for all is hinted at by the design of complex Insular artefacts and individual components. It suggests that the ability to produce multiple copies of an artefact was embedded into the design. The handles of the Ardagh chalice (figs. 17, 46) and the rim of the paten (figs.31, 67) demonstrate that while the structure of the artefacts may have been standardised, the recesses for ornament, such

⁵⁴¹Ryan 'The Derrynaflan Hoard and Early Irish Art,'; Michelle Brown has suggested the ornament may have been used to facilitate the complex fraction of the Eucharistic bread on the paten. Brown, 'Paten and Purpose,' pp.164-5.

as filigree, studs, embossed panels, and trichinopoly permitted it to be rearranged and reimagined on other versions. It is also highly possible that individual components such as handles and mounts could be changed as required within an artefact series. The stud settings on the side of the paten certainly suggest a generic type which could easily have been substituted or interchanged for other ornamental inlays. (CAT.1.31) (fig.122)

Therefore the glass studs on one version could have been replaced with matching filigree or embossed foil panels on another. Using this method, the relatively simply ornamented Derrynaflan ring may, in another manifestation have had gold filigree elements or gilt –embossed silver foils similar to the Derrynaflan paten. The design of the handles on the Ardagh chalice suggest that T-shaped filigree panels could have been made for the border recesses while rectangular and square shaped studs could have been formed for the central recesses which are filled with gold filigree. (fig.82) Given this design approach to forming artefacts and the potentially large numbers of craftsmen contributing silver grille studs to each artefact, we find evidence of a busy and dynamic workshop.

The individuality emerging within stud compositions, particularly from intermediate level raises a further point. To what degree were studs, particularly advanced examples used as ‘signatures’ by their maker? While to the uninitiated these may appear uniform, closer scrutiny of the detail shows that the character was quite different between different designers. To have ones work placed on a principal region of an artefact such as the paten or chalice may have had positive professional implications for future commissions in terms of prestige and advertisement.

4.56, Workshop connections

4.57, Comparison of similar studs on the Derrynaflan paten CAT.1.3 and ring CAT.2.3

The general similarities in ornament such as the embossed silver grilles and rectangular studs are proposed as evidence of common workshop tradition between the Derrynaflan Ring and Paten. The comparisons between the silver grilles of the paten stud CAT.1.3, (fig. 109) and ring -stud CAT.2.3, (fig.126) are striking and worth exploring to determine whether a link exists. The skill of the CAT.1.3, (fig. 109) and CAT.2.3,(fig.126) artist(s) is evident in the uniform width of the silver grille and proportionate measurements and use of space throughout to achieve legible motif within the complex designs. In general, the Derrynaflan paten and ring studs of this type have at their outermost edge an annular border of glass separating the grille from the setting. In the case of CAT.1.3, (fig. 109) and CAT.2.3, (fig.126) the grilles closely match

the dimensions of the stud. The ends of the spirals on both CAT.1.3, (fig. 109) and CAT.2.3, (fig.126) terminate in points which fold back upon themselves and integrate into other elements of the design. In both studs the trumpet forms have their central region cut away to form the device. Similarly on both grilles the artists appear to have been able to remove remarkably fine sections of foil to allow curved parallel lines flow alongside one another or for pointed motif to approach another form but not quite meet or overlap. The ends of the channels terminate in curved sections or flat edges on both. The central triskele on CAT.1.3, (fig. 109) and the examples on CAT.2.3, (fig.126) demonstrate a similar approach to cutting away foil in this intricate region. These points infer that both grilles were the handiwork of the same individual. While both studs employ the same glass, this does not imply that they were made at the same time, as we have seen blue was a prevalent colour during this period. A minute foil with such a complex pattern was extremely fragile, the craftsman who fused these grilles to their background was clearly able to lay them out so that the elements did not overlap or become entangled or distorted during heating. It is possible that either stud could have been relatively old workshop stock, or recycled from an earlier damaged artefact returned to the workshop for repairs or an upgrade. But either point provides a potential concrete link between the manufacture of both artefacts, beyond the similarities in general form and ornament or find position within the hoard.⁵⁴² The potential connection between these two studs, points to a relatively similar period of manufacture as suggested by Michael Ryan.⁵⁴³ It also suggests that an accomplished stud-maker was potentially involved in providing material for both artefacts. It may also be an indicator that this individual was the senior craftsman on this artefact and oversaw the production or assembly of the piece. While later craftsmen inscribed their name on artefacts alongside that of the patron and dedicatory saint, in this period craftsmen may have used visual literacy, the medium in which they were experts as the method of marking their involvement.

4.58, Workshop connections Ardagh chalice and Derrynaflan paten

The subtle differences detectable from such a detailed study as outlined above is useful when it comes to the comparison between artefacts, and a review of the work of similar hands and relative chronology. Although workshop connections have been proposed for the Ardagh chalice and Derrynaflan paten, reliant in part on stud design, the generally similar appearance of Ardagh chalice stud CAT.9.1, (fig. 102) and

⁵⁴² Ryan, *The Derrynaflan Hoard I*, p.38.

⁵⁴³ *Ibid.*

Derrynaflan paten stud CAT.1.7, (fig. 108) this examination suggests very different techniques in cutting the grille, and therefore different hands.⁵⁴⁴ However, this is not an exact science and it does not follow that the Ardagh chalice and Derrynaflan paten are not from the same workshop tradition as proposed by Michael Ryan.⁵⁴⁵ In fact, it is suggested that both artefacts and the Derrynaflan ring were designed and the production of their studs managed in very similar ways, which may point to a common workshop tradition or goldsmith's school for these artefacts.

4.59, Chronology and Dating during the Early Christian period

Ryan has suggested that the Derrynaflan ring was made as an afterthought to function as a foot for the paten.⁵⁴⁶ (fig.107) Despite the evidence from the studs which suggests workshop links between the artefacts, there is no definitive way of determining which artefact was produced first. Similarly, in connection with the Ardagh chalice, the techniques employed to make the studs shed little light on whether the artefact was produced before or after the Derrynaflan ring or the paten.

In terms of dating, traditionally amber use has been associated with the coming of the Vikings, and so ascribed to the ninth century, replacing polychrome glass studs that had reached their apogee in the eighth century. There is no amber on the Derrynaflan paten or the ring to compare with, but the Ardagh chalice contains amber on display alongside polychrome glass. The examples on display on the chalice, illustrate much evidence regarding the cross-application of material knowledge of opaque red glass and technical process from *champlevé* enamelling applied to the amber surrounds on the handle escutcheons CAT.15.1, (fig.65) and underfoot mounts. CAT. 15.3, (fig.101)

As we have seen metalwork components were made using repeatable techniques which allow the creation of accurate multiples, such as the pair of handles and escutcheons of the Ardagh and Derrynaflan chalices, multiple brooch moulds and mounts. Furthermore, the form and design of the settings assigned to the rectangular studs on the side of the Derrynaflan paten suggest they are a 'generic' multiple production component assigned to positions such as the embossed foils and studs on the side of the Derrynaflan paten. (Fig. 16) This hypothesis comes from the fact that the setting is overlaid over the trichinopoly and secured in the centre, rather than at the

⁵⁴⁴ Whitfield similarly noted that the gold filigree of the paten was different to that of the chalice. 'Filigree Animal Ornament from Ireland and Scotland,' p.231.

⁵⁴⁵ Ryan, *The Derrynaflan Hoard I*, p.38.

⁵⁴⁶ Ibid.

four corners as on the Derrynaflan ring. (fig. 128) Applied mounts usually have three to four minimum connection points as on the Derrynaflan ring and Ardagh chalice handle escutcheons disguised under small studs. (fig.49) Secondly the studs are not a perfect match to the aperture, hence the need for the beading and silver strip which obscures the ornament on the setting. This use of repeatable components and the detail invested into them suggests that the master dies of component such as handles, stems, hinge mounts, could be re-used on the production of other later artefacts. For example the die used to form the rectangular settings assigned to the sides of the paten could have been used to produce eight mounts to hold the rectangular studs on a sister manifestation of the Derrynaflan ring. (figs.16, 128) Or the master die of the handles of the Ardagh and Derrynaflan chalice had the potential to be reused on other chalices. (figs.82, 25) There is evidence of much repeat production within metalwork artefacts themselves and the technical processes developed to produce them, that it follows that these detailed components were reused elsewhere.

Secondly this approach apart from being highly efficient also allows a degree of versatility, mounts could be cast in bronze as on the Ardagh chalice stem and gilded, bronze was also tinned to imitate the effect of silver as on the Derrynaflan paten. On the 'Tara' brooch a silver cast was first made and then gilded. Therefore, in theory a master die could have been used in any of these ways dependant on the availability of materials and simply reformatted according to need. This is also evident with embossing, on the Ardagh chalice and Derrynaflan paten embossed silver foils are found, those on the side of the paten are gilded silver, while those on the ring are embossed copper-alloy. (figs. 16, 128)

Tools are kept and employed on different tasks, it follows that equipment such as master dies and stamps/moulds for embossing were kept and reused on different commissions. This idea is also hinted at by the use of geometry and rules and a measurement system has been suggested by Whitfield. This implies that the extant artefacts are potentially a snapshot of one potential 'material' option produced by a workshop at a particular point in time. It is possible that within the same workshop a richer version with more emphasis on silver and gilding was in production as evidenced by the Ardagh chalice or a less lavish version made using the same dies to form the same embossed foils in copper alloy as on the Derrynaflan ring which could be tinned or gilded. (Fig. 128) Similarly the recesses on the foot ring of the Ardagh chalice are ornamented with alternating trichinopoly and embossed panels, also pointing to

interchangeability of ornament. (fig. 27) The terminals on the obverse of the 'Tara' brooch display filigree while the matching panels on the reverse of the terminals are filled with 'Cortinthian' bronze. (figs.7, 24) Similarly the basic generic form of the settings with sub-conical forms on the 'Tara' brooch (figs.85, 99) and Lough Gara buckle (fig.20) and many other artefacts were developed to allow either materials be housed within. In the case of the medallions of the Ardagh chalice we have identical settings housing both materials within the same mount. (figs.80, 106)

Just as glass studs can be divided into four basic techniques, similar approaches were developed and applied to both amber stud-making, suggesting that these developments took place alongside one another rather than consecutively. The cast copper-alloy Lough Gara buckle, CAT.8 (fig.20) demonstrates *champlevé* enamelling with recesses filled with both opaque glass and amber side by side. Similarly, the sub-conical form of many settings appears to have been developed to house both glass and amber, as on the medallion of the Ardagh chalice, suggesting that they were interchangeable within an artefact. The same small sub-conical type of setting appear on the Derrynaflan ring (fig. 128) suggesting that these setting could also have been adapted to amber. Beyond these artefacts we see the same type of angled sub-rectangular settings, cast in silver, employed to house blue glass on the base of the Ardagh chalice (fig.27) and gilded with amber on the ring of the Hunterston brooch. (fig.8). Within the Derrynaflan strainer-ladle CAT.3.1 (fig.95) we find a comparable cast setting in copper-alloy only filled with a red glass stud and copper-alloy grille. We have already seen the close problem solving and technical links between working red glass studs such as this and the amber and lead-tin grille stud from the Lough Kinale Bookshrine CAT.17.5. (fig.97)

While it could be argued that the chalice and 'Tara' brooch demonstrate quite small amounts of amber, the expert and individual manner in which it is employed suggests that it is a material with which the maker had much experience and practice. Pointing to ample supplies which facilitated the development of these skills. If the material was scarce and little practice afforded, one would expect a much more generic approach to designing and handling such as shaping it into simple forms. However, within the 'Tara' brooch we have examples of combining the material with gold in different ways and combining it with malachite and in fusing it into channels in the manner associated with *champlevé* enamels on the Ardagh chalice.

Further evidence of the concurrent use of both amber and glass has been referred to earlier, from three high status metalworking sites in Ireland, Ballinderry *Crannóg* Co. Offaly, Lagore *Crannóg* and Knowth Co. Meath. These sites point to the manufacture and setting of both glass and amber studs on metalwork within the same workshop. While at 46-8 Scotch St. Armagh we have evidence of raw glass and amber within a workshop further suggesting the use of both materials side by side.⁵⁴⁷ When we consider the major artefacts which are ornamented with both materials including examples from the Ardagh and Derrynaflan hoards, evidence for a significant number of workshops with stud-makers fluent in both glass and amber-working emerges. (appendix 6)

The availability of the material and cultural significance in the preceding period alongside glass, the appearance of both materials on the same artefacts, the adaptability of standard settings to both materials, and the same technical approaches applied to both materials; suggests that glass did not give way to amber but rather that both materials were employed alongside one another. This interchangeability suggests that just as artefacts such as the Derrynaflan paten, ring and strainer-ladle were decorated just with polychrome glass studs, other versions with just amber or a mix of amber and glass ornament, as found on the 'Tara' brooch and Ardagh chalice may have been created at some point during the production line of an artefact. This evidence suggests that ascribing an eighth-century date based upon polychrome glass or the attribution of a ninth-century date based on glass or amber use may be unsafe and distort our understanding of design and production within the Insular goldsmiths atelier.

While it is proposed that it is not possible to accurately date artefacts on the basis of the method of manufacture of studs, is there any way of establishing patterns of how methods and techniques might have been developed? As outlined in chapter one, it is not until the eleventh century that fine metalwork objects begin to incorporate inscriptions that allow for a more secure method of dating. Examination of studs on two such dated objects, the Cross of Cong and Lismore crozier therefore has the potential to reveal much about this question, addressing, for example, whether there was continuity in this field of fine metalwork, or whether later examples reflect an attempt to copy the aesthetic, but not the technique of earlier masterworks.

⁵⁴⁷ For Amber studs at Lagore *Crannóg* see Hencken, 'Lagore *Crannóg*,' 151, figs. 74, 776. For Ballinderry *Crannóg* see Hencken, 'Ballinderry *Crannóg*, No.2' figs. 21, 75. For glass see page 58; for glass and amber at Knowth, Co. Meath, see Murray, 'Stud of Amber and Glass', pp.544-50. C. Lynn, Excavations at Scotch St, 69-84 and also Susan Youngs, 'Fragments of Amber', p.208, no. 216. For glass and amber at 46-8 Scotch St. Armagh.

4.60, Later enamelled studs on the Cross of Cong and Lismore crozier

The Cross of Cong is an early twelfth-century cross made under the patronage of the high king Turlough O'Connor to enshrine a piece of the true cross by Mael Isú.⁵⁴⁸ (fig.42) It is made from decorative copper-alloy plates secured to a wooden armature. Ornamentation includes gold filigree, silver plating, polychrome glass and enamelled studs. Three blue and white studs remain on the cross, two on the front and one on the reverse found on the knop. The reverse also originally contained eighteen red and blue enamelled studs, two of which are lost. A representative sample will be selected for discussion. (appendix 8, diagram 4)

4.61, Traditional enamelled stud from the knop of the Cross of Cong CAT. 12.1

Stud CAT. 12.1, on the knop is 15 mm in diameter and 3.1mm high approximately. (fig.57) A clay mould was formed and stamped with the imprint of the intended pattern as found on the Lagore *Crannóg*, Co. Meath stud and mould. (fig. 51) This was filled with deep blue glass, once cooled and removed from the mould the stud recesses were filled with white enamel. The stud is well made and formed into a domed shape. Similar studs, such as CAT. 13.7, are found on the knop of the Lismore crozier.⁵⁴⁹ (fig. 136)

4.62, Enamelled stud twelfth-century variant CAT.12.3

The studs on the reverse of the Cross of Cong are a particular variation of the enamelled stud variety which utilises two low temperature glasses and a copper-alloy support to keep the elements together during heating as found on (CAT.12.3). (fig.88) The higher melting point glass, opaque yellow, formed the primary structural material. It was cast with the intended yellow pattern in high relief as described above, when removed from the mould the yellow panel was set into the copper alloy tray.⁵⁵⁰ The shallow recesses were filled with opaque red enamel in powdered form and fused in place within the copper-alloy tray. The top of the panel was levelled by gentle grinding to remove surplus material. The merging of red into the yellow suggests that greater finishing and removal of material could have occurred, but given the thinness of the red layer it is likely that the maker did not want to over work the material and remove the enamel inlay.

⁵⁴⁸ Murray, *Cross of Cong*, p.112.

⁵⁴⁹ CAT. 13.7, fig. 136

⁵⁵⁰ CAT.12.3

4.63, Millefiori twelfth-century examples

4.64, Lismore crozier mosaic glass studs

The Lismore crozier is formed from copper alloy panels pinned to a wooden core. It was made by the craftsman Neachtain for Niall Mac Meic Aeducain, the Bishop of Lismore, who died in AD 1123.⁵⁵¹ (fig. 40) Originally there were twenty-six studs on the crozier set among gold filigree or perhaps gilt openwork plaques. Ten inlays of blue and white *millefiori* with borders of red glass ornament the sides of the drop, while the applied ornament on the obverse of the drop is lost. Several variations of mosaic glass were employed on the crozier, a selection will be outlined. (appendix 8, diagram 5)

Millefiori, is made by bundling groups of coloured glass rods into an arrangement which forms a pattern on their cross-section. This group is fused into one larger rod which is heated to a viscous state and drawn out with a tongs until it is the required diameter. This form is found secured into rectangular *cloisons* along the outer edge of the drop of the crozier with red glass employed as an enamel. (fig. 59)

- (a) In stud CAT.13.3 (fig.90) pre-made *millefiori*, was set at the base of a mould and blue glass was applied from the reverse. This stud is in high relief.
- (b) *Millefiori* was formed into a repeat pattern, and fused with blue glass into a mosaic panel. CAT.13.4 (fig. 91) Shallow holes were drilled within the lentoid design or created by heating the glass and using a hot tool to imprint the recesses. Opaque red glass was enamelled into the recesses.
- (c) Stud CAT.13.5 (fig.92) was formed from mosaic glass made from white squares and blue glass arranged into a chequer pattern, this was fragmented and placed at the base of a clay mould, blue glass was applied to form the reverse of the stud.
- (d) Stud CAT.13.6 (fig. 93) as stud CAT.13.5 (fig. 92) but red and white included in the chequered mosaic glass.

4.65, Discussion

The display of enamelled glass studs on the Cross of Cong and the Lismore crozier demonstrate technical continuity with the earlier enamelled studs found on early Insular metalwork. This suggests that the technique may have seen ongoing use from the earlier period. This continuity is also indicated by the use of red enamel to fuse the blue and white *millefiori* into place on the drop of the Lismore crozier as it was on earlier metalwork. It is notable however, that a variation of enamelled glass studs using only

⁵⁵¹ Bourke, 'Lismore Crozier,' p.315.

opaque red and yellow enamel together evolved. These materials have low melting points and are associated with low temperature, secondary, ornamental applications. Technically, they are not the best match, yet methods were developed to over-come the difficulties associated with their close melting points. This implies a specific requirement for their display together and the association with earlier *champlevé* enamelling has been made elsewhere by Henry.⁵⁵² The new approach developed at this time requires less copper-alloy than previous approaches and may indicate the development of a more economical approach to creating the *champlevé* effect.

While there are examples of blue glass and white inlays, CAT.12.1 and CAT.13.7 (figs.57 and 136) the blue and red combinations within enamelled glass studs found on the Derrynaflan paten, CAT. 1.14, (fig.47) and Ardagh chalice, CAT.9.9 (fig. 44) do not appear to have had analogues in the late eleventh and twelfth centuries. Similarly, studs of amber, silver grilles or gold inlays do not appear to survive on the Lismore crozier, Cross of Cong or other Romanesque artefacts, but this may be due to the survival patterns.⁵⁵³ The circular discs on the crozier, such as CAT.13.4 (fig.91) and CAT.13.5 (fig.92) and the use of traditional *millefiori* within *champlevé* enamelling on the drop CAT.13.1 (fig.59) suggest that the maker of the artefact was referencing *millefiori* found in earlier metalwork such as the Coolure Demense plaque. CAT.14.1. (fig.19) Rather than use *millefiori* throughout, the evidence suggests that the studs were manufactured in a number of ways which emulate *millefiori* but strictly speaking are mosaic glass techniques. Similar to the Romanesque approach to forming red and yellow enamel, the new method of using mosaic glass to emulate *millefiori* also conserves the ornamental glass. The mosaic elements are merely a veneer within the surface, the backing of blue glass forms the structure in many cases. In the earlier period *millefiori* does not survive in inlays of this size and was used as a secondary ornamental inlay within *champlevé* enamelling and not as the principal vitreous inlay in its own right. (figs.19 and 36) The general design features of later glass inlays suggest they were influenced to a degree by earlier metalwork, but the later manifestation has its own character, method of display and its own technical approach.

⁵⁵² Henry, *Irish Art in the Romanesque Period*. p.78.

⁵⁵³ A small stud reputedly of amber is found on St. Mura's Bell shrine, however, this is a later addition. The eleventh century side of the *Cathach* bookshrine displays a small blue stud with spiral formed from thin silver strip laid on edge, but no examples of silver foil. As noted previously using silver ribbon on edges was a much easier way of forming curvilinear ornament such as peltae, cutting the curved forms from silver foil. I would like to thank Dr. Paul Mullarkey for pointing this out to me.

The basic technical approach adopted in the later period and the diminution of the illustrative aspect suggests that the techniques were transmitted via intermediate level craftsmen rather than those of the elite masters who produced the Ardagh chalice and Derrynaflan paten. The evidence suggests that later goldsmiths did not have the same attitude to materials or impetus to develop minute detail within glass studs. This suggests that the metalwork was not developed for close scrutiny by an audience which would expect to look in and find minute Christian ornament within.

The same vitreous materials and metals were available, but the larger size, the lack of complexity and the simplicity of the motif contain little of the technical virtuosity of the finest studs on the Ardagh chalice and the Derrynaflan paten. This suggests less emphasis on the design aspect and the development of skills which can be used to form minute detail. This may relate to a change in training methods, which resulted in less peer learning or the freedom to experiment and thus develop skills and resulting virtuosity work found on earlier artefacts. It is also possible that key workshop traditions died out because of natural causes such as plague, war or the selection process for apprenticeship changed with perhaps less emphasis on taking on candidates with natural skill. It is likely that a number of factors rather than one single cause brought about the decline in technical virtuosity.

Other factors which may have changed were Irish audiences and patrons through increased contact with Europe and the Gregorian reforms which looked to England and the Continent. Murray notes the similarities between the Aghadoe Crozier and one used by the bishop of Canterbury in the twelfth century and the adoption of Continental style reliquary forms such as the shrine of St. Lachtin's arm.⁵⁵⁴ The Soiscele Molaise and River Laune crozier display oval garnets – spolia suggesting the import of gemstones, if not entire reliquaries, from the Continent.⁵⁵⁵ (fig.137) Henry notes true glass *cloisonné* inlay on an Insular crozier head, all pointing to a change in the material culture coming for regions beyond Ireland with a different material culture.⁵⁵⁶ It is possible that this emphasis on precious stones, based on the classical tradition coming in from the Continent eclipsed the use of glass and amber and thus any chance of the later recovery of the traditions associated with fine stud making in the Insular period.

⁵⁵⁴ Murray, *Cross of Cong*, p.213.

⁵⁵⁵ Murray, *Cross of Cong*, p.141.

⁵⁵⁶ Henry, *Irish Art in the Romanesque Period*, pp.78-9. I have only looked at this object through the glass in the National Museum, but I suspect this is an earlier Insular example which was reworked by a later craftsman. This artefact is worthy of a closer examination at a future time.

Similarly the paucity of precious metals may have prevented craftsmen from experimenting with glass and amber and as a result the craft did not develop. It is also possible that the rapid rise in production and the potential dominance of the Roscommon workshop may have negatively affected competition and thus the opportunity for craftsmen to experiment. But this apparent dominance may be as a result of find patterns rather than what existed. A further point maybe the shift in social function; it may be that the greater emphasis in the later period was on the prestige associated with the metalwork, rather than the emphasis on skill and votive aspect of the artefacts which was intrinsic in earlier examples.

In summary an analysis of a selection of studs from the Ardagh chalice, the Derrynaflan paten and the ring suggest that a number of people of varying skill were involved in contributing studs to an artefacts. The work of these craftsmen appears to have been accorded a position based on technical skill with the finer work found on the paten and lesser work in peripheral areas. Elementary stud making is associated with copper-alloy, casting and basic metalworking skills. The association of different levels of skills suggests a hierarchy which saw silver grilles or enamelled studs of particular quality placed in a prominent position alongside the work of accomplished masters and gold filigree panels once they were approximately 9-10mm in diameter. This type of stud may point to a level of intermediate master within Insular metalworking, while the highest levels were associated with gold filigree and the work of the Ardagh chalice and Derrynaflan paten. The finest stud makers utilise the same materials as other levels but differentiate their work through the use of technical complexity, reduced scale either in detail or stud size, gold is also a feature of key virtuosity studs. The emphasis on design suggests a strong dialogue with the scriptorium or painting, which may be as a result of some masters achieving expertise in both disciplines disseminating common design practices through the apprenticeship system and imitation of their work by others.

The workshops that produced the Derrynaflan paten, ring and Ardagh chalice appear to have been mixed ability settings with junior and more experienced craftsmen working alongside one another. The evidence suggests that the work of junior craftsmen was included within artefacts alongside the work of more experienced artists. The display of studs suggests that they may have been used a token or signal of a makers involvement in the making or supervision of an artefact. A stud found on the Derrynaflan ring has close parallels in a stud from the Derrynaflan paten pointing to

potential common authorship and concrete evidence of workshop links between the two artefacts.

Regarding the hypothesis that polychrome glass gave way to amber, the evidence suggests that the materials were worked in comparable ways to form geometrical relief studs, studs with metallic grilles, and to 'enamel' or fuse amber into channels. Sub-conical settings on the Ardagh chalice handles, medallion mounts and the Derrynaflan ring demonstrate that amber and glass could be interchanged if required. This is mirrored in the similar sub-rectangular settings used to hold glass and amber on the base of the Ardagh chalice and the ring of the Hunterston brooch. This suggests that they were used side by side rather than employed at different points in the eighth and ninth century. The emphasis on repeat production methods employed in general within metalworking, suggests that different versions of an artefact were potentially made in different materials. Some may have been entirely of bronze or silver, some gilded and some ornamented with inlays of amber, some of glass and some versions mixed materials. Perhaps according to the status of the master who supervised the production of the artefact and the requirements of the patron, this is in need of further investigation.

In terms of the eleventh-century revival the techniques suggest that there was continuity with intermediate level metalworking masters associated with basic casting and *champlevé* enamelling rather than elite metalworking. There is much less emphasis on illustrative design and the development of technical virtuosity. In the later period, enamelled glass continued in use and two adaptations of enamelled glass and *millefiori* were developed perhaps to conserve materials. In both cases the later adaptations are not direct copies of earlier work but significantly different in terms technique and use of material. This may be as a result of external cultural influences coming into Ireland as we also see the adoption of oval garnets and gemstones on metalwork and a response to the changing political and ecclesiastical situation during this period.

Chapter 5: Summary of findings

5.1, Introduction

This thesis set out to examine one of the key defining features of Insular metalwork, the polychrome stud, in greater detail.

Key among its findings is something that while apparently obvious, has seldom been singled out by scholars of Insular art, this is the very basic design differences found between the fine metalwork on the Continent and that being produced in the British Isles. It has been demonstrated how Continental craftsmen, and their patrons, were most concerned with the materiality of objects, through the display of imported and locally sourced polychrome quartzes, pearls and other hardstones, with balanced design and symmetry taking second place. The layouts of objects such as the Coffret of Teuderic and Cup of St. Martin in the Treasury of the Abbey of St Maurice d'Agaune are guided by a desire to show off the quantity of available precious metals and stones. (figs. 11 and 12) In the case of the polychrome gem settings, there appears to have been minimal working and shaping, on the part of the goldsmith. With re-used spolia items re-set on later pieces, the antiquity of the pieces was paramount, sometimes to the extent that they guided overall design. Within this system, in some cases, the goldsmith was reduced to merely assembling and connecting variously shaped amorphous gems, oval cameo and intaglio gems, recycled hardstone beads and other precious materials into vessels, shrines and personal jewellery. Often, as in the case of the Cup of St. Martin, the primary hardstone dictates the form and design of the vessel. Furthermore, the availability of significant quantities of gold for metalworking, filigree and forming settings required less skill on the part of the goldsmith. Gold is the most easily worked of all the precious metals, as it does not tarnish the lustre disguises poorer workmanship and less input or skill is required on the part of the maker.

In almost direct contrast to this Insular metalwork demonstrates a strong design ethos which is at odds with that found on the Continent. The Irish goldsmith was involved in the entire process of designing and forming an artefact from preparation of materials to the final setting of ornament. Each step involved the skill and input of the maker. Easy to form gold, was used lavishly within Continental metalwork to form collets and enclose irregular gemstones, whereas within Irish metalwork a broader range of materials were employed in various regions of an artefact based upon function and physical properties. Sturdy copper-alloy is employed to hold minute cast detail within mounts, while gilding is employed to apply a lustrous surface finish. (fig.14)

Delicate filigree is formed from highly malleable gold and set within recessed panels to protect the soft material. Insular metalwork also permitted the use of tinning and lead-alloys in place of silver, and orpiment in place of yellow enamel suggesting the overall effect was more than the sum of the parts

It has been shown how although basic forms and object types drew from a common continental source, these were adapted to not only to incorporate La Tène working methods and designs, but also to achieve a purer geometry. Thus for example, while Michael Ryan has traced the origin of the form of the Ardagh and Derrynaflan chalices back to the two-handled drinking vessels of Roman times, their geometric proportions and decoration set them apart. This interest in balance in design is not just applied to the overall form of objects, but is applied throughout, so that every element of an object reflects the use of both compass and ruler in its planning. This has previously been demonstrated for high crosses, and for the layout of the illuminated pages of manuscripts and also for brooch design, but its application in fine metalwork has never previously been examined down to the minutia of specially manufactured gemstones. Unlike the Continent and Anglo-Saxon metalwork, there are no amorphous or oval forms within Insular art and little compromise in terms of symmetry.

Where Continental metalwork continued the classical tradition of polychrome hardstone use and Germanic love of garnet cloisonné inlay, Insular goldsmiths appear to have drawn on their own material legacy. They looked to the existing contemporary material culture of glass and amber use in beads. Furthermore they used pigments from the scriptorium to develop gemstones specifically for the Insular milieu. This led metal craftsmen in the direction of experimentation with materials and techniques that are found nowhere else, and which ultimately created a broad range of polychrome studs, distinguished by both diversity in pattern and technique. Some garnets and rock-crystal are identifiable on Insular metalwork but it is noticeable that such hardstone spolia strictly adheres to the geometry and style prevalent in Insular metalwork. This may be as a result of survival pattern but it may also point to Irish makers eschewing oval and amorphous gemstones in favour of those that conform to the Insular art style and could have been readily incorporated into the highly controlled scheme of an artefact. Indeed it is difficult to imagine how an amorphous amethyst or oval cameo could be successfully worked into the Insular style without first modifying the form.

This thesis highlighted for the first time the substantial number of individual ways that craftsmen approached the manufacture of composite glass studs. In this, they adapted repeatable processes such as casting and stamping already engaged in more

general applications of metalwork manufacture, but at a deliberately, significantly smaller scale. The use of techniques such as these carried with them the obvious benefit of allowing multiple reproductions to a standard size. But, this is simply not just a matter of creating multiples. The intricacy of the process and the delicacy of amber and opaque red glass would have resulted in much loss, to produce one stud such as stud CAT.9.21 (fig.105) on the medallion mount of the Ardagh chalice is an outstanding achievement of skill. To produce two or more, confirms the status of the maker beyond doubt. Where Continental culture prizes large classical vessels and cameos found on the Coffret of Teuderic and Cup of St. Martin, Insular stud-maker imbued their creations with value through creating ever smaller and more intricate pieces formed from multiple materials carefully coloured and manipulated in a multiple step process. While the materials have local significance and meaning, it is the human factor which elevates, opaque red glass formed from reused metallurgical slag, blue glass and minute quantities of silver and gold into valuable pieces worth more than the sum of their parts.

5.2, Workshop tradition and authorship

As a result of the multi-step process involved in making glass studs, in particular silver grilles studs, each provides a unique opportunity to reveal the skill working signature and character of the individual craftsmen. The case study of three well-known objects helped to establish this, and highlighted three general key levels of skill apparent on complex objects such as the Derrynaflan paten, Ardagh chalice and Derrynaflan ring that in turn suggests the work of a relatively significant number of craftsmen. The evidence from these artefacts and their associated mounts has been employed to outline what appears to be a potential hierarchy within the workshop system that points to a mixed ability setting and less experienced stud makers attempting to emulate the work of the more experienced craftsmen. The higher levels of studs are associated with smaller size and minute detail and materials such as gold. In addition they include sophisticated illustrations of typical insular motif. These examples suggest that the elite stud makers were original designers and much thought and experimentation went into developing studs. This is particularly evidence on stud CAT.1.3 (fig.109). Graphic methods associated with drawing and illustration appear to have been adopted within enamelled studs, alongside the use of common pigments, and layering of materials to create effects, suggests a dialogue was taking place with the scriptorium that resulted in borrowings on both sides. This dialogue perhaps also points to shared expertise in the form of individuals with roles within both disciplines. It may also suggest that the Daigh the bishop of Iniskeen, was not unique in his reputed dual expertise. This would certainly account for the experimental approach and levels of virtuosity and complex

visual motif found in advanced stud making levels. This examination has also pointed to two studs, found on the Derrynaflan paten and ring with features which point to common authorship. Evidence from law tracts, and to a lesser extent from inscriptions on objects such as the Shrine of St Patrick's bell, seem to confirm that complex, composite pieces of metalwork would not have been the work of an individual. This raises the question, while we do not have evidence of inscriptions on early metalwork, did glass studs in particular act as the personal mark of their creator.

5.3, Workshop practice

It is also clear from the organisation of studs of different quality and working signatures that the overall design and compilation of different sections of a metalworking piece was carried out by different hands with different levels of skill and access to different levels of significant materials. This division of labour and materials according to skill was likely clearly thought out in advance and highly organised. This is demonstrated through the application of studs of the finest quality workmanship in the most prominent positions, with 'apprentice' pieces relegated to less obvious positions. Although it is clear that many of the finer artefacts were conceived and made from beginning to end resulting in a strictly controlled and homogenous outcome, the identification of loose studs on several sites and those set within Anglo-Saxon jewellery suggest the of recycling material where necessary. (fig.86) One artefact in particular stands out for this practice, the Moylough beltshrine. (figs.5, 35)

Unlike all other Insular artefacts the Moylough beltshrine displays an asymmetrical arrangement of studs on the front of the artefact. It is clear that two further studs with wire peltae should have been set on the left side of the buckle to match that on the right. (fig. 5) As the maker improvised with blue and white *millefiori*, it suggests that the studs were not available. O'Kelly has suggested that the silver foils were adapted from another artefact, pointing to the recycling of other elements within the shrine. In addition, there is a clear disparity between the principal enamelled mount on the front,⁵⁵⁷ and the level of skill found within the studs. (fig. 35) While this could be accounted for by attributing the mount to an apprentice, it seems unlikely that an

⁵⁵⁷ An examination of high resolution photographs of the Moylough beltshrine demonstrates that the die for the enamel mount was made from a soft material which was cast in copper-alloy. It is possible to see sections where the material began to warp and too little material was removed. The rendering of the motif suggest two approaches were taken, firstly the animal heads are well formed compared to the interlocked L and T shapes, this suggests that the former may have been executed using a model or stamp, while the other shapes are clearly formed free-hand. Over all the design and workmanship of the principal mount is far below that found on the studs suggest separate hands and in this case the re-use of limited materials.

apprentice would be entrusted with such a structurally and ornamentally important section of such complexity. Particularly in light of the relegation of less accomplished studs to peripheral regions on the Derrynaflan paten and Ardagh chalice. All of this points to the strong possibility that the shrine contains a number of re-cycled objects as part of its decorative scheme, which importantly, therefore, cannot be used to establish a date for the object itself.

5.4, Dating of artefacts

The problem of dating is also closely tied into the use of amber, which for many years has been used as a means of placing objects in the ninth century, on the basis of increased importations from Scandinavia. This thesis has shown that amber has a very long history in Irish metalworking and that it was being used in a sophisticated way on objects such as the Lough Gara buckle, but in particular the Tara brooch and Ardagh chalice together with glass studs. Both glass and amber were worked in the same manner, with amber working drawing significantly upon the problem solving and techniques applied to opaque red glass. In addition, it has been shown that different types of settings used on Insular artefacts, were adaptable to both materials, suggesting that they were interchangeable on different versions of an artefact.

There may have been a number of factors that guided the sole use of the material on objects such as the Derrynaflan chalice and a number of quite high-status brooches, but these do not necessarily need to be chronological. For example, the Law tracts demonstrate the use of different colours and materials as indicators of status, and Bede wrote about their symbolic meanings. Equally the prevalence of amber on items of personal adornment may be attributable to the level or ability of the craftsmen to work the material, or to its greater availability in certain centres of production at particular points in time – these are all aspects of metalwork production which require further future research.

What is perhaps the one of the most important findings of this thesis is the identification of the method used to shape amber on the majority of fine metalwork objects that retain well preserved examples of its use. It is clear that like glass, Insular craftsmen selected the material for its malleability when subjected to heat and pressure, and the fact that it permitted the repeat production of consistent stud shapes in a manner that no other semi-precious gemstone did. Although a comprehensive international search is beyond the scope of this study, this technique has yet to be identified as a standard feature of metalworking in any other early medieval culture, and like glass stud manufacture appears to set the Insular craft apart.

5.5, Chronology

In terms of the chronology of artefacts this thesis has shown that attributing a chronological sequence to artefacts based upon the use of less ostentatious materials, glass or amber use or simpler form or less skill is unsafe. The Derrynaflan ring is generally attributed to a later date than the manufacture of the paten but as we have seen there is concrete evidence from two studs CAT.1.3, (fig. 109) and CAT.2.3, (fig.126) which link the artefact to a single author. This suggests the potential manufacture of these examples within the life time of a single craftsman.

5.6, Eleventh century revival

In terms of the eleventh-century revival, the techniques suggest that there was continuity with intermediate level metalworking masters associated with basic casting and *champlevé* enamelling rather than elite metalworking. There is much less emphasis on illustrative design and the development of technical virtuosity. In the later period, enamelled glass continued in use and two adaptations of enamelled glass and *millefiori* were developed perhaps to conserve materials. In both cases the later adaptations are not direct copies of earlier work but significantly different in terms of technique and use of materials in stud making. Thus, while they attempt to visually emulate, the revival glass studs never become an accurate copy, nor do they compete with the virtuosity of earlier examples. Murray has suggested that material resources were scarce at this point in time, it follows that in the absence of material resources experimentation and thus innovation cannot occur. However, despite the apparent lack of materials unlike the earlier period there is little evidence of stud-makers sourcing materials elsewhere and harnessing amber or manuscript pigments.

We have seen the ability of craftsmen to develop many variant processes of a single technique across artefacts in the early period. This points to individuals, modifying and experimenting which suggests that while materials were scarce, not to the degree that it hampered experimentation. Indeed, the fact that craftsmen were confined to glass and amber compared to the wide selection of gemstones available to the continental metalworker, most likely forced them to innovate and thus develop their skills. Furthermore, the material and design elements which point to engagement with other crafts, such as painting and the positive results this can bring to stud creation in the Early Christian Period have also been demonstrated.

In contrast, the developments in the eleventh and twelfth century, provides evidence of much less technical diversity, although the different approaches used to form the mosaic glass discs on the Lismore crozier suggests evidence a willingness to experiment within a limited range. However, despite this the technical processes employed are notable for their homogeneity and lack of diversity. What is in evidence appears to be motivated by a material conservation emphasis which does not encourage experimentation. It is perhaps for this reason that heat and pressure moulded amber studs do not occur and the craft or the ability to achieve it was lost, whilst being mindful of possible distortions of fine patterns. The links between opaque red glass manipulation and amber working have been demonstrated, and it is notable that in the later period we have evidence that opaque red glass was, in contrast, employed in powder form unlike the earlier period. This change in use demanded much less skill and materials knowledge and may be linked to the overall diminution of metal-working skills and the lack of evidence for advanced amber working skills. In this later period there is no evidence of combining techniques or including other materials such as dyes or materials employed in illumination and painting. There is no evidence of the apprentices, or masters striving to improve and push the limits of their skill and the potential of the material. Furthermore, the later stud makers do not attempt to produce evermore complex creations at minute scales.

Factors which may have negatively affected the development of technical expertise and innovation includes the rapid rising demands for metal religious artefacts during the eleventh and twelfth centuries, which was ultimately not sustained. Perhaps if this level of production had continued, the skills to truly innovate would have naturally emerged. In addition, the focus on producing metalwork to emulate 'ancient' examples for political reasons, may have imposed a restrictive 'style guide' on stud-makers which may have constricted their ability to experiment and thus deviate significantly from the basic techniques. Similarly the apparent dominance of the Roscommon workshop under Mael Ísu may have adversely affected competition and the potential rise of competing workshops which may have stimulated experimentation and the development of virtuosity work. It is likely that the political and ecclesiastical upheaval of the period, may have introduced an element of uncertainty which hampered the development from craft level to the higher level of innovation and artistry, as evident in earlier metalwork. Similarly, the rise in hardstone display suggests that Irish patrons and craftsmen were moving towards a continental appreciation of materials and taste. There is scope for

much further analysis of overall skills and techniques in metalworking from this period to determine a broader picture of what occurred.

5.7, Areas for further study

In terms of amber, scientific examination of the fossilised resins on early Christian artefacts is required to determine what type of fossilised resins were employed and as far as possible determine if local sources were employed. This will also require investigation and scientific analysis of Irish sites such as lignite beds and west coast shorelines which are reported to contain amber. The results of both examinations can be compared to determine the original source of the amber, although as we have seen this is no guarantee of Early Christian provenance. The fragmented studs on the Lough kinale bookshrine may be a good starting point as these studs may have been formed using amber fragments from several sources pressed into an 'amberoid' type stud. Any future analysis of Early Christian amber will need to examine for pigments or dyes or evidence of heating which may be as a result of attempts to colour the material.

Furthermore, future finds, or those which have been overlooked, may include amber with recessed inlays which should be examined for inlays of orpiment or even red lead, similar to lignite Anglo-Saxon pendant crosses and the leather cover of the Stowe missal. In terms of dying or colouring amber, this author would begin with a scientific analysis of the studs on the Loughmoe brooch which are of a notably reddish hue, it is intended to examine it as part of a future study of amber. The amber on the Derrynaflan chalice similarly require, a broader and more in-depth scrutiny of the studs to determine whether evidence regarding potential colourants can be discerned.

Given the findings of this thesis regarding the developments in working amber, a future study should look at prior technical knowledge and how this technology came about within an Early Christian context. A starting point for this is further analysis of the cross-application of material knowledge may begin with the use of opaque red glass, to technical information pertaining to the adoption and development of gold filigree in Irish metalwork. Furthermore the amber panels on the obverse of the 'Tara' brooch terminals and pinhead require more in-depth examination and analysis of the particular method employed to create this virtuosity work. As part of this avenue of research it will be necessary to follow up with research on current industrial practices with a view to trying to recreate the process by hand.

As we have seen both glass and amber could be employed to imitate other materials and take on other colours and forms. Several colours of glass were employed

to imitate amber and amber doublets resembling green glass tones may once have ornamented the escutcheon mounts of the Ardagh chalice. In terms of glass and amber studs much information points to the development of specific stud types across artefacts, beyond the commonly recognised red and blue or monochrome blue with silver grilles grouping. Amber and gold, blue glass and gold, green and yellow, yellow amber coloured with silver inlays, red with are among the 'types' which can be discerned by looking across artefacts. These various features and motif of these groups must be deciphered and analysed in the context of the Early Christian meaning of shape, colour and hierarchy of materials outlined in the law tracts, the lapidary of Bede and the Biblical gemstones. This approach may offer some clue to the potential meaning and symbolism within studs. Despite its fame and multiple publications dealing with the topic the full potential meaning of the studs on the 'Tara' brooch have not been dealt with in detail. While this writer undertook preliminary work into the symbolism of the studs on the Derrynaflan paten as part of an M.Phil in Irish Art history, it was beyond the scope of this thesis to deal with such a broad topic, which will require its own dedicated study.

As noted by Fraquet, 'Scottish' amber from the 'Celtic' period has not been included among the histories of amber which focus on Greek, Roman, Medieval, eighteenth and nineteenth century use of the material. The findings from this thesis regarding the development of heat and pressure forming of amber within an Insular milieu at least a thousand years before this occurred in northern Europe suggests that Irish worked amber needs to be included within the broader discourse of amber history and technology. Furthermore in light of the contribution of Irish goldsmiths to the development of amber technology, further study is required In order to examine and identify the significance of amber in Irish culture though-out Irish history, not just the Early Christian period. By examining the sagas, folklore, charms, cures and other local customs, cottage industries and the potential importation of finished amber artefacts from other regions a picture of the cultural relationship with the material may be uncovered.

This thesis introduced a method of looking closely at the handiwork and individual character of craftsmanship as a way of determining authorship or common hand. This approach should be extended to other artefacts and a full study made of a larger group of objects or more closely within the objects looked at here. There is also the potential to use the hierarchy outlined here to assess other metalwork artefacts, and rather than use their material, techniques and skill level to assign them to an eighth or ninth century date, it may be used to determine the level of the *cerd* and refine our

understanding of the skills and role of the master craftsmen, workshop practice, training and broader Insular society. From this understanding it may be possible to gain insights which may point to or support other more reliable methods of dating artefacts in future.

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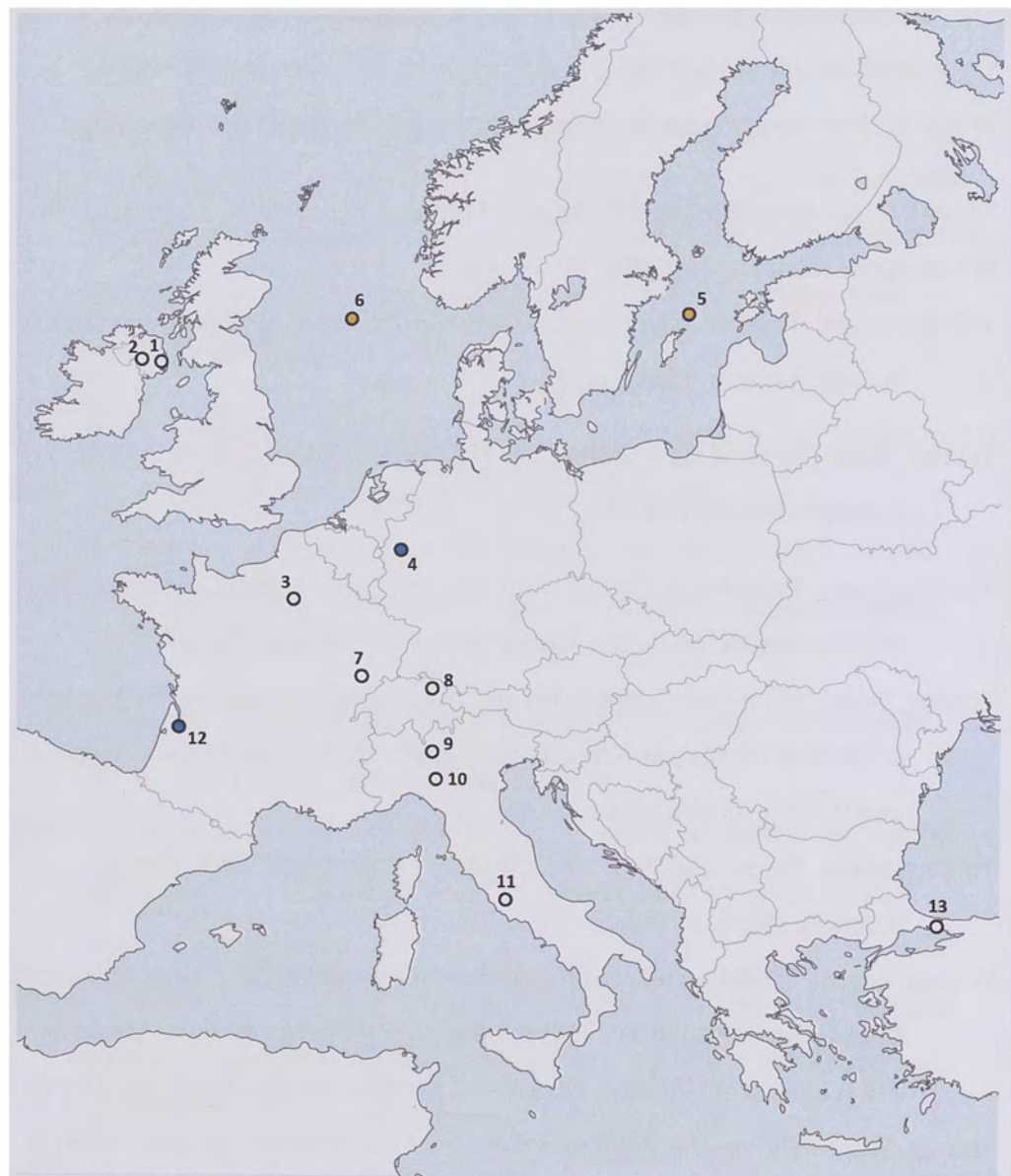
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Appendix 1: Map of Europe.



Ecclesiastical sites in Europe ○

Baltic amber sources ●

Glass centres ●

- | | |
|---------------|--------------------|
| 1. Bangor | 8. St. Gall |
| 2. Armagh | 9. Monza |
| 3. St. Denis | 10. Bobbio |
| 4. Cologne | 11. Rome |
| 5. Baltic Sea | 12. Bordeaux |
| 6. North Sea. | 13. Constantinople |
| 7. Luxeuil | |

Appendix 2: Map of the British Isles



Columban Paruchia 

Ecclesiastical Sites 

- 1. Derry
- 2. Iona
- 3. Kells
- 4. Durrow

- 5. Lindisfarne
- 6. Cnobbersberg
- 7. Malmesbury
- 8. Canterbury

Appendix 3: Map of Ireland.



Insular sites referred to in the text O

- | | |
|------------------|-------------------|
| 1. Carndonagh | 12. Kinnitty |
| 2. Dunmisk | 13. Bettystown |
| 3. Clogher | 14. Fishamble St. |
| 4. Nendrum | 15. Lagore |
| 5. Armagh | 16. Moynalough |
| 6. Tully lough | 17. Derry-naflan |
| 7. Lough Kinale | 18. Ahenny |
| 8. Moylough | 19. Lismore |
| 9. Lough Gara | 20. Garranes |
| 10. Cong | 21. Garryduff |
| 11. Clonmacnoise | 22. Ardagh |

Appendix 4: Map of glass stud production sites.



Glass stud production sites ●

- | | |
|---------------|----------------|
| 1. Iona | 5. Lagore |
| 2. Dunadd | 6. Knowth |
| 3. Tarbatness | 7. Ballinderry |
| 4. Dunmisk | 8. Garryduff |

Appendix 5: Map of amber stud production sites.



Amber stud production sites ●

- 1. Lagore
- 2. Ballinderry
- 3. Knowth

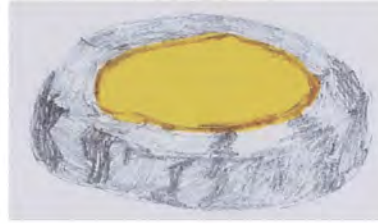
Appendix 6: Map of glass and amber stud artefacts and production sites.



Glass and amber stud production site. 
Glass and amber stud artefact find site. 

- | | |
|----------------|----------------|
| 1. Lagore | 6. Bettystown |
| 2. Ballinderry | 7. Lough Gara |
| 3. Knowth | 8. Derrynaflan |
| 4. Armagh | 9. Ardagh |

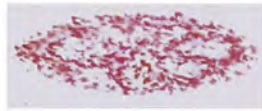
Appendix 7: diagram 1. Stud-making techniques, enamelled glass.



1. Yellow glass was cast into a stud using a clay mould.



2. The stud was cleaned and excess glass removed.



3. The stud was placed into a copper-alloy support and recessed areas filled with opaque red glass in powder form. The three elements were fused using heat.

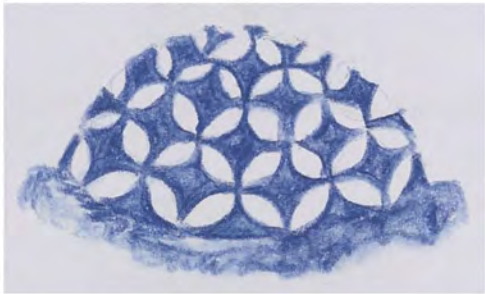


4. The finished stud was set within a brass collet on the Cross of Cong. (CAT.12.3)

Appendix 7: diagram 2. Stud-making techniques, mosaic glass cabochon.



1. *Millefiori* plaques were arranged around the base of a clay mould and blue glass applied.



2. The stud was removed from the mould and excess glass removed from the base.

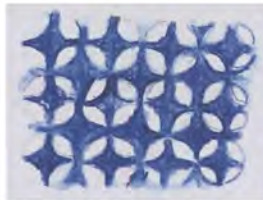


3. The finished stud CAT. Was set on the Lismore crozier. (CAT.13.3)

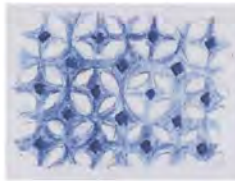
Appendix 7: diagram 3. Stud-making techniques, enamelled mosaic glass plaque.



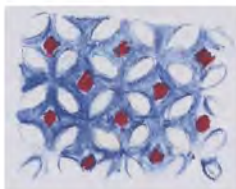
1. White platelet of glass are arranged at the base of a mould, blue glass is applied from the reverse.



2. The plaque is removed from the mould.



3. The circular recesses were created in the glass at specific points in the pattern.



4. Opaque red glass in powder form was applied to the recesses and the plaque was heated to fuse the materials together.



5. The disc shape was cut from the plaque and set on the Lismore crozier. (CAT.13.4)

Appendix 7: diagram 4. Stud-making techniques, mosaic glass disc.



1. Square platelets of white glass were arranged in a chequered pattern on the base of a clay mould, blue glass was applied and the materials fused.



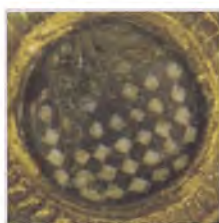
2. The plaque was removed from the mould and cleaned.



3. A fragment of glass was taken from the plaque and placed at the base of a mould with a disc-shaped recess.

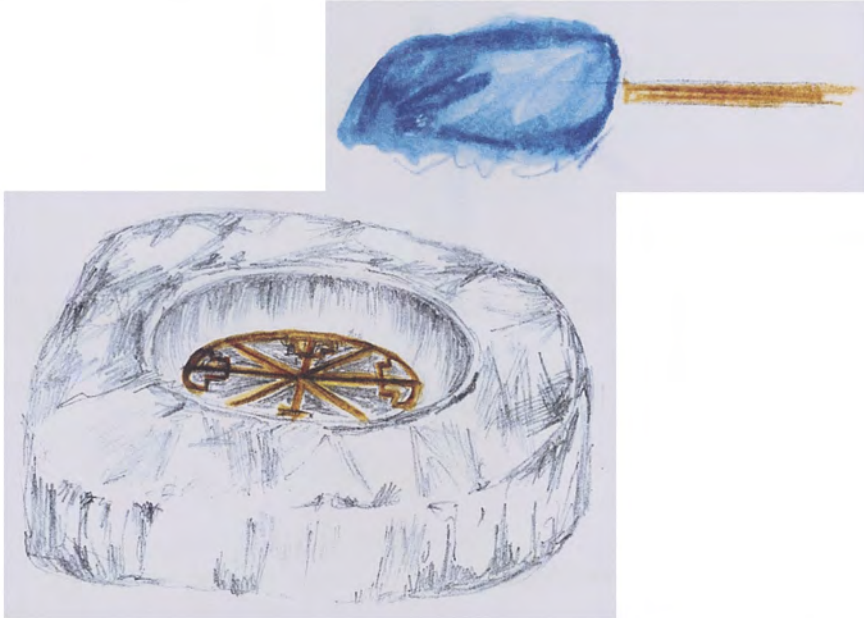


4. Blue glass was applied to the reverse.



5. The studs were removed from the mould, cleaned, excess glass was removed and the studs were set on the Lismore crozier. (CAT.13.5)

Appendix 7: diagram 5. Stud-making techniques, glass stud with fused metallic grille

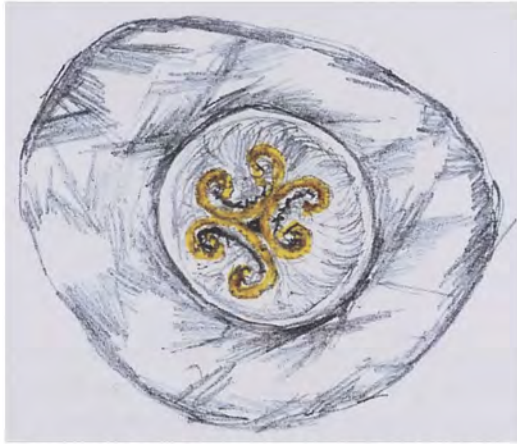


1. A silver grille was cut form foil and set at the base of a clay mould, molten glass was applied from the reverse and allowed to cool.



2. The studs was removed from the mould, excess glass removed, cleaned and set on the Ardagh chalice bowl-girdle. (CAT. 9.1)

Appendix 7: diagram 6. Stud-making techniques, glass stud with fused metallic inlay



1. Gold filigree wire was formed into peltae and set at the base of a clay mould.



2. Molten base was applied from the reverse and fused to the gold wire.



3. When cooled the studs was removed from the mould and excess glass was removed. The stud was cleaned and set on the Ardagh chalice under-foot mount. (CAT.9.24)

Appendix 7: diagram 7. Stud-making techniques, polychrome glass stud, with fused metallic inlays



- 1. A patterned grille was cut from silver foil.



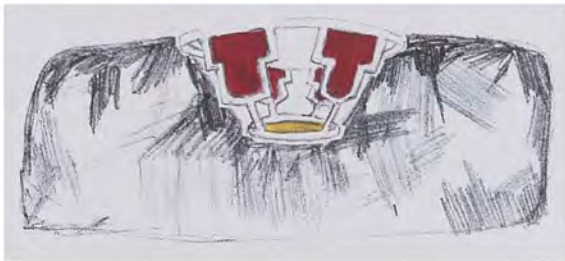
- 2. A disc ornamented with gold granulation was placed into the centre of the grille.



- 3. Fragments of opaque red glass were shaped to match cells within the silver grille.



- 4. The glass fragments were fused to the silver grille and placed at the base of a clay mould.

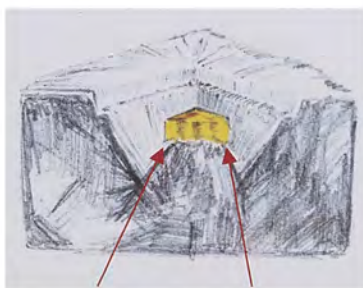


- 5. The grille was placed in a clay mould and blue glass applied from the reverse.



- 6. The stud was removed from the mould, cleaned and set on the Ardagh chalice escutcheon mount. (CAT.9.20)

Appendix 7: diagram 8. Stud-making techniques, glass stud with fused filigree cap

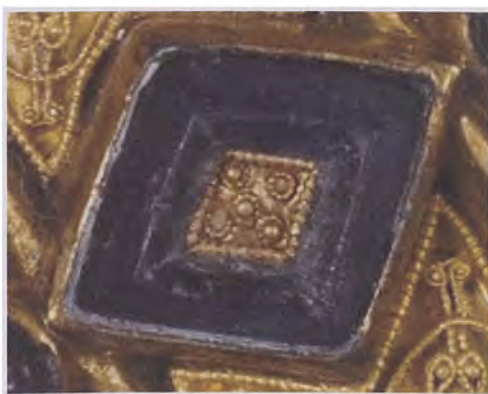


Under-cut areas

1. The filigree inset was positioned within the clay mould. Areas which would result in under-cuts were deliberately included to enclose the filigree inset once the glass was applied.



2. Molten blue glass was applied from the reverse, it flowed around the gold filigree inlay enclosing the edges with the glass.

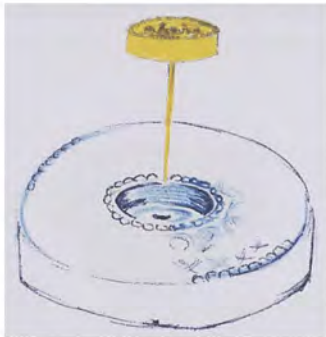


3. The finished studs was set within a collet on the 'Tara' brooch. (CAT.4.4)

Appendix 7: diagram 9. Stud-making techniques, glass stud with cold connected metallic inlay



1. A glass studs with a recess and perforation was prepared by casting.



2. A filigree inlay with a stem was threaded through the perforation.



3. The Stem of the inlay was cut several times and opened out.



4. The stud was set on the Derry-naflan paten ornamental rim. (CAT.120)

Appendix 7: diagram 10. Stud-making techniques, forming loose amber studs

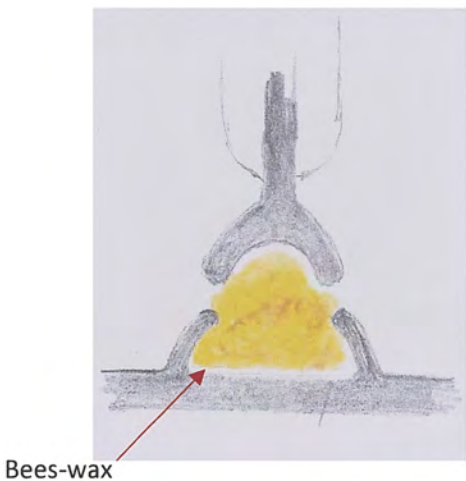


1. Loose amber studs may have been formed by heat pressing with a copper-alloy implement prior to setting.



2. The Roscrea brooch stud illustrate the simple geometric type amber studs this process could have achieved. (NMI 9737)

Appendix 7: diagram 11. Stud-making techniques, forming high-relief amber studs within a collet

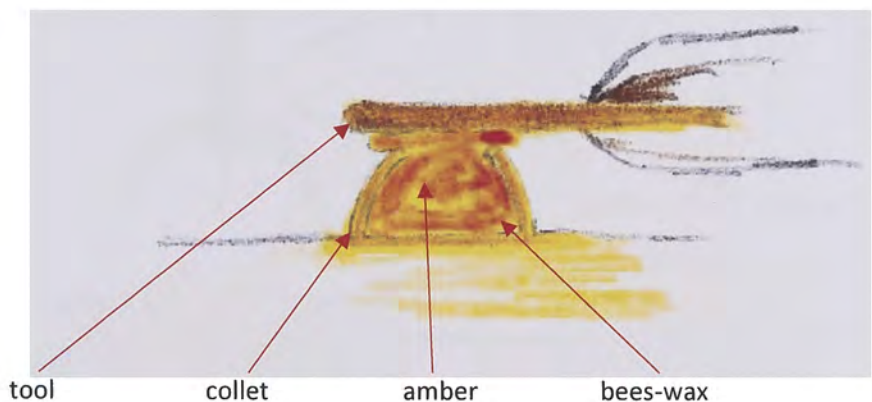


1. Studs were heat formed within their setting, using bees wax as a backing and a flux.



2. CAT. 17.1 contains a flange of amber and a groove around the base suggesting it was formed within a collet.

Appendix 7: diagram 12. Stud-making techniques, forming amber studs and inlays with a flat surface



1. Amber studs formed within a collet with a flat surface.



2. Amber stud, 'Tara' brooch, CAT.16.2.

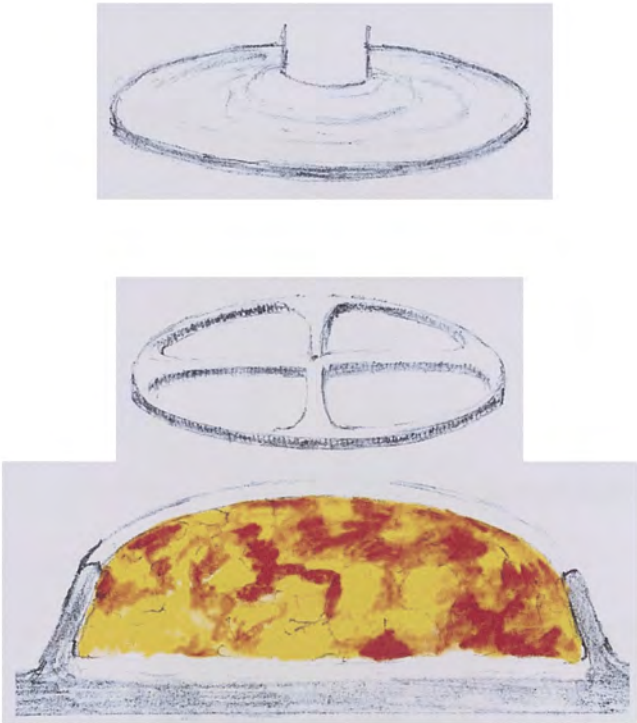


3. The amber in the under-foot mount of the Ardagh chalice. (CAT.15.3)



4. Amber studs on the Lough Gara buckle. (CAT. 20.1-2)

Appendix 7: diagram 13. Stud-making techniques, forming amber studs with a metallic grille

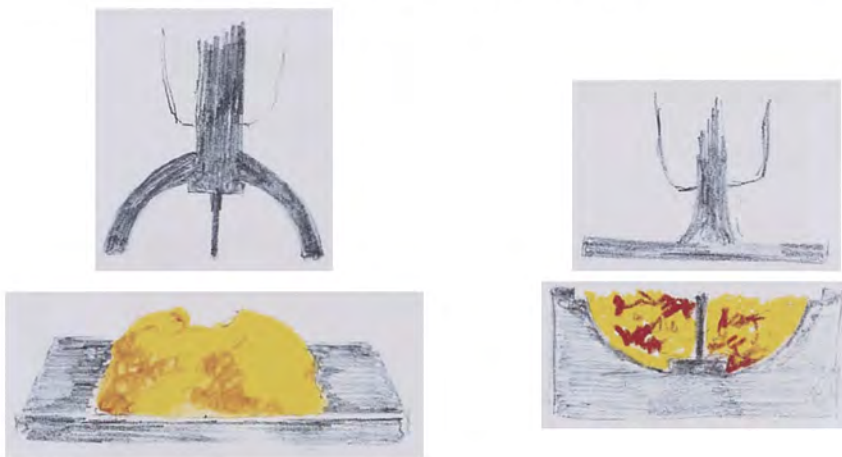


- 1. Amber fragments may have been placed within a collet with bees-wax, heated to a molten state and the lead-tin alloy grille pressed into place.



- 2. Amber stud with lead-tin alloy grille, Lough Kinale bookshine, (CAT. 17.5)

Appendix 7: diagram 14. Stud-making techniques, forming an amber stud with recesses for metallic inlays



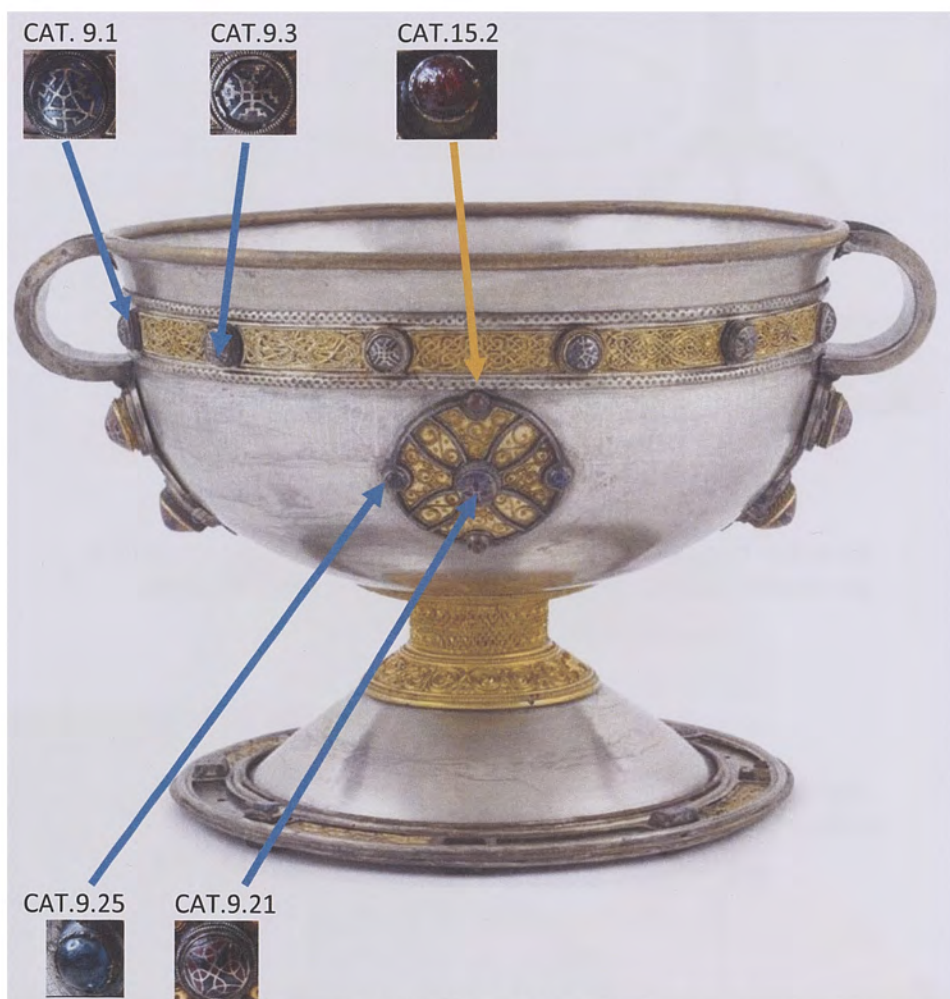
1. An amber studs was heat-formed using a mould to apply pressure. A perforation was created in the stud, perhaps using a hot needle.



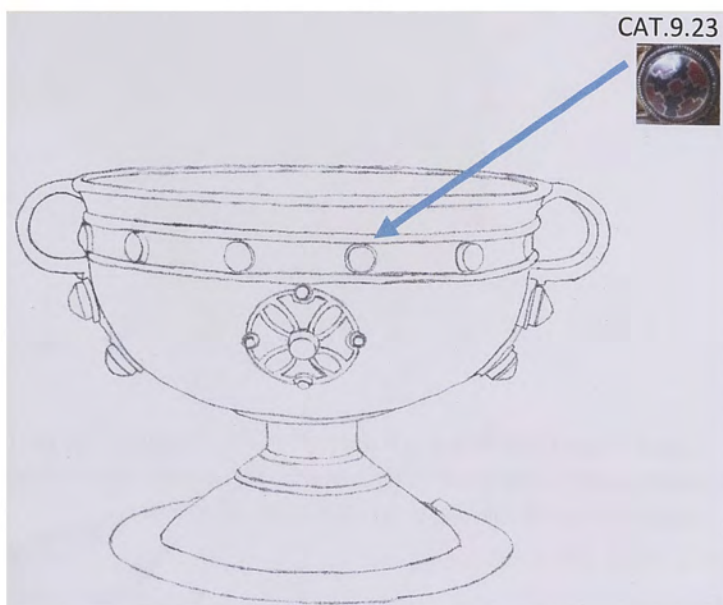
2. A gold filigree cap with a stem was threaded through the perforation and opened out at the back. This stud was also given a collar of gold prior to connection with the 'Tara' brooch. (CAT.16.1)

Appendix 8: Diagram 1, Ardagh chalice

Glass
Amber

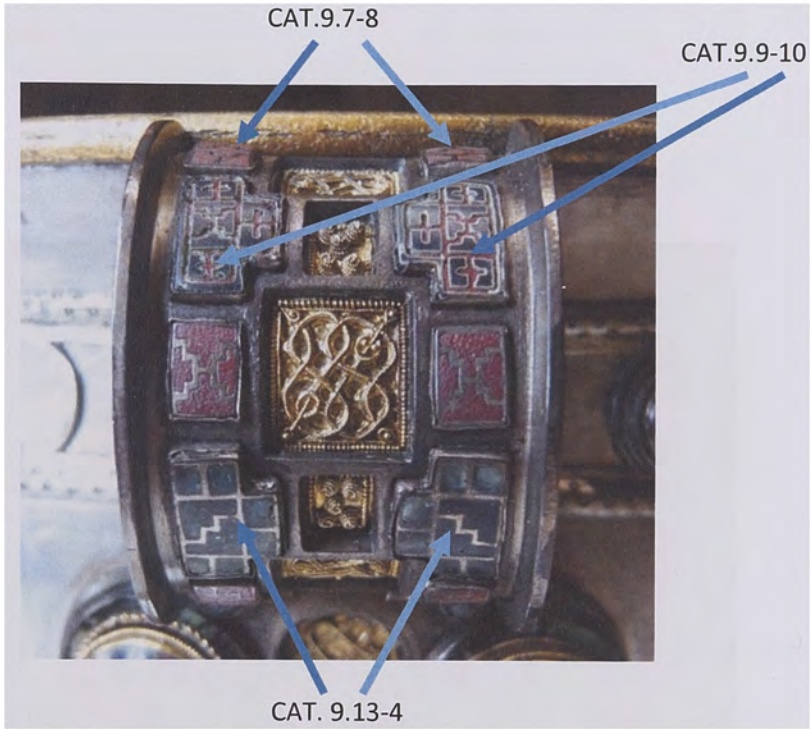


Ardagh chalice side one

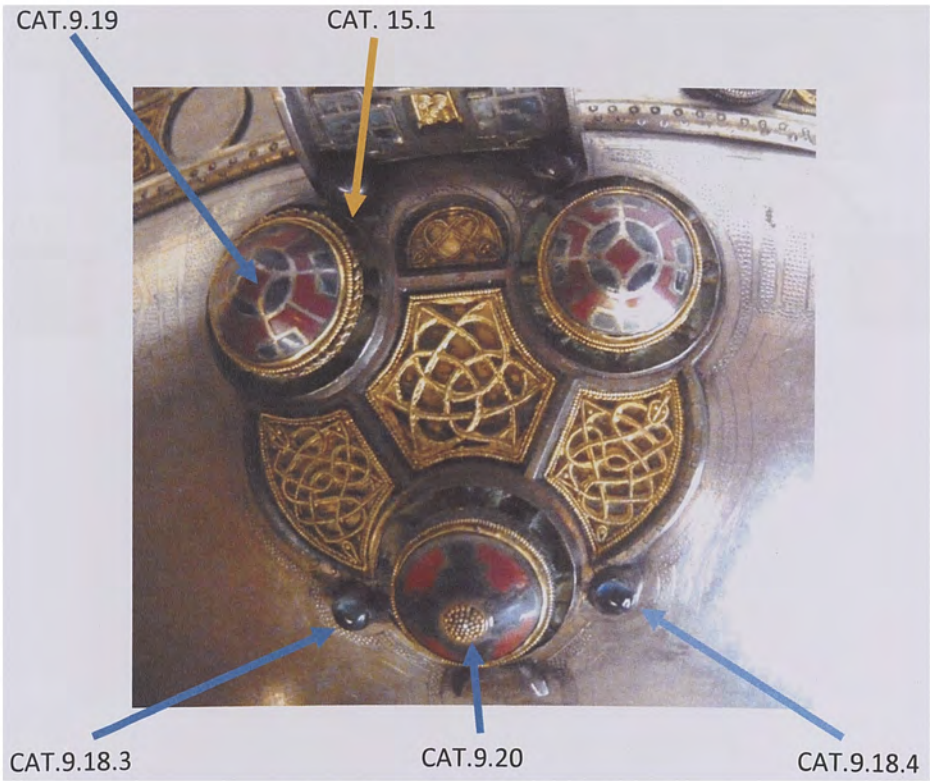


Ardagh chalice side two

Glass
Amber

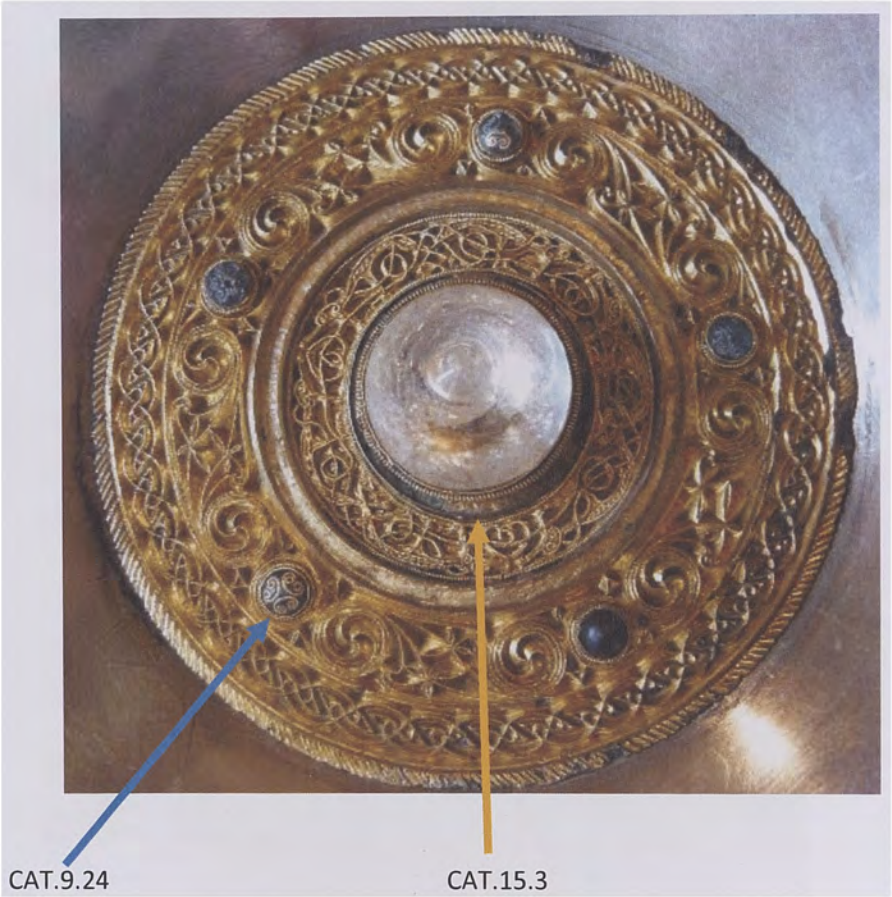


Ardagh chalice, left handle



Ardagh chalice, right escutcheon mount

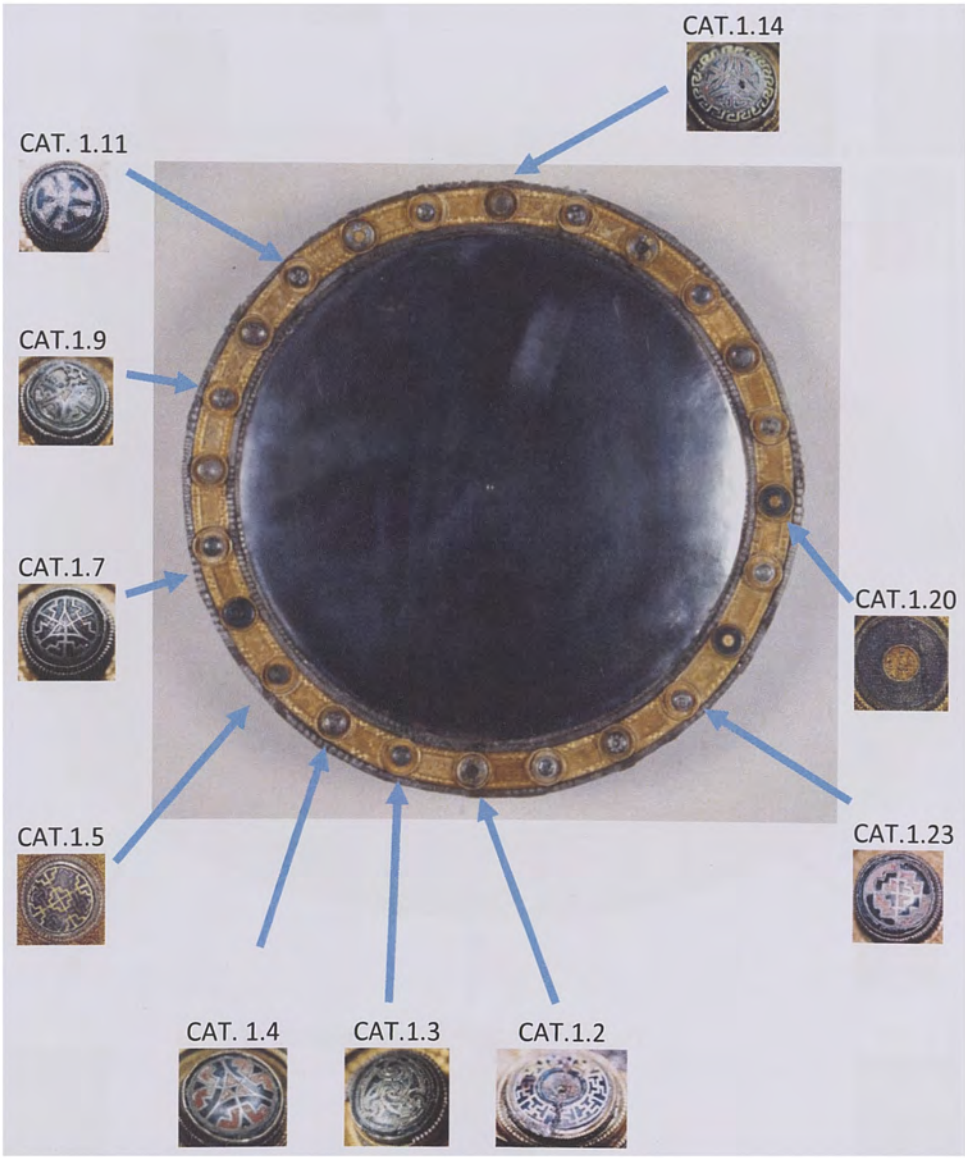
Glass
Amber



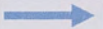
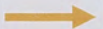
Ardagh chalice, underfoot mount

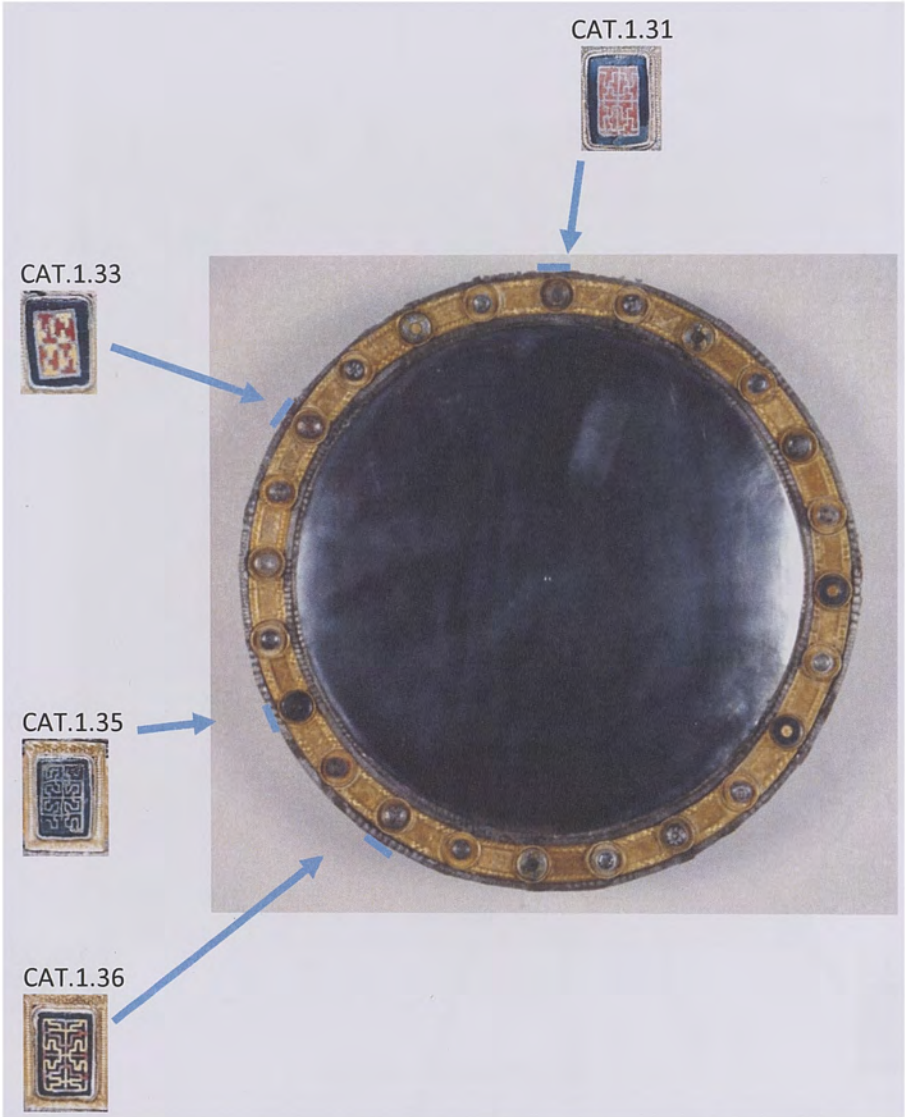
Appendix 8: Diagram 2, Derrynaflan paten

Glass 
Amber 



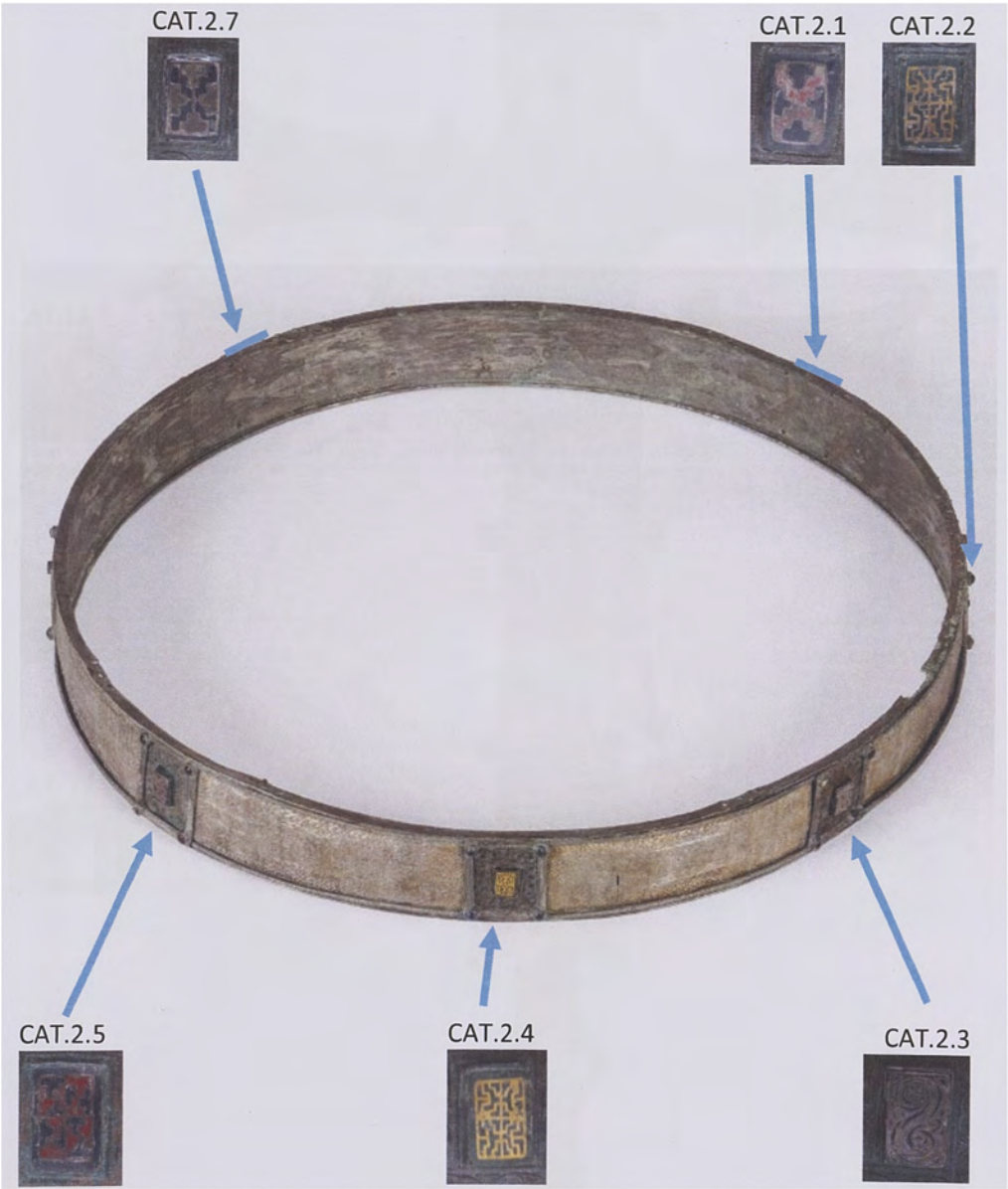
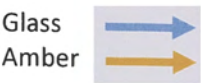
Derrynaflan paten, ornamental rim

Glass 
Amber 



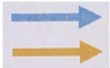
Derrynaflan paten, side, position of studs

Appendix 10: Diagram 3, Derrynaflan ring

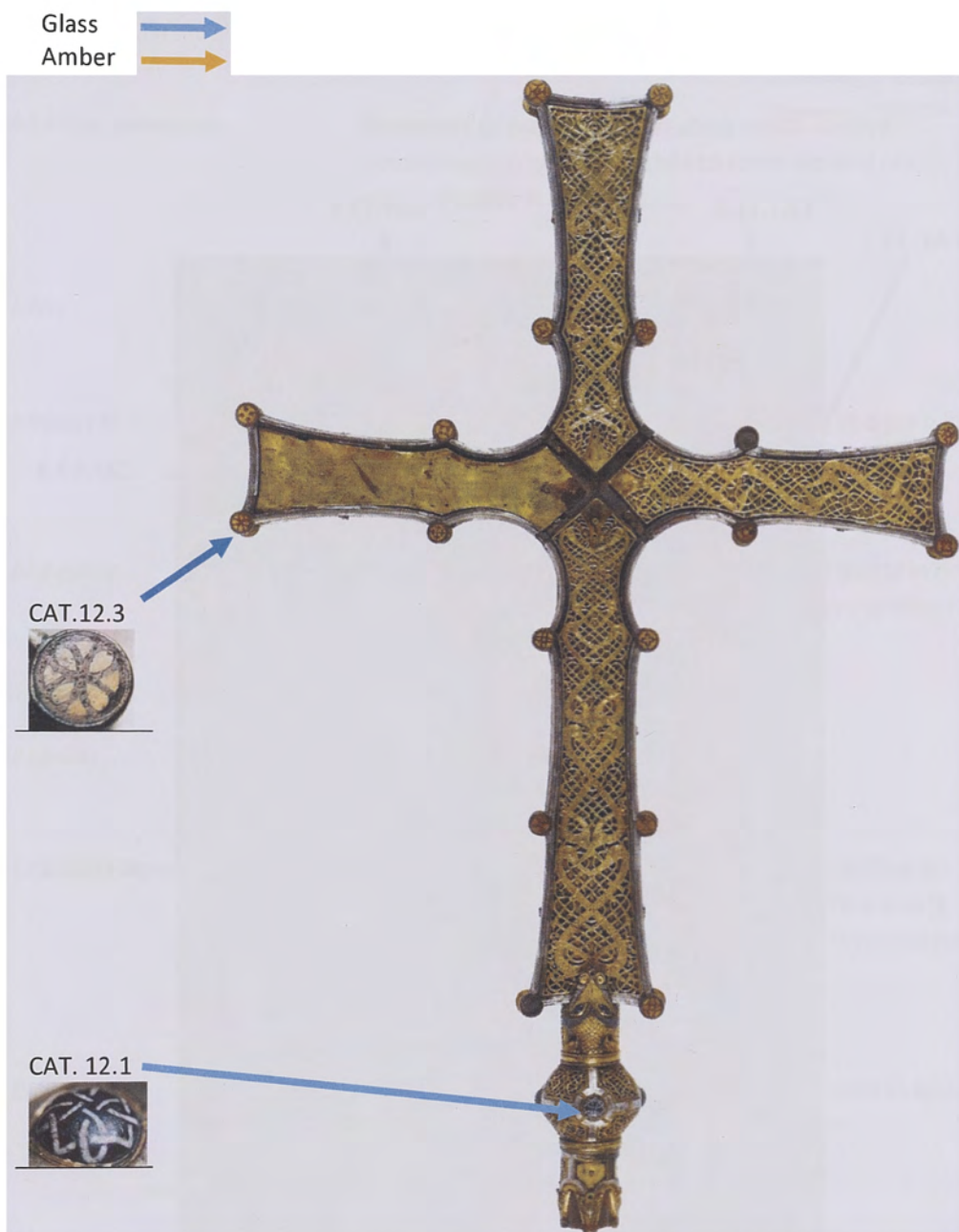


Appendix 11: Diagram 4, Cross of Cong

Glass
Amber



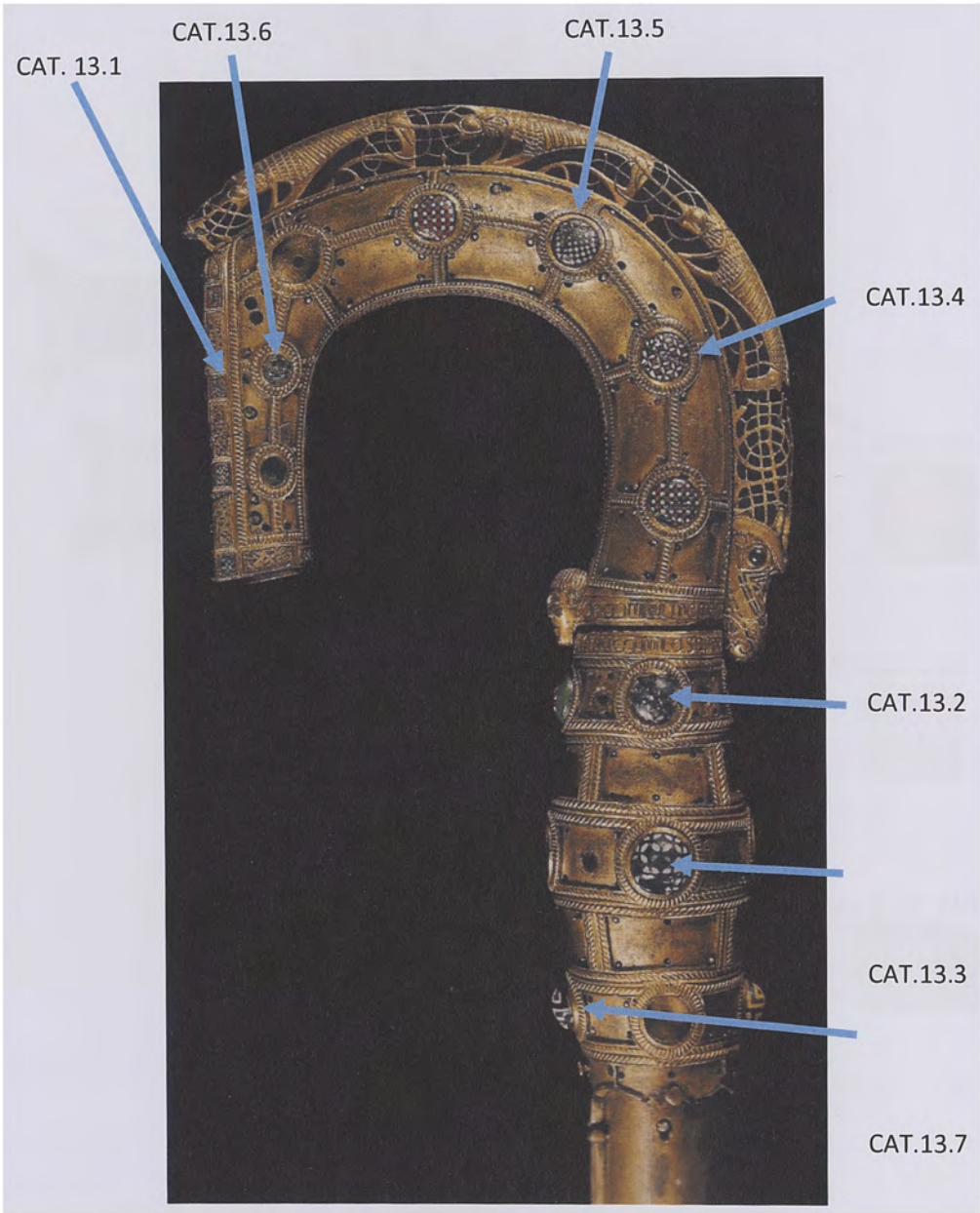
Cross of Cong, obverse



Cross of Cong, reverse

Appendix 8: Diagram 5, Lismore crozier

Glass 
Amber 



Appendix 9: Glossary

Additive techniques	Processes or methods of creating which involve combining elements together to form the end result; <i>see also</i> reductive techniques.
Alloy	The fusion of two or more metals.
Amberoid	Amber which has been formed by heating and pressing together smaller fragments into a larger block.
Annealing	A process of heat-treating work-hardened metal in order to reorganise its grain structure and return the metal to a softer more workable state.
Annular	In the form of a ring.
Bead setting	One of the three main categories of stone setting in which a gemstone is seated in a metal surface and is then set by raising 'beads' of metal with gravers to hold the stone in place.
Bezel	One of three main categories of stone settings in which a metal band encircles the girdle of the stone.
Blank	A piece of metal sheared, sawed, stamped or cast into shape prior to working into a finished object or component.
Brambled	Scored in a grid pattern to leave upstanding knobs like a blackberry.
Brooch-pin	Pin with a small separate pendant head resembling an annular or penannular brooch.
Buffing	A mildly abrasive process preliminary to final polishing.

Cabochon	Gemstone or glass finished with a smooth convex surface and flat underside.
Cartouche	An ornamental panel.
Chalice	Cup reserved for the blessing and/or distribution of the Eucharistic wine in the Christian Communion service.
Champlevé	Enamel applied to recesses cast into a metal base; <i>see also</i> cloisonné.
Chasing	An ornamental metalworking technique in which punches and chisels are used to impart fine detail to metal surfaces through carving or gouging the surface. Chasing is often used in conjunction with embossing and <i>repoussé</i> .
Chip-carving	The background metal base is partially removed with oblique cuts to leave a reflective faceted surface; <i>see also</i> Kerbschnitt. In Insular metalwork this effect was achieved by forming the facets in a die made from a soft material such as wax and forming the final casting from metal.
Cloisonné inlay	Cut glass or garnet plaques were set into matching metal cells.
Cloisonné enamel	Glass powder of various bright colours were separated by gold wires set on edge against a backing of gold. This arrangement was heated to fuse the elements together.
Crannóg	'Crann' from the Irish for tree. An artificial island built of wood dating from the later Bronze Age to the seventeenth century.
Crozier	The staff of office with a curved head carried by senior ecclesiastics such as a bishop or abbot. Originally of wood but often later encased within fittings of metal.
Die	A metal tool made of hardened material such as bronze or steel, used to imprint softer materials such

	as embossed metallic foils or to stamp clay moulds with the negative imprint of brooch, <i>champlevé</i> mount or glass stud.
Drawing	Pulling wire or tubing through a draw plate in order to reduce its size.
Drop	Terminal element of a crozier crook.
Engraving	The carving or incising of lines and patterns on metalwork. Artisans who carry out this work are termed engravers while the sharpened chisels called gravers.
Embossed foils	Silver and bronze foils were impressed against a metallic die with the pattern in the negative, thus transferring the positive pattern to the foil.
Filigree	Fine wires or ribbons of gold or silver often beaded and twisted and combined into intricate patterns. Commonly soldered onto an embossed foil backing.
Flux	A liquid, powder or solid used to seal metal from the atmosphere and/ or guide the flow of solder. Used during annealing, casting and soldering.
Foil	Sheet metal approximately 0.1mm thick.
Forming	A technique in which the thickness remains constant but the shape of the metal is altered by embossing or bending.
Gilding	Gilding in Irish metalwork is also known as parcel gilding. It involved dissolving gold particles in mercury painting it on the intended area and heating to 320°C to drive off the mercury and fuse the gold to the surface of the underlying metal.
Girdle	The widest perimeter of a stone by which it is usually set in metal.

Granulation	Minute decorative beads of gold or silver formed by heating on a charcoal block, the tiny fragments of metal produced from silver and gold working.
Grinding	The removal of material with rotating abrasive tools such as stone wheels and lathes.
High Cross	Large free-standing stone cross with arms intersecting the form of a ring. Ornamented with biblical imagery typically found in or near Irish monastic sites from the eighth century.
Insular	Belonging stylistically to the early medieval common cultural area of Britain and Ireland.
Investment casting	Metal casting process in which a die is formed from a soft material such as wax and repeatedly dipped in clay to coat the die. The wax is removed by heating and molten metal is added to the mould. Also known as 'lost wax' casting.
Jeweller's stitches	In metalworking describes the small hooks of metal gouged from the wall of a recess to hold a decorative inlay such as filigree in place.
Knop	Decorative metal fitting found on the shaft of a crozier or cross.
Lampworking	Forming glass products, usually beads and pendant rings, by hand. Heat is used soften and form glass rods into shape and fuse contrasting colours of glass for ornament.
Lemel	The dust and filings that are a by-product of jewellery work. The scrap of sawing, filing and casting that is reclaimed and recycled.
Lentoid	Pointed oval form formed by intersecting arcs using a compass.

Lost-wax casting	Also known as <i>cire-perdu</i> casting. See investment casting.
<i>Millefiori</i>	Decorative glass rods formed from bundles of rods arranged into a floral or chequered pattern on the cross-section. This was heated to fuse the elements together and drawn out to reduce the dimensions of the rod. <i>Millefiori</i> platelets were fused into recesses alongside <i>champlevé</i> enamels.
Mould	A negative space into which molten metal, wax or glass is poured, such as a stone ingot mould or clay mould for casting studs and metalwork components or brooches.
<i>Niello</i>	A black compound of metallic sulphides, often silver or copper, inlaid into channels within metalwork, often alongside ribbons of silver set on edge for decorative contrast.
Paten	A dish used by a priest to hold the Eucharistic bread or wafer during the communion service.
Pelta	Decorative motif formed from an arc with terminals curled inwards.
Penannular	Of circular form with a gap in the ring.
Reductive techniques	Processes which involve the removal of material to form a finished product as found in carving and grinding.
Repoussé	Sheet metal with relief ornament created by forming the metal from the reverse.
Reticella glass	Decorative glass rod made by winding and fusing at least one contrasting coloured glass trail around a central rod of glass.
Skeuomorph	Representation of an object in another material.
Slag	The fused residue separated in the reduction of metal from its ores.
Smelting	The process of reducing or separating metals in ores by means of fusion in a furnace.

Soldering	The process of joining metal components by heating and flowing an alloy with a lower melting point into the seam.
Spolia	The reuse or repurposing of older gemstones or decorative enamels on new metalwork or jewellery.
Stamping	The process of cutting or embossing metal sheet with a punch or die.
Stitching	In metalworking using wire stitches through carefully prepared perforations to join two sections of an artefact together.
Tarnish	The dull or discoloured appearance on a metal surface that has combined with oxygen or sulphur.
Triquetra	A simple knot with three points formed from three intersecting arcs.
<i>Tuyère</i>	Clay collar which protects the mouth of a furnace.
Zoomorphic	In the form of an animal or part of an animal.

Appendix 10: Object Catalogue

The Object catalogue consists of a list of studs produced between the late sixth and eleventh centuries AD;

Glass stud artefacts seventh to ninth century

Derrynaflan paten

Derrynaflan strainer-ladle

Derrynaflan ring

Ardagh chalice

'Tara' brooch

Ervey brooch

Killamery brooch

Lagore *Crannóg* stud and mould

Moylough beltshrine

Lough Gara buckle

Enamelled mount with studs

Glass stud artefacts sleventh to twelfth century

Lismore crozier

Cross of Cong.

Amber stud artefacts- seventh to ninth century

Lough Kinale bookshrine

'Tara' brooch

Ardagh chalice

Derrynaflan chalice

Lough Gara buckle

These artefact are held in the National Museum of Ireland. This listing is not intended to be comprehensive, but rather to provide a representative sample of the extensive variation created during the late sixth to eleventh centuries. The catalogue is divided according to primary materials glass, amber and copper-alloy groups according to artefact. Loose studs are grouped together. The format of each entry includes material, form, dimensions, colour, technique and repository and accession number (when known

or given). Colour is graded according to the Munsell Bead Color Book. In the case of glass the colour of the primary structural is given first followed by the secondary ornamental colour in the case of enamelled studs. Where glass is mottled the darker colour is listed first and lightest last. Where glass is clearly opaque, transparent or translucent, op., tsl., or tsp. appears after the code. The figure number and page is included in examples which are illustrated.

Part One: Glass Studs

CAT. 1.1- modern replacement	
Object: Derrynaflan paten, ornamental rim, Derrynaflan Co. Tipperary. (NMI:1980:4)	
Materials: Copper-alloy, tin, silver, gold, glass.	
Date: Late eighth to early ninth century.	
Dimensions: D. 37cm, H. 3cm	
Material	Glass.
Colour	Blue, dark navy 10.0B 2/6-2/2 op; Red, antique rose 7.5R 4/6 op
Form	Circular
Composition	A-symmetric
Dimensions	D.9mm
Technique	Glass with silver grille
Museum no.	RVS1

CAT. 1.2	
Object: Derrynaflan paten, ornamental rim, Derrynaflan Co. Tipperary. (NMI:1980:4)	
Materials: Copper-alloy, tin, silver, gold, glass.	
Date: Late eighth to early ninth century.	
Dimensions: D. 37cm, H. 3cm	
Material	Glass, original gold filigree inset now lost, glass is fractured.
Colour	Blue, dark navy 10.0B 2/6-2/2 op; Yellow, sunlight yellow 5.0Y 8/8 op; Red, antique rose 7.5R 4/6 op- shell pink 5.0R 9/2 op.
Form	Circular, slight sub-conical angle.
Composition	Annular
Dimensions	D.17.21mm, recess D.6mm
Technique	Enamelled glass with cast recess to receive gold filigree inset.
Museum no.	ORNST1
Figure no.	119, p. 383.

CAT. 1.3	
Object: Derrynaflan paten, ornamental rim, Derrynaflan Co. Tipperary. (NMI:1980:4)	
Materials: Copper-alloy, tin, silver, gold, glass.	
Date: Late eighth to early ninth century.	
Dimensions: D. 37cm, H. 3cm	
Material	Glass, silver. Silver grille is lifting from the surface, reticulation in evidence.
Colour	Transparent blue glass, strong blue 10.0B 2/6 tsl.
Form	Circular, slightly domed.
Composition	Radial, La Tène triple spiral.
Dimensions	9mm in diameter, ornament 8.5mm
Technique	Cast glass with silver grille.
Museum no.	RVS2
Figure no.	109-10, 112-3, pp. 373-4, 376-7.

CAT.1.4	
Object: Derrynaflan paten, ornamental rim, Derrynaflan Co. Tipperary. (NMI:1980:4) Materials: Copper-alloy, tin, silver, gold, glass. Date: Late eighth to early ninth century. Dimensions: D. 37cm, H. 3cm	
Material	Glass, silver
Colour	Blue, strong blue 10.0B 2/6 tsl- ultramarine 6.25PB 3/12 in transmitted light; Red Rose brown 5.0R 4/12 op- shell pink 5.0R 9/2op
Form	Circular slightly domed.
Composition	Radial, based on circle divided in to six equal segments.
Dimensions	D.12.2mm, silver grille D. 10mm.
Technique	Cast glass with opaque red glass and silver grille ornament.
Museum no.	ORNST 2
Figure no.	70, 114, pp. 348, 378.

CAT. 1.5	
Object: Derrynaflan paten, ornamental rim, Derrynaflan Co. Tipperary. (NMI:1980:4) Materials: Copper-alloy, tin, silver, gold, glass. Date: Late eighth to early ninth century. Dimensions: D. 37cm, H. 3cm	
Material	Glass
Colour	Black, lamp black N.1 op; Red, shell pink 5.0R 9/2 op; Yellow, canary yellow 7.5Y 9/6 op.
Form	Circular, slightly domed.
Composition	Radial, circle divided into eight equal segments.
Dimensions	10mm in diameter, H. 1.2mm, grille diameter 8mm
Technique	Enamelled glass stud.
Museum no.	RVS3
Figure no.	56, p.340

CAT. 1.6	
Object: Derrynaflan paten, ornamental rim, Derrynaflan Co. Tipperary. (NMI:1980:4) Materials: Copper-alloy, tin, silver, gold, glass. Date: Late eighth to early ninth century. Dimensions: D. 37cm, H. 3cm	
Material	Glass, original gold filigree inset is lost. Stud is fractured.
Colour	Blue, 10.0B 2/6 tsl.
Form	Circular, false relief ornament.
Composition	Annular.
Dimensions	17.1mm in diameter, 6mm recess.
Technique	Glass cast with relief ornament and recess to receive gold filigree inset.
Museum no.	ORNST 3.
Figure no.	48, pp.335.

CAT. 1.7

Object: Derrynaflan paten, ornamental rim, Derrynaflan Co. Tipperary. (NMI:1980:4)
Materials: Copper-alloy, tin, silver, gold, glass.
Date: Late eighth to early ninth century.
Dimensions: D. 37cm, H. 3cm

Material	Glass, silver.
Colour	Blue, strong blue 10.0B 2/6 tsl.
Form	Circular slightly domed.
Composition	Radial, based on circle divided in to six equal segments.
Dimensions	9mm in diameter, Silver grille D. 7mm.
Technique	Glass cast with silver foil grille.
Museum no.	RVS4
Figure no.	108, 111, pp. 372, 375.

CAT. 1.8

Object: Derrynaflan paten, ornamental rim, Derrynaflan Co. Tipperary. (NMI:1980:4)
Materials: Copper-alloy, tin, silver, gold, glass.
Date: Late eighth to early ninth century.
Dimensions: D. 37cm, H. 3cm

Material	Glass silver
Colour	Blue, dark navy 10.0B 2/2 op; degraded red, rose wine 2.5YR 4/10 op- light wine 2.5R op; Yellow, sunlight 5.0Y 8/8 op.
Form	Circular.
Composition	Radial, based on circle divided in to six equal segments. Annular border frames the scheme.
Dimensions	12mm in diameter.
Technique	Enamelled glass stud with silver foil ribbon.
Museum no.	ORNST 4

CAT. 1.9

Object: Derrynaflan paten, ornamental rim, Derrynaflan Co. Tipperary. (NMI:1980:4)
Materials: Copper-alloy, tin, silver, gold, glass.
Date: Late eighth to early ninth century.
Dimensions: D. 37cm, H. 3cm

Material	Glass, silver, the grille is damaged and lifting from the stud surface.
Colour	Blue, dark navy 10.0B 2/4 tsl; degraded red, light cherry rose 5.0R 7/8 op.
Form	Circular, slightly domed.
Composition	Radial, based on circle divided in to six equal segments.
Dimensions	9mm in diameter, silver grille, D. 8mm.
Technique	Glass cast with opaque red glass and silver grille.
Museum no.	RVS5
Figure no.	94, 116, pp. 362, 380.

CAT. 1.10

Object: Derrynaflan paten, ornamental rim, Derrynaflan Co. Tipperary. (NMI:1980:4)
Materials: Copper-alloy, tin, silver, gold, glass.
Date: Late eighth to early ninth century.
Dimensions: D. 37cm, H. 3cm

Material	Glass, silver.
Colour	Blue, dark navy 10.0B 2/6 op-6.25PB 3/12 op in transmitted light; Red, poppy red 8.75R 4/14 op.
Form	Circular slightly domed.
Composition	Radial, based on circle divided in to six equal segments.
Dimensions	D.13mm, silver grille D. 11mm.
Technique	Glass cast with opaque red glass and silver foil grille.
Museum no.	ORNST 5

CAT. 1.11

Object: Derrynaflan paten, ornamental rim, Derrynaflan Co. Tipperary. (NMI:1980:4)
Materials: Copper-alloy, tin, silver, gold, glass.
Date: Late eighth to early ninth century.
Dimensions: D. 37cm, H. 3cm

Material	Glass, silver.
Colour	Blue, dark navy 10.0B 2/6- deep blue 2.5PB 3/8 in transmitted light; Degraded red, light cherry rose 5.0R 7/8- 5.0R 9/2 op.
Form	Circular, slight dome.
Composition	Radial, based on circle divided in to six equal segments.
Dimensions	9mm in diameter; silver foil grille D. 7.8mm.
Technique	Glass cast with a silver foil grille.
Museum no.	RVS 6
Figure no.	115, pp.379.

CAT. 1.12

Object: Derrynaflan paten, ornamental rim, Derrynaflan Co. Tipperary. (NMI:1980:4)
Materials: Copper-alloy, tin, silver, gold, glass.
Date: Late eighth to early ninth century.
Dimensions: D. 37cm, H. 3cm

Material	Glass and gold.
Colour	Blue, dark navy 10.0B 2/6-2/2 op; Yellow, sunlight yellow 5.0Y 8/8op; Degraded red, shell pink 5.0R 9/2 op- pale blue 7.5B 8/2 op.
Form	Circular disc, inset of gold filigree now lost.
Composition	Annular
Dimensions	D. 17.2mm; Ornament D. 6mm
Technique	Enamelled glass stud with recess for filigree inset.
Museum no.	ORNST 6

CAT. 1.13	
Object: Derrynaflan paten, ornamental rim, Derrynaflan Co. Tipperary. (NMI:1980:4) Materials: Copper-alloy, tin, silver, gold, glass. Date: Late eighth to early ninth century. Dimensions: D. 37cm, H. 3cm	
Material	Glass, silver.
Colour	Blue, strong blue 10.0B 2/6 op,- ultramarine 6.25PB 3/12 transmitted light; Degraded red: rose brown 5.0R 4/12, mist blue 10.0B 6/3.
Form	Circular slightly domed silver grille.
Composition	Radial, based on circle divided in to six equal segments.
Dimensions	11mm in diameter, silver grille D. 9mm.
Technique	Glass cast with silver foil grille.
Museum no.	RVS7

CAT. 1.14	
Object: Derrynaflan paten, ornamental rim, Derrynaflan Co. Tipperary. (NMI:1980:4) Materials: Copper-alloy, tin, silver, gold, glass. Date: Late eighth to early ninth century. Dimensions: D. 37cm, H. 3cm	
Material	Glass, silver.
Colour	Blue, dark navy 10.0B 2/2 op; Red, rose wine 2.5YR 4/10- light wine 2.5R op; Yellow, sunlight 5.0Y 8/8 op.
Form	Circular, slight dome.
Composition	Radial, based on circle divided in to six equal segments. An annular border frames the composition.
Dimensions	12mm in diameter.
Technique	Enamelled glass stud with foil ribbon.
Museum no.	ORNST 7
Figure no.	47, 87, pp.334, 358.

CAT. 1.15	
Object: Derrynaflan paten, ornamental rim, Derrynaflan Co. Tipperary. (NMI:1980:4) Materials: Copper-alloy, tin, silver, gold, glass. Date: Late eighth to early ninth century. Dimensions: D. 37cm, H. 3cm	
Material	Glass, silver.
Colour	Blue, dark navy 10.0B 2/6- deep blue 2.5PB 3/8 in transmitted light; Degraded red, light cherry rose 5.0R 7/8- 5.0R 9/2 op.
Form	Circular, slightly domed.
Composition	The pattern is divided into eight segments to determine the position of ornament.
Dimensions	9mm in diameter, silver grille D. 7mm.
Technique	Glass cast with a silver grille.
Museum no.	RVS 8

CAT. 1.16

Object: Derrynaflan paten, ornamental rim, Derrynaflan Co. Tipperary. (NMI:1980:4)
Materials: Copper-alloy, tin, silver, gold, glass.
Date: Late eighth to early ninth century.
Dimensions: D. 37cm, H. 3cm

Material	Glass. Original filigree inset is now lost.
Colour	Blue, dark navy 10.0B 2/6-2/2 op; Yellow, sunlight yellow 5.0Y 8/8 op; Degraded red, rose brown 5.0R 4/12 op- shell pink 5.0R 9/2 op, light aqua blue 5.0b 8/4 op.
Form	Circular, slightly sub-conical.
Composition	Annular.
Dimensions	Enamelled glass stud.
Technique	D.17.2mm, 6mm.
Museum no.	ORNST 8.

CAT. 1.17

Object: Derrynaflan paten, ornamental rim, Derrynaflan Co. Tipperary. (NMI:1980:4)
Materials: Copper-alloy, tin, silver, gold, glass.
Date: Late eighth to early ninth century.
Dimensions: D. 37cm, H. 3cm

Material	Glass, silver.
Colour	Blue, strong blue 10.0B 2/6 tsl.
Form	Circular slightly domed.
Composition	Radial, based on circle divided in to six equal segments.
Dimensions	D. 9mm, silver grille D. 7.6mm.
Technique	Glass cast with silver grille.
Museum no.	RVS 9

CAT. 1.18

Object: Derrynaflan paten, ornamental rim, Derrynaflan Co. Tipperary. (NMI:1980:4)
Materials: Copper-alloy, tin, silver, gold, glass.
Date: Late eighth to early ninth century.
Dimensions: D. 37cm, H. 3cm

Material	Glass, silver.
Colour	Blue, dark navy 10.0B 2/4op- ultramarine 6.25PB 3/12 in transmitted light; Degraded red: dusty coral 5.0R 5/6 op- rose grey 5.0R 4/10 op.
Form	Circular slightly domed.
Composition	Radial, based on circle divided in to six equal segments.
Dimensions	D. 14mm, silver grille D.12.5mm.
Technique	Cast glass with opaque red and silver foil grille.
Museum no.	ORNST 9.

CAT. 1.19	
Object: Derrynaflan paten, ornamental rim, Derrynaflan Co. Tipperary. (NMI:1980:4) Materials: Copper-alloy, tin, silver, gold, glass. Date: Late eighth to early ninth century. Dimensions: D. 37cm, H. 3cm	
Material	Glass.
Colour	Black, lamp black N.10p; Degraded red, shell pink 5.OR 9/20p; Yellow, canary yellow 7.5Y 9/60p.
Form	Circular, domed.
Composition	Radial, based on circle divided in to eight equal segments.
Dimensions	D.10mm, 1.2mm high approx.
Technique	Enamelled glass stud.
Museum no.	RVS10.
Figure no.	71, p.349.

CAT. 1.20	
Object: Derrynaflan paten, ornamental rim, Derrynaflan Co. Tipperary. (NMI:1980:4) Materials: Copper-alloy, tin, silver, gold, glass. Date: Late eighth to early ninth century. Dimensions: D. 37cm, H. 3cm	
Material	Glass, gold. Glass is fractured.
Colour	Blue strong blue 10.0B 2/6 tsl.
Form	Disc.
Composition	Annular.
Dimensions	D.17.2mm; recess d.6mm.
Technique	Cast false relief pattern and a recess for an inset of filigree.
Museum no.	ORNST 10
Figure no.	67, p.346.

CAT. 1.21	
Object: Derrynaflan paten, ornamental rim, Derrynaflan Co. Tipperary. (NMI:1980:4) Materials: Copper-alloy, tin, silver, gold, glass. Date: Late eighth to early ninth century. Dimensions: D. 37cm, H. 3cm	
Material	Blue glass, silver.
Colour	Blue, strong blue 10.0B 2/4 tsl.
Form	Circular slightly domed.
Composition	Radial, based on circle divided in to six equal segments.
Dimensions	D. 9mm, silver grille d. 8.3mm
Technique	Cast glass stud with silver foil grille.
Museum no.	RVS 11.

CAT. 1.22

Object: Derrynaflan paten, ornamental rim, Derrynaflan Co. Tipperary. (NMI:1980:4)
 Materials: Copper-alloy, tin, silver, gold, glass.
 Date: Late eighth to early ninth century.
 Dimensions: D. 37cm, H. 3cm

Material	Glass, gold.
Colour	Blue, strong blue 10.0B 2/6 tsl.
Form	Circular.
Composition	Annular.
Dimensions	D.17.2mm; recess D. 6mm
Technique	Glass cast with false relief pattern and recess for gold filigree inset.
Museum no.	ORNST 11

CAT. 1.23

Object: Derrynaflan paten, ornamental rim, Derrynaflan Co. Tipperary. (NMI:1980:4)
 Materials: Copper-alloy, tin, silver, gold, glass.
 Date: Late eighth to early ninth century.
 Dimensions: D. 37cm, H. 3cm

Material	Glass, silver.
Colour	Blue, dark navy 10.0B 2/2, transparent in corner cerulean blue 7.5B 4/8 tsl; Red, rose brown 5.0R 4/12op- light red 5.0R 5/12op.
Form	Circular, slight dome.
Composition	Radial, cruciform based on circle divided in to four equal segments.
Dimensions	D. 9mm, h.1mm; silver grille, d. 7.8mm; height of setting 6mm.
Technique	Cast glass with opaque red glass and silver foil grille.
Museum no.	RVS12
Figure no.	117, 118, 120, pp.381-2, 383.

CAT. 1.24

Object: Derrynaflan paten, ornamental rim, Derrynaflan Co. Tipperary. (NMI:1980:4)
 Materials: Copper-alloy, tin, silver, gold, glass.
 Date: Late eighth to early ninth century.
 Dimensions: D. 37cm, H. 3cm

Material	Glass, silver.
Colour	Blue, dark navy 10.0B 2/2 op; degraded red, baby pink 5.0R 8/4op, ice blue 5.0BG 8/2op.
Form	Circular, slightly domed.
Composition	Radial, based on circle divided in to six equal segments.
Dimensions	D. 13mm. silver grille 12 mm.
Technique	Cast glass with opaque red glass and silver foil grille.
Museum no.	ORNST12

CAT. 1.25	
Object: Derrynaflan paten, side, Derrynaflan Co. Tipperary. (NMI:1980:4) Materials: Copper-alloy, tin, silver, gold, glass. Date: Late eighth to early ninth century. Dimensions: D. 37cm, H. 3cm	
Material	Glass, silver.
Colour	Blue, dark navy, 10.0B 2/4tsl-ultramarine PB 3/12 tsl in transmitted light; Degraded red, baby pink 5.0R 8/4op- light red 5.0R 5/6.
Form	Rectangular, flat.
Composition	Composition based on grid divided into eight fields, lattice like. Matches stud CAT. 1.34 and CAT.1.35.
Dimensions	H. 13.92mm x W. 10.57mm. Ornament: 12.91mm x 8.11mm
Technique	Cast glass with opaque red glass and silver foil grille.
Museum no.	ES 1

CAT. 1.26	
Object: Derrynaflan paten, side, Derrynaflan Co. Tipperary. (NMI:1980:4) Materials: Copper-alloy, tin, silver, gold, glass. Date: Late eighth to early ninth century. Dimensions: D. 37cm, H. 3cm	
Material	Glass and enamel.
Colour	Blue, dark navy 10.0B 2/4op- bright copin blue 5.0PB 4/10 tsl in transmitted light: Red, poppy red 8.75R 4/14op -coral red 10.0R 5/10op. yellow, sunlight 5.0Y 8/8-canary yellow 7.5Y 9.6 op.
Form	Rectangular, flat
Composition	Composition based on grid divided into eight fields, lattice like and matches stud CAT. 1.29 and CAT. 1.36.
Dimensions	H. 15.41mm x W. 9.97mm. Ornament: 13.65mm x 8.65mm.
Technique	Enamelled glass.
Museum no.	ES 2

CAT. 1.27	
Object: Derrynaflan paten, side, Derrynaflan Co. Tipperary. (NMI:1980:4) Materials: Copper-alloy, tin, silver, gold, glass. Date: Late eighth to early ninth century. Dimensions: D. 37cm, H. 3cm	
Material	Glass, silver.
Colour	Blue, dark navy 10.0B 2/4op; Red: poppy red 8.75R4/4op- coral red 10.0R 5/8op.
Form	Rectangular, flat.
Composition	Lattice like composition based upon grid divided into cross formation with swastikas within each quarter. Matches grilles on CAT.1.28, CAT. 1.30-32.
Dimensions	H.14mm x W. 10.58mm. Ornament: H.11.06mm x W.7.5mm
Technique	Poly chrome glass cast with a silver grille.
Museum no.	ES 3

CAT. 1.28	
Object: Derrynaflan paten, side, Derrynaflan Co. Tipperary. (NMI:1980:4) Materials: Copper-alloy, tin, silver, gold, glass. Date: Late eighth to early ninth century. Dimensions: D. 37cm, H. 3cm	
Material	Glass, silver.
Colour	Transparent blue, dark navy 10.0B tsl. 2/4- strong blue 10.0B 2/6 tsl. – horizon blue 10.0B 5/6 tsl. In transmitted light; degraded red, poppy red 8.75R 4/1-shrimp pink 6/10 op.
Form	Rectangular, flat.
Composition	Lattice like composition based upon cruciform division with swastikas within each quarter. Matches grilles on CAT1.27, CAT. 1.30-33.
Dimensions	H.11mm x W. 7mm. Ornament: H. 12.19 x W. 7.26mm.
Technique	Enamelled glass.
Museum no.	ES 4

CAT. 1.29	
Object: Derrynaflan paten, side, Derrynaflan Co. Tipperary. (NMI:1980:4) Materials: Copper-alloy, tin, silver, gold, glass. Date: Late eighth to early ninth century. Dimensions: D. 37cm, H. 3cm	
Material	Glass.
Colour	Blue, dark navy 10.0B 2/4op; Red, coral red 10.0R 5/10op; Yellow, sunlight yellow 5.OY 8/8 op.-Yellow, daffodil yellow 5.OY 8/10op.
Form	Rectangular, flat.
Composition	Lattice like Composition based on grid divided into eight fields, matches stud CAT. 1.25 and CAT. 1.36.
Dimensions	H.14.48mm x W. 10.42mm. Ornament: H.12.89mm x W. 8.3mm.
Technique	Enamelled glass.
Museum no.	ES 5
Figure no.	16, p.312.

CAT. 1.30	
Object: Derrynaflan paten, side, Derrynaflan Co. Tipperary. (NMI:1980:4) Materials: Copper-alloy, tin, silver, gold, glass. Date: Late eighth to early ninth century. Dimensions: D. 37cm, H. 3cm	
Material	Glass, silver.
Colour	dark navy 10.0B 2/4op- Cerulean blue 7.5B 4/8tsl; poppy red 8.75R 4/14op; daffodil yellow 5.OY 8/10op.
Form	Rectangular, flat.
Composition	Lattice like composition based upon cruciform division with swastikas within each quarter. Matches grilles on CAT.1.28 and CAT. 1.31-33.
Dimensions	H. 15.59mm x W. 10.27mm; Ornament: H. 12.19mm x 7.26mm.
Technique	Cast glass with opaque red and yellow glass within a silver grille.
Museum no.	ES6

CAT. 1.31	
Object: Derrynaflan paten, side, Derrynaflan Co. Tipperary. (NMI:1980:4) Materials: Copper-alloy, tin, silver, gold, glass. Date: Late eighth to early ninth century. Dimensions: D. 37cm, H. 3cm	
Material	Glass, silver.
Colour	Blue, dark navy 10.0B 2/4 -2/2tsl- twilight blue 5.0PB 6/8 tsl on fracture; Red, rose brown 5.0R 4/12op.
Form	Rectangular, flat.
Composition	Lattice like composition based upon cruciform division with swastikas within each quarter. Matches grilles on CAT.1.28, CAT.1.30 and CAT. 1.32-33.
Dimensions	H. 14.31mm x W. 10mm, Ornament: H.11mm x 6.85mm.
Technique	Cast glass with opaque red glass within a silver grille.
Museum no.	ES7
Figure no.	122, p.385.

CAT. 1.32	
Object: Derrynaflan paten, side, Derrynaflan Co. Tipperary. (NMI:1980:4) Materials: Copper-alloy, tin, silver, gold, glass. Date: Late eighth to early ninth century. Dimensions: D. 37cm, H. 3cm	
Material	Glass, silver.
Colour	Transparent strong blue 10.0B tsl. 2/6- bright copin blue 2.5PB 6/9tsl at fracture; Degrading red, 5.0R 5/12 op- bright peach 10.0 R 6/10op.
Form	Rectangular, flat.
Composition	Lattice like composition based upon grid divided into cross formation with swastikas within each quarter. Matches grilles on CAT1.28, CAT. 1.30, 31, 33.
Dimensions	H. 15.19mm, W. 9.8mm, Ornament: H.11.59mm x W.7.46mm.
Technique	Cast glass with opaque red glass within a silver grille.
Museum no.	ES 8

CAT. 1.33	
Object: Derrynaflan paten, side, Derrynaflan Co. Tipperary. (NMI:1980:4) Materials: Copper-alloy, tin, silver, gold, glass. Date: Late eighth to early ninth century. Dimensions: D. 37cm, H. 3cm	
Material	Glass, silver.
Colour	Dark navy 10.0B2/4-2/2-ultramarine 6.25PB 3/12 tsl; tomato red 7.5R 3/12 op-brick red 7.5R 3/8 op.; daffodil yellow 5.0Y 8/10op.
Form	Rectangular, flat.
Composition	Composition based upon grid divided into cross formation with swastikas within each quarter. Matches grilles on CAT1.28, 30-32.
Dimensions	H. 15.89mm x W. 10.87mm (max. top) 9.8 (min. base) Ornament: H. 12mm x W. 7.27mm.
Technique	Cast glass with opaque red glass and silver grille.
Museum no.	ES9
Figure no.	123-4, pp.386.

CAT. 1.34	
Object: Derrynaflan paten, side, Derrynaflan Co. Tipperary. (NMI:1980:4) Materials: Copper-alloy, tin, silver, gold, glass. Date: Late eighth to early ninth century. Dimensions: D. 37cm, H. 3cm	
Material	Glass, silver.
Colour	Blue, dark navy 10.0B 2/4-2/2 tsl.- ultramarine 6.25PB 3/12 tsl.; Red, poppy red 8.75R 4/14op. Yellow, daffodil yellow 5.0Y 8/10op.
Form	Rectangular, flat.
Composition	Lattice. Grille based on grid divided into eight fields and matches those on CAT. 1.25 and CAT.1.35.
Dimensions	H. 15.42mm x W.10.19mm. Ornament: 13.29mm x 8.16mm.
Technique	Cast glass with opaque red and silver foil grille.
Museum no.	ES 10.

CAT. 1.35	
Object: Derrynaflan paten, side, Derrynaflan Co. Tipperary. (NMI:1980:4) Materials: Copper-alloy, tin, silver, gold, glass. Date: Late eighth to early ninth century. Dimensions: D. 37cm, H. 3cm	
Material	Glass, silver. Silver foil torn away bottom left hand corner.
Colour	Blue, strong blue 10.0B 2/6tsl- ultramarine 6.25PB 3/12tsl.
Form	Rectangular, flat.
Composition	Lattice like grille based on grid divided into eight fields. Grille matches those on CAT. 1.34 and CAT.1.25.
Dimensions	H. 14mm x W. 1.01mm. Ornament: H. 13.17mm x W. 9.02mm.
Technique	Cast glass with silver foil grille.
Museum no.	ES 11
Figure no.	121, p.384.

CAT.1.36	
Object: Derrynaflan paten, ornamental rim, Derrynaflan Co. Tipperary. (NMI:1980:4) Materials: Copper-alloy, tin, silver, gold, glass. Date: Late eighth to early ninth century. Dimensions: D. 37cm, H. 3cm	
Material	Glass, silver
Colour	Dark navy 10.0B 2/4op; coral red 10.0R 5/10op, pale blue 7.5B 8/2 op; Yellow, daffodil yellow 5.0Y 8/10op.
Form	Rectangular, flat.
Composition	Lattice like composition based on grid divided into eight fields, matches stud CAT. 1.25 and CAT. 1.29.
Dimensions	H.14.50mm x W.10mm; Ornament H.12.5mm x W. 8.4mm.
Technique	Cast glass with opaque red and yellow glass within a silver foil grille.
Museum no.	ES 12
Figure no.	125, p.387.

CAT. 2.1	
Object: Derrynaflan ring, side, Derrynaflan Co. Tipperary. (NMI:1980:5) Materials: Copper-alloy, tin, silver, glass. Date: Late eighth to early ninth century. Dimensions: D. 35.8cm, H. 3.6cm	
Material	Glass.
Colour	Blue, dark navy 10.0B 2/4; Degrading red op, coral red 10.0R 5/10-mistletoe green 7.5GY 5/4.
Form	Rectangular, flat.
Composition	Composition based upon cruciform grid, with stepped motif. Grid matches stud CAT. 2.7 but colours are alternated.
Dimensions	H. 11.8mm, W. 8mm. Ornament: H. 9.1mm, W. 6mm.
Technique	Cast glass with opaque red glass within a silver foil grille.
Museum no.	RES 2
Figure no.	127, p.389.

CAT. 2.2	
Object: Derrynaflan ring, side, Derrynaflan Co. Tipperary. (NMI:1980:5) Materials: Copper-alloy, tin, silver, glass. Date: Late eighth to early ninth century. Dimensions: D. 35.8cm, H. 3.6cm	
Material	Glass.
Colour	Mistletoe green, 7.5 GY 5/4 tsl., dark green 2.5G 3/6 tsl, dark palm green 10.0GY 4/4 tsl; Fragment of yellow glass within green background has distorted the colour. Red rose gray 5.0R 4/10; Yellow, daffodil yellow 5.0Y 8/10 op.
Form	Rectangular, flat.
Composition	Lattice, quartered grid with L-shaped Composition, forming a central cross. Matches studs CAT. 2.4 and CAT. 2.6.
Dimensions	H.11.5mm. W.8.06. Ornament, H. 9.9mm W. 7.6mm.
Technique	Cast glass with yellow and red enamel inlay.
Museum no.	RES3
Figure no.	50, 130, pp. 337, 392.

CAT. 2.3	
Object: Derrynaflan ring, side, Derrynaflan Co. Tipperary. (NMI:1980:5) Materials: Copper-alloy, tin, silver, glass. Date: Late eighth to early ninth century. Dimensions: D. 35.8cm, H. 3.6cm	
Material	Glass, silver.
Colour	Strong blue 10.0B 2/6 tsl- bright copin blue 2.5PB 6/9 tsl.
Form	Rectangular, flat.
Composition	S-shaped La Tène composition with trumpet forms and four spirals in cruciform arrangement. See also CAT. 1.3.
Dimensions	H. 12.86mm x W. 7.99; Ornament: H. 12.8 mm W. 7.26mm.
Technique	Cast glass with opaque red and a silver foil grille.
Museum no.	RES 2
Figure no.	126, p.388.

CAT. 2.4	
Object: Derrynaflan ring, side, Derrynaflan Co. Tipperary. (NMI:1980:5) Materials: Copper-alloy, tin, silver, glass. Date: Late eighth to early ninth century. Dimensions: D. 35.8cm, H. 3.6cm	
Material	Glass.
Colour	Green dark jade green 10.0G. 4/5 tsl.-trns; Yellow, mustard gold 2.5Y 6/8 –daffodil 5.0Y 8/10.
Form	Rectangular, flat.
Composition	Lattice, quartered grid with L-shaped Composition.
Dimensions	H.12 x W. 8.07mm. Ornament, H. 9.9mm W. 7.6mm.
Technique	Cast glass with yellow enamel.
Museum no.	RES 5
Figure no.	131, pp.393.

CAT. 2.5	
Object: Derrynaflan ring, side, Derrynaflan Co. Tipperary. (NMI:1980:5) Materials: Copper-alloy, tin, silver, glass. Date: Late eighth to early ninth century. Dimensions: D. 35.8cm, H. 3.6cm	
Material	Glass, silver.
Colour	Deep blue 2.5 PB 3/8 tls-light navy 5.0PB 4/4 tls, translucency and colouring suggests two colours on reverse; poppy red 8.75R 4/14-coral red 10.0R, degraded sections fawn 5.0YR 2/4.
Form	Rectangular, flat.
Composition	Lattice like composition based upon grid divided into cross formation with swastikas within each quarter. Matching grilles on CAT1.28, 1.30-32.
Dimensions	11.5mm x W. 8.02mm; Ornament H. 9.5mm x 6.3mm.
Technique	Cast glass with opaque red and yellow glass within a silver foil grille
Museum no.	RES 6
Figure no.	129 p.391.

CAT. 2.6	
Object: Derrynaflan ring, side, Derrynaflan Co. Tipperary. (NMI:1980:5) Materials: Copper-alloy, tin, silver, glass. Date: Late eighth to early ninth century. Dimensions: D. 35.8cm, H. 3.6cm	
Material	Glass. Stud is chipped.
Colour	Green dark jade green 10.0G 4/5- 6/6; sunlight yellow 5.0Y 8/8.
Form	Rectangular, flat.
Composition	Lattice, quartered grid with L-shaped Composition, forming a central cross and Composition. Matching pattern on studs CAT.2.2, CAT. 2.4.
Dimensions	H.11.50mm x W. 8.09mm. Ornament, H. 10mm W. 7.9mm.
Technique	Enamelled glass.
Museum no.	RES 7

CAT. 2.7

Object: Derrynaflan ring, side, Derrynaflan Co. Tipperary. (NMI:1980:5)

Materials: Copper-alloy, tin, silver, glass.

Date: Late eighth to early ninth century.

Dimensions: D. 35.8cm, H. 3.6cm

Material	Glass, silver.
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Colour	Dark navy 10.0B 2/4; tomato red- 7.5R 3/12 op -coral red 10.0R 5/10 op.
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Form	Rectangular, flat.
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Composition	Composition based upon cruciform grid, with stepped composition. Grid matches stud, CAT. 2.1, but colours are alternated.
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Dimensions	12mm x W. 8.1mm. Ornament: H. 10.9mm x W. 7mm.
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Technique	Cast glass with opaque red glass within a silver foil grille.
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Museum no.	RES 8
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Figure no.	128, p.390.
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CAT. 2.8 a-d

Object: Derrynaflan ring, side, mount at CAT.2.5, Derrynaflan Co. Tipperary. (NMI:1980:5)

Materials: Copper-alloy, tin, silver, glass.

Date: Late eighth to early ninth century.

Dimensions: D. 35.8cm, H. 3.6cm

Material	Glass
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Colour	Black 2/1- very dark brown 2/2 op.
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Form	Circular domed.
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Composition	Plain.
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Dimensions	D. 4mm.
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Technique	Cast glass.
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Museum no.	-
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Figure no.	81, p.354.
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CAT. 2.9 a-c

Object: Derrynaflan ring, side, mount at CAT.2.4, Derrynaflan Co. Tipperary. (NMI:1980:5)

Materials: Copper-alloy, tin, silver, glass.

Date: Late eighth to early ninth century.

Dimensions: D. 35.8cm, H. 3.6cm

Material	Glass
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Colour	Strong blue 10.0B 2/6- deep blue 2.5PB 3/8 tls.
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Form	Circular domed.
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Composition	Plain.
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Dimensions	D. 4mm.
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Technique	Cast glass.
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Museum no.	-
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Figure no.	131, p.393.
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CAT. 3.1

Object: Derrynaflan strainer-ladle, Derrynaflan Co. Tipperary. (NMI:1980:7)

Materials: Copper-alloy, tin, silver, glass, rock crystal.

Date: Late eighth to early ninth century.

Dimensions: L. 37.8cm D. 11.5cm.

Material	Glass, copper-alloy and <i>millefiori</i> .
Colour	Red, poppy red tomato red 7.5R 3/12op-poppy red 8.75R 4/14op. <i>millefiori</i> inset, Green bright chartreuse 2.5GY 7/10 op., Blue ultramarine 6.25PB 3/12 tls.
Form	sub-rectangular, slightly curved.
Composition	Radial, based upon a quartered square.
Dimensions	Max L. 10mm; Min. L. 8mm, W 9mm. T. 2mm max.
Technique	Cast glass with copper-alloy grille.
Museum no.	ES1
Figure no.	95, p. 362.

CAT. 3.2

Object: Derrynaflan strainer-ladle, Derrynaflan Co. Tipperary. (NMI:1980:7)

Materials: Copper-alloy, tin, silver, glass, rock crystal.

Date: Late eighth to early ninth century.

Dimensions: L. 37.8cm D. 11.5cm.

Material	Glass, copper-alloy and enamel.
Colour	Dark navy 10.0B 2/4, Red, poppy red tomato red 7.5R 3/12op-orange 2.5Y 6/14 op.
Form	Circular slightly curved.
Composition	Radial, based upon a circle divided into eight segments.
Dimensions	D. 12mm
Technique	Cast glass with copper-alloy grille.
Museum no.	ES2
Figure no.	13, p.311.

CAT. 4.1

Object: 'Tara' brooch, obverse, Bettystown, Co. Meath, (NMI:4015).

Materials: Silver, gold, copper-alloy, glass, amber.

Date: Late seventh to early eighth century.

Dimensions; brooch diameter 8.7cm, pin 32cm.

Material	Glass, gold
Colour	Blue, Ultramarine 6.25PB 3/12 tsl. (assessed under field conditions)
Form	Circular domed.
Composition	Annular.
Dimensions	D. 4.5mm, H. 2mm
Technique	Cast glass.
Museum no.	1B matching stud 2B within the brooch
Figure no.	7, p.306.

CAT. 4.2

Object: 'Tara' brooch, obverse, Bettystown, Co. Meath, (NMI:4015).

Materials: Silver, gold, copper-alloy, glass, amber.

Date: Late seventh to early eighth century.

Dimensions; brooch diameter 8.7cm, pin 32cm.

Material	Glass.
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Colour	Brown, yellow-brown 5/8- yellow 7/8tls. (assessed under field conditions)
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Form	Circular domed.
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Composition	Radial. 1B, matching stud 4B.
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Dimensions	D. 4.5mm, H. 2mm.
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Technique	Cast glass.
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Museum no.	3B
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Figure no.	55, p.339.
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CAT. 4.3

Object: 'Tara' brooch, obverse, Bettystown, Co. Meath, (NMI:4015).

Materials: Silver, gold, copper-alloy, glass, amber.

Date: Late seventh to early eighth century.

Dimensions; brooch diameter 8.7cm, pin 32cm.

Material	Glass, copper-alloy (gold now lost).
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Colour	Blue, ultramarine 6.25PB 3/12 tsl. Red. Poppy red 8.75R 4/14. (assessed under field conditions)
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Form	Circular domed.
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Composition	Annular. matching stud 5B within the brooch.
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Dimensions	D. 4.5mm, H. 2mm
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Technique	Cast glass.
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Museum no.	6B
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Figure no.	7, p.306.
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CAT. 4.4

Object: 'Tara' brooch, obverse, Bettystown, Co. Meath, (NMI:4015).

Materials: Silver, gold, copper-alloy, glass, amber.

Date: Late seventh to early eighth century.

Dimensions; brooch diameter 8.7cm, pin 32cm.

Material	Glass, gold.
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Colour	Dark shadow blue 7.5B3/3 tsl-strong blue 10.0B 2/6tsl. (assessed under field conditions)
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Form	Parallelogram, with high relief pitched obverse.
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Composition	cruciform.
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Dimensions	H. 7.4mm, W. 8.9mm.
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Technique	Glass cast with filigree inset during casting.
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Museum no.	7B
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Figure no.	85, p.357.
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CAT. 4.5	
Object: 'Tara' brooch, obverse, Bettystown, Co. Meath, (NMI:4015). Materials: Silver, gold, copper-alloy, glass, amber. Date: Late seventh to early eighth century. Dimensions; brooch diameter 8.7cm, pin 32cm.	
Material	Glass,
Colour	Purple lavender mist 7.5PB 3/8 tls. (assessed under field conditions)
Form	Anthropomorphic head.
Composition	Symmetrical.
Dimensions	L. 4.8mm, W. 3.2mm.
Technique	Glass cast.
Museum no.	8B.
Figure no.	7, p.306.

CAT. 4.6	
Object: 'Tara' brooch, reverse, Bettystown, Co. Meath, (NMI:4015). Materials: Silver, gold, copper-alloy, glass, amber. Date: Late seventh to early eighth century. Dimensions; brooch diameter 8.7cm, pin 32cm.	
Material	copper-alloy, enamel.
Colour	Blue, dark blue 7.5PB 2/5; Red, poppy red 8.75R 4/14 op. (assessed under field conditions)
Form	Disc.
Composition	Circle was divided into six equal segments to compose pattern.
Dimensions	D. 9mm.
Technique	<i>Champlevé</i> and enamelled glass.
Museum no.	11B. left.
Figure no.	24, p.317.

CAT. 4.7	
Object: 'Tara' brooch, reverse, Bettystown, Co. Meath, (NMI:4015). Materials: Silver, gold, copper-alloy, glass, amber. Date: Late seventh to early eighth century. Dimensions; brooch diameter 8.7cm, pin 32cm.	
Material	copper-alloy, enamel.
Colour	Blue, dark blue 7.5PB 2/5; Red, poppy red 8.75R 4/14 op. (assessed under field conditions)
Form	Disc.
Composition	Circle was divided into six equal segments to compose pattern.
Dimensions	D. 9mm.
Technique	<i>Champlevé</i> and enamelled glass.
Museum no.	12B. right.
Figure no.	77, p.351.

CAT. 5.1

Object: Hinged shrine mount, no locality, (NMI1920.45).

Materials: Copper-alloy, glass enamel, orpiment.

Date: Eighth century.

Dimensions; L 5.2cm, W. 4.4cm.

Material	Glass, orpiment.
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Colour	Green, water green-7.5 GY 8/4trns.
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Form	Semi-circular cabochon.
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Composition	Plain glass with stepped pattern in orpiment.
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Dimensions	L. 9mm, W.4.5mm
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Technique	Cast glass, drawing.
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Museum no.	ES1 matching stud ES2 within the mount.
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Figure no.	52, p. 338.
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CAT. 6.1

Object: Glass stud and mould, Lagore *Crannóg*, Co. Meath. (NMI E14:157, a & b)

Materials: Glass, clay.

Date: Eighth century.

Dimensions: clay mould, D. 26mm, Th. 8mm.

Material	Glass.
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Colour	Green, leaf green 7.5GY 6/6-7.5GY 8/4 tls.
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Form	Disc.
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Composition	Based upon cruciform, quartered circle.
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Dimensions	D. 21.2mm, Th. 4mm.
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Technique	Glass cast with recessed motif.
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Museum no.	stud E14:157a. Clay mould E14:157b
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Figure no.	51, p.337.
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CAT. 7.1

Object: Beltshrine, Moylough, Co. Sligo. (NMI:1945.81)

Materials: copper-alloy, glass, silver, tin, mica.

Date: Eighth century.

Dimensions: L.91cm, W.52cm.

Material	Glass, silver, original red glass inlay now lost.
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Colour	Dark navy 10.0B 2/4- 10.0B 2/6, ultramarine 6.25PB 3/12 appears in transmitted light. (assessed under field conditions)
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Form	Circular cabochon.
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Composition	Circle divided in three.
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Dimensions	D. 9mm
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Technique	Glass cast silver ribbon formed into peltae, peltae terminals were enamelled with red glass.
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Museum no.	Stud b
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Figure no.	35, p.325.
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CAT. 7.2	
Object: Belt-shrine, Moylough, Co. Sligo. (NMI:1945.81) Materials: copper-alloy, glass, silver, tin, mica. Date: Eighth century. Dimensions: L.91cm, W.52cm.	
Material	Glass, silver, original red glass inlay now lost.
Colour	Blue, dark navy 10.0B 2/4- 10.0B 2/6, bright teal blue 7.5BG 3/8 appears in transmitted light. (assessed under field conditions)
Form	Circular cabochon.
Composition	Circle divided into eight segments.
Dimensions	D. 21.2mm, Th. 4mm.
Technique	Glass cast with silver foil and opaque red glass.
Museum no.	Stud d
Figure no.	35, p.325.

CAT. 8.1	
Object: Buckle, Lough Gara, Co. Sligo, (NMI:1958.20) Materials: copper-alloy, glass, amber. Date: Seventh to eighth century. Dimensions: L.76mm, W.25mm.	
Material	Reticella glass.
Colour	Blue, ultramarine 6.25PB 3/12, White N9.
Form	Disc
Composition	Circle divided into four segments.
Dimensions	D. 9mm. approx..
Technique	Glass cast with recessed pattern.
Museum no.	Stud c
Figure no.	61, p.342.

CAT.9.1	
Object: Ardagh chalice, bowl-girdle, Reerasta, Co. Limerick. (NMI 1874.99) Materials: Silver, gold, copper-alloy, glass, amber, mica, malachite, rock-crystal. Date: Eighth century. Dimensions: H. 178mm, bowl d. 195mm.	
Material	Glass, silver
Colour	Blue, ultramarine 6.25PB 3/12 tsp. appears in transmitted light.
Form	Circular cabochon
Composition	Radial based upon a circle divided into six segments.
Dimensions	9mm.
Technique	Glass cast with a silver grille.
Museum no.	BGS1.
Figure no.	29, 102, pp. 321, 368.

CAT.9.2

Object: Ardagh chalice, bowl-girdle, Reerasta, Co. Limerick. (NMI 1874.99)
Materials: Silver, gold, copper-alloy, glass, amber, mica, malachite, rock-crystal.
Date: Eighth century.
Dimensions: H. 178mm, bowl d. 195mm.

Material	Glass, silver
Colour	Blue, bright navy 7.5PB 2/7, ultramarine 6.25PB 3/12 tsp, Red tomato red 7.5R 3/12 op.
Form	Circular cabochon
Composition	Radial based upon a circle divided into eight segments.
Dimensions	9mm.
Technique	Cast glass with opaque red enamel and silver foil grille.
Museum no.	BGS10.
Figure no.	45, p.333.

CAT.9.3

Object: Ardagh chalice, bowl-girdle, Reerasta, Co. Limerick. (NMI 1874.99)
Materials: Silver, gold, copper-alloy, glass, amber, mica, malachite, rock-crystal.
Date: Eighth century.
Dimensions: H. 178mm, bowl d. 195mm.

Material	Glass, silver
Colour	Blue, dark navy 10.0B 2/4- 10.0B 2/6 tsl. ultramarine 6.25PB 3/12 appears in transmitted light. Red, tomato red 7.5R 3/12.op.
Form	Circular cabochon
Composition	Radial based upon a circle divided into eight segments.
Dimensions	9mm.
Technique	Cast glass with opaque red enamel and silver foil grille.
Museum no.	BGS3.
Figure no.	103, p.369.

CAT.9.4

Object: Ardagh chalice, bowl-girdle, Reerasta, Co. Limerick. (NMI 1874.99)
Materials: Silver, gold, copper-alloy, glass, amber, mica, malachite, rock-crystal.
Date: Eighth century.
Dimensions: H. 178mm, bowl d. 195mm.

Material	Glass, silver
Colour	Blue, Wedgewood blue 10.0B 4/10 -horizon blue 10.0B 5/6 tsl.
Form	Circular cabochon
Composition	Radial based upon a circle divided into six segments.
Dimensions	9mm.
Technique	Cast glass with silver foil grille.
Museum no.	BGS4. Matches BGS1.

CAT.9.5	
Object: Ardagh chalice, bowl-girdle, Reerasta, Co. Limerick. (NMI 1874.99) Materials: Silver, gold, copper-alloy, glass, amber, mica, malachite, rock-crystal. Date: Eighth century. Dimensions: H. 178mm, bowl d. 195mm.	
Material	Glass, silver
Colour	Blue, Wedgewood blue 10.0B 4/10 -horizon blue 10.0B 5/6 tsl.- Degraded opaque red poppy red 8.75R 4/14 op, damaged area English green 7.5GY 7/10 op
Form	Circular cabochon
Composition	Radial based upon a circle divided into four segments.
Dimensions	9mm.
Technique	Cast glass with silver foil grille.
Museum no.	BGS5

CAT.9.6	
Object: Ardagh chalice, bowl-girdle, Reerasta, Co. Limerick. (NMI 1874.99) Materials: Silver, gold, copper-alloy, glass, amber, mica, malachite, rock-crystal. Date: Eighth century. Dimensions: H. 178mm, bowl d. 195mm.	
Material	Glass, silver
Colour	Blue, Wedgewood blue 10.0B 4/10 -horizon blue 10.0B 5/6 tsl.
Form	Circular cabochon
Composition	Radial based upon a circle divided into four segments.
Dimensions	9mm.
Technique	Cast glass with silver foil grille.
Museum no.	BGS6

CAT.9.7	
Object: Ardagh chalice, left handle, Reerasta, Co. Limerick. (NMI 1874.99) Materials: Silver, gold, copper-alloy, glass, amber, mica, malachite, rock-crystal. Date: Eighth century. Dimensions: H. 178mm, bowl d. 195mm.	
Material	Glass, silver
Colour	Red rose brown 5.0R 4/12.
Form	Rectangular plaque.
Composition	Based upon a quartered rectangle. stud matches L2 matching stud occur on the right handle
Dimensions	L 6.5mm W. 4mm.
Technique	Cast glass with silver foil grille.
Museum no.	L1
Figure	104, p. 369.

CAT.9.8	
Object: Ardagh chalice, left handle, Reerasta, Co. Limerick. (NMI 1874.99) Materials: Silver, gold, copper-alloy, glass, amber, mica, malachite, rock-crystal. Date: Eighth century. Dimensions: H. 178mm, bowl d. 195mm.	
Material	Glass, silver
Colour	Red rose brown 5.0R 4/12.
Form	Rectangular plaque.
Composition	Based upon a quartered rectangle. stud matches L2 matching stud occur on the right handle
Dimensions	L 6mm W. 4mm.
Technique	Cast glass with silver foil grille. The silver grille is 1mm too short for the stud.
Museum no.	L2
Figure	104, p.369.

CAT.9.9	
Object: Ardagh chalice, left handle, Reerasta, Co. Limerick. (NMI 1874.99) Materials: Silver, gold, copper-alloy, glass, amber, mica, malachite, rock-crystal. Date: Eighth century. Dimensions: H. 178mm, bowl d. 195mm.	
Material	Glass, enamel
Colour	Dark navy 10.0B 2/4 op., Red, rose brown 5.0R 4/12 op.
Form	T-shaped plaque, slightly curved in line with the handle form.
Composition	T-shape divided into rectangular fields and quartering each section to form the design.
Dimensions	L 9.5mm W. 6.5mm.
Technique	Glass cast with recessed pattern, which was enamelled.
Museum no.	L3
Figure	44, p.333.

CAT.9.10	
Object: Ardagh chalice, left handle, Reerasta, Co. Limerick. (NMI 1874.99) Materials: Silver, gold, copper-alloy, glass, amber, mica, malachite, rock-crystal. Date: Eighth century. Dimensions: H. 178mm, bowl d. 195mm.	
Material	Glass, enamel
Colour	Dark navy 10.0B 2/4 op., Red, rose brown 5.0R 4/12 op.
Form	T-shaped plaque, slightly curved in line with the handle form.
Composition	T-shape divided into rectangular fields and quartering each section to form the design.
Dimensions	L 9.5mm W. 6.5mm.
Technique	Glass cast with recessed pattern, which was enamelled.
Museum no.	L4
Figure	44, p.333.

CAT.9.11-9.12

Object: Ardagh chalice, left handle, Reerasta, Co. Limerick. (NMI 1874.99)
 Materials: Silver, gold, copper-alloy, glass, amber, mica, malachite, rock-crystal.
 Date: Eighth century.
 Dimensions: H. 178mm, bowl d. 195mm.

Material	Glass, silver
Colour	Red, rose brown 5.0R 4/12 op.
Form	Rectangular plaque.
Composition	Rectangle divided into grids (5 horizontally 4 vertical grid lines.)
Dimensions	L 6.5mm. W.4mm
Technique	Glass cast with silver foil grille
Museum no.	L5 and L6

CAT.9.13-9.14

Object: Ardagh chalice, left handle, Reerasta, Co. Limerick. (NMI 1874.99)
 Materials: Silver, gold, copper-alloy, glass, amber, mica, malachite, rock-crystal.
 Date: Eighth century.
 Dimensions: H. 178mm, bowl d. 195mm.

Material	Glass, silver
Colour	Blue Ultramarine 6.25PB 3/12 tsl.- Sky blue7.5PB 7/6tsl.
Form	Stepped 'T'-shape. Slightly curved in line with the handle.
Composition	T-shape divided into rectangular fields and quartering each section to form the design.
Dimensions	L 9.5mm W. 6.5mm.
Technique	Glass cast with silver grille.
Museum no.	L7 & L8.
Figure	46, p.334.

CAT.9.15

Object: Ardagh chalice, left handle, Reerasta, Co. Limerick. (NMI 1874.99)
 Materials: Silver, gold, copper-alloy, glass, amber, mica, malachite, rock-crystal.
 Date: Eighth century.
 Dimensions: H. 178mm, bowl d. 195mm.

Material	Glass, silver
Colour	Red, rose brown 5.0R 4/12 op.
Form	Rectangular plaque.
Composition	The rectangle was divided into grids (3 horizontally, 2 vertical grid lines.
Dimensions	L 6.5 W. 4mm stud.
Technique	Glass cast with silver grille.
Museum no.	R.7

CAT.9.16	
Object: Ardagh chalice, left handle, Reerasta, Co. Limerick. (NMI 1874.99) Materials: Silver, gold, copper-alloy, glass, amber, mica, malachite, rock-crystal. Date: Eighth century. Dimensions: H. 178mm, bowl d. 195mm.	
Material	Glass, silver
Colour	Red, rose brown 5.0R 4/12 op.
Form	Rectangular plaque.
Composition	Based upon dividing the rectangle into grids (5 horizontally 4 vertical grid lines).
Dimensions	L 6.5 W. 4mm stud.
Technique	Glass cast with silver grille.
Museum no.	L 9

CAT.9.17	
Object: Ardagh chalice, left handle, Reerasta, Co. Limerick. (NMI 1874.99) Materials: Silver, gold, copper-alloy, glass, amber, mica, malachite, rock-crystal. Date: Eighth century. Dimensions: H. 178mm, bowl d. 195mm.	
Material	Glass, silver
Colour	Red, rose brown 5.0R 4/12 op.
Form	Rectangular plaque.
Composition	Based upon dividing the rectangle into grids (5 horizontally 4 vertical grid lines).
Dimensions	L 6.5 W. 4mm stud.
Technique	Glass cast with silver grille.
Museum no.	L 10

CAT.9.18, 1-4	
Object: Ardagh chalice, right-handle escutcheon, Reerasta, Co. Limerick. (NMI 1874.99) Materials: Silver, gold, copper-alloy, glass, amber, mica, malachite, rock-crystal. Date: Eighth century. Dimensions: H. 178mm, bowl d. 195mm.	
Material	Glass,
Colour	(1) wedgewood blue 10.0B 4/10- bright copin blue 2.5PB 6/9 tsl. (2) wedgewood blue 10.0B 4/10- bright copin blue 2.5PB 6/9 tsl. (3) light turquoise 10.0BG 7/4- turquoise 10.0bg 4/8 tsl. (fig. 54) (4) wedgewood blue 10.0B 4/10- ultramarine 6.25PB 3/12 tsl.
Form	Plain circle.
Composition	Plain
Dimensions	D. 4mm
Technique	Cast glass.
Museum no.	-
Figure	No.3, fig.55, p.339.; no 3 and 4, fig. 76, p.351.

CAT.9.19	
Object: Ardagh chalice, right-handle escutcheon, Reerasta, Co. Limerick. (NMI 1874.99) Materials: Silver, gold, copper-alloy, glass, amber, mica, malachite, rock-crystal. Date: Eighth century. Dimensions: H. 178mm, bowl d. 195mm.	
Material	Glass, silver.
Colour	Blue, deep blue 2.5PB 3/8-ultramarine 6.25PB 3/12. Red, tomato red 7.5YR 3/12 op.
Form	Circular sub-conical.
Composition	Radial, composition based upon dividing a circle in eight segments and using a compass to form annular fields.
Dimensions	D. 14mm, H. 5mm.
Technique	Glass cast with red glass and silver grille.
Museum no.	Es A
Figure	49, 65, pp. 336, 345.

CAT.9.20	
Object: Ardagh chalice, right-handle escutcheon, Reerasta, Co. Limerick. (NMI 1874.99) Materials: Silver, gold, copper-alloy, glass, amber, mica, malachite, rock-crystal. Date: Eighth century. Dimensions: H. 178mm, bowl d. 195mm.	
Material	Glass, silver, gold.
Colour	Blue, deep blue 2.5PB 3/8-ultramarine 6.25PB 3/12. Red, tomato red 7.5YR 3/12 op.
Form	Circular sub-conical.
Composition	Radial, composition based upon dividing a circle in eight segments and using a compass to form annular fields.
Dimensions	D. 14mm, H. 5mm.
Technique	Glass cast with red glass, gold disc with granulation and a silver grille.
Museum no.	Es C
Figure	49, 76, pp.336, 351.

CAT.9.21	
Object: Ardagh chalice, medallion mount, Reerasta, Co. Limerick. (NMI 1874.99) Materials: Silver, gold, copper-alloy, glass, amber, mica, malachite, rock-crystal. Date: Eighth century. Dimensions: H. 178mm, bowl d. 195mm.	
Material	Glass, silver.
Colour	Blue, deep blue 2.5PB 3/8-ultramarine 6.25PB 3/12. Red, tomato red 7.5YR 3/12 op.
Form	Circular, domed.
Composition	Radial, composition based upon dividing a circle in eight segments and using a compass to form annular fields.
Dimensions	D.9mm
Technique	Glass cast with red glass and a silver grille.
Museum no.	Es O.
Figure	105, p.370.

CAT.9.22	
Object: Ardagh chalice, upper foot-flange, Reerasta, Co. Limerick. (NMI 1874.99) Materials: Silver, gold, copper-alloy, glass, amber, mica, malachite, rock-crystal. Date: Eighth century. Dimensions: H. 178mm, bowl d. 195mm.	
Material	Glass, silver.
Colour	Blue, dark navy 10.0B 2/4op. Red, poppy red 8.75R 4/14 op. Yellow, Buttercup 5.0Y 8/12op.
Form	sub-rectangular.
Composition	grid employed to form angular ornament
Dimensions	9mm x 11mm x 6mm.
Technique	Glass cast with a recessed pattern lined with silver foil ribbon and filled with red glass.
Museum no.	UFF6

CAT.9.23	
Object: Ardagh chalice, lower foot-flange, Reerasta, Co. Limerick. (NMI 1874.99) Materials: Silver, gold, copper-alloy, glass, amber, mica, malachite, rock-crystal. Date: Eighth century. Dimensions: H. 178mm, bowl d. 195mm.	
Material	Glass, silver.
Colour	Blue, deep blue 2.5PB 3/8-horizon blue 10.0B 5/6 tls.
Form	sub-rectangular.
Composition	grid employed to form angular ornament on backing foil.
Dimensions	9mm x 11mm x 6mm.
Technique	Glass cast set against embossed backing foil.
Museum no.	LFFS 3-4
Figure	27, p.319, embossed foil see fig. 84, p.356.

CAT.9.24	
Object: Ardagh chalice, underfoot mount, Reerasta, Co. Limerick. (NMI 1874.99) Materials: Silver, gold, copper-alloy, glass, amber, mica, malachite, rock-crystal. Date: Eighth century. Dimensions: H. 178mm, bowl d. 195mm.	
Material	Glass, gold
Colour	Blue, deep blue 2.5PB 3/8- dusk blue- 5.0PB 4/8 tsl.
Form	Circular, domed.
Composition	Circle divided in three, radial plan.
Dimensions	4mm.
Technique	Glass cast with beaded gold wire formed into pelate.
Museum no.	UFF-1-5
Figure	96, p.363.

CAT.9.25	
Object: Ardagh chalice, Medallion mount, Reerasta, Co. Limerick. (NMI 1874.99) Materials: Silver, gold, copper-alloy, glass, amber, mica, malachite, rock-crystal. Date: Eighth century. Dimensions: H. 178mm, bowl d. 195mm.	
Material	Glass.
Colour	Blue, deep blue 2.5PB 3/8- dusk blue- 5.0PB 4/8 tsl.
Form	Circular, domed.
Composition	Plain.
Dimensions	4mm.
Technique	Cast glass.
Museum no.	Ms (o) (d)
Figure	80, p.353.

CAT.10.1	
Object: Ervey brooch, obverse, Co. Meath, (NMI:1958.70) Materials: Silver, gold, glass. Date: Eighth to ninth century. Dimensions: D. 39mm, pin, L.77mm.	
Material	Glass.
Colour	2.5YR 6/14-10.0R 3.8 tsp. (assessed under field conditions)
Form	Circular, slightly domed
Composition	Plain.
Dimensions	4mm.
Technique	Cast glass.
Museum no.	Stud a left terminal.

CAT.11.1	
Object: Killamery brooch, obverse, Co. Meath, (NMI:R165) Materials: Silver, gold, glass. Date: Eighth to ninth century. Dimensions: D. 39mm, pin, L.77mm.	
Material	Glass.
Colour	2.5YR 6/14-10.0R 3.8 tsp. (assessed under field conditions)
Form	Circular, slightly domed
Composition	Plain.
Dimensions	4mm.
Technique	Cast glass.
Museum no.	Stud a left terminal.
Figure	54, p.339.

CAT.12.1	
Object: Cross of Cong, reverse, Co. Roscommon (NMI, R2833) Materials: Wooden core, copper-alloy, silver, gold, niello, glass. Date: Eleventh century. Dimensions: H.76.5cm, W. 48cm.	
Material	Glass.
Colour	Blue, bright navy 7.5PB 2/5-ultramarine 6.25PB 3/12 tsl; White, N9.,
Form	Circular, slightly domed
Composition	Radial
Dimensions	D. 14mm, H. 5mm.
Technique	Cast glass with enamelled ornament.
Museum no.	K 2
Figure	57 p.340.

CAT.12.2	
Object: Cross of Cong, obverse, Co. Roscommon (NMI, R2833) Materials: Wooden core, copper-alloy, silver, gold, niello, glass. Date: Eleventh century. Dimensions: H.76.5cm, W. 48cm.	
Material	Glass.
Colour	Blue, bright navy 7.5PB 2/5-ultramarine 6.25PB 3/12 op; White, N9.,
Form	Circular, slightly domed
Composition	Radial
Dimensions	D. 14mm, H. 5mm.
Technique	Cast glass with enamelled ornament.
Museum no.	Stud 2
Figure	Appendix 11, diagram 4, p.240.

CAT.12.3	
Object: Cross of Cong, reverse, Co. Roscommon (NMI, R2833) Materials: Wooden core, copper-alloy, silver, gold, niello, glass. Date: Eleventh century. Dimensions: H.76.5cm, W. 48cm.	
Material	Glass.
Colour	Colour: Yellow, buttercup 5.0Y 8/12op; Red, scarlet 7.5R 4/14-bright coral red 10.0R 5/14 op.
Form	disc
Composition	Radial
Dimensions	D. 14mm
Technique	Cast glass with enamelled ornament.
Museum no.	R5
Figure	88, p.359.

CAT.13.1	
Object: Lismore crozier, drop, left side, Co. Waterford. (NMI: L1949.1) Materials: Wooden core, copper-alloy, silver, gold, glass. Date: Eleventh century. Dimensions: H.116cm.	
Material	Glass.
Colour	White N9.5 op; blue, bright navy 7.5PB 2/7-deep blue 2.5PB 3/8 tsl; Red, scarlet 7.5R 4/14-bright coral red 10.0R 5/14 op.
Form	disc
Composition	Chequered.
Dimensions	D. H. 7mm W. 4mm
Technique	<i>Millefiori</i> embedded in opaque red glass within a recess.
Museum no.	D1-4 left side.
Figure	59, p.341.

CAT.13.2	
Object: Lismore crozier, left side, Co. Waterford. (NMI: L1949.1) Materials: Wooden core, copper-alloy, silver, gold, glass. Date: Eleventh century. Dimensions: H.116cm.	
Material	Glass <i>millefiori</i> . damaged
Colour	White N9.5 op.; blue, bright navy 7.5PB 2/7-deep blue 2.5PB 3/8 tsl.
Form	disc
Composition	Chequered, unclear due to damage.
Dimensions	D. 13mm
Technique	<i>Millefiori</i> mosaic against blue glass.
Museum no.	K2
Figure	89, p.359.

CAT.13.3

Object: Lismore crozier, left side, Co. Waterford. (NMI: L1949.1)

Materials: Wooden core, copper-alloy, silver, gold, glass.

Date: Eleventh century.

Dimensions: H.116cm.

Material	Glass shaped glass rods, <i>millefiori</i> .
Colour	White N9.5 op; blue, bright navy 7.5PB 2/7-deep blue 2.5PB 3/8 tsl.
Form	disc
Composition	Chequered lentoids.
Dimensions	D. 15mm
Technique	Lentoid platelets fused within a clay mould to a backing of glass.
Museum no.	K3
Figure	90, p.360.

CAT.13.4

Object: Lismore crozier, left side, Co. Waterford. (NMI: L1949.1)

Materials: Wooden core, copper-alloy, silver, gold, glass.

Date: Eleventh century.

Dimensions: H.116cm.

Material	Glass shaped glass rods, <i>millefiori</i> , enamel.
Colour	White N9.5 op.; blue, bright navy 7.5PB 2/7-deep blue 2.5PB 3/8. Red, scarlet 7.5R 4/14-bright coral red 10.0R 5/14 op.
Form	disc
Composition	Repeat pattern.
Dimensions	D. 15mm
Technique	Lentoid platelets fused into a mosaic glass plaque, deliberately formed recesses were enamelled with opaque red glass.
Museum no.	L4
Figure	91, p.360.

CAT.13.5

Object: Lismore crozier, left side, Co. Waterford. (NMI: L1949.1)

Materials: Wooden core, copper-alloy, silver, gold, glass.

Date: Eleventh century.

Dimensions: H.116cm.

Material	Glass shaped glass rods.
Colour	White N9.5 op.; blue, bright navy 7.5PB 2/7-deep blue 2.5PB 3/8.
Form	disc
Composition	Chequered pattern.
Dimensions	D. 15mm
Technique	Lentoid platelets fused into a mosaic glass plaque, fragment were cast into studs within clay moulds.
Museum no.	L3
Figure	92, p.361.

CAT.13.6	
Object: Lismore crozier, left side, Co. Waterford. (NMI: L1949.1) Materials: Wooden core, copper-alloy, silver, gold, glass. Date: Eleventh century. Dimensions: H.116cm.	
Material	Glass shaped glass rods.
Colour	White N9.5 op.; blue, bright navy 7.5PB 2/7-deep blue 2.5PB 3/8.; Red, scarlet 7.5R 4/14-bright coral red 10.0R 5/14 op.
Form	disc
Composition	Chequered pattern. Damaged.
Dimensions	D. 15mm
Technique	Glass platelets fused into a mosaic glass plaque,
Museum no.	R2
Figure	93, p.361.

CAT.13.7	
Object: Lismore crozier, left side, Co. Waterford. (NMI: L1949.1) Materials: Wooden core, copper-alloy, silver, gold, glass. Date: Eleventh century. Dimensions: H.116cm.	
Material	Glass.
Colour	White N9.5 op.; blue, bright navy 7.5PB 2/7-deep blue 2.5PB 3/8. tsl
Form	disc
Composition	Radial
Dimensions	D. 15mm H.3.1mm
Technique	Enamelled glass
Museum no.	K4
Figure	136, p.398.

CAT.14.1	
Object: Coolure Demense Plaque, Co. Westmeath (NMI:E499.325) Date: Eighth century.	
Material	Copper-alloy, glass.
Colour	Yellow, buttercup 5.0Y 8/12op; Red, scarlet 7.5R 4/14-bright coral red 10.0R 5/14 op. <i>millefiori</i> ; blue, bright navy 7.5PB 2/7-deep blue 2.5PB 3/8 op.
Form	Disc
Composition	Cruciform
Dimensions	L.33.44mm, W. 31.47mm
Technique	<i>Champlevé</i> enamelling
Museum no.	NMI:E499.325
Figure	19, p.314.

PART TWO- AMBER

CAT.15.1

Object: Ardagh chalice, right-handle escutcheon, Reerasta, Co. Limerick.
Materials: Silver, gold, copper-alloy, glass, amber, mica, malachite, rock-crystal.
Date: Eighth century.
Dimensions: H. 178mm, bowl d. 195mm.

Material	Amber, malachite.
Colour	malachite, apple green 10.0GY 6/6-surf green 5.0G 5/4 op.; Amber reddish yellow 7/8- 6/8op.
Form	Sub-rectangular fragment.
Composition	Annular originally.
Dimensions	Max d. 17.8mm inside d. 15mm min. approx.
Technique	viscous amber embedded into place.
Museum no.	Right handle Es a
Figure no.	65, p.345.

CAT.15.2

Object: Ardagh chalice, medallion mount, Reerasta, Co. Limerick.
Materials: Silver, gold, copper-alloy, glass, amber, mica, malachite, rock-crystal.
Date: Eighth century.
Dimensions: H. 178mm, bowl d. 195mm.

Material	Amber, originally, now replaced with red wax.
Colour	-
Form	Circular cabochon.
Composition	Plain
Dimensions	D. 4mm at aperture, base of collet 5.8mm wide.
Technique	viscous amber embedded into place, formed on the surface into cabochon form.
Museum no.	Medallion stud a
Figure no.	106, p.371.

CAT.15.3	
Object: Ardagh chalice, underfoot mount, channel surrounding the rock-crystal mount, Reerasta, Co. Limerick. Materials: Silver, gold, copper-alloy, glass, amber, mica, malachite, rock-crystal. Date: Eighth century. Dimensions: H. 178mm, bowl d. 195mm.	
Material	Amber, malachite.
Colour	Malachite, apple green 10.OGY 6/6-surf green 5.0G 5/4op; amber reddish yellow 7/8-6/8tsl-russet orange 5.0YR 6/12tsl.
Form	Arc shaped fragment originally annular.
Composition	Plain.
Dimensions	21mm-26.8mm ring is approximately 2.5mm thick.
Technique	Viscous amber embedded into place.
Museum no.	-
Figure no.	101, p.367.

CAT.15.4	
Object: Ardagh chalice, underfoot mount, channel surrounding the filigree inlay, Reerasta, Co. Limerick. Materials: Silver, gold, copper-alloy, glass, amber, mica, malachite, rock-crystal. Date: Eighth century. Dimensions: H. 178mm, bowl d. 195mm.	
Material	Amber.
Colour	Gilt copper-alloy channel remains.
Form	Annular
Composition	-
Dimensions	D. max. 42.5mm- min.39mm
Technique	Viscous amber embedded into place.
Museum no.	-
Figure no.	100, p.367.

CAT.16.1	
Object: 'Tara' brooch, obverse, Bettystown, Co. Meath, (NMI:4015). Materials: Silver, gold, copper-alloy, glass, amber. Date: Late seventh to early eighth century. Dimensions; brooch diameter 8.7cm, pin 32cm.	
Material	Amber and gold.
Colour	Red featherb2.5R 3/4- sandalwood 7.5 YR 5/10 tsl. (assessed under field conditions)
Form	Circular.
Composition	Concentric pattern, gold cap surrounded by a ring of amber.
Dimensions	9mm, ornament 4.2mm
Technique	Heat and pressure moulded amber
Museum no.	5a
Figure no.	69, p.348.

CAT.16.2	
Object: 'Tara' brooch, obverse, Bettystown, Co. Meath, (NMI:4015). Materials: Silver, gold, copper-alloy, glass, amber. Date: Late seventh to early eighth century. Dimensions; brooch diameter 8.7cm, pin 32cm.	
Material	Amber.
Colour	Red featherb2.5R 3/4- sandalwood 7.5 YR 5/10 tsl. (assessed under field conditions)
Form	Lentoid.
Composition	Plain.
Dimensions	L.. 6mm x W. 2.8mm-3mm. Base dimensions 6mm by 3.5-4mm approx.
Technique	Heat and pressure moulded amber, formed within a collet.
Museum no.	9A
Figure no.	99, p.366.

CAT.17.1	
Object: Lough Kinale bookshrine, obverse, Co. Longford, (NMI:1986:141). Materials: Silver, copper-alloy, tin, amber. Date: Late eighth to ninth century. Dimensions; L. 34cm, W.28cm, Th.11cm.	
Material	Amber.
Colour	Strong brown 4/6 - orange 2.5YR 6/14 op- russet orange 5.0YR 6/12 tsl.
Form	Lentoid.
Composition	Plain.
Dimensions	L.18mm x W. 10mm. Th. 6mm
Technique	Heat and pressure moulded amber, formed within a collet.
Museum no.	Oval stud C
Figure no.	63, 98, pp.344, 365.

CAT.17.2	
Object: Lough Kinale bookshrine, obverse, Co. Longford, (NMI:1986:141). Materials: Silver, copper-alloy, tin, amber. Date: Late eighth to ninth century. Dimensions; L. 34cm, W.28cm, Th.11cm.	
Material	Amber.
Colour	Strong brown 4/6 - orange 2.5YR 6/14 op- russet orange 5.0YR 6/12 tsl.
Form	Lentoid originally- fragmented
Composition	Plain.
Dimensions	max length 16mm, fragmented.
Technique	Heat and pressure moulded amber, formed within a collet.
Museum no.	Oval stud D

CAT.17.3	
Object: Lough Kinale bookshrine, obverse, Co. Longford, (NMI:1986:141). Materials: Silver, copper-alloy, tin, amber. Date: Late eighth to ninth century. Dimensions; L. 34cm, W.28cm, Th.11cm.	
Material	Amber.
Colour	Rust tan 10.0R 5/6 - orange 2.5YR 6/14 op- russet orange 5.0YR 6/12 tsl.- yellow 8/8 tsl.
Form	Circular now in fragments
Composition	Plain.
Dimensions	9mm max length.
Technique	Heat and pressure moulded amber, formed within a collet.
Museum no.	Circular stud F

CAT.17.4	
Object: Lough Kinale bookshrine, obverse, Co. Longford, (NMI:1986:141). Materials: Silver, copper-alloy, tin, amber. Date: Late eighth to ninth century. Dimensions; L. 34cm, W.28cm, Th.11cm.	
Material	Amber.
Colour	Rust tan 10.0R 5/6 - orange 2.5YR 6/14 op- russet orange 5.0YR 6/12 tsl.- yellow 8/8 tsl.
Form	Circular, three arc shaped fragments have come away from the stud.
Composition	Plain.
Dimensions	9mm.
Technique	Heat and pressure moulded amber, formed within a collet.
Museum no.	Circular stud H

CAT.17.5	
Object: Lough Kinale bookshrine, obverse, Co. Longford, (NMI:1986:141). Materials: Silver, copper-alloy, tin, amber. Date: Late eighth to ninth century. Dimensions; L. 34cm, W.28cm, Th.11cm.	
Material	Amber and lead-tin alloy.
Colour	Rust tan 10.0R 5/6 - orange 2.5YR 6/14 op- russet orange 5.0YR 6/12 tsl.- canary yellow 7.5Y 9/6 tsl.
Form	Circular, now damaged
Composition	Cruciform
Dimensions	15mm approx. Ornament diameter, 11.5mm approx.
Technique	Heat and pressure moulded amber, formed within a collet.
Museum no.	composite stud (C)/2.
Figure	64, 97, pp.344, 364.

CAT.18.1	
Object: Amber stud, Lagore <i>Crannóg</i> , Co. Meath	
Date: Eighth century.	
Material	Amber
Colour	Orange-Yellow, Russet orange 5.0YR 6/12-marigold 10.0YR 7/14 tsp.
Form	Circular.
Composition	Plain.
Dimensions	D. 8mm. H. 5mm
Technique	Hand worked reductive techniques.
Museum no.	E14:1456

CAT.18.2	
Object: Amber stud, Ballinderry <i>Crannóg</i> II, Co. Meath	
Date: Eighth century.	
Material	Amber
Colour	Orange-Yellow 7.5R 3/10 - marigold 10.0YR 4/8- tsp.
Form	Circular- amorphous.
Composition	Plain.
Dimensions	D. 8.5mm. H. 6mm.
Technique	Hand worked reductive techniques. Chipped into roughly circular form.
Museum no.	NMI,E16:667

CAT.19.1	
Object: Derrynaflan chalice. Handle escutcheon, Co. Tipperary. (NMI 1980:6)	
Materials: Silver, copper-alloy, gold, amber.	
Date: Ninth century.	
Dimensions; H.19.2cm, W. 21cm.	
Material	Amber, copper-alloy and gold.
Colour	Colour: Orange-Yellow, 7.5 YR 2/6- Russet orange 5.0YR 6/14- 2.5YR 5/10. tsp. (assessed under field conditions)
Form	Circular, sub-conical with recess and perforation for gold filigree and gilt pin.
Composition	Annular.
Dimensions	D. 12mm
Technique	Heat and pressure moulded amber, inlay cold connected in place.
Museum no.	Escutcheon stud a

CAT.20.1, a and b	
Object: Buckle, Lough Gara, Co. Sligo, (NMI:1958.20) Materials: copper-alloy, glass, amber. Date: Seventh to eighth century. Dimensions: L.76mm, W.25mm.	
Material	Amber.
Colour	Strong brown 4/6 op-2.5YR 6/14 tsl.
Form	Circular.
Composition	Plain.
Dimensions	4mm approx.
Technique	Amber embedded into <i>champlevé</i> cell.
Museum no.	Studs a and b
Figure no.	20, p.314.

