Culduthel

An Iron Age Craftworking Centre in North-East Scotland

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Part D

Glass

The glass artefacts and glassworking debris from Culduthel: typology, discussion and catalogue

Fraser Hunter

Culduthel has produced a nationally important glass assemblage, since it includes evidence for the working of glass, both opaque red for metalwork inlay, and yellow, blue and clear glass for jewellery, primarily beads (Illus. 6.61 and 6.62). It is one of only a handful of sites in Britain with such evidence. It has also produced a notably wide range of beads, many of which are local products. Several come from dated contexts; this is a great asset, as depressingly few beads are closely dated. The number of small beads recovered from sieving (60% of the total of 22) emphasises the vital need to sample and sieve in order to recover a representative selection of such finds. Sampling also emphasised the ability of modern finds to get into ancient layers, with small fragments of modern glass (as well as plastic and post-medieval glassy blast furnace slag) coming from over 20 layers or features. This report should be read in conjunction with the analytical report (Davis and Freestone, Chapter 6, Analysis of the glass objects cross-reference here), which provided evidence critical for the interpretation of the assemblage.

Working debris

The remarkable evidence of working debris is mostly in the form of small flakes, droplets or fragments of rods or bars recovered in wet-sieving. They are predominantly opaque red (21 fragments, mostly flakes and blobs), with single items of opaque yellow (a small sphere), translucent blue (blob) and clear (flattened blob) glass (Illus. 6.62). Additionally, four more complex pieces of working debris show the combination of different colours. The debris is overwhelmingly linked to Hearth 2434 in the area to the south-east of House 10, which was also the focus of the non-ferrous metalworking evidence; only two fragments come from elsewhere in the area, plus a single piece from later levels in House 10/3, and two pieces from close to the palisade. These latter hint at a secondary working area, as they are rather different in character (see below). The evidence suggests the material represents both inlays in metal (the red) and glass jewellery (the other colours). Associated radiocarbon dates put this phase of production in the period *c.*200 BC–AD 20. Two dates are associated with glass production: a single AMS date from an oval pit beneath the hearth [2166] (pit [2777]), which contained sherds from crucibles, yielded a date of 200 cal BC–cal AD 1 (SUREC-30388); and a single AMS date from charcoal retrieved from hearth [2434] (2677) which yielded a date of 170 cal BC–cal AD 20 (SUREC-30386).

Red is extremely unusual for Iron Age glass jewellery, although opaque red beads are known from Iron Age contexts in Scotland, for instance, from Dun Ardtreck and High Pasture Cave, Skye, Dun Vulan, South Uist, and Airrieolland, Wigtownshire, while a red-coated yellow bead is claimed from Dun Bharabhat, Lewis (MacKie 2000, 387, no. 51, illus. 24 and 28; Hunter [forthcoming b]; Parker Pearson and Sharples 1999, 39; Maxwell 1889, fig. 50; Harding and Dixon 2000, 28–9, fig. 12.6). It is much more likely to have been intended as inlay in metalwork; this is consistent with the fragments that have been drawn into rods or bars (SF1268 – Illus. 6.63). The process is attested in the unfinished strap mount from the site (SF0318 – Illus. 6.50), its cells prepared for inlay, while the local ‘massive’ metalwork tradition of north-east Scotland used opaque red and yellow glass inlays on armlets and finger rings (MacGregor 1976, nos 239, 242–3, 260). From this, it follows that the opaque yellow could also have been used for inlay, but it could equally have been for jewellery, either yellow annular beads or as trails on class 13 beads (see below). The analytical results show that the yellow trails and many of the yellow beads are closely similar, suggesting both these types were being manufactured on site. Blue inlays are exceedingly rare in the massive tradition (attested only as tiny dots in the eyes of the Culbin bracelet; MacGregor 1976, no. 214); thus, it is much more likely that the blue blob comes from jewellery manufacture, as blue glass beads are a typical Iron Age type; it comes from an area far away from the main concentration of working debris. As Davis and Freestone note (Chapter 6, Analysis of the glass objects cross-reference here), working debris for clear glass is rare, but the cluster of analytical data suggests that the clear glass was being worked on site for the manufacture of class 13 beads.

There are a few intriguing pieces of working debris that combine two or more colours. SF1286 is a clear triangular blob with a yellow blob at one corner. The colour combination is common in class 13 beads and, although this seems too small to be a roughout, it is probably working debris from such a bead. More complex and puzzling is SF1289 (Illus. 6.64), a broken opaque red block, rather bubbly, with a series of trails set into it. The trails are themselves interesting, as one of them is a yellow strand twisted with a clear one. This may have been to eke out

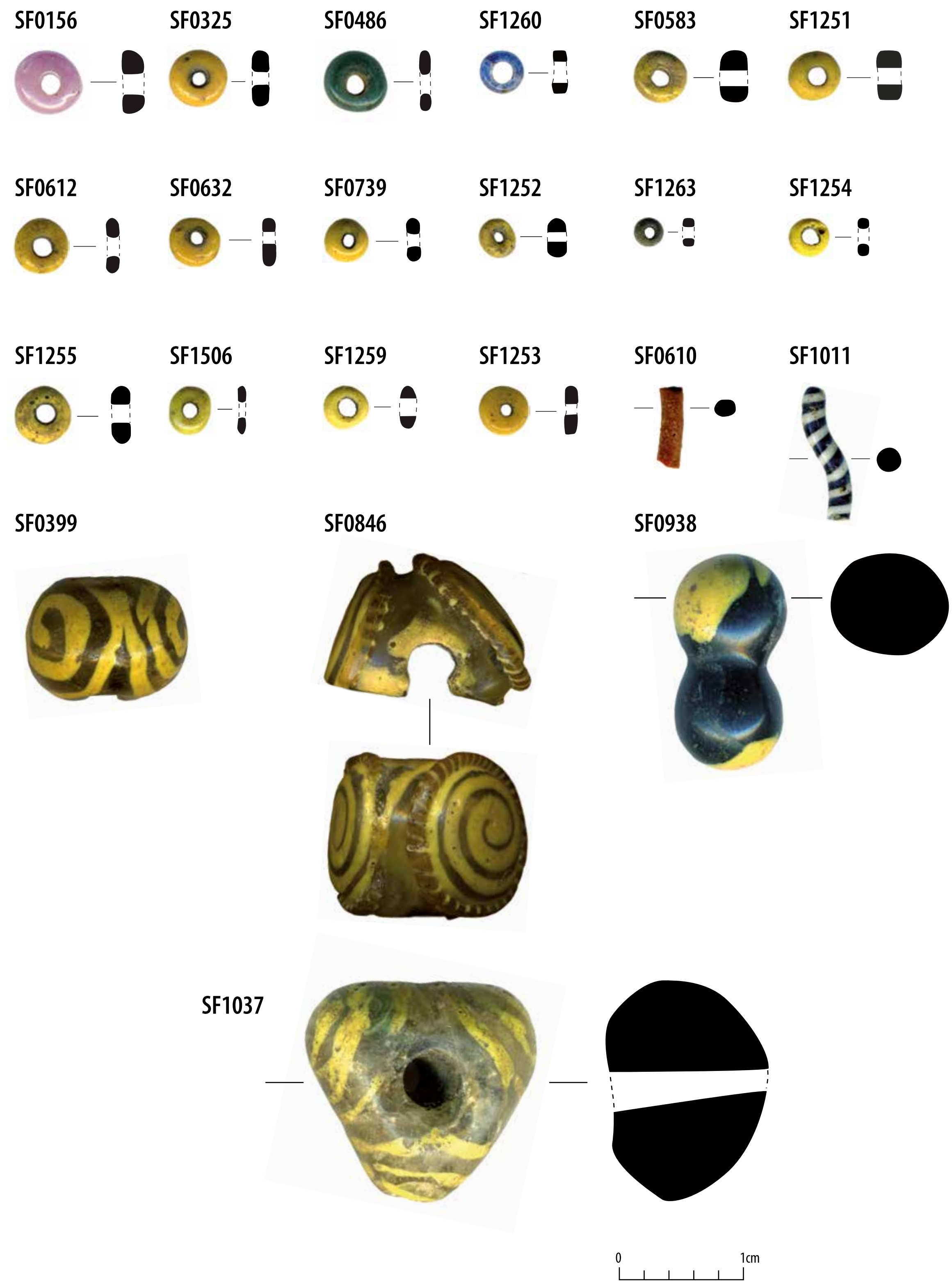

Illustration 6.61
Glass artefacts

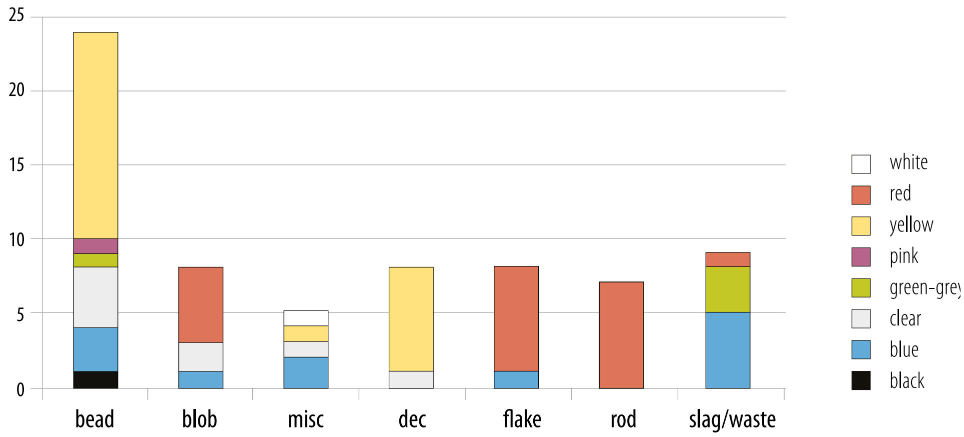

Illustration 6.62
Glass – colours and types of object

yellow glass, although the number of yellow glass beads suggests it was not particularly rare, or it might have decolourised due to overheating (cf. Henderson 1987a, 173). The red has collapsed over two of the trails, and this must be seen as a discarded item, but what was it? It could be a complex inlay for metalwork, but this is otherwise unknown in the massive tradition; yet, as noted, red beads are also exceedingly rare, inlaid ones are unknown, and there are no other obvious and plausible forms of jewellery. Although class 1 glass bangles used red trails in their coatings, distributional evidence strongly suggests they were not local products (Stevenson 1976), while a series of small glass balls, perhaps gaming pieces, only used red in fine inset eyes, much smaller than this (e.g. Ralston and Inglis 1984, 41). The other possibility is the much more human one of a mistake in the workshop, with different glass strands accidentally becoming mixed; they would then be essentially unusable, as they could not be easily separated.

There is one high-quality cable or trail from the site, an opaque blue and white one SF1011. This must have been intended for inlay in beads; the more ornate examples of both class 13 and 14 beads can have cable trails (e.g. SF0846 – Illus. 6.65), and although blue and white is not found in class 13s, there are parallels in class 14 (e.g. Guido 1978, pl. IIId; she refers to them rather disparagingly as 'ladder patterns which are in effect imitation cables' (p.87), but they clearly are inlaid cables). Intriguingly, the analytical data indicates this was rather separate from the other glass on the site, and its composition is more typical of Roman glass. This is a remarkable observation, indicating the import of pre-formed specialist components from the Roman world.

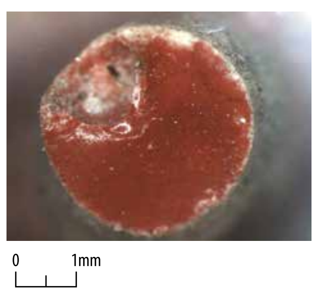

Illustration 6.63
Cross-section of opaque red rod (SF1268)

Jewellery

The beads themselves cover a notably wide range, including typical north-east types such as Guido class 8 and 13 (respectively yellow annular (14 examples) and triangular with yellow spirals (three examples)), three versions of the ubiquitous blue beads, and two more unusual ones, a 'black' bead and a two-tone green bead. Pink bead SF0156 (Illus. 6.61) is problematic, as although from an apparently secure context, it is interpreted here as intrusive because it does not have an ancient glass composition,

Illustration 6.64
Broken opaque red block showing the trail of a yellow strand twisted with a clear strand (SF1289)

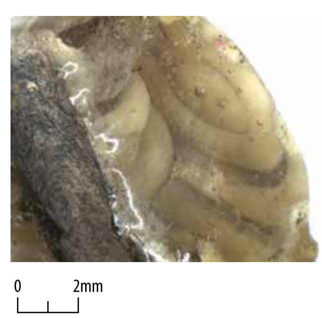

Illustration 6.65
Opaque yellow decoration on bead seen through broken clear glass (SF0846)

is a colour otherwise unattested in the Iron Age, and appears remarkably fresh; small items of glass can be quite mobile in deposits, as the quantities of modern glass sherds recovered by wet-sieving demonstrate. There is also a single dumb-bell toggle. The analytical data suggests that much of this glass jewellery was made on site: many of the yellow annular beads form a tight analytical cluster, as do the class 13s. This is supported by the evidence for iron scale on the interior of the perforations from their manufacture, which has not been worn away by use.

The yellow glass beads are a common type in the Scottish Iron Age. Guido's discussion and map (1978, 73–6, fig. 25) are now over 30 years old, and her distribution shows a concentration in the Culbin Sands (close to Culduthel), which was a production centre for glass jewellery, but gives no other north-east examples. This can now be redressed by examples from Culduthel, Brackla (Harden and Bone 1990, 24), Birnie and Clarkly Hill (unpublished). The yellow glassworking debris from Culduthel indicates there were several centres of production; implications of this are discussed below. Guido's dating (late 1st century BC–2nd century AD) was rather conservative, as she was constrained by the diffusionist framework of the period. Campbell (1991, 162) argued that associations supported her dates, but at that time there were few associated radiocarbon dates. At Culduthel, dates from contexts or associated structures producing these class 8 beads demonstrate a 2nd century BC–2nd century AD floruit, and indeed SF1251 comes from a structure with a 4th–1st century BC dating bracket. This agrees with a recently obtained date from excavations at Dun Glashan, Argyll, where such a bead came from a layer dated to 350–50 BC (Henderson 2005, 166).

Guido's class 13 (1978, 85–7, fig. 34), triangular beads with inlaid yellow spirals, is a typical product of north-east Scotland north of the Mounth, as her distribution map shows. Recent finds strengthen rather than change this, although they have produced a few more outliers. This includes one from a dated context, at Dun Bharabhat, Lewis (Harding and Dixon 2000, 28): dates for this phase (2100±50 bp, 2010±50 BP) can be combined to give a two-sigma range of 170 BC–AD 30. An example from Thainstone (Aberdeenshire) was associated with 1st–2nd century AD radiocarbon dates. Examples from Culduthel are linked to dates of *c*.110 BC–AD 70, 50 BC–AD 130 and AD 20–230, confirming a floruit of the later 2nd century BC to the 2nd century AD. The variation in quality among the class 13s is notable, with SF1037 (Illus. 6.61) having a rather incompetently applied spiral while SF0846 (Illus. 6.61 and 6.65) has a complex design applied with considerable care, including applied cordons round the spirals. Indeed, it is the most complex yet known; no other published examples have such applied cables. All three Culduthel examples are of clear glass, in contrast to Guido's comment that this is not found in class 13 beads (1978, 85–6). (See now Bertini et al's technological examinations of the type; 2011; 2014.)

Blue glass beads are a common and long-lived type, their currency extending well past the Iron Age. These three examples are notably varied in form and colour, and this variety is seen also in their analysis. SF1260 (Illus. 6.66), a mid-blue annular bead (group 6(iv b); Guido 1978, 66–8) comes from a structure dated to 360–50 cal BC (2σ) (GU- 21914 2140 ± 35 BP). SF1261 (Illus. 6.67), a barrel-shaped form (group 7(iv); Guido 1978, 70), is later, *c*.90 BC–AD 90, while the markedly darker blue globular example (SF1263 – Illus. 6.61; also group 7(iv)) potentially dates to *c*.160 BC–AD 60.

Illustration 6.66
Small blue annular bead (SF1260)

Illustration 6.67
Small blue barrel-shaped bead (SF1261)

There are two more unusual beads. SF1264 appears black, though under strong transmitted light it is actually a very dark blue. Truly black glass is unknown in prehistory, though it is found in the Roman period (Van der Linden et al 2009). The context of this one indicates a pre-Roman date, and there are local parallels for black glass: a number of class 13 beads are described as 'very dark opaque' (Guido 1978, 194–5), suggesting that black glass was available to bead manufacturers in the north-east (this has been confirmed by Bertini et al 2011).

The other unusual bead, SF0486 (Illus. 6.68), is mid-blue-green with an opaque green trail. The blue-green colour can be paralleled in the Iron Age; green is much less common, although green ring beads are known (e.g. Dun Ardtreck, Skye and Dun Mor Vaul, Tiree; MacKie 2000, 398–9; MacKie 1974, 148 no. 1). The idea of applying trails to a bead is a common Iron Age habit, so this may well be an Iron Age bead of unusual type.

The dumb-bell toggle (SF0938 – Illus. 6.69) is a type well attested in glass, copper alloy and bone; indeed, there is a copper alloy version from the site. Clickhimin (Shetland) has produced a similar two-tone one, in this case clear with a yellow stripe (Hamilton 1968, 144, fig. 64.1), while an example from Howe (Orkney) was monochrome turquoise green (Henderson 1994). Henderson (1994, 236) notes a further example from Leckie (Stirlingshire), and gives Irish parallels that indicate the type runs into the Early Historic period.

Illustration 6.68
Dark green/blue bead (SF0486)

Illustration 6.69
Blue toggle with yellow decoration (SF0938)

Glassworking in the Scottish Iron Age

The Culduthel evidence for glassworking is exceptional. It is one of only a handful of Iron Age sites in Britain to produce such debris, otherwise securely attested only at Culbin Sands (Moray), Dunagoil (Bute), Meare (Somerset) and Hengistbury Head (Dorset), with more circumstantial evidence from Luce Sands (Wigtownshire; Henderson 1989a; unpublished, Bute Museum; Hunter et al 2018). From around the Iron Age/Roman transition there is also evidence of the manufacture of blue wave-trail beads at Parc Bryn Cegin, near Bangor, north Wales (Cool 2008). Culbin, just 40km north-east of Culduthel, has long dominated discussions of north-east Scottish glassworking (Henderson 1989a, 69–71 reviews the convincing evidence), but Culduthel changes the picture. Henderson argued there was glassmaking at Culbin, but the Culduthel evidence points to the reworking of glass ingots, and this seems a more likely explanation for Culbin as well. Guido's discussion of production was framed in terms of 'factories' producing beads, but this seems rather anachronistic (1978, 32–7), and the current find, so close to Culbin, suggests a rather less centralised situation. It also emphasises that much glassworking was for metal inlays ('enamel') as well as for glass jewellery. The spatial co-occurrence of the opaque red glass and the non-ferrous casting debris suggests either they were the work of the same person or two specialists worked closely together.

The analytical data suggests that the class 8s, class 13s and blue beads were all being made on site, although the scatter of some yellow and blue beads beyond the core cluster shows that beads from other sources also arrived on site. Other finds support a multi-centre view of jewellery production, relying on imported glass ingots (as Davis and Freestone's work suggests) but well-equipped with the pyrotechnological skills to work it. From Dunagoil (Bute) comes an unpublished ingot of opaque yellow glass, while Castlehill (Ayrshire) produced bead-making debris in yellow, blue and white glass, although this is probably Early Historic in date (Smith 1919, 128). The distributional evidence of glass bangles also suggests various production centres in southern Scotland and northern England (Kilbride-Jones 1938; Stevenson 1976), though this remains a complex and poorly understood type. Analytical evidence has added to this evidence of multiple centres: Henderson's (1987b) analysis of typologically similar beads from Meare (Somerset) and near Donaghadee (County Down) showed that they had different origins.

The difficulty in pinning down glassworking sites is unsurprising, when the Culduthel evidence shows how vestigial such evidence can be. It came from a very small area of a very large site, and was almost all recovered from samples rather than in the field. We must surely envisage a larger number of production sites for glass jewellery, working imported ingots, rather than a centralised picture of a few 'factories'. The Culduthel evidence also highlights the interlinking of glass- and metalworking, with jewellery manufacture, bronze-casting and glass inlay-work being done around the same hearth.

Catalogue

Jewellery

Yellow glass beads (Guido class 8; Guido 1978, 73–6). All are opaque yellow; unless stated they are annular and D-sectioned with flat faces. Almost all have a thin dark layer coating the perforation, identified under the SEM as iron scale; this suggests an iron rod was used to form the beads around. Perforation to nearest 0.5mm.

Class 8 beads; annular

SF0612 Antimony-coloured bead. (Illus. 6.70)

Illustration 6.70
Antimony-coloured bead (SF0612)

Illustration 6.71
Tin-coloured bead (SF1254)

SF1254 Tin-coloured bead. (Illus. 6.71)

SF1251 Globular D-section, edges smooth, dark layer in perforation (deep red as well as deep blue). D 4.0 × 4.2, H 2.4, perforation D 1.5mm. Context 1888 (fill of post-hole [1887, House 9). (Illus. 6.61)

SF325 Ends smooth. Dark layer in perforation. Glossy surface with worn faces suggesting use-wear. D 4.5, H 2.4, perforation D 1mm. Context 1896 (occupation deposit around Workshop 11 and the three hearths [2166], [2434] and [26]). (Illus. 6.61)

SF583 Surfaces rather eroded. D 4.2, H 1.8, perforation D 1mm. Context 2225 (occupation deposit within Workshop 12). (Illus. 6.61)

SF612 Rounded edges merge into flat faces; ends smoothed. Wear on faces. Dark layer in perforation. D 4.4, H 1.9, perforation D 1.5mm. Context 2225 (occupation deposit within Workshop 12) (Illus. 6.70 and Illus. 6.61)

SF632 Slightly mis-shapen with one edge slightly squashed and perforation off-centre; one face slightly dished. One end smoothed, the other with a slight collar from manufacture. Very thin dark layer within perforation, flaked in parts, merging with yellow. D 3.8 × 4, H 1.8, perforation D 1mm. Context 2225 (occupation deposit within Workshop 12). (Illus. 6.61)

SF1252 Irregular doughnut, perhaps a pierced blob; circular-sectioned, rather eroded and vesicular. Dark layer within perforation. D 2.8 × 3.1, H 1.6, perforation D 1mm. Context 2285 (post-hole [2284] of Workshop 16). (Illus. 6.61)

SF1253 Well-rounded edge merges into face. Notably glassy surface. End of perforation irregular where glass broken off. Dark vertical streaks on perforation interior. D 3.8, H 1.7, perforation D 1mm. Context 1853 (stone wall base House 10/3). (Illus. 6.61)

SF1254 Globular D-section with well-defined worn narrow faces. Dark layer in perforation. D 3.1, H 1.9, perforation D 1.5mm. Context 3218 (Fill of metalworking pit [3217] adjacent to Workshop 13. (Illus. 6.71)

SF1255 Annular D-section merging with faces, ends smoother. Rather eroded; dark layer in perforation. D 4.5, H 2.0, perforation D 1.5mm. Context 3458 (fill of space between furnace stones and edge of cut of Furnace [3050] Workshop 13. (Illus. 6.61)

SF1469a One face flat with smooth perforation edge, the other slightly convex with perforation edge extended and broken off. A dark material coats the interior of the perforation. D 3.8, H 1.8, perforation D 1.5mm. Context 3467 (basal fill of Furnace 3790 Workshop 13; 90 cal BC–cal AD 80 (SUERC-30391).

SF1469b Broken flanges at both ends. Dark skin in perforation and in places on surface – a deep blue-gray, perhaps an oxidation state of the glass. Rather eroded. D 4.0 , H 2.4, perforation D 1.5mm. Context 3467 (basal fill of Furnace 3790 Workshop 13; 90 cal BC–cal AD 80 (SUERC-30391).

SF1506 Rounded edges merge into rather rounded faces; rather irregular, with traces of slight collar at ends. Dark layer in perforation. D 3.3 × 3.9, H 1.8, perforation D 1.5mm. Context 3467 (basal fill of Furnace 3790 Workshop 13; 90 cal BC–cal AD 80 (SUERC-30391). (Illus. 6.61)

SF739 Globular D-section, glossy surface, ends smoothed; dark layer in perforation. D 3.5 × 4, H 2.1, perforation D 1mm. Context 3961 (fill of Pit [3959] located within the interior of House 10/3. (Illus. 6.61)

SF1259 Slightly irregular, the perforation with rounded edges and remains of a dark layer. Slight use-wear on faces. D 3.5, H 1.6, perforation D 1.5mm. Context (fill of post-hole [3492] Workshop 15. (Illus. 6.61)

(Guido 1978, 73–6.)

Class 13 beads; triangular with inlaid spirals

SF0399 Half of a rounded triangular bead (class 13); bead; clear body with few bubbles and flush inlaid opaque yellow clockwise spirals; two (?of three) survive, one a single trail that overlaps the second, which is composed of two trails that touch but do not join perfectly. Wear at ends. Thin dark layer in perforation and some white or blue-green lenses within the body, apparently at the interface of folds within the glass body. D 13.2, H 9.8, perforation D 2.5mm. Context 2156 (=1853) (stony surface E of House 10/3 ring-ditch; *c.*AD 30–230). (Illus. 6.72)

Illustration 6.72
Colourless glass bead with yellow decoration (SF0399)

SF0846 Half of a triangular bead (class 13), of complex design and high quality. The base glass is clear with some bubbles. The two surviving flattened bosses (of three originally) have inlaid anti-clockwise opaque yellow spirals, with one spiral springing off the next. This creates a slightly blobby yellow pattern at the ends, as parts of the spiral have been folded into the body of the bead and are visible around the perforation. Each boss is bordered by an applied cordon in pale translucent yellow-brown glass with an S-twist fine opaque yellow cord; on the more complete one the two ends are butted in a subtle join. The outer surfaces of the cables are worn away at the ends, indicating the bead saw heavy use. Thin dark coating within perforation, with longitudinal striations. D 16, H 13.2, perforation D 3–3.8, cable D 1.3mm. Context 4342 (occupation deposit, Workshop 15; *c.*40 BC–AD 130). (Illus. 6.61)

SF1037 Triangular bead (class 13), one face flattened, the other rounded. Clear body, made less translucent by the swirls within it from manufacturing; some faint opaque trails. On each point is an inlaid spiral, rather incompetently applied – irregular and composed of several trails, with bits of the spiral merging or branching off; one ends up as a circle surrounding a spiral. Wear and damage at ends. Side L 19.0, H 12.5, perforation D 3–4.3mm. Context 1096 (F1095. Workshop 12; 110 cal BC–cal AD 70 (2σ) (GU-21924 2015 ± 35 BP). (Illus. 6.61)

(Guido 1978, 85–7.)

Blue beads

SF1260 Translucent mid-blue annular bead, D-sectioned with rounded faces. Guido (1978, 68) group 6(iv b). D 3.5, H 1.4, tapering perforation D 1.5mm. Context 1779 (F1778. House 7; 360–50 cal BC (2σ) (GU-21914 2140 ± 35 BP). (Illus. 6.66)

SF1261 Translucent mid-blue barrel-shaped bead, the ends slightly rounded and slightly worn. Guido (1978, 70) group 7(iv), although the colour is not as deep as cobalt blue. D 3.5, H 3.0, perforation D 1mm. Context 2471 (sandy deposit SW of stones 2456, Workshop 11; *c.*90 BC–AD 90). (Illus. 6.67)

SF1263 Globular D-sectioned dark blue translucent bead (near opaque), slightly rounded ends. Guido (1978, 70) group 7 (iv). D 2.2, H 1.5, perforation D 1mm. Context 2877 (F2876 pit within Workshop 19). (Illus. 6.61)

Other beads

SF0156 Opaque pink irregular globular bead with one face slightly flattened; rounded remains of a slight protuberance, probably where detached. No wear; very fresh, and analysis shows it is a potash glass; thus it is an intrusive, modern item. D 5.3, H 3.5, perforation D 1.5mm. Context 595 (F597, Workshop 2). (Illus. 6.61)

SF0486 Annular two-tone blue-green bead with well-rounded D-section. The main body of the bead is a translucent mid-blue-green with an opaque bright green trail inlaid at one end. Some wear on ends. Spiral trails from manufacturing visible. D 4.9, H 2.3, perforation D 1.5mm. Unstratified, from section cleaning; probably pit 2416. (Illus. 6.68)

SF1262 Bead fragment? Clear body with two closely spaced opaque yellow trails inlaid. Too small to determine form; surface worn. 2.5 × 2.5 × 1mm. Context 2548 (F2547, linked to Hearth 2434; *c.*170 BC–AD 20). (Illus. 6.73)

SF1264 Annular 'black' bead, D-sectioned with narrow flat faces. The colour is not strictly black (which is almost unknown in prehistory) but a very deep ?blue which appears black. Guido (1978, 68) group 6(ix). D 3.2, H 1.4, perforation D 2mm. Context 3467 (fill of Furnace 3790; 90 BC–AD 80).

Illustration 6.73
Pale glass fragments (SF1262)

Other glass jewellery

SF0938 Dumb-bell toggle, appearing black and yellow (the black actually a deep translucent slightly greenish blue within which trails, probably from production, can be seen). Each end is decorated with a large blob and a small stripe of opaque yellow. The surface is slightly corroded in one area. At the junction of the two lobes is a slight indent, probably from a tool such as tongs. L 17.5, D 9mm. Context 4380 (4379, Workshop 15, 40 BC–AD 120). (Illus. 6.69)

WORKING DEBRIS

These are listed by context and associated structure where applicable to give an idea of distribution.

Pits adjacent to Workshop 22

Context 1074 (F.1077) SF1007 Rounded sub-triangular mid-blue translucent blob. 7.0 × 4.7 × 1.7mm.

Context 1075 (F.1076) SF1011 Cable prepared for inlay (opaque white and translucent mid-blue), slightly sinuous, one end rounded, other broken. Seven twists/cm. L 11, D 2mm. (Illus. 6.74)

Context 2548 (F.2547), linked to Hearth 2434

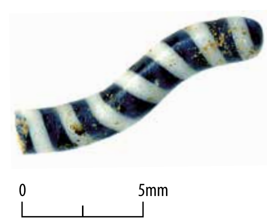

Illustration 6.74
Blue and white spiral (SF1011)

Opaque red

SF1268 Rod; bubbly, ends broken. L 16.5, D 1.8mm. (Illus. 6.63)

SF0610 Bar fragment, rectangular-sectioned with rounded corners; one end cut, the other ?deliberately snapped, with subsequent flaking. Some striations on surface from drawing. 8.5 × 3.3 × 2.4mm.

SF1271 Broken tapered droplet, slightly bubbly. 2.5 × 1 × 1mm.

SF1272 Longitudinal drip with irregular bubbly surface, broken along one side and both ends. L 4.5, D 1.5mm.

SF1273 Fragmentary (non-joining) longitudinal drip with irregular bubbly surface, broken along one side and both ends; vestigial dark layer on fracture surface. L 5.8, D 2mm.

SF1278 Broken edge of irregular rounded flat droplet. 4.5 × 1 × 0.5mm.

SF1277 Angular fragment with rounded surface. 6 × 3 × 0.5mm.

SF1269, SF1270, SF1274, SF1275, SF1276, SF1279 (×3) Eight small angular flakes.

Other glass types

SF1266 Opaque blue slightly curved fragment with opaque yellow trail; the other side, apparently original, is slightly bubbly, with a further yellow trail, suggesting it is probably working debris rather than a broken object. 2.3 × 2.0 × 0.7mm. (Illus. 6.75)

Illustration 6.75
Antimony-rich blue flake (SF1266)

SF1267 Broken flattened clear glass blob. 5 × 2.5 × 1.5mm.

Context 2550, 2549, linked to Hearth 2434
SF1280 Curved strip of opaque red glass, rounded rectangle in section with edge damaged on one side, suggesting it was prepared for manufacture or use as an inlay. Remains of dark strip on interior (cf. similar dark layers on beads). Broken at both ends. 7 × 2.5 × 1mm. Sample 989 context 2550.

Context 2677, charcoal spread linked to Hearth 2434 (150 BC–AD 30)
SF1281, SF1282, SF1283 Three opaque dull red angular flakes, one from a rounded blob

Context 3022, spread linked to Hearth 2434
SF1286 Translucent blob folded into a triangle, a dot of opaque yellow inlaid into one end. Too small to be a waster; probably working debris, the colour combination suggesting perhaps a class 13 bead. Around half of the outer edge abraded. 6.5 × 5 × 4.5mm.

SF1287 Linear nodular dribble of opaque red glass. 10.5 × 5mm, D 1–2mm.

SF1288 Angular flake of opaque red glass, the irregular outer surface suggesting it is a waste or droplet; layer of opaque yellow in centre. Accidental mixture? 6.5 × 4 × 1.5mm.

SF1289 Accidental mixture? Bubbly opaque red block, the ends broken, with a series of trails set into it: a yellow trail with two clear threads Z-twisted into the surface; an adjacent translucent green trail with yellow set in it (perhaps two trails), which is visible in the section, although covered on the surface by red; and on another face a rather collapsed and bubbly ?yellow trail with ?carbonised flecks within it. Its irregular and inconsistent form, and the mixture of colours, suggests it was an accident that was discarded. 8.5 × 6 × 3.5mm. (Illus. 6.64)

Context 3402 Furnace 3790 (90 BC–AD 80)
SF1294 Near-perfectly spherical droplet of slightly bubbly opaque yellow glass, probably an accidental droplet of working debris. D 2.5mm. (Illus. 6.76.)

Illustration 6.76
Opaque yellow ball (SF1294)

Context 2100, abandonment deposit, Workshop 11 (90 BC–AD 90)
SF0355 Linear drip of opaque red glass, circular-sectioned with flowed appearance; one end rounded, other broken. Slight facet on one side, possibly from tongs or from touching something. L 17, D 3mm. (Illus. 6.77)

Illustration 6.77
Glass 'rod' with discoloured outer surface (SF0355)

Context 3440 F.3439, House 10/3 (AD 30–230)
SF1295 Bubbly opaque red rounded broken glass lump. Small white crystal growth in surface layer. The bubbles suggest it was a discarded lump rather than raw glass. 14 × 16 × 13.5mm.

Analysis of the glass objects

Mary Davis and Ian Freestone

The glass from Culduthel offers an excellent opportunity to determine the composition of glass being used to manufacture small items in the Later Middle Iron Age. While a significant number of Iron Age glass objects have been analysed from Britain, the published data are still limited, and material from production sites is rare. The assemblage consists predominantly of beads, plus a number of 'blobs' and working residues such as rods and flakes. The majority of the objects are yellow, red and blue, though black, green and decorated clear beads were also present (Illus. 6.62). Whereas the yellow glass is present predominantly in the form of beads, the red glass, most of which was from a single context, comprises flakes, working pieces and waste.

Analytical methods

Analysis was carried out using a CamScan Maxim 2040 scanning electron microscope (SEM) fitted with an Oxford Instruments energy dispersive X-ray detector and ISIS spectrometer (EDS). Operating conditions employed a 30° take-off angle, a 20kV accelerating voltage, and the samples were analysed for 100 seconds livetime with a beam current that yielded a count rate of *c*.4,000 counts per second when on a metallic cobalt standard. The spectrometer was calibrated using pure elements, oxides and minerals; for lead, a leaded glass standard was used where high concentrations of PbO were present. Corning A-D (Brill 1999) and a range of commercial glass standards were used to evaluate accuracy and precision. Results on flat polished samples are believed to be better than 2% relative for SiO_2, 5% relative for minor components present in concentrations greater than 2%, and 10% for components around 1%, with uncertainties increasing towards the detection limits

Forty samples of glass were selected for analysis; most of the objects were sampled once, though when decorated and consisting of more than one colour, additional samples were taken (Table 6.37). Eleven out of 20 red fragments were sampled, mounted and polished (many pieces had the same context and arrived in the same bag). It emerged that these included a piece of red slag, and a modern fragment of plastic material. The compositional analyses (scatter diagrams) below exclude the latter two pieces. Two methods of sampling were employed. The red glass was sampled in the conventional way: approximately 1mm^3 pieces were removed and embedded in polyester resin, which were then polished down using silicon carbide and alumina polishing agents. To avoid unnecessary damage, the other objects, mostly beads plus some fragments, were sampled using the method devised by Bronk and Freestone (2001). This uses a diamond-coated file to score across a small section of the surface of the object to produce fine glass flakes (Illus. 6.63). The procedure was originally assessed to be suitable for the classification of glass types and to allow useful conclusions to be drawn about raw materials, provenance and date, although not as accurately and precisely as for mounted and polished samples (Bronk and Freestone 2001). Fragments for analysis were selected using a close examination of both secondary (SEI) and back scattered electron images (BSEI) in the SEM (Illus. 6.78 and 6.79). The two images when viewed in tandem allowed the selection of a flat, clean surface, not shadowed by other pieces (SEI image) with a consistent atomic number and lack of surface abnormalities or corrosion (BSE image). As expected, using the flake method the overall percentage totals departed from 100% due to the variable geometry. Sometimes considerable time was needed to locate the most appropriate flakes or areas of flakes to achieve the best analytical total. As observed by Bronk and Freestone (op cit) the standard deviation for the flakes was slightly greater than that for polished samples; also as with the polished samples, the largest standard deviations were for sodium, possibly due to its volatility in the electron beam, and lead, antimony and tin (plus copper in red glass), probably due to uneven dispersal of these metal compounds within the glass matrix, especially when used as opacifiers. Analyses were normalised to totals of 100% so they could be compared to one another and to other analyses. Overall, the flake method proved a useful and effective way to obtain analyses of objects that would otherwise have been difficult to sample. However, the user must be aware of potential problems and limitations, and it should be noted that it is a slow and laborious (hence expensive) procedure. Furthermore, as will be seen below, with certain types of glass there may be unpredictable sources of error that were not anticipated in the original evaluation.

Analytical results are presented in Table 6.37 and in greater detail within the archive report. Excluding a fragment of copper corrosion product, 12 samples, mainly categorised as waste or 'cullet' are clearly modern and/or non-glass waste, and unrelated to the focus of this report. These are separated from the remaining soda-lime-silica glasses in the archive report. Each possesses a number of characteristics that are inconsistent with the great majority of glass pre-dating the 15th century, notably high

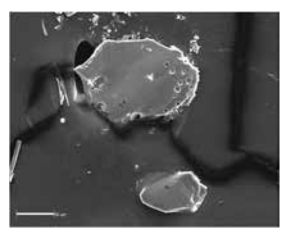

Illustration 6.78
SEI yellow and clear glass (scale bar = 50μm); surface undulation in the flake (SF1286)

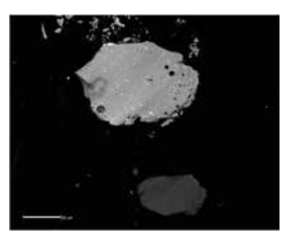

Illustration 6.79
BSEI yellow and clear glass (scale bar = 50μm); fine particles (SF1286)

Table 6.37
Analytical results

		Content	SF No.	Na2O	MgO	Al2O3	SiO2	P2O5	Cl	K2O	CaO	TiO2	MnO	FeO	CuO	SnO2	Sb2O3	PbO		original total		
opaque red																						
flake, cut broken	red	2548	1269	11.18	0.51	1.57	41.56	0.37	0.64	0.65	4.71	0.12	0.46	0.51	10.63	b.d.	0.98	26.07	100.00	99.56	LIA	
flake, cut 'heated'	red	2548	1274	11.54	0.56	1.69	42.37	0.34	0.65	0.84	5.13	0.08	0.43	0.46	8.65	b.d.	0.61	26.63	100.00	99.52	LIA	
rod, burned organic on surface	red	2550	1280	10.65	0.43	1.83	41.15	0.40	0.65	0.61	4.90	0.10	0.40	0.58	9.64	b.d.	0.85	27.81	100.00	99.05	LIA	
rod	red	2548	1268	10.16	0.39	1.66	42.03	0.34	0.65	0.58	4.70	0.03	0.47	0.53	11.03	b.d.	1.14	26.28	100.00	99.55	LIA	
flake	red	2548	1275	10.65	0.46	1.93	42.57	0.43	0.64	0.77	5.27	0.11	0.40	0.63	9.35	b.d.	0.83	25.90	100.00	100.3	LIA	
fragment, heated elongated	red	3022	1287	11.22	0.55	2.00	42.59	0.35	0.63	0.80	5.26	0.14	0.42	0.60	8.82	b.d.	0.79	25.73	100.00	101.8	LIA	
object/lump	red/yellow/ clear	3022	1289	11.18	0.42	1.77	42.28	0.30	0.67	0.56	4.66	0.14	0.38	0.55	9.90	b.d.	1.01	26.16	100.00	101.9	LIA	
rod, darkened outer surface	red	2100	355	10.97	0.33	1.44	43.82	0.41	0.76	0.46	4.54	0.08	0.29	0.32	6.67	b.d.	1.21	28.64	100.00	100.1	LIA	
rod, 'squared'	red	2548	610	11.04	0.35	1.46	43.09	0.33	0.76	0.52	4.36	0.04	0.34	0.37	7.76	b.d.	1.09	28.45	100.00	100.1	LIA	
rod, 'squared'	red	2548	610	11.21	0.44	1.71	42.27	0.34	0.62	0.58	4.70	0.08	0.36	0.50	10.56	b.d.	1.07	25.53	100.00	100.1	LIA	
flake	red	2677	1281	11.13	0.40	1.59	42.68	0.34	0.69	0.55	4.53	0.06	0.35	0.44	9.16	b.d.	1.08	26.99	100.00	100.1	LIA	
flake, burned	red	2677	1282	11.13	0.54	1.89	41.84	0.29	0.60	0.81	5.36	0.19	0.44	0.59	9.97	b.d.	0.87	25.45	100.00	100	LIA	
Blue																						
flake	blue	2548	1266	18.43	0.66	2.42	59.40	0.18	0.30	0.93	8.68	0.10	0.35	2.01	<0.5	b.d.	4.89	1.00	100.00		Roman	
bead	blue	1779	1260	22.14	0.56	1.55	63.51	0.11	1.12	0.49	7.38	0.15	0.05	1.13	<0.5	b.d.	0.51	0.78	100.00			
part toggle	blue/yellow	4380	938	19.51	0.54	2.52	62.51	0.07	0.99	1.21	8.10	0.08	0.55	0.84	<0.5	b.d.	b.d.	0.80	100.00			
blue spiral	blue/white	1075	1011	17.02	0.72	2.72	59.08	0.23	0.96	6.63	8.52	0.07	1.73	1.59	<0.5	b.d.	b.d.	0.08	100.00		Roman	
bead	blue	2471	1261	15.78	1.11	0.89	67.35	0.40	1.10	5.16	6.73	0.05	0.18	0.47	<0.5	b.d.	b.d.	0.10	100.00		ODD compo- sition	
bead	blue	2877	1263	25.40	1.27	1.78	54.57	0.14	1.29	1.39	4.90	0.12	6.67	0.93	<0.5	b.d.	b.d.	0.98	100.00		ODD compo- sition	
opaque yellow																						
bead	yellow	1869	325	10.87	0.41	2.19	55.85	0.27	1.05	0.69	6.20	0.05	0.13	1.77	<0.5	b.d.	0.80	19.08	100.00		LIA	
bead	yellow	3961	739	12.88	0.46	2.12	54.55	0.27	0.76	0.69	7.16	0.09	0.50	0.95	1.21	b.d.	1.41	16.83	100.00		LIA	
ball	yellow	3402	1294	11.52	0.73	1.85	42.78	0.62	0.51	2.05	3.99	0.10	0.72	1.60	<0.5	b.d.	3.74	29.15	100.00		LIA	
bead	yellow	2725	1253	16.18	0.47	2.00	46.48	0.31	0.70	0.49	5.39	0.07	0.08	1.37	1.41	b.d.	2.26	22.75	100.00		LIA	
bead	yellow	3458	1255	15.86	0.50	2.27	53.89	0.29	0.77	1.20	6.15	0.04	0.52	0.77	1.30	b.d.	1.23	15.18	100.00		LIA	
bead	yellow	3467	1469A	13.89	0.85	1.93	46.90	0.65	0.66	1.46	4.83	0.10	0.73	1.32	0.88	b.d.	2.42	23.27	100.00		LIA	
bead	yellow	3467	1469B	10.45	0.84	1.64	42.55	0.62	0.54	1.17	3.93	0.08	0.44	1.34	1.20	b.d.	1.97	33.23	100.00		LIA	

alumina, high lime and high manganese contents. They fall into a number of categories; a group are early modern manganese-rich blast-furnace slag, a pink bead is potash-lead-silica glass post-dating 1700, a blue 'lump' has a modern composition with low levels of several minor elements, especially chlorine, and the remainder appear to be various metallurgical waste products or fuel ash slag. Some of this waste material may relate to the Iron Age industrial activity on the site (fuel, slagged structural material) but does not represent glass product. No high medieval glass appears to be present.

The majority of the remaining glasses are of the soda-lime-silica type, all with magnesia contents at around or below 1.5%. They are therefore categorised as natron-type glass, which is the major glass type in use in the Later Middle Iron Age and Roman

Table 6.37
(continued)

		Content	SF No.	Na2O	MgO	Al2O3	SiO2	P2O5	Cl	K2O	CaO	TiO2	MnO	FeO	CuO	SnO2	Sb2O3	PbO		original total		
bead	yellow	1888	1251	13.07	0.46	2.29	56.75	0.23	0.95	4.28	5.43	0.04	0.04	0.79	<0.5	b.d.	0.68	14.42	100.00		LIA	
bead	yellow	2223	612	14.06	0.43	2.15	52.47	0.26	0.98	0.79	5.17	0.09	0.00	1.13	<0.5	b.d.	0.32	21.44	100.00		LIA	
bead	yellow	2223	632	13.76	0.43	2.12	53.30	0.28	0.90	0.68	5.65	0.07	0.11	0.88	0.76	b.d.	0.79	20.23	100.00		LIA	
bead	yellow	2285	1252	14.04	0.49	2.13	51.23	0.35	0.81	1.25	6.25	0.06	0.55	0.86	<0.5	b.d.	0.93	19.93	100.00		LIA	
bead	yellow	3467	1506	11.31	0.46	2.14	51.47	0.50	0.58	1.32	6.30	0.08	0.29	1.61	<0.5	b.d.	1.41	22.00	100.00		LIA	
bead	yellow	3996	1259	14.41	0.42	2.15	56.70	0.21	1.07	0.59	5.91	0.08	0.05	0.76	0.96	b.d.	0.83	15.78	100.00		LIA	
part object	yellow/red/ clear	3022	1288	14.56	0.53	2.16	54.27	0.23	0.79	0.65	6.57	0.10	0.46	0.82	<0.5	b.d.	0.99	17.39	100.00		LIA	
part bead	yellow/clear	1096	1037	14.10	0.40	1.87	48.66	0.39	0.78	0.86	6.05	0.05	0.15	1.17	1.03	b.d.	0.93	23.47	100.00		LIA	
part bead	yellow/clear	2156	399	13.47	0.60	2.51	56.65	0.27	0.62	1.08	7.29	0.05	0.59	0.80	<0.5	b.d.	1.08	14.55	100.00		LIA	
part bead	yellow/ trans/clear	4342	846	14.17	0.37	1.92	49.81	0.28	0.71	0.80	6.41	0.06	0.20	1.25	0.96	b.d.	0.60	22.34	100.00		LIA	
part toggle	yellow/blue	4380	938	13.32	0.44	1.93	47.69	0.34	0.88	0.88	5.63	0.06	0.07	0.98	1.15	b.d.	0.68	25.90	100.00		LIA	
part blob	yellow/clear	3022	1286	14.60	0.54	2.23	54.01	0.22	0.73	1.54	6.58	0.08	0.55	0.75	<0.5	b.d.	0.92	16.51	100.00		LIA	
bead	yellow	2223	583	10.37	0.47	1.82	33.73	0.51	0.55	0.53	4.48	0.09	0.59	0.59	<0.5	3.43	b.d.	42.13	100.00		LIA or 4th C or later	
bead	yellow	3218	1254	9.57	0.37	1.75	34.31	0.50	0.77	0.34	3.73	0.02	0.61	0.77	<0.5	2.00	b.d.	44.71	100.00		LIA or 4th C or later	
translucent yellow-brown																						
part bead	trans/ yellow/clear	4342	846	17.47	0.45	1.91	68.95	0.20	1.10	1.57	6.99	0.04	0.01	0.32	0.94	b.d.	b.d.	b.d.	100.00		LIA	
clear																						
part bead	clear/red/ yellow	3022	1289	19.57	0.70	2.43	64.68	0.19	1.11	1.04	6.94	0.06	0.31	0.30	<0.5	b.d.	2.04	b.d.	100.00		Roman	1-4th
part bead	clear/yellow	1096	1037	19.36	0.61	2.50	64.18	0.12	1.14	1.54	7.98	0.06	1.18	0.29	<0.5	b.d.	b.d.	b.d.	100.00		Roman	1-4th
part bead	clear/ yellow/trans	4342	846	19.04	0.57	2.59	64.59	0.16	1.01	1.30	8.08	0.06	1.16	0.29	0.81	b.d.	b.d.	b.d.	100.00		Roman	1-4th
part bead	clear/yellow	2156	399	19.20	0.72	2.86	64.13	0.10	0.92	1.58	8.08	0.08	1.10	0.50	<0.5	b.d.	b.d.	b.d.	100.00		Roman	1-4th
blob	clear/yellow	3022	1286	18.73	0.57	1.45	67.90	0.06	0.60	1.37	8.12	0.03	0.54	0.44	<0.5	b.d.	b.d.	b.d.	100.00		Roman	1-4th
misc																						
bead	black	3467	1264	17.97	0.51	1.31	57.87	0.09	0.89	0.78	7.95	0.10	0.03	10.39	<0.5	b.d.	0.56	0.90	100.00		Roman	
spiral	white/blue	1075	1011	17.61	0.55	2.53	59.80	0.18	0.44	2.61	7.30	0.03	0.85	0.37	<0.5	b.d.	7.15	b.d.	100.00		Roman	
lump	pale	2548	1267	15.31	1.52	3.39	64.90	0.11	0.70	1.75	9.05	0.15	1.39	0.84	0.86	b.d.	b.d	b.d.	100.00		Roman/ Byzantine	
bead	green-blue	2416	486	17.42	0.62	2.62	63.76	0.13	0.89	2.19	7.90	0.06	1.18	0.46	2.24	b.d.	b.d	0.50	100.00		Roman	

periods, in Britain, Western Europe and the Mediterranean. The glasses contain variable quantities of copper, lead, antimony and tin, which were added as colourants and opacifiers. To assess the relationships between the glasses it is useful to exclude these additions (Brill 1999; Brill and Cahill 1988, 19), so that the underlying composition of the base glasses can be compared. For this purpose, the data are presented in some diagrams as reduced or recast data, where the analyses were recalculated after the removal of elements with a higher atomic weight than iron as all were used as colourants and/or opacifiers in at least some of the objects. The remaining analysed elements were normalised so their totals equalled 100%. Asterisked components in the graphs signify that they represent these reduced compositions (e.g. *% CaO).

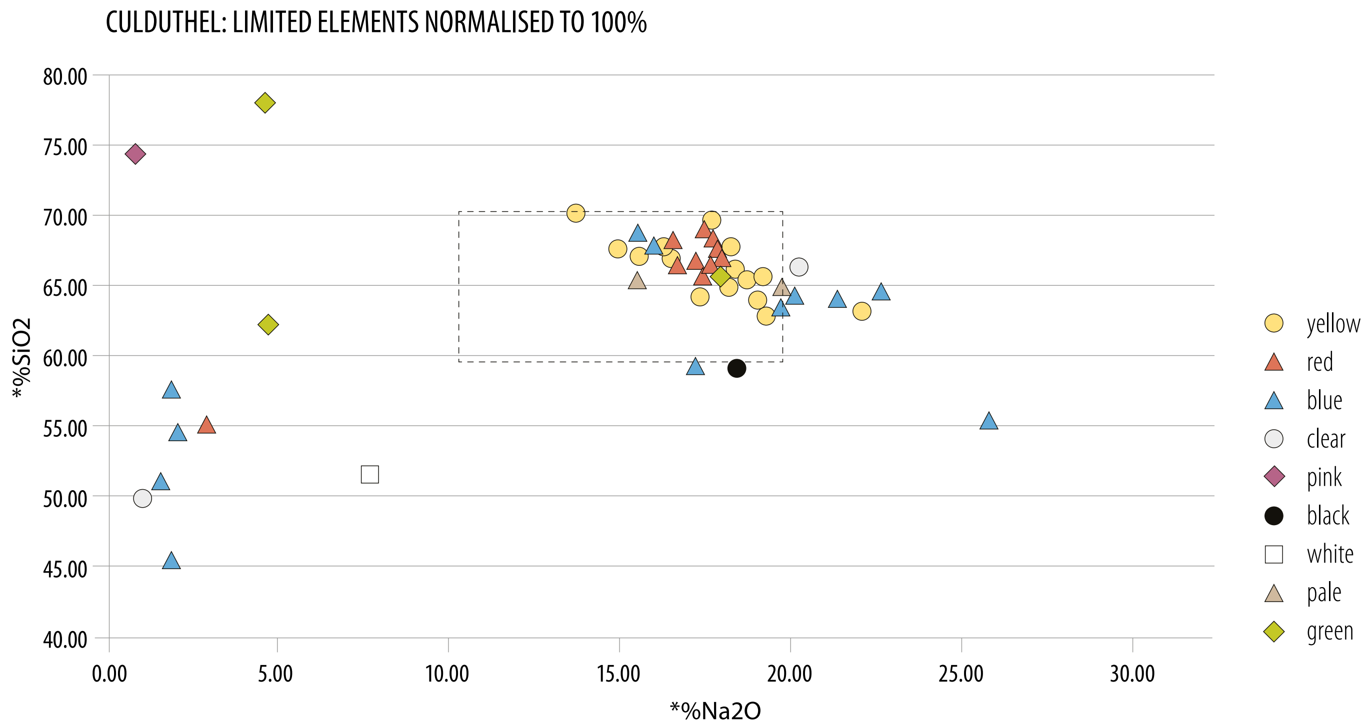

Illustration 6.80
Soda/silica composition of the glass; the box illustrates the normal composition for soda-lime-silica glass from the LIA/Roman period, and differentiates outliers with low soda values

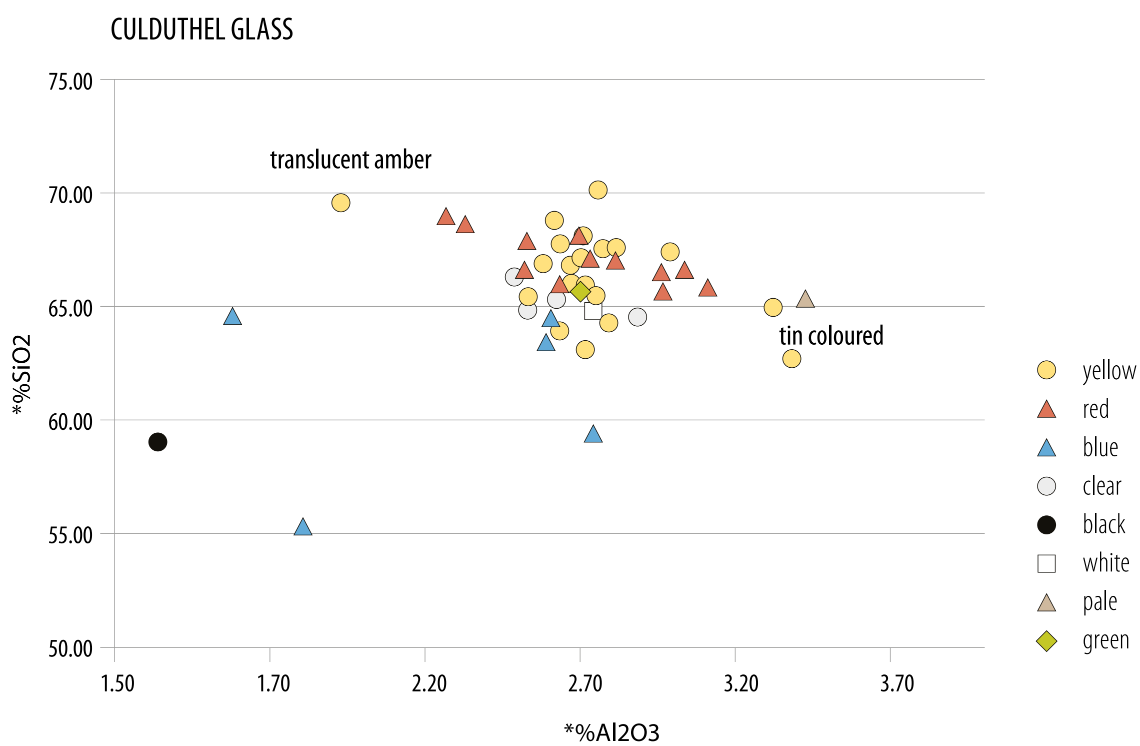

Illustration 6.81
Scatter diagram of alumina versus silica illustrating some of the glass outliers

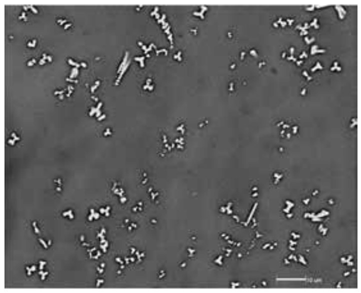

Illustration 6.82
BEI of cuprite dendrites within red glass (scale bar = 10 μm) (SF1269)

Illus. 6.80 shows the samples in terms of their reduced soda and silica contents. The 'box' indicates the usual compositional range for uncoloured soda-lime-silica glasses in the Later Middle Iron Age (LIA) and Roman period (approx. 60–70% silica and 14–20% soda). The majority of the glass from Culduthel lies within this range, with the modern and waste samples appearing as outliers. The status of one blue glass bead (SF1263) with exceptionally high Na_2O is unclear. Most of these soda-lime-silica glasses have low magnesia (MgO) and potash (K_2O) contents.

Alumina is likely to have been incorporated into the glass with the silica as a naturally occurring impurity; its concentration therefore reflects the raw material and may be used to provide an initial impression of production-related groupings. Illus. 6.81 shows that the majority of the yellow and red glass samples form a fairly compact group, while the blue is much more dispersed, as is the ?Roman-style black glass bead. Interestingly, neither of the two blue objects that do fall within the main group of glass are the small annular beads; one is the toggle decorated with yellow glass (Illus. 6.69) and the other is a flake – suggesting that blue glass may have been worked on site. The two yellow beads with high alumina are both coloured with tin rather than antimony; and the yellow in the top left-hand corner is the one example of yellow/amber translucent glass used as decoration on one of the clear beads.

Roman and Later Middle Iron Age soda-lime-silica glasses were typically made using natron, a mineral source of soda, and these 'natron glasses' are generally found to have less than 1.5% each of MgO and K_2O, and typically less than one per cent. The analyses of the Culduthel glasses have low MgO, but in some cases the K_2O contents are higher than is typical for glass of the period. Potash contents greater than 1.0% are frequent in the yellow, blue and colourless glasses, and in several cases exceed four per cent (Table 6.37). Given that these compositions resemble Later Middle Iron Age/Roman glass in other respects, along with their contexts and typologies, it must be assumed that they are of Later Middle Iron Age/Roman date, but have been contaminated with potash by some process. Recent examination of the glass products from an experimental replication of a wood-fired Roman glass furnace has shown that potash contamination may occur due to the vapour from the wood fuel (Paynter 2008). We therefore assume that the elevated potash contents encountered in the Culduthel beads were a product of the bead-making procedures adopted. One possibility is that the flake sampling procedure we have adopted removed samples from much closer to the surfaces of the objects than those usually analysed, and the surfaces of the beads had been contaminated by potassium in the manufacturing process (perhaps during annealing).

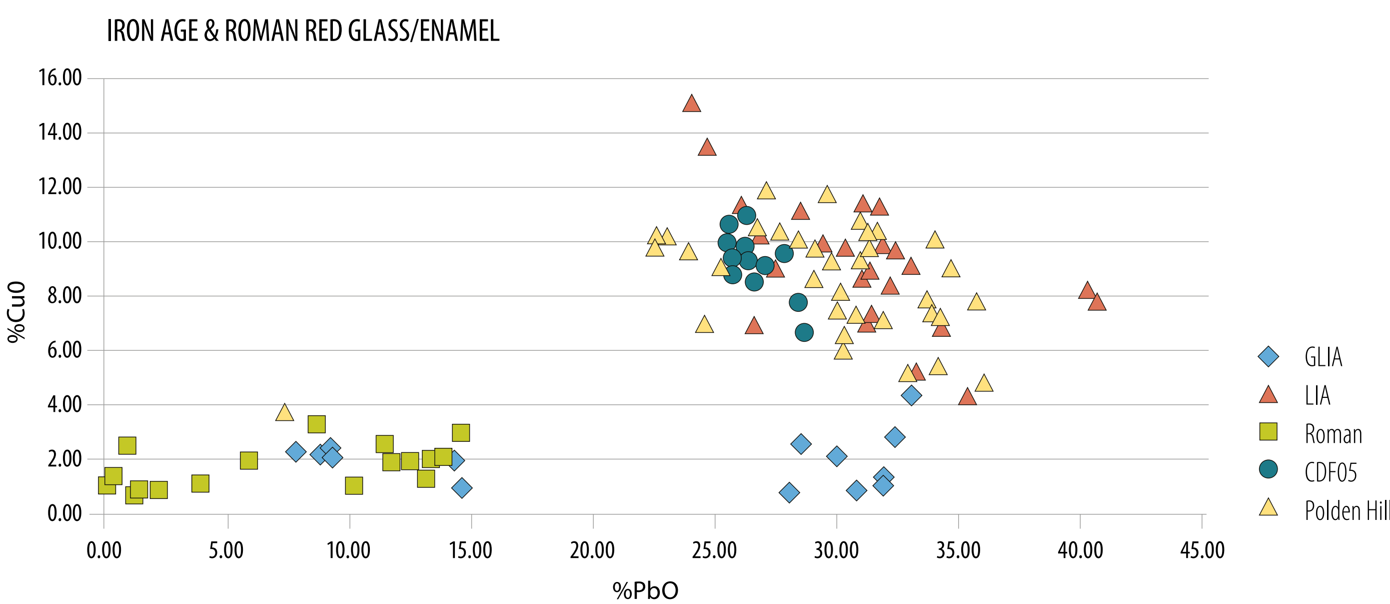

Illustration 6.83
This scatter diagram of the two main additional elements (copper oxide and lead oxide) added to LIA opaque red glass illustrates how the Culduthel glass sits as a discrete group among other similar Late Iron Age red glass, and away from Roman red glass

Opaque red glass

The red glass from Culduthel is a soda-lime-silica glass with large additional quantities of both lead and copper (averaging 26.64% lead oxide and 9.35% copper oxide). Like other examples of Later Middle Iron Age opaque red, the copper occurs in the form of dendritic (branching) crystals of cuprite (cuprous oxide, Cu_2O) within the glass matrix, which give the glass its intense colour and opacity (Illus. 6.82). It is highly likely that this glass was traded as ingots or blocks of glass; several examples of these have been found (e.g. Tara Hill, Ireland (Freestone et al 2002); Fish Street, London (Stapleton et al 1999)). The original clear glass, before the colourants were added, as with the majority of Iron Age and Roman glass is likely to have been derived from the Eastern Mediterranean (e.g. Nenna et al 1997; Degryse and Schneider 2008). Where and by whom the glass was coloured has not been determined, but this type of red glass was used for decorating La Tène metalwork in northern, rather than Mediterranean Europe. However, similar compositions of glass do occur very occasionally on the walls of nymphaea in the 1st century AD (Arletti et al 2006; Boschetti et al 2007) and in Roman orange tessera (Brun 1991, Appendix 1). The composition of all the red glass from Culduthel corresponds well to other Iron Age opaque red glasses from Britain in terms of its copper and lead oxide contents (Hughes 1972; Henderson 1989b) (Illus. 6.83). Also shown are red Roman glass tesserae from Italy (Freestone and Stege, unpublished data), which typically have lower copper and lead oxide contents, while red glass from 'geometric' Later Middle Iron Age enamelled objects differs in its copper oxide content. Although geometric Later Middle Iron Age material probably dates from the same or an overlapping period as the Culduthel, Polden Hill and other Later Middle Iron Age samples, the decoration on these artefacts is different stylistically, and often incorporates polychrome enamel, rather than inlaid red (and occasionally yellow) glass (Davis and Gwilt 2008, 154–58). A feature that is well illustrated in this figure is the relatively limited compositional range of the Culduthel reds relative to the other groupings.

Illus. 6.84 shows that the levels of manganese oxide within the Culduthel red glass vary from 0.29–0.47%. Levels of MnO above 0.1% are likely to indicate its deliberate addition as a decolourant (Freestone 2006); the levels here imply that the base glass used to produce the opaque red had been decoloured using manganese. The use of MnO as a decolourant appears to have been introduced in the 2nd century BC. The Culduthel reds once again appear to form a discrete group despite their varied shape and use. Some appear to have more of a burnt/melted appearance; these particular fragments tend to show a slightly higher than normal potassium oxide content at around 0.8% rather than 0.5% K_2O (Table 6.37), which is likely to represent contamination during glassworking. Ash from charcoal, used to maintain a reducing atmosphere to preserve the cuprite colourant in the glass, may have become incorporated into the glass (see Paynter 2008).

One further important observation on the elemental composition of the red glass from Culduthel is the strong linear correlation noted between the alumina and iron oxide values (Illus. 6.85). The lead oxide and silica contents of these glasses are relatively constant, so this is not a dilution effect due to increased content of lead. Alumina was not available for use as an independent additive, and the increase with iron oxide strongly suggests that a clay component was being incorporated into the glass matrix. The most likely cause of this would be from the use of a clay crucible at high temperatures. The high lead content of the molten red glass would have been very corrosive at high temperatures, as noted by Heck et al (2003) in their work on a Merovingian crucible fragment that had reacted with lead-rich yellow glass colourant. If the Culduthel red-coloured glass was also being prepared in a crucible, it could be assumed that the high lead content would have a similar affect on this glass. This would account for trend seen in Illus. 6.70, which is also present to some extent with other components in the Culduthel glass such as magnesia, potash and silica. This in turn has implications for the processes of manufacture and exchange (see discussion below).

Many of the red pieces of glass occur as small fragments, rods or elongated 'dribbles', and the latter, in particular, often show a discoloured/oxidised surface round the outside (e.g. SF0355 – Illus. 6.77). Inlaying into metal was the most common use for 'sealing wax' red glass in the Later Middle Iron Age, where it was also occasionally used in conjunction with yellow glass, for example on the massive armlet from Castle Newe in north-east Scotland (MacGregor 1976 no. 239). However, the size of some of the rods from Culduthel could indicate that drawn 'threads' are being made for decorative purposes (as with the yellow spirals on the larger beads), though there are no surviving red artefacts to confirm this. There is no indication that the Culduthel red glass was being used for the manufacture of beads or discrete glass objects; Later Middle Iron Age beads of red glass are virtually unknown in Britain (see Hunter's report here for Scottish examples).

There are two unusual pieces of red glass from Culduthel where a very fine, predominantly yellow glass rod or trail has been fused to a red lump (SF1289 – Illus. 6.64). The yellow glass looks as if it has been finely twisted with clear glass as part of cane making – in a manner often used for manufacturing mosaic glass, though on a much smaller scale here. The fineness of the twisted rod suggests the yellow and clear glass might have been mixed to make a scarce yellow glass go further; a more obvious example of this can be seen in 'yellow' glass arm rings from the vicinity of Berne (Müller 2009, 35), where yellow glass is applied only to the inner surface of the plain glass ring (see Hunter's glass report here for further discussion).

Opaque yellow glass

The most numerous type of glass artefact from the site is the small opaque annular yellow bead. There are 14 of these, plus one small yellow ball (SF1294 – Illus. 6.76), which may have been made in preparation to be converted into a bead. Yellow glass has also been used to decorate other objects; mainly larger colourless beads, but also a blue toggle (SF0938 – Illus. 6.69). There is one blob of colourless/pale-green glass with a small amount of yellow on one side (SF1286), plus the yellow/clear rod with the red lump discussed above, and a translucent yellow/brown with opaque yellow spiral attached to one of the large decorated beads (SF0846 – Illus. 6.61 and 6.65).

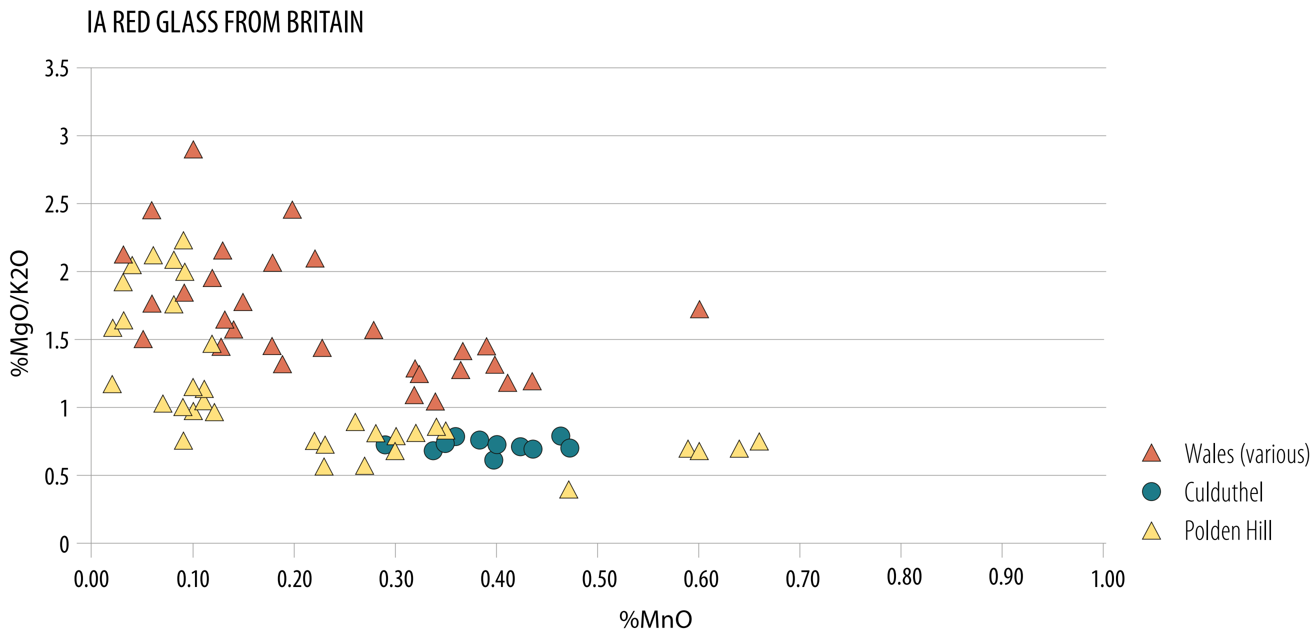

Illustration 6.84
Scatter diagram of manganese oxide versus magnesia and potash, showing grouping of red glass from Culduthel

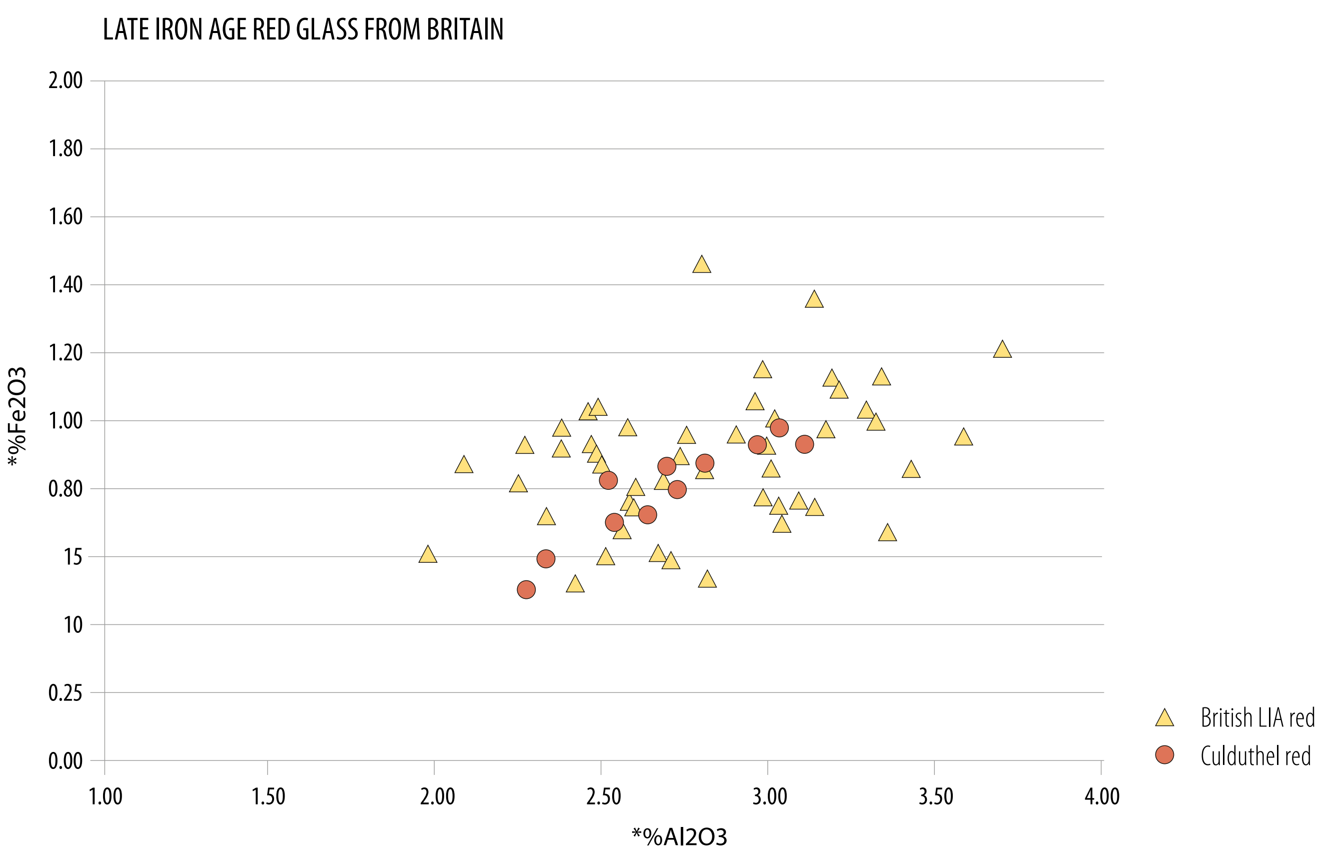

Illustration 6.85
Scatter diagram showing a clear linear correlation between alumina and iron oxide on red glass from Culduthel

Illustration 6.86
Lead and antimony levels in the yellow glass. The two tin-coloured beads are in the top left-hand corner

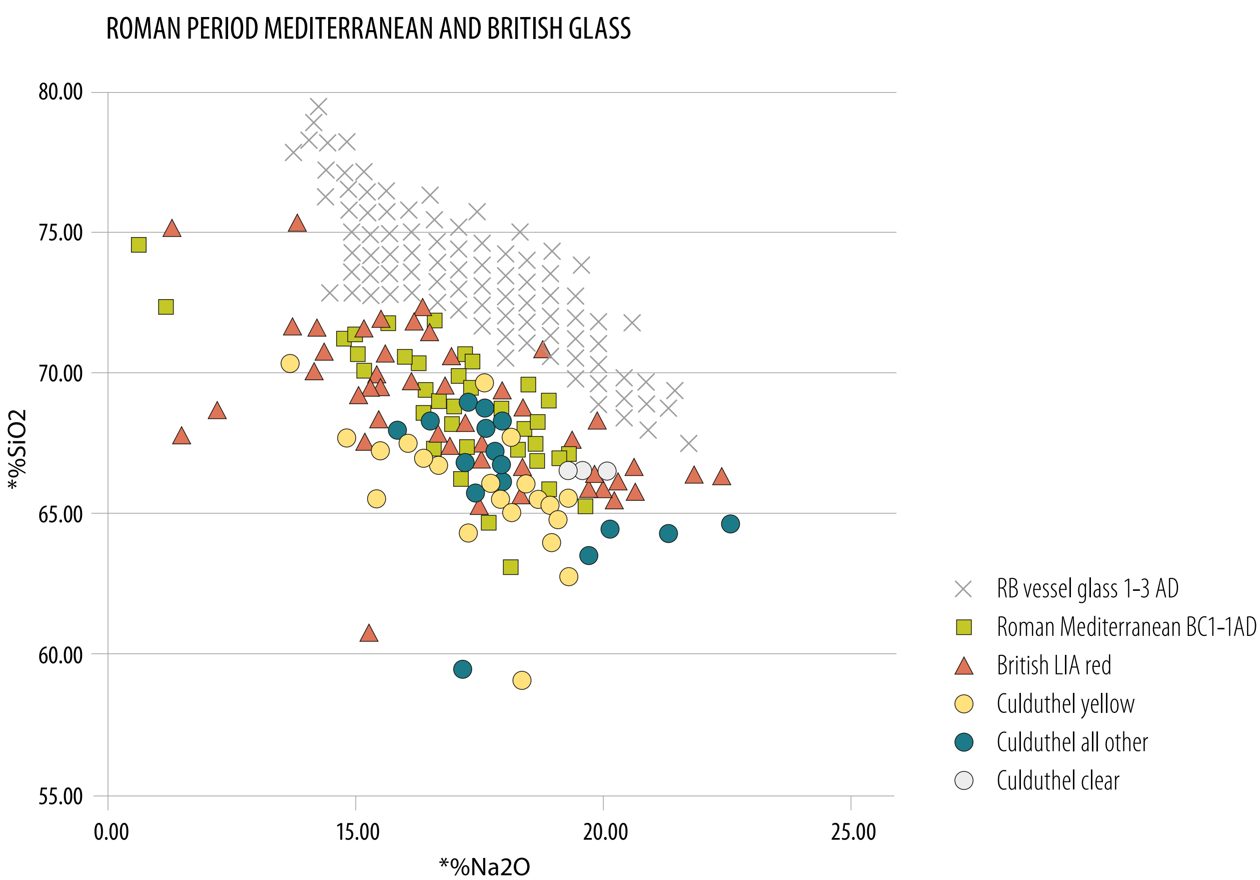

Illustration 6.87
Scatter diagram showing the similarity of the yellow glass from Culduthel to other British IA glass and Roman Mediterranean coloured glass dating from 1st century BC to 1st century AD (Freestone Roman mosaic vessel glass, Jerusalem glass ref). There is a noticeable difference from British vessel glass from Binchester (Paynter 2006); Colchester, York, Leicester, Mancetter (Jackson 2005) and Lincoln

All but two of the analyses of the opaque yellow glass showed that this was coloured by lead antimonate, by far the most common colourant used in the Iron Age and Roman period for yellow glass (Illus. 6.86). Like the sealing wax red glass, the original 'clear' glass was probably manufactured in the eastern Mediterranean and coloured in secondary workshops, from where it would have been distributed as yellow blocks or ingots (Tite et al 2007). This scenario would make sense for the yellow beads here; although they are generally similar to each other, their composition is more variable than the red fragments (although it should be borne in mind that they were analysed using the less precise 'flake' sampling technique). For example, the yellow used for applied trail decoration on other glass from Culduthel, including the yellow and clear spiral on the red fragment, seems to form a distinct group, close to several of the annular beads, but not all of them. There were possibly two or three different ingots worked on the site, probably within overlapping timeframes, considering the similarity of the artefacts and decorative styles.

Two of the yellow annular beads, virtually indistinguishable in appearance from the antimony-coloured beads (SF0612 – Illus. 6.70), were coloured using lead stannate (SF1254 – Illus. 6.71). This is a relatively rare colourant in the Iron Age; however, Henderson and Warren (1982) have analysed a number of Iron Age tin-opacified yellow artefacts (mainly beads) from Britain and Ireland ranging in date from the 3rd century BC to the 3rd century AD. Other notable instances of the use of tin-opacified yellow glass are for armlets from Hengistbury Head (Henderson 1987c), the trail decoration on one bead from Glastonbury (Henderson 1995) and on the hilt of the Thorpe sword (Freestone unpublished analysis). It is difficult to determine on the basis of composition alone whether these tin-opacified beads date from the Later Middle Iron Age, or from a second influx of tin-coloured beads in the 4th century AD, or even into the early medieval period. Tite et al (2007) have a higher average tin content for analysed tin-yellow beads from the Iron Age based upon their review of published analyses by other authors, and their conclusions would have the Culduthel beads sitting more comfortably with Late Roman or continental early medieval yellow glass (Tite et al 2007, 77). However, available analyses for the Thorpe sword (Stead 2006; Freestone, unpublished data) and Hengistbury Head armlets (Henderson 1987c) are not dissimilar to Culduthel (Illus. 6.86), and given their similarity in style to the antimony-opacified beads, and their contexts, it seems probable that they are indeed Later Middle Iron Age. It is unlikely that the small amount of tin-opacified yellow glass from Culduthel was made on site; there is evidence for making objects, but not for modifying the glass colours. The tin-coloured glass was probably also imported either as a block from a different source, or as finished beads.

One further indication for a Later Middle Iron Age date for the yellow beads, along with most of the Culduthel glass assemblage, is the overall levels of soda and silica compared to 1st–3rd century AD Romano-British vessel glass (e.g. Paynter 2006; Jackson 2005). It can be seen (Illus. 6.87) that the base composition of the yellow glass corresponds with the distinctive Later Middle Iron Age red glass, and with clear and coloured Mediterranean glass from Italy and Jerusalem (1st century BC to 1st century AD) but not with the Romano-British colourless glass. Coloured glass tesserae from the 1st to 3rd centuries overlap both areas on the diagram (Freestone, unpublished work). The absence of Culduthel data from the colourless glass field strongly suggests that glass made after the middle of the 1st century AD is absent.

Blue glass

Blue is another colour of glass commonly used in the Iron Age and Roman periods. The blue glass from Culduthel consists of three small, individually distinctive annular beads (SF1260 – Illus. 6.66, SF1261 – Illus. 6.67 and SF1263), one flake (SF1266 – Illus. 6.75), a toggle decorated with yellow glass (SF0938 – Illus. 6.69) and a twisted spiral of blue and white glass (SF1011 – Illus. 6.74). There are also five pieces of post-medieval waste/slag (Table 6.38). The slag was all of a mid-blue-grey colour and some pieces were deformed with attached concretions or prominent air bubbles. All had a composition and appearance that suggest these were fragments of slag from an iron blast furnace, and therefore post-medieval contaminants (Tylecote 1992, 126). Lump SF10007 is likely to be post-medieval, in the light of its very low chlorine content.

The majority of the blue glass artefacts had compositions consistent with Roman glass (Illus. 6.88); the flake had a large amount of calcium antimonate present. One bead SF1262 was close in form and appearance to the yellow annular beads, and the toggle (SF0938 – Illus. 6.69), which was decorated with yellow glass, is best seen as Iron Age in style. The yellow glass used for the decoration of the toggle fits well with the composition for other decorative yellow glass from the site (Illus. 6.86). As noted in Illus. 6.81, the flake and toggle, which might be associated with glassworking on the site, both show alumina and silica levels similar to the red working debris plus the yellow and clear glass beads. The variability of the blue objects from Culduthel might suggest a much larger number of sources, possibly being supplied over a longer period of time. Alternatively blue glass material for glassworking may have been obtained from a range of sources on an opportunistic basis, and may have consisted of tesserae, vessel fragments and old beads. Blue glass annular beads were present in the MIA in particular (for example those from Rudston and Glastonbury; Henderson 1991a; 1995); however, the Culduthel ones are all small and all different from each other in both shape and colour. In Illus. 6.84, it can be seen that the soda/silica levels for the blue glass are relatively variable in their quantities; but that one of the beads (SF1261) is quite close to the plotted Roman and Romano-British blue glass. It seems likely that blue glass objects were being made at Culduthel, but that the exchange and availability of this glass was different to that of the traded red and yellow glass. This could in part be due to the relative scarcity of blue-coloured glass in both the Roman Late Republican era and the British Later Middle Iron Age.

Clear glass

There is relatively little extant colourless glass at Culduthel. There are three very small colourless fragments (SF1262 – Illus. 6.73 and SF1267), and the rest of the colourless glass consists of components of three polychrome beads and a small thread twisted with yellow glass and attached to a red lump. Colourless glass would have been available as cullet, and was probably easier

Table 6.38
Modern and slag analytical results

		Content	SF	Na2O	MgO	Al2O3	SiO2	P2O5	Cl	K2O	CaO	TiO2	MnO	FeO	CuO	ZnO	SnO2	Sb2O3	PbO		Original total
waste/slag	blue	3204		1.92	1.27	7.06	54.38	0.03	0.00	6.52	15.64	1.42	10.17	1.17	bd	0.08	0.01	0.02	0.03	100	post-med
waste/slag	blue	2877	1138	1.79	1.39	6.69	45.26	0.09	0.02	4.68	18.84	0.56	15.08	4.79	bd	0.02	0.00	0.17	0.02	100	post-med
waste/slag	blue	3064	1222	1.53	2.03	5.90	50.94	0.21	0.03	5.01	16.15	0.99	11.72	5.10	bd	0.02	0.00	0.00	0.03	100	post-med
cullet	blue	Cullet		1.75	3.87	6.96	56.48	0.15	0.42	1.88	23.13	0.39	0.05	2.56	bd	0.05	1.76	0.07	0.06	100	metallurgical waste?
lump	blue	1074	10007	15.40	0.54	1.00	68.42	0.15	0.17	0.67	12.46	0.18	0.13	0.25	bd	0.02	0.00	0.08	0.28	100	late
clear ball	clear	3467	1469	1.01	2.55	15.68	49.48	0.12	0.03	3.34	22.61	0.79	3.38	0.45	bd	0.02	0.00	0.14	0.07	100	
waste/slag		2101	416	3.08	2.71	6.87	59.67	3.41	0.00	7.43	8.60	0.50	0.34	7.30	bd	0.02	0.00	0.00	0	100	fuel ash slag
waste/slag		2821	1108	3.09	2.10	4.05	67.67	2.63	0.00	11.91	4.71	0.51	0.37	2.84	bd	0.00	0.00	0.00	0	100	fuel ash slag
slag	red	3440		2.75	1.66	16.88	53.05	0.34	0.00	9.76	5.73	0.89	0.24	4.81	3.81	0.08	0.00	0.00	0.00	100	metallurgical waste?
waste/slag		4256	1697	3.68	1.61	15.16	63.69	0.25	0.00	4.78	4.40	0.85	0.14	5.32	bd	0.06	0.00	0.00	0	100	
lump	green-grey	3144	1231	4.66	0.54	7.41	62.00	0.46	0.03	15.64	2.06	0.69	0.23	5.82	bd	0.03	0.00	0.04	0.04	100	
lump	green	2778	1085	4.23	0.74	3.04	73.59	0.21	0.83	1.22	8.56	0.08	0.65	1.20	4.24	0.02	0.00	0.00	1.38	100	metallurgical slag?
lump	green	2677	1037	4.44	3.30	0.56	3.45	8.86	0.09	0.01	0.22	0.03	0.03	1.93	18.43	0.10	56.15	0.05	2.36	100	corrosion
bead	pink	595	156	0.50	0.04	0.24	47.30	0.38	0.26	14.73	0.00	0.05	0.04	0.05	0.70	0.05	0.00	0.06	35.57	100	post-Med
Batch 2		**Batch 2**																			
waste/slag		2101	416	3.08	2.71	6.87	59.67	3.41	0.00	7.43	8.60	0.50	0.34	7.30	0.09	0.02	0.00	0.00	0	100	
waste/slag		4256	1697	3.68	1.61	15.16	63.69	0.25	0.00	4.78	4.40	0.85	0.14	5.32	0.08	0.06	0.00	0.00	0	100	
waste/slag		2821	1108	3.09	2.10	4.05	67.67	2.63	0.00	11.91	4.71	0.51	0.37	2.84	0.11	0.00	0.00	0.00	0	100	

to obtain than specially coloured glass. It would also have been easy to remelt/soften and reuse without compromising its colour, which could be one explanation for the lack of waste glass found.

The colourless glass used for the polychrome beads has a relatively consistent composition; a very tight group of three objects is present (Illus. 6.81 and 6.89), which along with the use of consistent compositions of added yellow decoration, implies that these were made in a single campaign of glassmaking, perhaps in a single batch.

Other natron-type glass

There are a number of other objects; a small greenish blue annular bead with a Roman/natron-type composition coloured by copper, and a blue and white spiral fragment (SF0486 – Illus. 6.68 and SF1011 – Illus. 6.74). There are no comparative compositions to either the blue or the white glass in this piece, and no working debris in these colours, which could imply a pre-worked imported cable; although other spiral rods, the amber and clear glass on bead SF0846 (Illus. 6.65) and the clear and yellow spiral on SF1289 (Illus. 6.64) imply cables might have been manufactured on the site.

There is also a small black bead, coloured by iron, again with a composition consistent with other Roman black glass (Bateson and Hedges 1975), Van der Linden et al's recent study of 'black' Roman glass suggests this bead was probably manufactured after AD 150 (Van der Linden et al 2009, 828, 837), based on high iron content correlating with relatively high antimony, plus calcium oxide levels of 7–9%. However, a further paper includes analyses of Iron Age black glass from France and Switzerland, dating into the 2nd century BC. This glass has similar iron, alumina and potassium oxide levels to the Culduthel glass but with slightly lower calcium oxide levels. However, a full set of data is not available for more detailed comparison (Gratuze 2009).

Discussion

In conclusion, it is difficult to be precise about the date of the assemblage from the analytical work alone; there is both Later Middle Iron Age and Roman-type glass present, which probably dates the material from the 1st to the 4th centuries AD, the Later Middle Iron Age or perhaps a little earlier. Red, yellow and dark blue are colours commonly used for glass in the Iron Age, and these stand slightly apart from the black, pale-blue, white and green colours that are characteristically Roman in their composition,

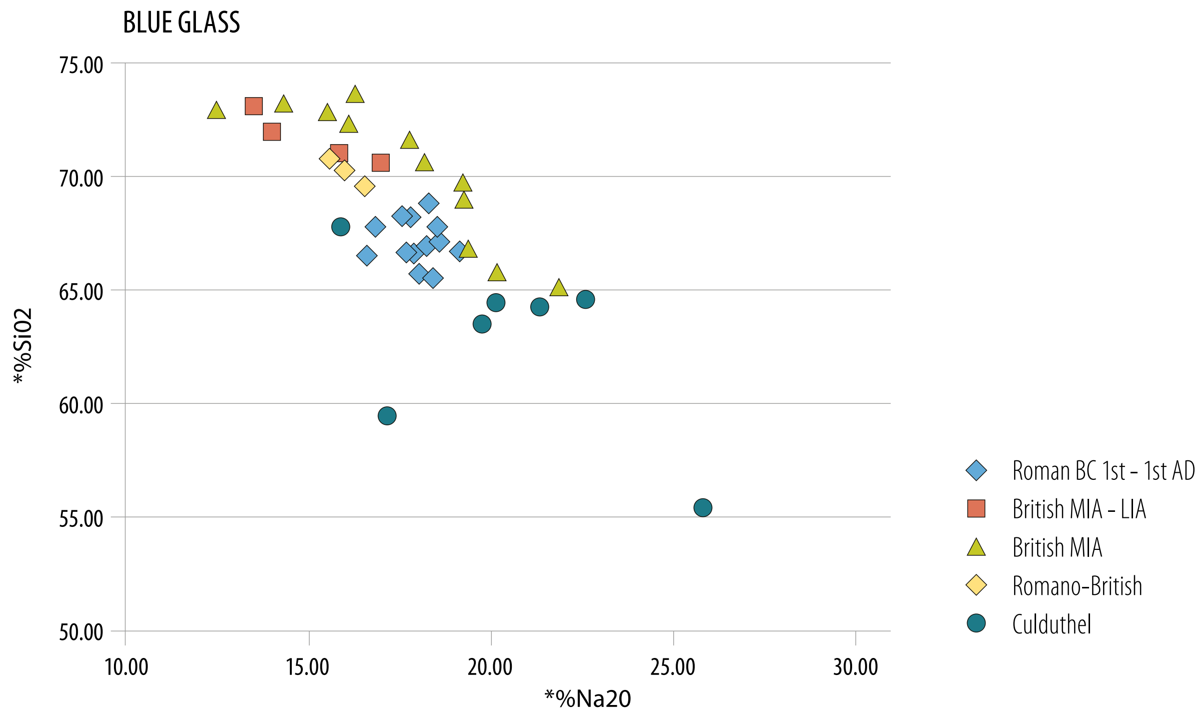

Illustration 6.88
Various IA and RB blue glasses showing a diversity of colourless glasses used before the addition of colourants. (Henderson 1995; 1987c; 1987b; MacDonald & Davis 2002)

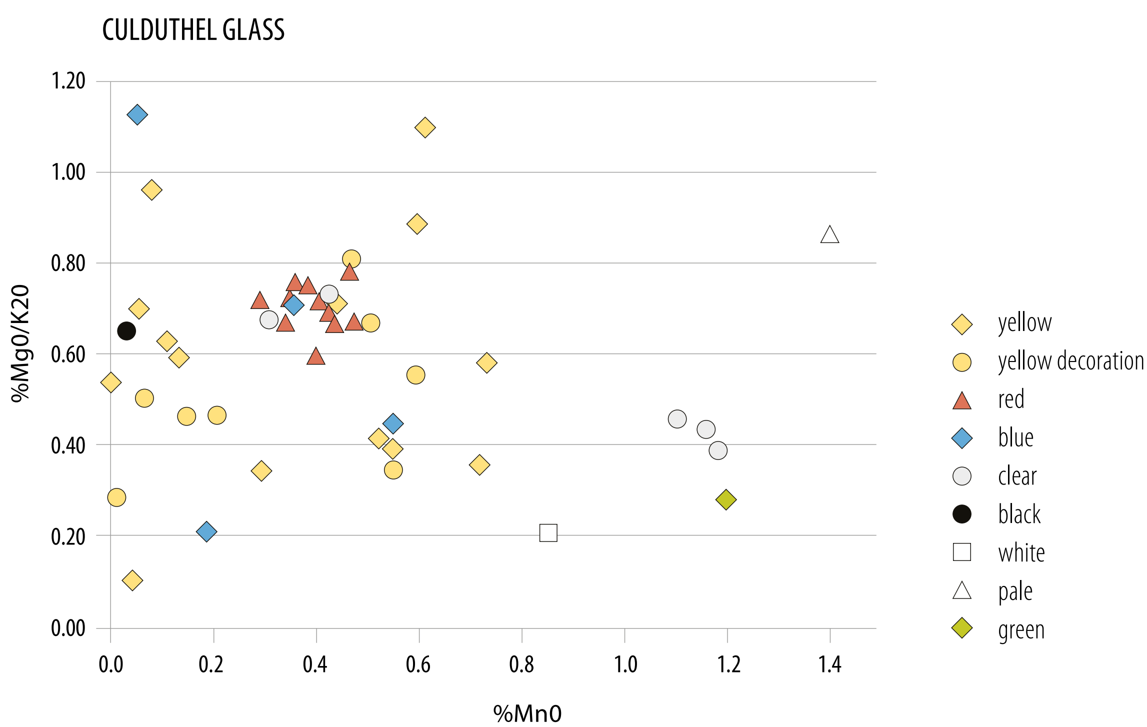

Illustration 6.89
Scatter diagram showing how the colourless glass is distributed; the three decorated beads are on the right-hand side

but quite possibly contemporary in date. No red glass objects are extant; this is possibly because red glass would only have been used for inlaying into metal. The yellow glass beads are all minute, and probably represent accidental loss; there are no unworked yellow lumps, which implies little waste. The presence of tin-coloured as well as antimony-coloured yellow glass could testify to the scarcity of yellow glass (Tite et al 2007), which was used as sparingly as possible, either as trail decoration on other glass objects, inlaid into metal, or for very small artefacts. The only sizeable glass artefacts are the polychrome beads, of which two out of three are broken. There is very little scrap clear glass, suggesting this could have been reworked. It appears that the majority of the glass was native in style and manufacture, but that some single glass items of Romano-British material and style were being acquired. It is possible that Roman blue glass was also being reworked at Culduthel, for example the blue flake (SF1266). The fact that the compositions of the blue glass objects and fragments from the site are so variable could imply pieces were being acquired when and if the chance occurred, possibly via 'Roman' routes rather than more established 'Celtic' trade links. No lumps/ingots of blue glass have been discovered in Britain from this period, unlike red and purple glass. There are several levels at which glass could have been worked on the site. It seems increasingly likely that the later prehistoric and Early Historic soda-lime-silica glasses in Europe were being manufactured in the Eastern Mediterranean (Freestone 2005 and 2006; Nenna et al 1997; Degryse and Schneider 2008). By the 1st century AD, the manufacture of artefacts by glass-blowing would have been established, and glass production would increasingly be carried out on an industrial scale.

Examination of sealing-wax red glass used for La Tène artefacts in particular, has shown some variation through time and also geographically, for example differences between Middle and Later Middle Iron Age glass on both mainland Europe and Britain (Brun and Pernot 1992; Henderson and Freestone 1991). The discovery of coloured ingots (those mentioned from Tara Hill and Fish Street, but also examples such as the purple ingot from Hengistbury Head (Henderson 1987c)) suggests that certain coloured glasses were traded in lumps. Although the composition of such lumps can be similar, variations might suggest a number of different centres were colouring the glass before trading it on. The occurrence of the sealing-wax red glass within Continental La Tène Europe and Britain suggests a number of specialist sites may have been colouring the glass away from its original Mediterranean source of manufacture, specifically for use on Celtic Iron Age artefacts. Brun and Pernot (1992) have pointed out that the amount of red glass in circulation for the decoration of artefacts was probably relatively small, as examples such as the lump from Tara Hill would have provided enough glass to decorate hundreds of objects. They also feel that the technical sophistication required to produce opaque red glass would probably only have been achieved in a few workshops (Brun and Pernot 1992, 236–7). Other analyses of opaque red glass, e.g. from Polden Hill, have shown that although chemically similar, differences within red glass compositions can be distinguished by certain element content, e.g. magnesium, potassium and manganese (Illus. 6.89).

In order to colour the glass, it would need to be heated to high temperatures to incorporate the colour evenly, and the use of fine particles of colourant materials would help obtain an even dispersal in the glass-melt and so produce a homogeneous glass colour. In the case of red glass, specific ingredients and heat treatments would also be needed to produce the very bright and intense colour. Although soda-lime-silica glass will melt at approximately 1100°C, so obviously requires a relatively high level of pyrotechnic sophistication, it is possible to reshape, decorate and anneal glass at much lower temperatures, when the glass is not liquid but has become ductile. Leaded glasses, in particular, will readily soften at lower temperatures, which would have been the case for both the red and yellow glass from Culduthel. Extra heat would increase the glass flow, and could be varied depending on the need of the glassworker. This level of technology would allow red glass to be softened enough to press into metal recesses, allow cullet to be reshaped into beads, and allow yellow glass to be shaped into artefacts or used for trailing decoration. While there is evidence for such relatively low-temperature activity at Culduthel, there is no evidence in the production area for the high temperatures needed for colouration, and it is pertinent that no crucibles for glass were recovered.

Analytical work by Heck et al (2003) on a Merovingian crucible fragment containing yellow glass, and tin-opacified beads from the same area of Schleitheim in Switzerland, show that the concentration of the tin and lead within the crucible is far higher than in the manufactured beads. This work led to the conclusion that the yellow colourant was produced independently, and later added to clear soda-lime-silica glass during a separate part of the manufacturing process. A similar colouration process could have been undertaken for the red glass from Culduthel, implied by the elevated correlating levels of alumina and iron oxide discussed above (Illus. 6.84). Both this, and Heck et al's work add weight to the argument that coloured glass blocks were imported to the site at Culduthel, rather than manufactured or coloured at the site. Indeed, the very tight correlation compared to other British Later Middle Iron Age red glasses also adds evidence to the theory that the red glass from Culduthel was from a single batch. Further evidence for the manufacture of the objects at Culduthel (other than the glass waste itself), is the remains of iron scale in the holes of many of the beads (Illus. 6.90 and 6.91), suggesting these were worked on an iron mandrel. It is possible that the iron rods were pre-heated to develop a scale which would adhere to the heated glass and was removed as part of the bead; removing glass directly from iron rods without some form of release agent is very difficult. Beads can easily be rounded, and trail decoration incorporated by rotating heated glass on a mandrel.

Conclusion

The majority of the red, yellow and clear glass is Iron Age in date and style; this would conventionally be seen as 1st–2nd century AD in date, although the evidence is poor, and the slightly earlier range suggested by the Culduthel radiocarbon dates (*c.*170 BC–AD 20) is entirely consistent with the analytical information. Many of the 'single' items such as the blue, black and green beads, and the blue and white spiral are characteristically Roman, and could be roughly contemporary or slightly later in date, but appear to

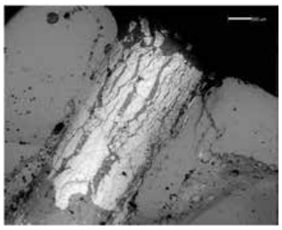

Illustration 6.90
BSEI of bead perforation, showing iron scale lining the inside of the hole. (Scale bar = 500 µm) (SF0399)

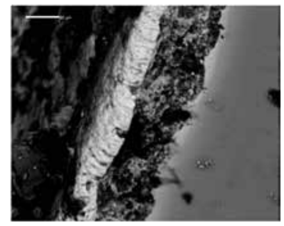

Illustration 6.91
BSEI of bead perforation, showing cross-section of iron scale lining the hole. (Scale bar = 30 µm) (SF0399)

come from a different tradition of glass making, though used at Culduthel in a similar manner.

There is no evidence for primary glass manufacture or colouring of glass on site, though many of the objects could have been formed there, and the shape and nature of many of the red fragments imply this was happening. The strap union (SF0318) with empty recesses is a typical example of metalwork that would have been inlaid. The iron scale within the majority of the beads could also imply local manufacture, as it suggests relatively little use-wear. Its presence in the yellow and polychrome beads (both antimony and tin coloured) is in contrast to the blue, and black beads (which appear Roman in composition and style), where there is no iron scale in the holes.

Vessel glass

Hillary E M Cool

Vessel glass was found in two contexts. Nos 1 and 2 came from the fill of a post-hole of roundhouse House 10/3, and no. 3 came from a deposit sealing it. All are in very poor condition, with nos 2 and 3 reduced in the main to the texture and size of granulated sugar and the body fragments no. 1 having unusual clouded surfaces. The soil conditions at Culduthel are presumably to blame for this, as it is most unusual for a soda glass (as the fragments appear to be), to be reduced to this state.

Their condition poses problems for identification as even the original colour is difficult to be sure of. Given their contexts, they may be assumed to be ancient rather than modern. They appear to be naturally coloured and no. 3 retains the typical blue/green colour of the 1st to 3rd century AD. No. 1 clearly comes from a blown vessel that was not a bottle, and such evidence as there is from no. 2 suggests that it too was not a bottle. No. 3 retains larger granules, some of which are thick enough to have come from a bottle, though equally they might have come from the thicker elements such as bases of other types. The most that can be said of these remains is that they show features that would be consistent with them coming from later 1st to 3rd century AD vessels. This is consistent with their context. An earlier date would not be possible as vessel glass generally appears in most areas of Britain at the same time as a Roman presence can be seen, in the form of the army. Shades of blue/green glass were also favoured in the mid- to late Saxon period but glass vessels of that date are much rarer than they were during the Roman period. In the light of the presence of Roman coinage and a Romano-British brooch from this structural phase, a Roman date seems more likely.

In addition to this evidence for blue/green vessels, two small flakes of deliberately coloured glass were found from context 2550, the fill of a post-hole surrounding Hearth 2434. It is always difficult to tell the colour of flakes of translucent glass but the intensity of the colour remaining rules out the possibility that they came from blue/green vessels and a shade such as peacock is most likely. This was a rare colour within the output of the Roman glass industries and not particularly common either among beads of Iron Age or Roman date. Within vessels the colour was probably commonest among the cast vessels of the early 1st century AD (Grose 1989, 254) and this identification cannot be ruled out. The colour was also very occasionally used for blown vessels of the mid-1st century and even more rarely on some luxury vessels of the late 2nd to 3rd centuries (Cool et al 1995, 1569–71, fig. 739). It might be thought unlikely that luxury vessel glass was to be expected on a site so far to the north, but it is worth pointing out that it might fit a pattern that has previously been noted. Roman vessel glass is rarely found in the Highlands and Islands but when it does occur there is a disproportionate number of unusual forms compared with the general contemporary pattern further south in the province of Britannia (Cool 2003, 142). Alternatively, these flakes could be part of the glassworking industry attested at the site. Certainly their colour would be appropriate for decorative items though, as noted, it is rarely encountered in beads. The glassworking debris does not appear to have produced glass of this colour.

Catalogue of vessel glass

SF0533 Two pale-blue/green to light-green body fragments, not from a bottle. Surfaces clouded and edges starting to strain crack. Context 2540 (fill of post-hole 2539, House 10/3).

SF1301 Strain-cracked granules from a probably pale-blue/green vessel. The one fragment retaining both surfaces indicates that the granules did not come from a bottle. Context 2540 (fill of post-hole 2539, House 10/3).

SF0528 Strain-cracked blue/green granules from a vessel. The thickness of some of them would allow the original fragment to have come from a bottle. Context 2198 (occupation deposit overlying post-hole 2539, House 10/3).

SF1302 Two chips from separate samples. Deliberately coloured glass, most probably peacock (green/blue). Context 2550 (fill of post-hole 2549, associated with Hearth 2434).