

L'OR DANS L'ANTIQUITÉ

DE LA MINE À L'OBJET

Sous la direction de Béatrice Cauuet

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COUVERTURE

PHOTO DU HAUT : *Détail de la maquette de la mine d'or des Fouilloux
(Jumilhac, Dordogne, France), exploitée à la Tène finale.*

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PHOTO DU BAS : *Extrémité d'un collier d'or datant du Bronze final, Gleninsheen, Co. Clare, Irlande
(cliché National Museum of Ireland).*

DOS DE COUVERTURE

PHOTO DU HAUT : *Bouloun-Djounga (Niger) : mine d'or ouverte dans la latérite (cliché G. Jobkes).*

PHOTO DU BAS : *Femme Fulbe (Mali) parée de boucles d'oreilles massives à lobes effilés (cliché B. Armbruster).*

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Bronze Age gold in Britain

Résumé

Les Iles Britanniques possèdent plusieurs gisements d'or et une très grande variété d'ornements en or de l'Age du Bronze remontant aux premiers usages des métaux. Cet article expose l'histoire du travail de l'or à l'Age du Bronze en Grande Bretagne, sous ses aspects épisodiques et contradictoires. En correspondance étroite avec le Chalcolithique et les Ages du Bronze ancien, moyen et final locaux, l'orfèvrerie et la métallurgie de l'or présentent quatre étapes distinctes, illustrées par des exemples pris dans l'ensemble de l'île. Les technologies, origines et fonctions différentes révélées par les objets d'or, pour chacune des périodes évoquées, seront étudiées tour à tour. La possibilité d'attribuer une valeur intrinsèque à l'or en terme de poids étalon ou de valeur de lingot par opposition à ses propriétés extrinsèques telles que sa malléabilité, sa noblesse et sa couleur sera discutée. L'argumentation sur la métallurgie s'appuie sur une nouvelle évaluation des données publiées.

Abstract

The British Isles possess a number of gold occurrences and a rich variety of gold ornaments of Bronze Age date reaching back to the earliest use of metal. This paper sets out the history of gold working in the Bronze Age in Britain and emphasises its curiously episodic and contradictory evolution. Gold metalwork and metallurgy exhibit four distinct stages neatly corresponding to the local Copper and Early, Middle and Late Bronze Ages, and illustrative examples are taken from all parts of the island. In each of these successive periods the gold objects exhibit distinct technologies, origins and functions, and these are explored in turn. The possibilities of an interest in ascribing an intrinsic value to the gold in terms of a weight standard and bullion value as opposed to its extrinsic properties of malleability, nobility and colour are considered. Metallurgical discussion is based on a re-evaluation of the published data.

Introduction

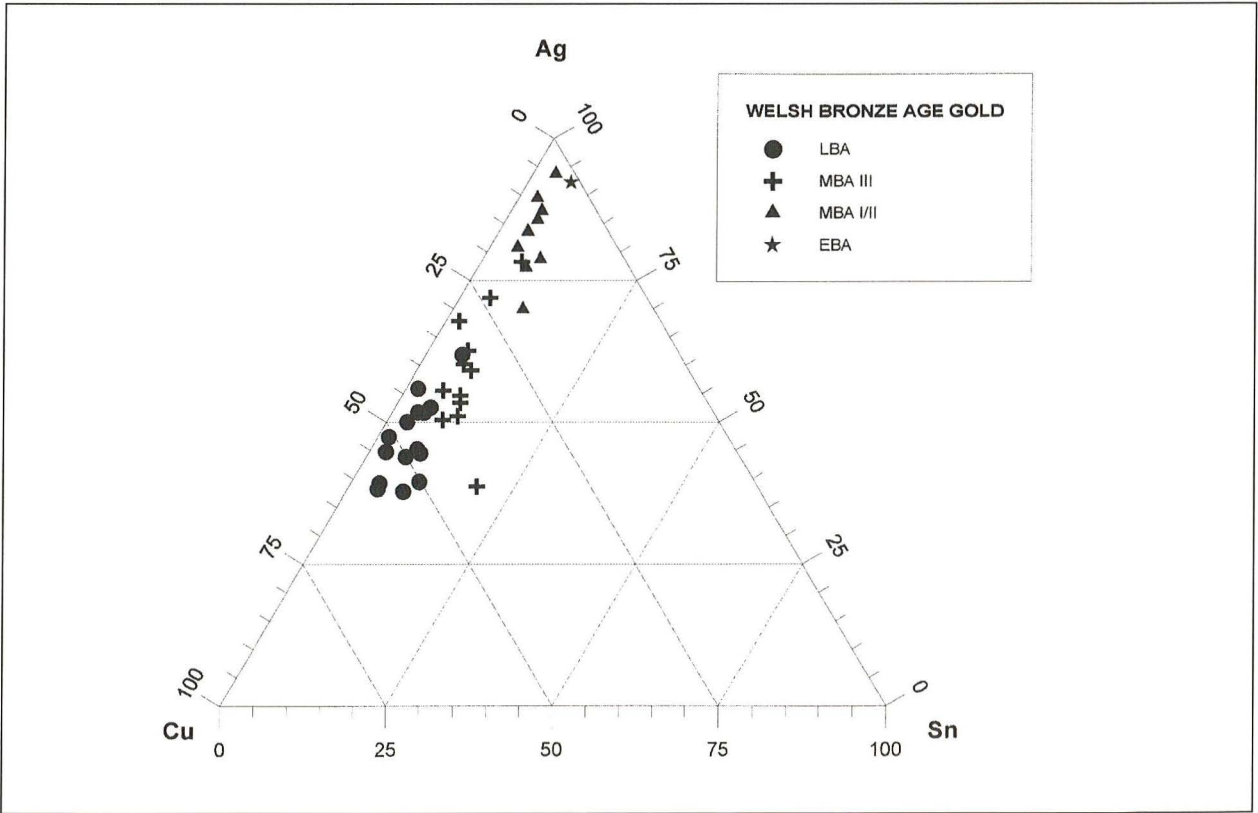
The British Isles possess a number of gold occurrences and a rich variety of gold ornaments of Bronze Age date reaching back to the earliest use of metal. However the history of gold working in the Bronze Age is curiously episodic and contradictory : for example, periods when gold is at its scarcest can show increased production and technical innovation in bronze metallurgy. Conversely, when the amount of copper alloy in circulation is declining rapidly, as at the end of the Middle Bronze Age, deposition of gold by number of objects and, even more, by weight is rising. Gold metalwork and metallurgy exhibit four distinct stages neatly corresponding to the local Copper and Early, Middle and Late Bronze Ages, and illustrative examples will be taken from all parts of the island (See Table 1 for the example of Wales). In each of these successive periods the gold objects exhibit distinct technologies, origins and functions, and these are explored in turn. The possibilities of an interest in ascribing an intrinsic value to the gold in terms of a weight standard and bullion value as opposed to its extrinsic properties of malleability, nobility and colour are considered. Metallurgical discussion is based on a re-evaluation of the data of Hartmann ¹.

Resources

In the 18th and 19th centuries the British Isles were major copper producers and now there is clear evidence that a number of copper deposits in the British Isles was exploited in the Bronze Age. In Wales there are, for example Pen-y-Gogarth (Great Orme) and Mynydd Parys, Gwynedd, and Cwmystwyth, Dyfed ², while in Ireland there are Ross Island, Co. Kerry, with associated Beaker pottery, and Mount Gabriel, Co. Cork ³. Bronze Age copper mining can also be inferred in Scotland and in southwest England on the basis of archaeological and metallurgical evidence ⁴. Cornwall and Devon are well known as a major tin mining area, with one mine surviving (just) today, and this too is reflected in Bronze Age production ⁵. The British Isles have never been as significant in terms of gold, but in Wales gold was exploited by the Romans, while mining in the Dolgellau gold belt has survived more or less to the present with a small operation continuing at the Gwynfynydd mine. In other parts of

1. Hartmann, 1970 ; Hartmann, 1982.
2. For a review see Crew and Crew, 1990.
3. O'Brien 1994 ; O'Brien, sous presse.
4. Burgess, Northover, sous presse.
5. Pearce, 1984.

Fig. 1
Pseudo-ternary plot
of Welsh Bronze
Age gold analyses.



the British Isles gold extraction tended to be from placer deposits, for example in the Goldmines River area in Ireland, in south-west England and, especially, at Kildonan, Sutherland, Scotland. However it is possible that commercial gold mining, possibly opencast, will start shortly in the Sperrin Mountains of the north of Ireland, an issue of current environmental concern. What we lack so far is conclusive evidence that any of this metal was used in the Bronze Age, rather than the circumstantial evidence of clusters of distinctive goldwork in and around some of these occurrences and deposits.

The experiences of the Welsh gold mines illustrate what levels of production British sources could support in a more industrial environment. In what is sometimes referred to as the Dolgellau gold belt, to the south and east of the Harlech Dome there is still a vestigial mining activity extracting gold from quartz veins, with gold panning on an amateur basis in the surrounding area. When the world gold price was at its highest there was a proposal by an international mining company to place a large gold dredge in the adjacent Mawddach estuary. The Dolgellau gold belt contained a number of mines opened after a minor gold rush in 1843, of which only four were of any significance. Typical were Glasdir, where the ore was associated with chalcopyrite in brecciated, thinly interbedded siltstones and sandstones of the Ffestiniog Flags formation of the Upper Cambrian ; gold tellurides also occur. Concentrates typically contained 30 ppm gold with periodically larger amounts of silver. In 1913, 1475 tons of copper ore yielded 7375 ounces of silver and 737 ounces of gold, while in 1914, 1600 tons of ore yielded 900 ounces of silver and 900 ounces of gold. In the neighbouring Clogau mine the miners reported that the best gold ore was to be obtained where the quartz had a cloudy, greenish hue and often included brecciated country rock. Between 1861 and 1907, 145 080 tons of quartz yielded 77 501 ounces of gold ; an average composition was 90,16 % gold and 9,26 % silver ⁶. To the south-west, at Dolaucothi, Dyfed, is a somewhat different occurrence in the Llandovery formation, to the north-west of Llandovery. The Ogofau mine had the alternative name of Roman Deep and was almost certainly worked by the Romans ; it is now managed by the National Trust and is accessible to the public. The gold was obtained partly from a quartz lode containing free gold and auriferous sulphides, and partly from auriferous pyrite impregnating and replacing shales.

Hartmann's data ⁷ suggest that Welsh gold can have copper contents of the order of 100 ppm, while some sources produce metal, with 0,10-0,15 %. Silver ranges from below 5 % to 15 % ; tin is absent but mercury, lead and zinc may accompany the gold. Although it is impossible to correlate these ore analyses, with Welsh gold objects on the present level of analysis, we should note that even Bronze Age gold objects found in Wales close to these sources can contain tin up to 0,5 % and silver levels above 25 %. However, we cannot evade the question of whether they might have been exploited in the Bronze Age. To do this we must look at typology and distribution and also make detailed comparisons between the compositions of the goldwork of all areas.

Analysis

Before discussing the goldwork found in each period of the Bronze Age some mention must be made of how the available analytical data is treated. This data comes from Hartmann's publications and from analysis made on behalf of the National Museum of Wales at the British Museum and in Oxford for the purpose of Treasure Trove inquests. The latter analyses were obtained with all elements as weight %, while Hartmann's give weight % for silver and parts per 100 Au for copper and tin. A computer spreadsheet can be used to transform the data in either direction, and the Hartmann format was used here. The British Museum data were obtained by X-ray fluorescence and did not include values for tin ; arbitrary values were assumed for the purposes of graphing the data. The data for Wales are displayed in fig. 1 as a pseudo-ternary plot based on a formula developed by Taylor ⁸ where :

$$100 = Ag + 2 * Cu + 10 * Sn$$

The resulting pseudo-ternary plot shows very clearly the main trend in composition, which is a stepwise increase in the proportion of copper with each successive period. From the beginning of the Middle Bronze Age there was also not so much an increase in the proportion of tin as an increasing spread of tin contents. The graph has been used in two ways ; its framework is based on the dating of associated finds while, conversely, the results are then used to date other material.

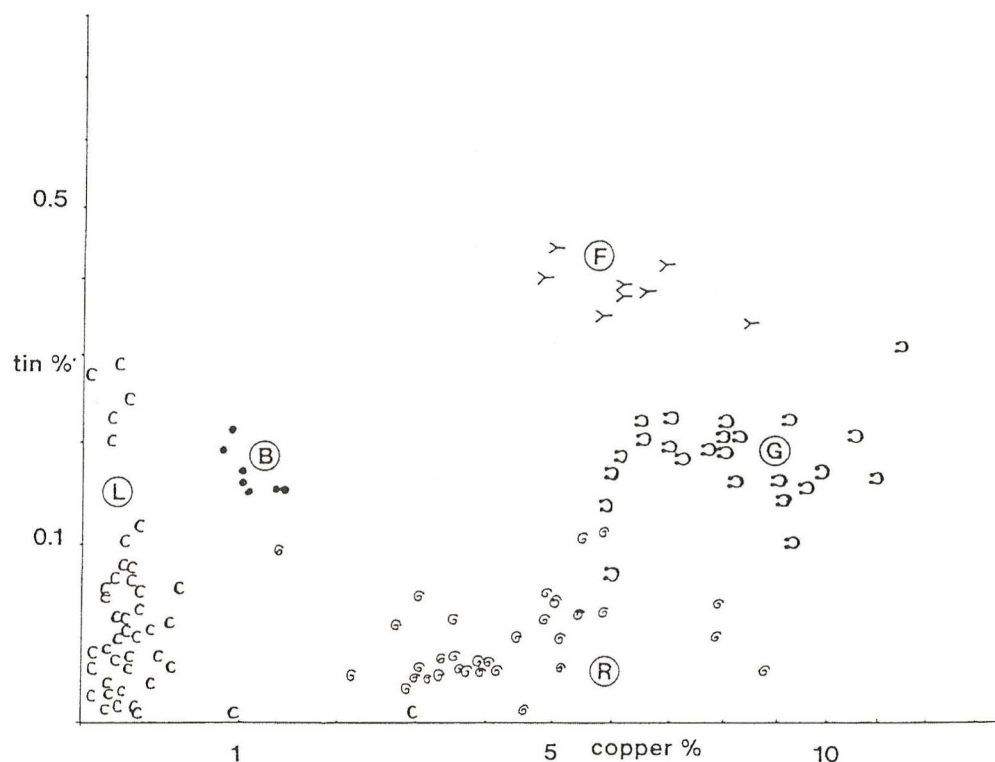
6. Smith, Carruthers, 1925.

7. Published in Taylor, 1980, p.141.

8. Taylor, 1980.

Fig. 2

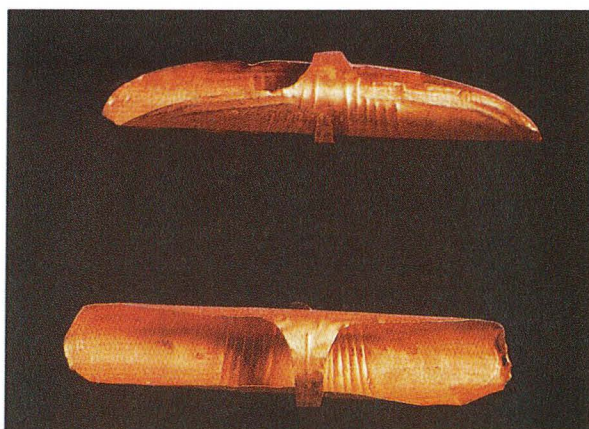
Correlations of compositions and typology for Irish gold (after Warner, 1993); the axes are transformed to the power of 2/3 (L = lunulae, B = bar-twist bracelets, F = flange-twist torcs, G = gorgets, R = ribbon torcs).



Similar approaches were used by Warner ⁹ to explore the gold of Ireland and the same trends are visible. The picture (fig. 2) shows a neat correlation between typology (and therefore chronology) but Warner's interpretation was hindered by an unsatisfactory periodisation of Irish Bronze Age metalwork, especially the Middle Bronze Age where we have yet to take advantage of recent research on the Irish Middle Bronze Age contained within unpublished theses ¹⁰. However, typological correlations across the Irish Sea with areas such as Wales where the chronology is more robust are valid and, indeed, on the basis of Hartmann's data we can see some of these trends as general across Europe.

Fig. 3

Basket ear-rings from Barrow Hills, Radley, Oxfordshire.



Copper Age

Gold makes its first appearance in Britain in Beaker contexts in the form of basket ear-rings, bead covers and, possibly, sheet gold discs at a time when copper and arsenical copper were the standard metals for tools and weapons rather than bronze. Recently two southern English finds have been dated, and other examples from northern Britain must be contemporary; although there are Beaker burials in Wales none are recorded as containing gold. It is the English Beaker graves that provide the best dated and described contexts for this earliest gold. In that from Chilbolton, Hampshire, the primary burial in a small ring ditch was associated with, among other things, a tanged copper dagger, a gold bead or bead cover and two pairs of basket ear-rings. One pair contained 9,4-9,5 % silver and 1,3-1,5 % copper, the other 10,8-11 % silver and 0,2-0,3 % copper, while the bead contained 9,5 % silver with copper undetected; tin was undetected in all these analyses obtained by X-ray fluorescence. The 1- σ date range is 2290-2040 BC (cal) and at 2- σ is 2460-1940 BC, so that at this early date copper must have been entering the gold melts if only accidentally ¹¹. Another

9. Warner, 1993.

10. Ramsey, 1989.

11. Russel, 1990.

LUNULAE

Weight distribution

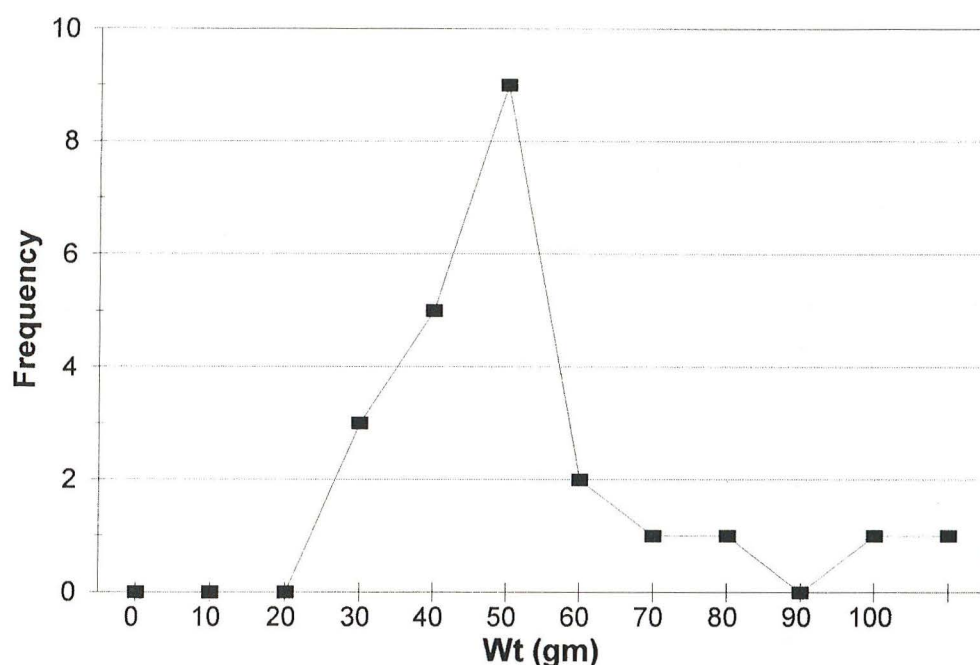


Fig. 4
Distribution
of weights of
lunulae.

pair of ear-rings (fig. 3), from Radley near Oxford has a similar date, and contains 6,9 % silver, 0,8 % copper and less than 0,05 % tin, with a 2- σ C14 date range of 2650-2040 BC, i.e. contemporary with Chilbolton. The Radley burial has also produced a gold bead cover. The total quantity of gold involved is small ; regrettably very few of these items have been published with weights, but with an average weight of 5-6 g for a dozen ear-rings, less than 100 g of metal can be assigned to this earliest goldwork.

The Radley barrow cemetery has also produced the earliest dated copper metalwork in Britain ¹², a group of three copper rings in a burial with a 2- σ date of 2860-2140 BC. Like these the gold basket ear-rings and other Beaker goldwork can be seen as continental in inspiration ¹³. At the same time metallurgy was developing in Ireland with the earliest dates for the Beaker copper mine at Ross Island falling just after 2500 BC ¹⁴. Compared with the extensive record of copper metallurgy in Ireland in the second half of the third millennium BC the amount of gold is small and it is reasonable to interpret it as inspired by, if not actually coming from, Britain and ultimately the continent (see also Table 1).

	Cu/bronze axes	Gold objects
Copper Age	21	0
EBA I (Migdale)	37	1
EBA II/III (Wessex/Arreton)	71+	0
MBA I	190	1
MBA II	136	13
MBA III	50	20
LBA I	35	0
LBA II	310	44+
LBA III	35+	0

Early Bronze Age

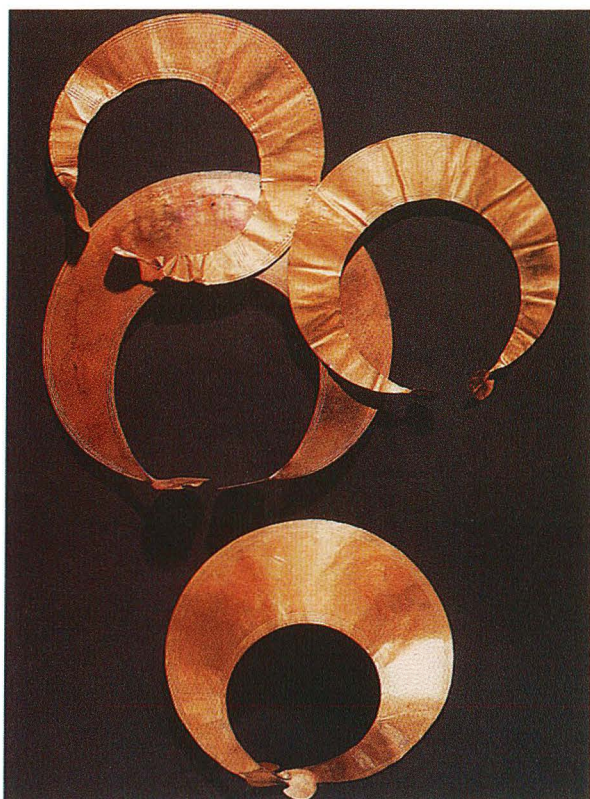
That first step in goldworking was concerned only with sheet, and sheet remained the dominant form through the Early Bronze Age as well, until about 1500-1400 BC. In this second stage gold ornaments may be more widespread than surviving evidence suggests ; for example in Wales there are tantalising descriptions of gold objects found in the last century when Early Bronze Age burials were uncovered but nothing has survived to be identified. In southern Britain there is a marked gap between the Beaker finds and the most notable goldwork of the early Bronze Age, that

12. Barclay, Halpin, *sous presse*.

13. Taylor, 1980, p.22-23 ; Eogan, 1994, p.15-18.

14. O'Brien, *sous presse*.

Fig. 5
Irish *lunulae*.



associated with some of the richest graves of the "Wessex Culture" ¹⁵. These is marked by geometric ornament in engraved lines, rectangles, lozenges and fine punched dots carefully executed on both personal ornaments of prestige and pieces designed to enhance the appearance of other materials. The tombs containing this gold are rather few, in number and concentrate in central southern England with outliers East Anglia and the south-west. A new discovery, near Derby in the midlands of England is of two gold cuff bracelets which have strong parallels in bronze bracelets of the British Early Bronze Age.

The gold used in the Wessex graves contains from 5 % to 20 % silver and less than 0,5 parts copper per 100 parts Au and, usually, less than 0,05 parts tin. Exceptions such as the Rillaton gold cup from Cornwall have up to 0,2 parts tin but these objects tend to have a peripheral distribution. In terms of dates, Wessex I and II span much of the first half of the 2nd millennium BC, from c. 1900 Cal BC to a little after 1500 cal. BC ¹⁶, the gap following the Beaker objects possibly being a century or more in length.

This hiatus may be filled by the largest group of early Bronze Age sheet ornaments, the *lunulae*. *Lunulae* are penannular neck ornaments expanding

from square tab-terminals to a broad crescent shape often ornamented with geometric designs seen as echoing those on Beakers ¹⁷. Taylor was able to form a number of stylistic groups which showed some correlation between size, weight and distribution. One aspect of the *lunulae* shows a marked advance on the small Beaker items and that is weight. Too often gold objects are published without their weights ; the calculations here are based only on those weights of intact *lunulae* in Armstrong's meticulous catalogue of 1933 ¹⁸. The overall distribution is shown in fig. 4 ; there is a marked cluster between 40 g and 50 g with a small number of much heavier examples, a pattern we shall see repeated. It is probably not sensible yet to talk about a weight unit (if it existed it would be between 7 g and 8 g, about 120 grains in Troy weight).

Lunulae as a whole are a product of the highlands and islands of the British Isles, with a concentration in the west and north of Ireland (fig. 5), continuing across Scotland to the north-east and with a single find in north-west Wales. An important association is a hoard from Harlyn Bay on the north coast of Cornwall where *lunulae* occur with simple flat axes, which could date the find as early as 2100-2000 BC although dates up to 1800 BC would be reasonable. The Llanllyfni *lunula*, the only example from Wales, belongs to Taylor's "Provincial" group which is distributed almost wholly outside Ireland and we could look to Cornish, Welsh or Scottish gold as much as to Irish for its metal. The Harlyn Bay association links this British distribution of the "Provincial" type with Ireland since it also contains a *lunula* of Taylor's "Classical" type which, with the exception of three finds in Cornwall, is only known in Ireland. An obvious, although unproven, connection is with the trade in tin. Compositionally, the *lunulae*, in the shape of the Llanllyfni example, stand at the head of the time series in the ternary diagram in fig. 1.

Interestingly it is not possible to separate *lunulae* as a whole from the Wessex gold but both, and especially the *lunulae* seem to split into two groups on the basis of tin content ¹⁹. The significance of this has yet to be determined but at the least suggests, as might be expected, more than one origin for the metal used in these ornaments.

15. Taylor, 1980, p.45-49.

16. Gerloff, 1993.

17. Taylor, 1980, p.25-44.

18. Armstrong, 1933.

19. Warner, 1993, fig. 6.

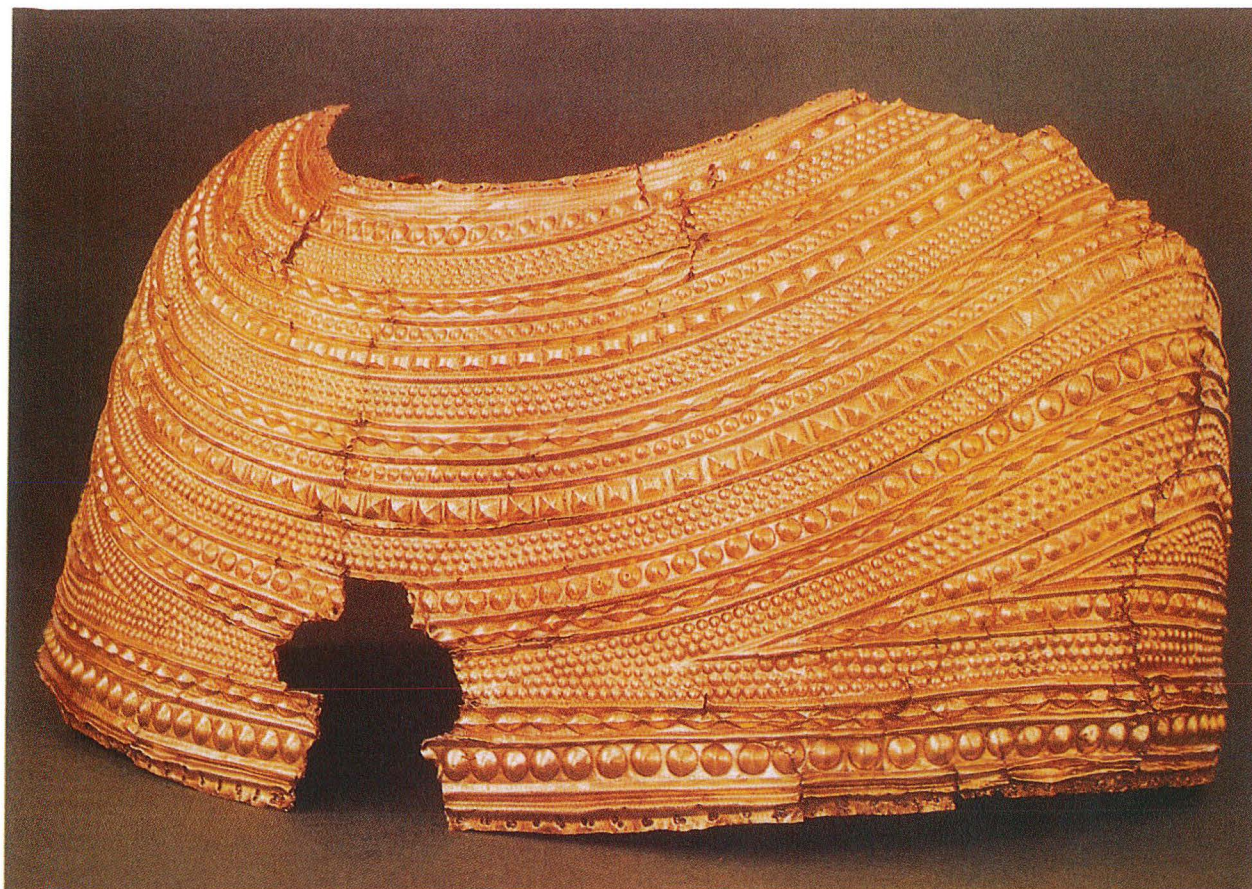
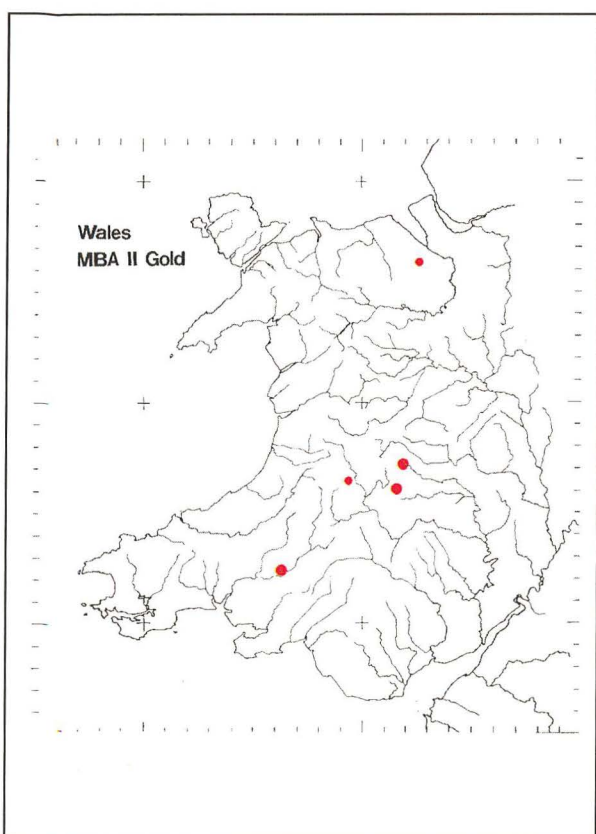


Fig. 6
The Mold gold cape,
Clwyd.



The Middle Bronze Age

The culmination of the sheet gold tradition is the magnificent and unique gold cape from Mold, Clwyd²⁰ (fig. 6). This remarkable construction has all-over decoration of *repoussé* ribs and alternating bands of small round, rectangular and lenticular bosses. Taylor²¹ has reviewed some of the parallels that might resolve the dating of the cape, but did not consider the evidence of the composition. In the ternary diagram in fig. 1 the Middle Bronze Age (MBA) II grouping is based on a small number of Welsh hoards which comprise only gold ornaments which share morphological and compositional features. The actual dating to MBA II depends on a number of parallels in continental Europe, notably in Brittany²², but the use of this composition may actually extend back to MBA I and the end of the Early Bronze Age. The compositional grouping defined by these hoards encompasses the Mold cape. Taylor suggested that the Mold Cape might have influenced the decorati-

Fig. 7
Distribution
of MBA I/II
goldwork in Wales.

20. Powell, 1953.

21. Taylor, 1980, p.52.

22. Savory, 1977.

ve elements of a number of gold "vessels", for example from Avanton, Vienne, France and Schifferstadt, Germany. An MBA I date, in the 15th-14th centuries BC would in fact encourage this notion because in MBA I Welsh metalwork was being directly exported to Continental Europe²³, while in MBA II the tendency was in the other direction. Of course the influence could well be in the other direction with the Mold cape being dependent on the continental pieces. A better interpretation may be to see the "vessels" as hats complementing the Mold Cape as ceremonial wear²⁴ and to consider that they are products of the same workshops and tradition. On this basis it is probably better to see them all as dating to MBA II. In contrast Eogan²⁵ would like to interpret the cape as evoking the body armour newly introduced in western Europe, and dating the piece as late as MBA III, which is really unacceptable on metallurgical grounds.

If an MBA II date is accepted for the cape there is no goldwork in Wales to be assigned to MBA I and probably very little elsewhere in Britain (fig. 7). The discussion of the wider range goldwork in the succeeding stages of the Middle Bronze Age is based on

the Welsh evidence as this is at present the best defined and has had the most extensive treatment of its compositions. Welsh mining and copper production remained important in MBA II (Bronze Moyen II/III in France, mainly Bronze C/D further east) but there appears to have been a shift in emphasis from the north, which was important in MBA I, to mid and central Wales. This new focus included the Dolgellau gold belt and reached towards Ogofau, so creating thoughts of Welsh gold mining at this time. The distribution and typology of the gold ornaments tend to support such an idea. Here we are really concerned with three hoards and one single find all concentrated in south central Wales. From Capel Isaf, Manordeilo, Dyfed, and Maesmelan, Powys come two hoards of flanged bracelets (fig. 8). A specific feature of some of the bracelets is their hooked, slightly expanded terminals. The general form of the bracelets can be paralleled in Brittany but in detail are decidedly idiosyncratic and local. The same hook terminals are also seen on the hoard of simple ribbon torcs from Heyope, Powys²⁶ (fig. 9). These are personal ornaments which appear at a time when metal ornaments are becoming an important part of the smiths' repertoire (fig. 10).

Fig. 8
The Capel Isaf,
Dyfed, bracelets.

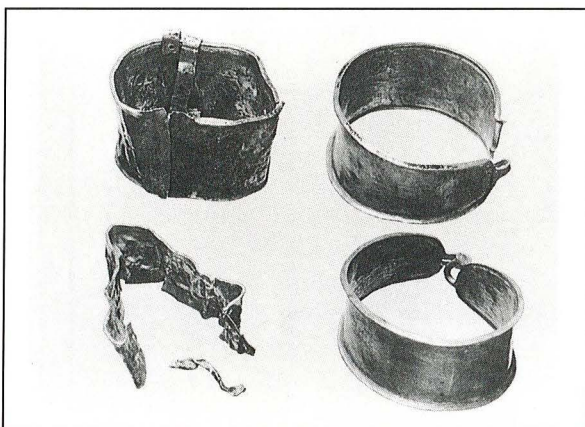
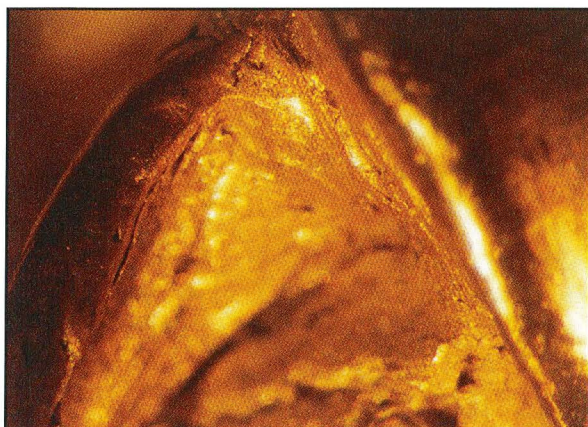


Fig. 9
Terminal joint of
torc from central
Wales.



It is with the simple twisted torcs that we can approach the question of dating (fig. 11). Twisted ornaments, whether of bronze or gold appear in Britain during MBA II, often referred to as the Taunton period after a well-known and typical bronze hoard from Somerset²⁷. The twisted bronze ornaments of the Taunton period comprise a variety, of neck-rings and bracelets. They are usually formed from square or round-section wire or bar, manually twisted or cast with a mock twisted pattern (fig. 12). The neck-rings or torcs have, almost without exception, simple hooked terminals while the bracelets have plain ends. The gold plain and twisted torcs that begin by imitating these bronze examples also tend to have these same simple hook terminals. Given these very exact parallels between bronze and gold for objects with hooked terminals in the Taunton period, and given that all associations for objects with extended terminals, as in the flange twisted torcs to be discussed next, are later it is reasonable to make the correlation exact²⁸. If we do so

23. Northover, 1980.

24. Gerloff, pers. comm.

25. Eogan, 1994, p.75-78.

26. Savory, 1958.

27. Smith, 1959.

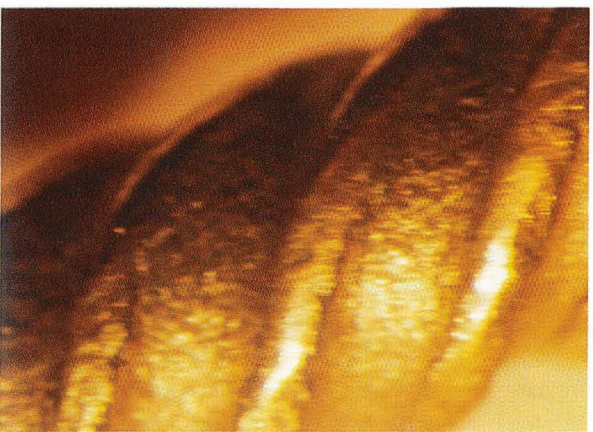
28. Northover, 1989, p.122-123.

**Fig. 10**

Tool marks on torc body from Harlech, Gwynedd.

**Fig. 11**

Body of flange-twisted torc from central Wales.



12 | 13

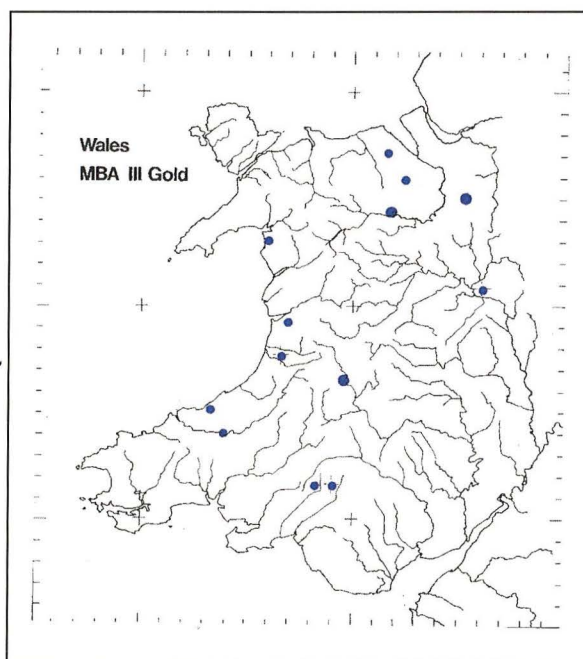
Fig. 12

Wire-twisted torc body from Llanwrthwl, Powys.

Exactly where the development of the simple twisted ribbon tore into the elaborate flange-twisted tore of the MBA III or Penard period (Bronze Final I or Bronze D/Ha A1) took place is not certain. It

Fig. 13

Distribution of MBA III goldwork in Wales.



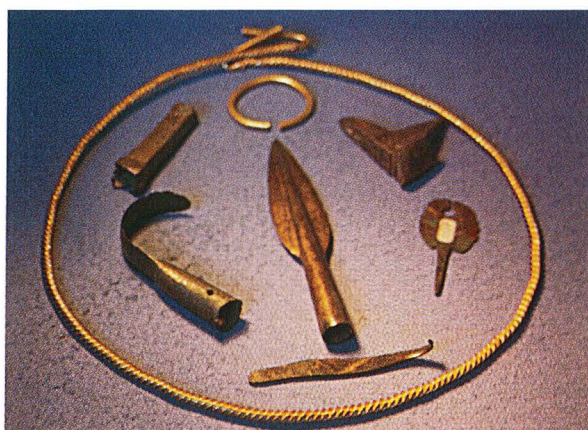
we can put the Capel Isaf and Maesmelan bracelet hoards and the Heyope torcs together in this period.

Taking these hoards as a self-consistent group we can see from fig.1 that they also from a coherent compositional group, and it should also be pointed out that these compositions differ from those of other ribbon torcs which fit Hartmann's PC group and for which there is good evidence to believe that they are Iron Age in date²⁹. Both copper and tin contents have increased since the Early Bronze Age. Copper is typically at 1-2 parts per hundred

29. Warner, 1993.

30. Northover, 1989.

Fig. 14
The Fresné-la-Mère,
Calvados hoard
(France).



may have happened in Ireland, or even in France but Wales and the Marches are one of the prime areas. Together with its lighter wire-twisted cousin (a form utilised when the gold wire was too slender to be split into a cruciform shape) there are now 17 examples from that area. In Wales all associations are of torcs with torcs except for a possible hoard of a double-looped transitional palstave and a flange-twisted tore from central Wales. Elsewhere, though, associations with bronzes firmly place the flange-twisted tore in the Penard period ³¹.

The flange- and wire-twisted torcs are substantial ornaments and the heaviest Welsh example weighs 754 g. Most concentrate in the range 200-275 g, with wire twisted torcs being lighter. Their manufacture has been reviewed elsewhere ³² and it is probable that the correct interpretations have yet to be made. Some joining technique is implied because many of the tore terminals were formed separately and then attached, but so far analysis and microscope have failed to find the exact means. It is believed that the torcs were designed to be worn as a large single ring, perhaps at the waist or coiled as an armring, their function probably being more as a symbol of power and ceremony rather than the showing the personal aspect of the MBA II ornaments. The more usual choice is unknown as several torcs have been interfered with and are no longer in their original shape. The elaboration of the torcs also relates to other contemporary trends: this is the period when bronze cauldrons and *repoussé* decorated sheet bronze shields first make their appearance. Also new are specialised metal-working tools such as bronze hammers and anvils. At Fresné-la-Mère, Calvados, France (fig. 14), a small hoard associates a gold tore and bracelet with, among other bronzes, an anvil and hammer ³³, while the Bishopsland bronze hoard from Ireland has an even wider range of tools ³⁴.

Metallurgically there is a step change from the Taunton period with a marked increase in copper contents and, to a lesser extent, in tin contents (fig. 1). Some incorporation of bronze is implied but it is also necessary that copper metal was added. This is of some importance because the Penard period was one of declining if not dormant mining activity in Britain and the usual metal supply was bronze scrap ³⁵. As in some Welsh gold mines, like Glasdir, chalcopryrite and gold are found close together the use of local copper as well as gold is a possibility. Distributional evidence is neutral as these torcs are spread through a wide area of Wales, but still have a concentration in the mining areas (fig. 7 and 13).

In the same way as the Mold cape was approximately dated to MBA I/II another unique Welsh find, the Caergwrle model boat can be dated by its composition to this Penard period. The boat is deeply carved from shale; into each carved field a piece of gold foil is inserted to simulate the bulwarks, perhaps with concentrically ribbed shields, the oars, the sea and the keel. The gold is finely decorated with ruled or compass drawn grooves, either worked or stamped. To provide a resilient backing for this work, the gold was wrapped round metallic tin.

The Late Bronze Age

Events at the beginning of the British Late Bronze Age are confused. In southern and eastern Britain a new industrial tradition appeared, named after a hoard from Wilburton, Cambridgeshire ³⁶. This industry, contemporary with Bronze Final II in France and Ha A2-B1 in Alpine and central Europe, developed a very sophisticated ceramic piece-mould casting technology and pioneered the use of leaded bronze alloys for complex castings. It had direct relations across the Channel with Brittany and the Paris Basin and was entirely dependent on imported scrap for its bronze supply. This metal is radically different from the preceding imports of the Middle Bronze Age, production having switched from pyritic to fahlerz type sources. This change is synchronous across a wide area of Europe from the Alps to Denmark, and in some areas the changed trade pat-

31. Needham, 1990.

32. Taylor, 1980; Northover, 1989.

33. Eluère, 1982.

34. Eogan, 1983, N° 16.

35. Northover, 1980.

36. Northover, 1982.

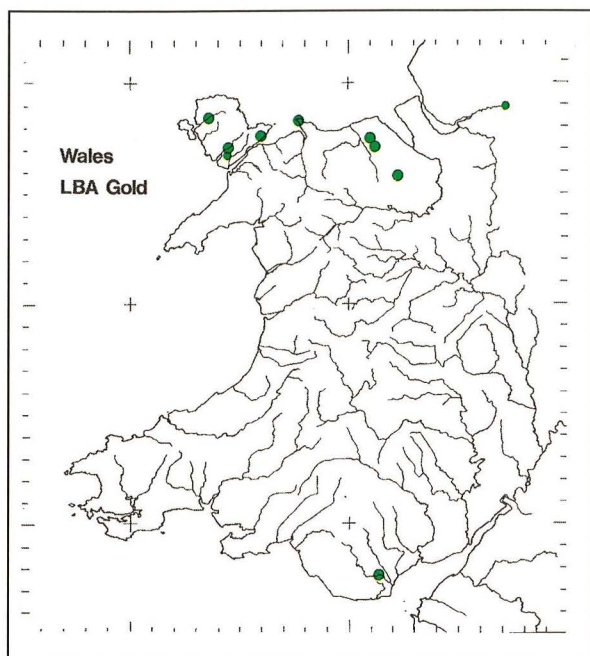


Fig. 15
Distribution
of LBA
goldwork in Wales.

local Late Bronze Age industries. Further north there is a concentration of Wilburton hoards and single finds in the Severn-Dee corridor, where it is possible the lead the industry needed was extracted although other areas are geochemically more likely⁴⁰. Apart from this the map is rather blank and we must conclude that western Wales the availability of metal really had diminished, and Welsh mining activity could have ceased (fig. 15). This is even more true of gold and there is a clear break in the record.

When gold appears again, in Late Bronze Age II contexts (the Ewart Park Period, contemporary with Bronze Final III and Ha B2/B3) both distribution and typology are radically different. Apart from some small fragments of gold, including part of a coil terminal bracelet, with a socketed axe from just outside Cardiff in the south-east all gold objects are concentrated along or close to the north coast and most have Irish affinities or reflect contacts between Britain and Ireland. Many of the objects are now sadly lost but almost all can be confidently identified as to type. Of some forty identifiable objects with a reliable provenance twenty-nine are concentrated on Ynys Môn (Anglesey) which is even now the home of one of the mam ferry ports for Ireland⁴¹. Of the forty gold objects all but four belong to just two types : the expanded terminal bracelet and the lock-ring. The latter are elegant biconical, penannular hair ornaments with ruled decoration fabricated in one of two ways⁴². In Britain there are two distributions, in the south east and along the north Welsh coast and then across northern England and southern Scotland. Nonetheless almost all have the same sheet construction, while almost all the Irish examples, concentrated in Munster have their bodies formed from concentric wires fused together. A hoard from Gaerwen, Ynys Môn contained eleven lock-rings and eleven bracelets but all but four have been lost⁴³. These bracelets are an Irish type with a circular cross-section and evenly expanded terminals. Further east the bracelets tend to be of an English type although detached from their main concentration in the south and east⁴⁴; the Irish connection is then reflected in associations such as that from

terns, in southern Britain for example, may be related to the arrival of new and intrusive elites serviced by these industries. One of the most important features of the changes as they affected Britain was that the development of leaded bronze seems to have taken place there using a combination of the imported scrap and British lead³⁷.

Given the elegance and prestige value of many of the Wilburton bronzes it might be reasonable to expect an equal creativity with gold. This, in fact, is far from the case and there is only one Wilburton association with gold, a hoard from Thirsk, Yorkshire, on the fringes of the main concentration of Wilburton material³⁸. Until recently it was believed in those parts of the British Isles outside the domination of the Wilburton industry, the metallurgical traditions of the Penard period continued³⁹ using united bronze, but slowly coming under the influence of Wilburton in both product types and metallurgy. If this were the case we could see the use, if not the manufacture, of gold torcs continuing until some unspecified date in this period. Needham's 1990 discussion radically alters this view and suggests that Penard traditions ended everywhere at much the same time and that for a while bronze might have been rather scarce in these peripheral regions.

Again Wales provides a useful introduction to the gold of the Late Bronze Age. In Wales Wilburton types penetrate along the southern coastal plain and Wilburton metal is recycled into the developing

37. Northover, 1982.

38. Needham, 1990.

39. Burgess, 1968.

40. Rohl, pers. comm.

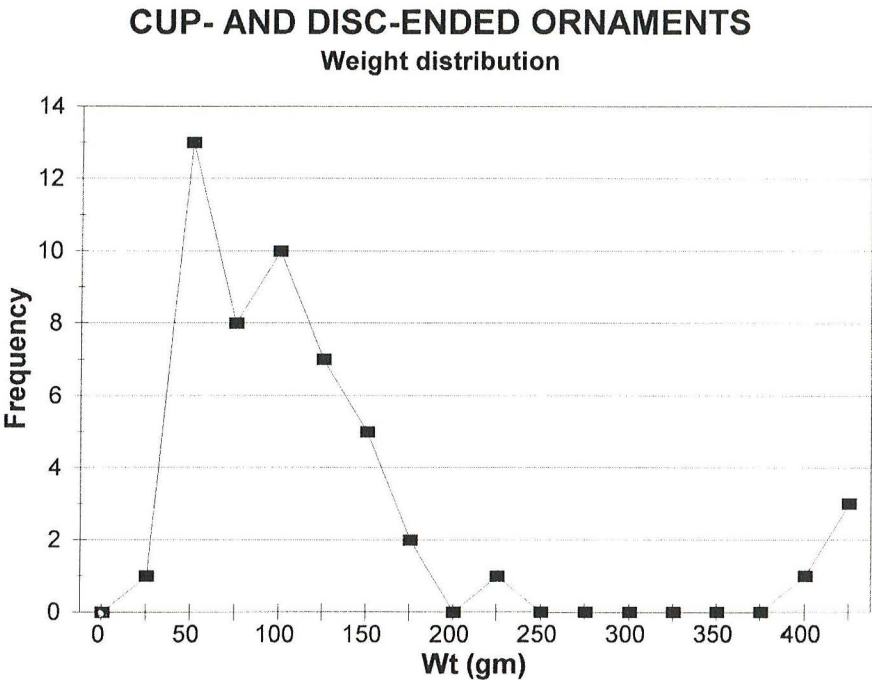
41. Lynch, 1991.

42. Eogan, 1969 ; Eogan, 1994, p.89, 100.

43. Lynch, 1991.

44. Eogan, 1994, fig.38.

Fig. 16
Distribution
of weights of
cup-ended
ornaments.



Llanarmon-yn-Iâl, Clwyd ⁴⁵ where the bracelets were found in the socket of an axe of Irish type and bronze composition. Indeed, much of the bronze in north Wales at this time could well have originated in Ireland ⁴⁶. Another interesting find is that from Pigeon's Cave on the Great Orme ⁴⁷ which combines lock-rings with local bronze tools and a provenance close to an important Bronze Age mining site which may have been active at this time.

Very few, Late Bronze Age objects from Wales were analysed by Hartmann ⁴⁸ ; some other data are available but not all published analyses include tin. Reference back to fig. 1 shows that there is a tendency for the proportion of copper to increase in both solid and sheet objects. The compositions also agree very well with their counterparts across the Irish Sea. There is every reason to believe that a good proportion of the Welsh examples were actually made in Ireland and England and that there may not have been any significant local goldsmithing tradition in Wales in the Late Bronze Age. The only exception to the pattern of gold compositions is a piece of "ring-money" from Llanllyfni, Gwynedd, in the north-west of the country. Ring-money is a group of rather various small, thick, penannular rings often, as with this example, consisting of a thick gold foil formed round a bronze or other base-metal core. The gold, with 6,33 % copper and 11,01 % silver is typical enough of Late Bronze Age gold in Ireland and Wales, but it is inlaid or plated with a

pattern of narrow bands of electrum with 41,88 % silver and 4,04 % copper ⁴⁹. As silver metal is practically unknown in the entire Bronze Age in the British Isles the idea of an alloy deliberately made up with silver is hard to accept at the moment but ideas may change. The exploitation of a discovery of a very high silver natural gold is the alternative explanation and not beyond the bounds of possibility. The exact means by which the electrum was prepared and fused to the gold has yet to be determined but there are several examples available for study in the near future. Another hint of variation in the composition of gold lies in the fragments of gold still attached to a Late Bronze Age bronze anvil from Litchfield, Staffordshire ⁵⁰. These showed gold with 2-5 % silver and 2-3 % copper, finer than usual for the period but undoubtedly depleted in copper and silver by corrosion.

The pattern of Irish and English connections exhibited by the Welsh Late Bronze Age gold-work is merely an exemplar for the British Isles as a whole where for some classes of objects the record is entirely dominated by Irish material. In others there can be isolated regional distributions in England and Scotland, and it is only for the British

45. Green, 1983.
46. Northover, 1980.
47. Savory, 1958 ; Savory, 1980.
48. Hartmann, 1982.
49. Green, 1988.
50. Needham, Meeks, 1993.

types of bracelet that the distribution is overwhelmingly British. For some types, especially the more elaborate, Ireland is the only recorded provenance (e.g. gorgets, boxes). As far as can be seen, the periodisation of the Late Bronze Age in Ireland is very much equivalent to other areas of Atlantic Europe. There is a steep dip in the quantity of gold used contemporaneously with the Wilburton period (Co. Roscommon in Ireland) ⁵¹. The long recognised concentration of gold in Ireland in the Late Bronze Age, then, clusters in Eogan's Dowris phase and is strictly contemporary with Ewart Park in Britain. The preponderance is real and is reflected in the Table 2. Taking one characteristic Irish form as an example, the cup-ended penannular ornaments, one can make some estimation of quite how great it was, using Taylor's 1980 catalogue as a guide. Out of

direct connections possibly only with Brittany and adjacent parts of the Atlantic coast, areas where gold is not present in any quantity. Ireland at this time was certainly an exporter of bronze and of finished gold objects ⁵⁴, and evidence for trade in the other direction is scarce. In this economic *milieu*, then, it is only reasonable to accept the bulk of this gold as Irish in origin, be it from the Wicklows or from the north. There is still a great deal of work to do in assessing the compositions but the Irish dimension will always be required. A recent assessment of British Late Bronze Age bracelets ⁵⁵ came to no satisfactory conclusions but the Irish evidence was excluded from the metallurgy.

	England	Scotland	Wales	Ireland
Cup-ended ornaments	13	13	0	97
Lock-rings	11	9	14	23
Sleeve fasteners	1	1	0	87
Ring-money	20	18	1	>100

a total of over 120, only 26 are from Britain. Taking the Irish examples, and related disc-ended ornaments, from Armstrong's catalogue ⁵² the weights are plotted in fig.16. Compared with the *lunulae* the mean weight has risen from 49,1 g to 121,2 g. The distribution has two peaks, close to 50 g and 100 g, again raising the question of weight units (see below). As with the *lunulae* and with the flange-twisted torcs ⁵³ there is also a small number of very heavy examples, here in excess of 500 g. Based on the mean weight, the cup-ended ornaments themselves amount to 14,5 kg of gold, with 11,5 kg from Ireland. The writer's own calculations on the survival of bronze suggest that we see something of the order of 1 % of Bronze Age objects surviving to the present day. A 1 % survival of gold would mean that originally over 1 tonne of gold went into the cup-ended ornaments. Intuitively this feels like an exaggeration but may actually be not too far from the truth. If survival is set at 10 % then the overall total original Irish gold production is of the order of a tonne, which perhaps seems too small.

In answer to the question of whether this mass of gold, together with the mass of assumed exports, was Irish in origin, common sense says that the answer must be largely yes. Irish was at this time relatively remote from continental Europe with

Weight Standards

Hoards with numerous copies of an individual type, such as the Gaerwen hoard in Wales ⁵⁶ with its eleven bracelets and eleven lock-rings, or the Great Clare find in Ireland ⁵⁷ prompt questions about the extent to which their manufacture was standardised and whether that in turn implies a weight standard. Such a possibility, was first discussed in the publication of the hoard of gold torcs, bars and bracelets from Towednack, Cornwall ⁵⁸. With one odd exception the weights of objects in this hoard fell into three bands : 28-30 g, 60-63 g, 94-96 g. This is close to 1-2-3 although the lighter pieces are in fact proportionately light. Nevertheless a specific way of dividing up the gold appears to have been aimed at and pairs of like objects are very close in weight. The present writer took this idea further with a review of the weights

51. Eogan, 1983 ; Eogan, 1994.
52. Armstrong, 1933.
53. Northover, 1989.
54. Northover, 1980.
55. Hook, Needham, 1985.
56. Lynch, 1991.
57. Eogan, 1983.
58. Hawkes, 1932.
59. Northover, 1989.

of MBA gold torcs⁵⁹. Taking the class as a whole, it was apparent that there was a regional variation, with a broad range from 300-500 g in France and Ireland, 210-270 g in Wales and the Marches, and 125-185 g in England. At first sight this must represent the availability and, possibly, cost of the gold. Above this spread is a small number of "super"-torcs weighing 750-1200 g with examples in Ireland, Wales, England and the Channel Islands. Things are more interesting when we come to multiple finds of gold torcs : for example in the Llanwrthwl, Powys, hoard the weights, allowing for missing terminals, suggest ratios of 2 : 1 (0,75 : 0,5). The 2 : 1 ratio is repeated in pairs of torcs such as those from Tara, Co. Meath and Hampton, Cheshire, so the use of weight in apportioning and valuing gold was of importance. The weights spread too widely, however, to suggest a well-developed weight standard. The split may have been decided between the smith and his patron depending primarily on the quantity, of gold available. Now, to confuse the issue a recent find of three torcs from Tiers Cross, Dyfed in south-west Wales (National Museum of Wales records) has two torcs with weights that are equal to within a gram. How much this preoccupation with weight and proportion was important at other times is still debatable. Analysis of the weights of bracelets and cup-ended ornaments⁶⁰ has failed to reveal any clear cut standard, despite the regular bimodal distribution of weights seen in fig. 16.

The end of gold

The end of this story of gold in much of Britain is very simple. It just ends. In Wales and the rest of southern Britain gold disappears from the archaeological record at or about the end of the 8th century BC. No 7th century (Llyn Fawr or Ha C) contexts contain gold. Indeed during this time and the beginnings of the Iron Age in Ha D, metal of all kinds becomes scarce in Britain, in dramatic contrast to the wealth of the Hallstatt core area. Gold persists in Ireland and Scotland in the form of ribbon torcs (rather different from those of the Middle Bronze Age). In the south, though, gold does not reappear until the arrival of the first imported Celtic gold coins in the late 3rd or 2nd century BC, and perhaps the making of the first Iron Age gold torcs⁶¹.

60. Armstrong, 1933.

61. Jope, pers. comm.

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