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Summary

A selection of 151 objects collected from the eroded coast at Meols, Cheshire was submitted for X-ray fluorescence analysis. Most of the objects were medieval or post-medieval and consisted of glass beads, buckles, strap-loops and other small items in silver, copper, lead and tin based alloys. Many of the glass beads are of a particular composition that dates them to the early medieval period and the metal compositions indicate a variety of alloy types typical of the medieval and later periods.

Keywords

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Introduction

During the 19th century the large-scale dredging along the approaches to the then rapidly expanding port of Liverpool drastically increased coastal erosion around Meols, on the Wirral coast, to such an extent that in some areas up to half a kilometre of coast was lost. As a consequence of this erosion extensive traces of ancient settlements were exposed together with large numbers of objects. From around 1810 people from the villages of Great Meols and Hoylake began to seek out and pick-up these objects, which included brooches, mounts, pins, glass beads and buckles and interest in the area spread and grew. The first person to appreciate the archaeological significance of these finds was the Rev. Abraham Hume, a respected Liverpool Antiquarian. Hume reported the discoveries at an archaeological congress in York in 1846 and subsequently began to regularly visit the area and encourage the local people to bring their finds to him for the reward of a few pence. Other people began amassing collections of Meols objects, including Henry Ecroyd Smith, the first curator of Liverpool Museum, and a number of local merchants and businessmen. In 1863, Hume published a monograph entitled 'Ancient Meols' in which he presents a detailed account of the site and the objects recovered. Eventually the objects collected were donated to the museums of Chester and Liverpool, where they still are.

The Meols assemblage, across all the holding museums, numbers some 3,000 objects and includes Bronze Age and Iron Age material, some with intriguing suggestions of long distance trade, together with some of the earliest Roman material from the region. However, it is the medieval material that makes up by far the largest proportion of the assemblage. Indeed, the extent and range of the Medieval finds from Meols is greater than that from any site outside of London.

The material analysed

A group of 151, mainly medieval, objects were selected for analysis by Geoff Egan (Museum of London) and Rob Philpott (Liverpool Museum). The aim was to address some specific questions about certain groups of objects and a number of individual pieces by conducting X-ray fluorescence analysis on the surfaces of the objects. X-ray fluorescence was chosen because it is quick and non-destructive. The quality of the data produced by this technique is generally limited because the surface composition is changed over time by the action of the burial environment. It was therefore not possible to address questions requiring high precision analysis and the measurement of trace elements, such as looking for chemical signatures that may help distinguish between local and imported objects. However, it is possible to distinguish between copper, brass and bronze and between lead-rich and tin-rich pewter as well as to characterise different glass compositions. Because of specific questions, permission was given to undertake more invasive analys is of the silver-alloy objects.

Analytical technique

An EDAX Eagle II X-ray fluorescence spectrometer was used to analyse a small area on each object. Where an object had several distinct parts, such as a buckle or a decorated mount, each part was analysed separately. The operating parameters were an accelerating voltage of 40 kV and a current of 200 mA , counting for 100 seconds. Appropriate standard reference materials were analysed alongside the unknowns and reasonable agreement between the certified and measured compositions was achieved. However, the greatly varying geometry of the objects due to differences of size and shape, together with the fact that the analysis was of a corroded surface, means that the standard reference materials could only be used as a guide to instrumental performance rather than the accuracy and precision of the analysis. Wherever possible a clean, bright area of metal was chosen for analysis, but this was not possible for all the metal objects. In the case of the silver-alloy objects, a small area was abraded to reveal bright metal. Many of the glass objects were heavily degraded and this is reflected in the quality of the results.

Results

The analyses of the metal objects enabled the alloy type of each piece to be determined and the approximate proportions of the main alloying metals estimated.

Copper-alloys

The copper-alloy objects can be divided into those of copper, bronze (the alloy of tin and copper), brass (zinc and copper) or a mixed alloy containing significant amounts of both tin and zinc, commonly called gunmetal. Where lead has been added to any of the alloys, the alloy is referred to as leaded-bronze, leaded-brass etc. The proportion of the different alloying metals has been the subject of some discussion (Bayley 1991, 1998), but much depends on the nature of the data under scrutiny. For the data presented here the criteria suggested by Bayley (1991) for medieval alloys have been used. Brass is defined as having approximately 4 times as much zinc as tin and bronze approximately 3 times as much tin as zinc. Gunmetals obviously fall in between. Un-alloyed copper is problematic for medieval metalwork because the degree of 'contamination' by other metals is relatively greater than with alloys of earlier periods. Again the criteria suggested by Bayley (ibid) to define un-alloyed copper are used broadly here; less than 8% of zinc, less than 2.5% tin and less than 5% lead.

The majority of copper-alloy objects are made of gunmetal (61%), with 22% being bronzes and only 9% of both brass and un-alloyed copper. There is no strong correlation between alloy type and artefact type other than with the small group of four swan's neck and ring-headed pins. All four of these are made of bronze with an estimated tin content of around 10% and make up 40% of all bronze items in the group analysed. The measured surface tin content varies between 20% and 39% which is the level that would be expected for a bronze with a true tin content of around 10%. For example, pin number 5116 has a surface tin content of 20.1% whereas a slightly abraded area gave a tin content of 11.1%, still probably a little high because clean metal was not exposed by the abrasion but reasonable close to the likely 'true' value. Ring-headed and swan's neck pins are a form of personal ornament originating in the Late Bronze Age and continuing into the Early Iron Age. The ring-headed form is generally regarded as having developed from the swan's neck pin and is therefore a later, solely early Iron Age phenomenon (Megaw and Simpson 1984, 389). The bronze metalwork of the Late Bronze Age is characterised by the use of relatively highly leaded alloys with the likelihood of a gradual decline in the amount of lead used towards the end of the period (Dungworth 1996, 400). Early Iron Age bronzes, on the otherhand, are usually almost lead free; Dungworth (ibid) found a mean lead content of only 0.9% for the 112 objects that he analysed. It is therefore of interest that the three earlier swan's neck pins all contain significant levels of lead, even accounting for some surface depletion, levels that are consistent with the metalwork from Scarborough and Staple Howe (ibid). Furthermore, the ring-headed pin contains the least lead at approx. 1.5% and is therefore well within the spread of Northern British Iron Age objects (ibid).

The other bronze objects form an unrelated group and include a single finger-ring, a brooch, a knife haft, the only non-pewter strap loop and two pieces of workshop waste. The alloy of the finger-ring (963) is consistent with the suggested Late Iron Age or Roman date, however the alloy also contains almost a percent of zinc, an alloy trait that makes it unlikely to be earlier than the 1st century BC and quite possibly Roman. There are therefore only three bronze items (6.5%) that are likely to be of medieval date suggesting that it was an uncommon alloy during that period. This is a similar picture to that found by the analysis of the medieval items from London, where 12% of the copper-alloy objects analysed were found to be bronze (Heyworth 1991).

Table 1. Alloy type by artefact type.

	alloy type				Total
	brass	gunmetal	bronze	unalloyed copper	
Brooch		4	1		5
Buckle		1		1	2
Door handle	1				1
Finger ring		1	1		2
Key		5		1	6
Knife end-cap	1	5	1		7
Mount	1	1		1	3
Pin		2			2
Ring pin			4		4
Strap loop		2	1		3
Unknown		2			2
Waste	1	5	2	1	9
Total	4	28	10	4	46
	8.7%	60.9%	21.7%	8.7%	100.0%

Three of the four brass objects are relatively high-status objects; a knife end-cap (2287) (the majority of which are gunmetal), a decorated strap-clasp or mount (140) and a fragment of a door handle (2071); only a piece of brass scrap (1872) is more mundane, but is suggestive of brass working at Meols. The brass door handle is a particularly prestigious object and reflects the fact that brass in the medieval period was a relatively high-status metal. Similarly, the decorated strap-clasp is also an up-market item and this is reflected in the quality of the metal used in its production. Gunmetal on the other hand is ubiquitous; the majority of brooches, keys, knife end-caps, non-pewter strap loops and even waste metal are made of it. The measured tin and zinc contents of the gunmetals are very variable, although differences in burial environment will have affected both the tin and zinc contents to varying degrees. Zinc will tend to be depleted at an objects' surface whereas tin will be enriched, as we have seen above. The reality may therefore be a less broad distribution of compositions, possibly in the range of 5%-10% tin and 10%-15% zinc. This suggests that the gunmetals can probably be associated with the medieval term *latten* (for a discussion of this see Bayley 1991) and, as such, are very similar to the objects analysed from London (Heyworth 1991).

Un-alloyed copper accounts for only four items (9%). The London analyses again show a similarly low incidence of un-alloyed copper (approx. 10% of the copper-alloys) (ibid). The pieces made of un-alloyed copper are a buckle (2905), a key (27), a decorative stud or mount (2219) and some metalworking waste (5013). The key is made of an alloy that is almost brass, containing approx. 4% or so of zinc and little else, but being employed to make a rather crude key (a replacement for one lost or broken?) suggests that the metal sheet was perceived as copper rather than brass, not having sufficient zinc to affect its colour. The flattened ends used to form the bit of the key were fixed together by a pure copper rivet, probably used because of its softness, but also because it was assumed to be of the same composition as the main key.

Gilding was usually done on a fairly pure copper substrate because the presence of alloying metals can cause the gold to discolour (Egan and Prichard 1991, 27; Oddy 1982). However, no traces of gold were found on the buckle (2905) or the mount (2219) and so these were unlikely to have been gilded.

The presence of pieces of waste material including spillages of metal and crucible fragments with traces of metal (2753 and 2754) suggests that copper-alloy working (casting) was being conducted in the area. The composition of these 9 pieces broadly reflects the composition of the artefacts; five are gunmetal, two are bronze and there is one piece each of brass scrap and un-alloyed copper waste.

Because the analyses were limited to surface XRF, it was not possible to obtain any useful trace element data that would have allowed a discussion of metal groups and production centres. However, it was noted that the two gunmetal sheet discards (2378 and 2358) both contain a significant amount (approx. 1%) of antimony.

Table 2. All copper alloys

Number	Material	Type
27	Unalloyed copper	Key
95	Gunmetal	Brooch
116	Bronze	Pin
117	Bronze	Pin
118	Bronze	Pin
128	Gunmetal	Mount
140	Brass	Strap clasp
259	Bronze	Brooch
262	Gunmetal	Pin
419	Gunmetal	Strap loop
548	Gunmetal	Key
550	Gunmetal	Key
551	Gunmetal	Key
552	Gunmetal	Key

Number	Material	Type
564	Gunmetal	Key
755	Gunmetal	Strap loop
756	Bronze	Strap loop
811	Gunmetal	Brooch
913	Gunmetal	Ring
963	Bronze	Finger ring
1549	Gunmetal	Buckle
1872	Brass	Waste
1987	Gunmetal	Brooch
2071	Brass	Door handle
2162	Gunmetal	Unknown
2165	Gunmetal	Waste
2172	Gunmetal	Waste
2174	Gunmetal	Waste
2219	Unalloyed copper	Mount
2279	Gunmetal	Knife end-cap
2280	Bronze	Knife end-cap
2282	Gunmetal	Knife end-cap
2283	Gunmetal	Knife end-cap
2284	Gunmetal	Knife end-cap
2286	Gunmetal	Knife end-cap
2287	Brass	Knife end-cap
2378	Gunmetal	Unknown
2385	Gunmetal	Waste
2905	Unalloyed copper	Buckle
5013	Unalloyed copper	Waste
5030	Gunmetal	Brooch
5116	Bronze	Pin
5161	Gunmetal	Waste
5166	Bronze	Waste
5281	Gunmetal	Pinhead
5289	Bronze	Runnel

Tin-lead alloys

This is the second most frequent alloy among the objects analysed and makes up 39% of all the metal items (33 pieces). Heyworth (1991) divides this alloy into three types on the basis of their lead/tin ratios; alloys that are predominantly tin, predominantly lead, or pewter, where there is a significant amount of both lead and tin. The London alloys are described as predominantly tin or pewter, with 52% being tin, 46% being pewter and only 2% being lead. When described in the same fashion, the Meols pieces correspond quite well with these figures (Table 3), although there is a greater proportion of lead objects (12%) and correspondingly less pewter.

Table 3. All Lead-tin alloys (figures are percentages)

Number	Material	Type	copper	lead	antimony
86	Lead	Brooch		>20	
91	Tin-rich pewter	Brooch	>1	>20	
165	Tin	Strap loop			
166	Lead-rich pewter	Strap loop		>20	
271	Tin	Spoon top	>1		
423	Lead-rich pewter	Strap loop		>20	
425	Tin-rich pewter	Strap loop		>20	
426	Lead-rich pewter	Strap loop	>1	>20	>5
427	Tin	Strap loop	>1		>5
464	Lead-rich pewter	Clasp		>20	
472	Tin-rich pewter	Clasp		>20	
475	Tin	Strap end	>1		>5
478	Tin	Strap loop			
575	Tin	Mount	>1		
576	Tin	Mount	>1		
578	Tin	Mount	>1		
593	Tin-rich pewter	Mount	>1	>20	
754	Tin	Strap loop	>1		
819	Lead-rich pewter	Brooch	>1	>20	>1
850	Tin-rich pewter	Brooch pin		>20	
851	Tin	Brooch pin			
888	Lead-rich pewter	Ring	>1	>20	>1
1880	Tin	Mount	>1		
1970	Tin	Buckle	>1		
1973	Tin-rich pewter	Buckle		>20	>1
1982	Lead	Spindle whorl		>20	
2045	Tin-rich pewter	Brooch		>20	
2901	Tin	Buckle	>1		>1
2915	Lead	Jetton		>20	
2916	Tin	Mirror case?	>1		
5019	Lead	Bar		>20	
5049	Lead-rich pewter	Buckle		>20	
5557	Lead-rich pewter	Brooch	>1	>20	

The lead objects consist of a jetton (2915), an ornamental mount (86), a twisted bar (5019) and a spindle whorl (1982); the spindle whorl and the bar are almost pure lead, whilst the jetton and mount contain 5% or so of tin. The tin and pewter objects are of similar types, in fact equal numbers of strap loops and buckles are made of tin and pewter. One brooch pin is made of tin, as is the mirror case decoration (2916) and the spoon top (271), which suggests that the increased tin content indicated higher status, although three of the four brooches are made of pewter. Some of the pieces also contain up to a few percent of copper and there is evidence for a loose correlation between the amount of copper and the amount of tin in the alloy. Re-deposition of copper onto the surface of the objects would account for the looseness of the correlation; more invasive analysis might result in a better correlation.

Seven of the pewter objects (426, 427, 475, 819, 888, 1973, and 2901) contain significant traces (over 1%) of antimony and copper. Three (426, 427 and 475) of these contain between 5% and 20% antimony. Antimony was added to harden pewter from about 1680 (Hornsby et al 1989: 47). However, Britannia metal, containing from 2% to 5% of antimony and 1% to 2% copper, appears to have been introduced in the middle of the 18th century (Lewis 1960: 19). All the Meols objects containing significant antimony are either buckles (2901, 1973, 888 and 819) or strap loops/ends (426, 475 and 427) and all but one (1973) contain copper, indeed, it is the strap loops/end that contain particularly elevated levels of antimony. A variant of pewter called Ashberry metal contains up to 25% antimony and has the effect of enhancing casting properties, enabling very hard, sharp castings (ibid).

Despite being made of lead with only a small amount of tin, the ornamental mount (86) is a very decorative object and is enhanced by the addition of brass appliqués. These appear to be made of thin sheet metal that has been soldered or burned-on. A similar object in terms of construction is 5557, originally thought to be a buckle with bands of red and blue enamel. Analysis shows that the body of this object is a 1:2 tin:lead pewter with a couple of percent of copper. The concentric bands are in fact an inlay of a silver/copper sulphide niello on a thin sheet of pure copper that was backed with the pewter, after the niello had been applied. The material that was between the bands has long since corroded or dissolved away. The niello contains no lead, which suggests that it may be early medieval because silver/copper/lead niello's only appear in the 13th century. Copper/silver niello is commonest in the early medival period (laNiece 1983, 286), whilst Roman niello is usually silver or copper sulphide, rarely both.

The importance of lead-tin alloys in the repertoire of medieval materials is reflected in the issuing of ordinances and charters to regulate the industry in London and the establishment of a Guild of Pewterers (Welch 1902). The documents provide useful insights into the production of these alloys in London and can be used in understanding the material from Meols. The 1348 ordinance of the London Guild of Pewterers distinguishes between two types of pewter: Fine metal and Lay metal. Fine metal was mainly tin with an unspecified addition of copper, whilst Lay metal was tin with added lead. The amount of lead in the pewter was clearly of concern and although the exact level permitted is unclear, somewhere around 20% seems likely. Later, in the 16th century, the records indicate that three grades of pewter were in use: Fine (tin containing 4% copper), Trifle (tin with 4% lead and copper) and Lay (tin with up to 15% lead). Of these, Fine and Trifle were permitted for eating and drinking use, whilst Lay was not. The control of the amount of lead added seems to have been a major concern of the regulation and the reason for the introduction of pewterer's marks for tableware in the 16th century (Welch 1902: 94-7). Outside of London, however, the Guild's control seems to have been limited, although by the 17th century inspections in the Midlands and further afield are recorded (Hornsby et al 1989: 13).

The high proportion of Meols objects that appear to contain in excess of 20% lead (19 objects – 58%) suggests that contravention of the Guild's regulations was endemic. Whilst a number of items probably made no pretence of being anything other than lead, such as the spindle whorl and perhaps the jetton, examples of other object types exist that were made of the correct alloy, so the lead-rich versions could well be sub-standard. For example, four of the nine pewter strap loops are made of metal containing high levels of lead. However, it may be that the Guild regulations for pewter did not apply to small dress accessories. It is therefore of interest that the pewter spoon top (271) was found to conform precisely with the Guild regulations containing approx. 4% copper and approx. 4% lead (Dungworth 2002).

Silver alloys

Six of the objects submitted for analysis are made of an alloy of silver and copper (92, 93, 98, 152, 855, 2109). The initial surface analysis revealed a fairly base silver-copper alloy (approx. 80% silver) that, under normal environmental conditions, would suggest an even baser bulk composition. However, more invasive analysis involving the abrasion of a small area to expose representative bulk metal revealed that a relatively thick sulphide crust was obscuring an essentially sterling silver composition:

Table 4. All silver alloys.

Number	Type	silver	copper	gold	lead
92	Brooch	90.1	7.1	0.4	2.4
93	Brooch	91.8	6.5	0.4	1.3
98	Brooch	90.5	7.4	1.3	1
855	Brooch pin	92.3	5.8	0.4	1.6
2109	Fragment	91.5	4.3	3.3	0.9
152	Ring	92.0	4.8	1.9	0.8
	sterling	92	7.4	0.2	0.4

A section cut from a Victorian florin was analysed alongside the objects to provide a standard against which to monitor accuracy. The florin was struck on the sterling standard and should be nominally 92.5% silver, and indeed, as the analysis shows it within 1% of that figure. We can thus be reasonably confident that the bulk analyses of the objects are accurate.

It should be noted that the traces of gold and lead are lower in the florin than in the objects. This is consistent with the objects being earlier in date when the refining process was not as rigorous. Indeed, Percy (1870) states that, for reasons of economy, the product of an initial, large-scale cupellation was continued until the metal was only approximately 94% fine silver, the remainder consisting chiefly of lead. Thus a subsequent, smaller-scale after-cupellation was necessary to reduce the impurities to a negligible level. The criteria for determining when the silver had reached a sufficient level of purity were very subjective; to do with colour, drop-shape etc. and so complete chemical purity was never in practice achieved. The amounts of lead remaining in the silver are therefore an index of the rigour of the process, whilst the amounts of gold relate directly to the ore source/s as this metal can not be oxidised away by cupellation. Analyses of silver trial plates held by the Royal Mint (Forbes and Dalladay 1959) show that gold and lead at similar levels to the Meols objects were usual prior to 1600, when efforts were made to procure purer metals. Trial plates of 1873 and 1900 were produced from stock metals that are 'typical of coinage and silver wares of corresponding date' (ibid), and have gold and lead levels at least an order of magnitude lower than in the Meols objects. It is therefore likely, on the basis of the silver composition, that the Meols objects were produced before 1600. Furthermore, the brooches as a group, contain over 1% lead (mean 1.6%) and 0.6% gold, whereas the ring and the gilded fragment contain 0.9% lead and over 2% gold. This suggests that the brooches are made from less well-refined silver from a low-gold source whilst the other two objects are made from better-refined metal from a high-gold source. The metal of neither group is made of silver of purity equivalent to post-1600 coinage metal.

In addition to the silver objects there were two small, bone-ash cupels or tests. These were used for the assaying of silver and are saturated with litharge (lead oxide) which shows that they have been used. The size and shape of the cupels is very similar to those from the Tower of London, which are securely dated to the 16th century (Bayley 1992).

Glass

There are 60 glass objects in the assemblage analysed, 48 of which are beads (Appendix 1). The majority of the remainder are pinheads with a small group of four fragments of vessel glass (663, 664, 665, 666) and a single ring fragment (667). The majority of the objects are made of a glass that has a particularly high lead content, generally over 60% lead oxide. Such a glass would have a low melting point (approx. 750C) and would therefore be relatively easy to produce using a simple furnace, it is also a highly refractive glass, lending it a jewel-like appearance (Tyson 1996). Glass of this composition occurs in Britain especially about the 10th century when it is used for the manufacture of beads, rings and other trinkets (Bayley and Doonan 2000). This glass is characteristically translucent yellow in colour, although copper was sometimes added to produce a translucent green, or when present in larger quantities, a very dark opaque green that can appear almost black. From the 13th century, glass of this composition began to be used to make vessels in north-west Europe and examples are also known from Britain (Tyson 1996). However, there is still some debate as to whether the production of lead-glass vessels from the 13th century is a direct continuation of the earlier trinket glass industry. One of the stylistic features of these lead-glass vessels is the use of 'berry' prunt decoration, which used to be thought a 17th century innovation. Lead glass 'berry' prunt fragments are known from medieval contexts in Bedford and Swan Lane in London and there is also one from Meols (663). This consists of a yellow glass stem made of high-lead glass with a prunt of very dark green/ black glass coloured by about 2% of copper. A small amount of zinc was also detected suggesting that the copper was added in the form of brass, and indeed, Book III of Heraclius ' *De coloribus et artibus Romanorum* (probably 12th century) refers specifically to brass (*auricalcum*) as the colorant for green lead-glass (Merrifield 1967). The other three vessel fragments (664, 665 and 666) are all yellow lead-glass containing between 68% and 83% lead oxide and are therefore all consistent with a 13th/early 14th century date.

The pinheads are likewise made of high-lead glass are therefore likely to be of medieval date. There is a similar range of colours and colorants.

Most of the beads are made of high-lead glass and could therefore be as early as the 10th century. Similarly the ring fragment (667) is high-lead translucent yellow glass. Its lead oxide content is approx. 78% and is in close agreement with the lead oxide content ascertained by Bayley (1990) for glass rings from 10th to 13th century contexts in Winchester. The high-lead glass beads are also predominantly yellow in colour and contain an average of approx. 75% lead oxide (Std.Dev. 10.4). The yellow colour is the result of traces of iron in the glass, probably from contamination of the raw materials (Bayley 1990). The green beads are coloured by the addition of small amounts of copper or copper-alloy (approx. 0.5% to 3%) and the black beads all have high iron contents (approx. 5% to 10%) and some have traces of copper as well (up to 3%). These results are very similar to those of Anglo-Scandinavian beads from York (Bayley and Doonan 2000) and suggest an almost identical production technology further supporting an early date for these beads.

Of the beads that are not high-lead glass two are soda-lime-silica glass and two arsenical opal glass. The soda-lime-silica glass beads are coloured, one green (690) and one blue (699). The blue melon-shaped bead is coloured with a small amount of copper and a trace of cobalt. Its general composition is consistent with that of similar beads from Anglo-Scandinavian York (Bayley and Doonan 2000) although such compositions are also consistent with Roman glass and have been used to suggest the re-working of Roman blue glass in the early medieval period, or its importation from the eastern Mediterranean (ibid, 2528). The green soda-lime-silica bead is unlikely to be early medieval but could be Roman. The arsenical glass beads (661 and 711) have to be considerably later in date: arsenic appears to have been introduced as an additional flux in the later 17th century (Turner 1956) and especially to enhance brilliance or as an opacifier producing opaque white or opaline glass. It appears to have become a common glass constituent by the 19th century. The two beads contain 8% and 20% arsenic trioxide respectively with the remainder being mostly silica with some lime, potash and alumina.

Conclusion

The analysis of objects from the Meols assemblage has provided some useful information both on specific objects and on several general issues. The proportions of the different metal alloy types fit well with the published work on medieval objects from London and also demonstrates the high degree to which pewter was used for small items. There is no apparent correlation of alloy type to object type, except for the prehistoric pins, which are all of bronze. However, there is an indication that brass was a scarce and relatively high-status alloy and that the medieval and post-medieval gunmetals tend to have more zinc than tin. The extent to which the composition of the pewter contravenes the Guild of Pewterers regulations suggests that either the regulations did not apply to dress accessories or that the Guild was unable (or un-willing) to enforce it's regulations in far-away Meols. An interesting comment on this question is the fact that the analysis of the spoon top shows that its alloy adheres closely to the regulations. The silver objects are all of a similar, sterling silver composition suggesting rigorously controlled regulation of precious metal. This is further supported by the inclusion of cupels in the assemblage. Furthermore, the level of impurities in the silver objects is relatively high and this may indicate a medieval date.

The glass compositions suggest that the majority of glass objects, beads, pinheads and vessels are medieval in date and that some of the beads may be as early as the 10th century. Beads of soda-lime-silica composition may be Roman or early medieval. Two beads opacified with arsenic are probably 18th or 19th century and serve to highlight the large date-range of glass from Meols.

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Appendix 1: The glass analyses (X = element detected)

Number	Type	colour	Cu	Co	Fe	Pb	As
262	Pinhead	yellow				XXX	
656	Pinhead	green	X			XXX	
657	Pinhead	black			X	XXX	
658	Bead	yellow				XXX	
659	Pinhead	green	X			XXX	
660	Pinhead	green	X			XXX	
661	Bead	opal					XX
662	Bead	black			X	XXX	
662	Bead	green	X			XXX	
662	Bead	yellow				XXX	
662	Bead	yellow				XXX	
663	Prunt	blue/black	X		X	XXX	
664	Vessel	yellow				XXX	
665	Vessel	yellow				XXX	
666	Handle	yellow				XXX	
667	Ring	yellow				XXX	
668	Bead	yellow				XXX	
669	Pinhead	yellow				XXX	
670	Bead	black	X		X	XXX	
671	Bead	yellow				XXX	
672	Bead	black	X			XXX	
673	Bead	black			X	XXX	
674	Bead	black			X	XXX	
675	Bead	yellow				XXX	
676	Bead	black			X	XXX	
677	Bead	yellow				XXX	
678	Bead	yellow				XXX	
679	Bead	yellow				XXX	
680	Bead	yellow				XXX	
681	Bead	yellow				XXX	
682	Bead	yellow				XXX	
683	Bead	yellow				XXX	
684	Bead	yellow				XXX	
685	Bead	yellow				XXX	
686	Bead	black	X		X	XXX	
687	Bead	yellow				XXX	
688	Bead	yellow				XXX	
689	Bead	yellow				XXX	
690	Bead	green	X				
691	Bead	yellow				XXX	
692	Bead	yellow				XXX	
693	Bead	yellow				XXX	
694	Bead	yellow				XXX	

Number	Type	colour	Cu	Co	Fe	Pb	As
695	Bead	yellow				XXX	
696	Bead	green	X			XXX	
697	Bead	yellow				XXX	
698	Bead	yellow				XXX	
699	Bead	blue	X	X			
700	Bead	yellow				XXX	
701	Bead	yellow				XXX	
702	Bead	yellow				XXX	
703	Bead	yellow				XXX	
704	Bead	green	X			XXX	
705	Bead	yellow				XXX	
706	Bead	yellow				XXX	
707	Bead	green	X			XXX	
708	Bead	yellow				XXX	
709	Bead	yellow				XXX	
711	Bead	opal					XX
5281	Pinhead	yellow				XXX	