Secrets of the Anglo-Saxon Goldsmith:
The results from the analysis of the gold in the Staffordshire Hoard

Dr Eleanor Blakelock
Staffordshire Hoard

• Found in 2009 by a metal detectorist

• Near the village of Hammerwich, near Lichfield, in Staffordshire.

• Excavation by archaeologists from Staffordshire County Council, and a team from Birmingham Archaeology, which was funded by English Heritage.

• When the discovery was publicly announced, it attracted worldwide attention with people queuing for hours to see the hoard.
Staffordshire Hoard

- Over 3,500 objects or object fragments have been found, predominately gold or silver.

- The Hoard is essentially military in character. The bulk of the identified pieces comes from the handles of edged weapons, shield fittings and one or more helmets.
“The great Anglo-Saxon poem Beowulf, once believed to be artistic exaggeration, now has a true mirror in archaeology.”

Chris Fern
Staffordshire Hoard
Staffordshire Hoard

But ……… there are a few other objects of unknown use

And a small number of explicitly Christian items have also been identified

It is still likely that these were taken from a battlefield, as it was not uncommon to take your priest to war
Staffordshire Hoard
Staffordshire Hoard

- The Hoard was valued at £3.285 million
- An international fundraising campaign to save the hoard for the nation was mounted
- In less than 10 weeks it was a success
- It is now jointly owned by Birmingham and Stoke-on-Trent City councils.
- The collection is displayed in four museums
Research Project

• Metals analysis just one part of a larger study ....

  *Contextualising Metal Detected Discoveries: Staffordshire Anglo-Saxon Hoard*
Conservation
Reconstruction
Reconstruction
Chris Fern the archaeologist is trying to create a typology to date the Hoard using stylistic information. Also looking at status of individuals.
Typology

- c. 560AD
- c. 600AD
- c. 610AD
- c. 620AD
- c. 630AD
- c. 625AD
Identifying objects

Mystery Object

- No idea what it is, no parallels anywhere
- Is it the lid of a container?
- Saddle fitting?
- Or an extension to a hat?
Identifying objects

• This is a manuscript showing the prophet Ezra and he is wearing something on his head
Analysis

- Gold
- Silver
- Copper alloys
- Gilding
- Garnet
- Glass
- Niello inlay
- Green inlay
- Organic
Research Project

• Metals analysis just one part of a larger study ....

  Contextualising Metal Detected Discoveries:
  Staffordshire Anglo-Saxon Hoard

  – Conservation & public engagement
  – Typology and classification of objects
  – Scientific analysis of materials
    • Gold & silver
    • Organics
    • Pastes and glass
  – Fully illustrated publication
  – Online research database
Gold Research Project

- Provenance the gold
- Can the gold be used to date the hoard
- Identifying workshops
- Choice of alloy for specific roles
- Effects of burial environment on gold
Gold Research Project

158 objects analysed
- 114 Staffordshire Hoard
- 1 Stoke on Trent
- 43 British Museum
Gold Research Project

- During the analysis 288 different components were analysed
  - Sheets
  - Filigree panels
  - Cast or solid
  - Wires
  - Cell walls
  - Large borders
  - Caps
Choice of instrument

**XRF**
- Cheap and quick
- Museum owned one
- Completely non-destructive
- Large beam size
- Relatively deep penetration

**SEM-EDX**
- Small beam size
- Limited by object size
- Small penetration so surface had to be prepared
Anglo-Saxon gold

• Gold in the past was not pure
  – Native gold contains silver and some copper

• Deliberate alloying of gold was also used to change the properties of gold
  – Working properties
  – Melting temperatures
  – Colour
Anglo-Saxon gold

- This graph shows the range of gold alloys in the Staffordshire Hoard objects analysed.
- Majority of objects have between 1-4% copper.
Anglo-Saxon gold

- During the Saxon period there was a gold shortage
- Studies of coinage has shown a general change in the gold to silver ratios
- It was hoped that this information could be used to date the Staffordshire Hoard objects

Silver increases over time
Anglo-Saxon gold

- No clear pattern was seen relating to dates
- The Hoard will have to be dated based on stylistic differences
Anglo-Saxon gold

- Are there regional differences to perhaps indicate workshops?
- The analysis showed no clear regional groups
- Exception was Suffolk
There was no obvious link between function and alloy either.
Anglo-Saxon gold

- Evidence points to recycling and mixing
Surface Enrichment Project

- Gold is resistant to corrosion but ..
  .....the surface can be depleted of base elements, either naturally or deliberately
- In the burial environment
  - Copper is depleted
  - Small quantities of silver could also be potentially lost

Gold core composition K1143
- 83.7% gold, 14.3% silver and 2% copper
- 85.3% gold, 13.6% silver and 1.1% copper

Gold enriched surface
- Small quantities of silver and copper lost at surface

Copper lost at surface
Surface Enrichment Project

- The term ‘surface enrichment’ is used but the surface has technically not been enriched in gold.
- A pilot study was carried out on 16 objects to investigate the effects of the burial environment.
Surface Enrichment Project

• Surface enrichment due to burial
  • Hilt-plate K1143
  • A small loss of silver at the surface.
  • A substantial loss of copper due to the burial environment
Surface Enrichment Project

- Surface enrichment seen during pilot study
  - A large number of objects had a significant loss of silver at the surface
  - Some objects had over 40% depletion of silver
  - Could not be explained by natural mechanisms
Surface Enrichment Project

- Surface enrichment seen during pilot study
Surface Enrichment Project

The importance of the pilot study was recognised, so the surface enrichment project was extended.

This aimed to investigate differences in enrichment between

- Time periods
- Find location
- Components, to learn more about object construction and goldsmith workshops
- Function (including Male vs Female objects)
Surface Enrichment Project

- The results suggested that only specific components on each object were being enriched.
Surface Enrichment
Case study - K88

All the components appear to have a similar core composition.
Surface Enrichment
Case study - K88

All the components appear to have a similar core composition

Analysis showed that the sheet was depleted in silver
Surface Enrichment
Case study - K88

All the components appear to have a similar core composition

Analysis showed that the sheet was depleted in silver

But the cap and wires show no sign of deliberate treatment
Surface Enrichment
Case study - K88

This may explain the colour contrast often seen between wires and the sheets behind them.

It also suggests that the treatment was most likely taking place in the workshop.
Surface Enrichment Project

- Analysis was undertaken on sheets from different types of decorated object
  - Filigree
  - Cloisonné
  - Cloisonné and filigree
  - Green cloisonné
  - Niello
  - As cast or engraved objects
Surface Enrichment Project

- The level of enrichment is different, based on the decoration method.
- Sheets are more often enriched:
  - behind filigree
  - engraved designs or plain sheets
- This suggests a deliberate choice by the goldsmith.
Surface Enrichment Project

- No difference in type or amount of enrichment based on object
  - Date
  - Location
  - Function
  the exception being ...

Male vs Female items
Surface Enrichment Project

• Part of the reason for including the British Museum collection was to get representative female items.
Surface Enrichment Project

• More of the male associated items tend to have a higher gold core
• Instead the female items are more often enriched than male items
• This means that they tend to have the same surface compositions
New Research at Birmingham

• Carried out in conjunction with Birmingham University
• SEM-EDX and metallographic analysis of a small number of objects
• Aim to determine
  – the type of solders used
  – how the surface was enriched
Solder
‘1 ounce of copper calcine, 3 solidus of olive-oil soap, 1 solidus of calcothar. For use mix these together first grinding the copper calcine and the calcothar separately into powder. Mix with as much soap and water as is necessary for gold solder.’

Mappae Clavicula circa 9th century AD Italy
So how did the Goldsmiths do it?

### Historical Sources

- Kauṭiliya Arthaśāstra
- Agatharchides’s ‘On the Erythraean Sea’
- Pliny the Elder ‘Natural History’
- Leyden (or Leiden) Papyri
- Codex Lucensis 490
- Late Longobardian Latin document at Lucca
- Mappae Clavicula
- Greek manuscript ‘On the noble and illustrious art of the goldsmith’
- Theophilus ‘On Divers Arts’
- Agricola ‘De Re Metallica’
- Benvenuto Cellini ‘Goldsmithing and sculpture’
- Vannoccio Biringuccio ‘treatise on metals and metallurgy’
So how did the Goldsmiths do it?
### Historical Sources

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<td>Yellow natron and salt, rubbed to gild</td>
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<td>Verdigris and salt rubbed and heated</td>
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<td>Washed in boiled powdered yellow sulphur</td>
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• Leyden Papyrus
  - ‘roasted misy, 3 parts; lamellose alum, (and) celandine, about 1 part; grind to the consistency of honey with the urine of a small child and colour the object; heat and immerse in cold water.’
  - ‘For gilding a vase of silver or copper without leaves [of gold], dissolve some yellow natron and some salt in water, rub it with this and it will be gilded.’

• Codex Lucensis
  - ‘take clean tragacanth and carefully pound it in a mortar and salt in equal weights, and rub, mix with diluted vinegar, spread over the petals on both sides equally with the first; and heat on the hearth to a moderate degree.’

• Mappae Clavicula
  - ‘Take vitriol and roast it, as you know how, and as much salt again, and temper it with red wine not too thinly, in a copper pot, and coat the gold with it.’
Life of an object

- There are many pieces in the hoard that look like they belong as sets
- Therefore a couple of obvious sets were examined during this study
- This revealed more about their life history
Seax set

- The hilt collars all shared a similar core composition
- But the pommel cap has a different composition
- This suggests that the pommel was constructed at a different time to the rest of the set

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<th>Cu</th>
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<td>K376</td>
<td>85.0</td>
<td>13.9</td>
<td>1.1</td>
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<tr>
<td>K354</td>
<td>82.2</td>
<td>15.2</td>
<td>2.6</td>
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<tr>
<td>K690</td>
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<td>15.3</td>
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<td>82.2</td>
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<td>K449</td>
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Weight % Ag vs. Weight % Au graph shows a trend for the hilt collars, with the pommel cap deviating from this trend.
Market Rasen set

- The sheet of the pommel is made from a similar alloy as the cap, but has been treated
Market Rasen set

- The sheets used in the pommel and both hilt collars are a similar composition.
- The hilt plates however have different compositions.

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<td>1</td>
<td>85.3</td>
<td>12.8</td>
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<tr>
<td>2</td>
<td>83.6</td>
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</tr>
<tr>
<td>3</td>
<td>84.7</td>
<td>13.4</td>
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Market Rasen set

• The bottom hilt plate has been treated to achieve a similar surface composition
• The top hilt plate hasn’t and is therefore a different colour
Conclusion

• We know very little about the Anglo-Saxon goldsmith who made these pieces
• Deliberate surface treatment in the Anglo-Saxon period
• The data is beginning to reveal the
  • methods and techniques used by the goldsmiths
  • some of the thought processes and decisions made by the goldsmiths
And the thousands of members of the public who donated towards the acquisition of the Staffordshire Hoard and who continue to support this campaign.
The Historical Metallurgy Society provides a form for exchange of information and research in historical metallurgy, and the conservation of all historical and archaeological metallurgy heritage.

**Activities:**
- Conferences and special interest meetings
- Publish two *Historical Metallurgy* journal volumes per year
- Updates via our newsletter *The Crucible*

**Resources:**
- Datasheets and guidelines
- Network of specialists
- Grants for research and travel
- Archives and reference collections