Strain analysis of 15th century guns and projectiles

Introduction

This proposal forms part of a much wider research programme at the University of Huddersfield to investigate the origins and evolution of firepower on the battlefields and siege sites of Europe between the mid 14th and 17th centuries. The archaeological evidence (principally from the fired lead projectiles) is beginning to provide a detailed picture of the scale and chronology of the use of guns in the field, including information on their bore, type and how they were used, and is complemented by knowledge obtained from surviving guns; from documentary sources; from unfired projectiles and obturators from wrecks.

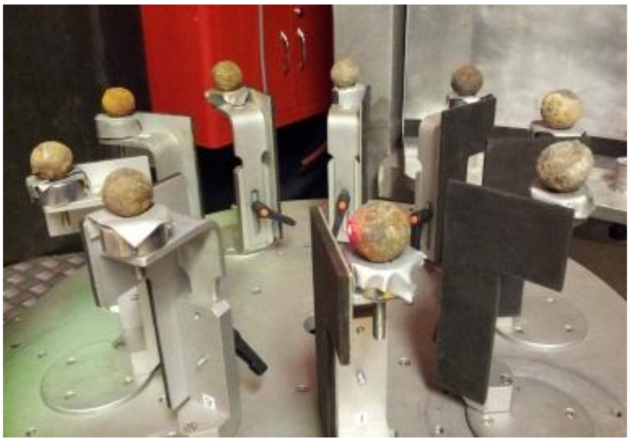
Background

The early stages of our research programme focussed upon archaeological investigations of the 15th and 17th century battlefields of the 1485 battle of Bosworth (Foard & Curry 2011), and the 1642 battle of Edgehill (Foard 2009, 2011). Later projects (which are all still in progress) include research into the 1708 battle of Oudenaarde, Belgium, an AHRC funded PhD research programme on siege sites of the Civil War in England, and a British Academy funded pilot study of surviving guns of later 15th and early 16th centuries from across Europe examining the construction and geometry of gun barrels. To complement these archaeological investigations firing experiments with modern and reproduction gun barrels are being undertaken in collaboration with Cranfield University at the Defence Academy, Shrivenham, UK.

This experiment focuses upon early 15th and 16th century roundshot. Our early investigations have shown that shot was generally made from lead, lead composite, wrought iron, cast iron or stone. In addition to round shot there was hail-shot of lead, fired in large groups from artillery at close quarters, which has a very distinctive form resulting from compression during firing which creates a polygonal faceted surface. These measurement extend this work by using neutron techniques as a non-destructive probe of the materials properties of the artefacts.

Experimental details

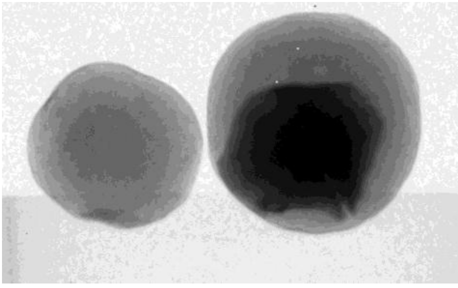
Neutron diffraction patterns were collected on D2B from all samples at ambient temperatures. The sample changer was modified to take 9 cannon balls at the same time to ensure that beamtime was used efficiently during the night. The results were compared with results obtained from an earlier tomography experiment on NEUTRA at PSI.



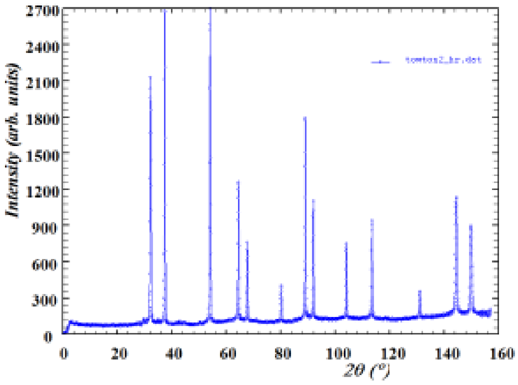
Results

The diffraction patterns, shown in figures 1-3 confirm that all the round shot studied were either (i) pure lead, (ii) pure iron or (iii) lead with an iron inclusion.

Figure 1: Round shot from battle of Towton (1461)



The neutron tomography and radiography images show that the small Towton round shot is a single sphere of metal. The diffraction data show this to be lead. The larger shot contains a cubic inclusion. The neutron diffraction data show this to be elemental iron. Again the surrounding material is lead.



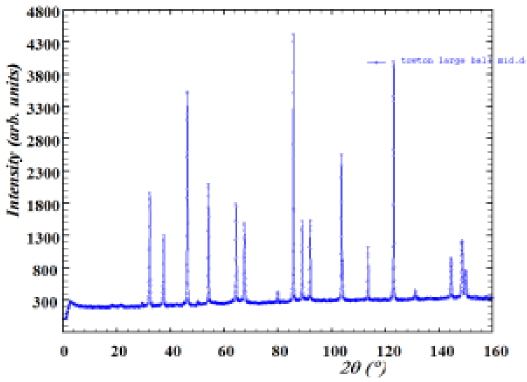
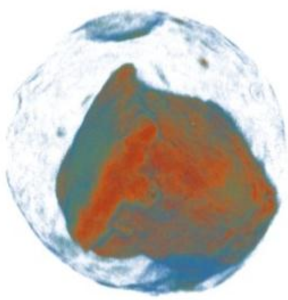
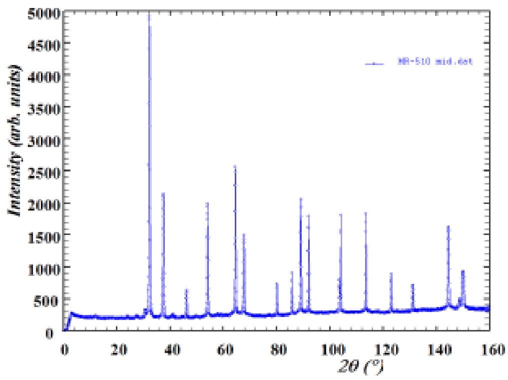


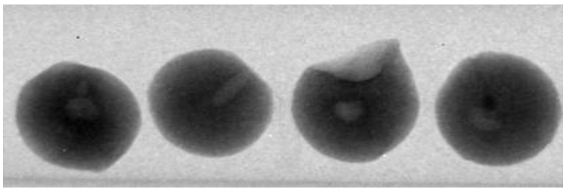
Figure 2: Small lead round shot from the *Mary Rose* (1545).

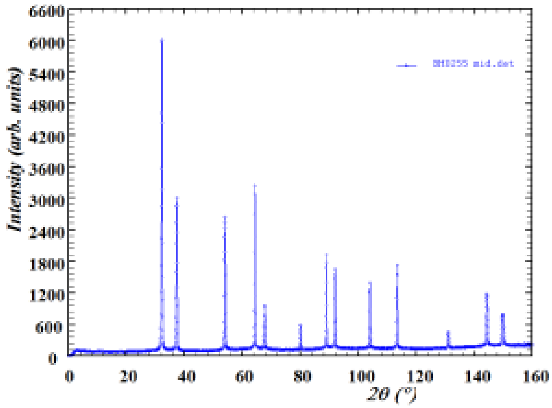




The images above are representative of all the data obtained for the Mary Rose cannon balls. All are composed of lead, with a cubic elemental iron inclusion

Figure 3: English Civil War musket balls from Basing House (1643-5)





Although the neutron tomography and radiography images of the Civil War musket balls suggested the presence of small randomly shaped inclusion the diffraction data showed the balls to be solid lead, suggesting the shadows are air bubbles, created during manufacture.

Future work

A full refinement of all the data is currently underway. The diffraction results will then be compared to the tomography data to enable us to get a full description of each roundshot. Finally, an attempt will be made to confirm the that these iron inclusions are made of wrought iron, and to obtain a more detailed characterisation of the iron.

If these measurements show the existence of distinctive compositional signatures for each assemblage then we will apply this non-destructive technique to collections of known provenance, eg Battle of Bosworth (1485). This will allow us to distinguish between rounds from different armies, which would transform our ability to interpret the distribution pattern across the battlefield.