

# Experimental Bronze Age Copper Smelting

## A tool for research and outreach

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### Project Aims

The aims of the project were two fold:

#### 1) Archaeological aims:

- To test the functionality of a pre-historic bowl-shaped furnace in extracting copper from its ores.
- To test the ability of air supplied only by blowpipes (as opposed to bellows) to reach and maintain the temperatures required for copper smelting.
- To compare the waste products produced (slags) by experimental copper smelting with those obtained from the archaeological site of Pyrgos-Mavroraki, in Cyprus in order to aid interpretation of smelting technologies at the site.

#### 2) Public Outreach aims:

- To engage the public directly with archaeological research through public demonstration.
- To help connect Newcastle University research with the local area through collaboration with Jarrow Hall.
  - To deliver a public lecture about experimental archaeology at Jarrow Hall.
- To produce, in collaboration with the Culture Lab, a short documentary film, aimed at the public, on experimental archaeology and demonstrating the work of EXARN.



Map of Cyprus showing location of Pyrgos-Mavroraki.



Blowpipe-nozzles recovered from Pyrgos. These nozzles were fitted to the end of blowpipes and helped direct the blast of air, as well as insulate the blowpipe and user from the heat of the furnace.

### Glossary

**Smelting:** To extract a metal from its ore by a process of heating.

**Ore:** a mineral from which a metal can be obtained

**Slag:** a glass like waste product produced when a metal is extracted from its ore, composed largely of silica and metal oxides.

**Crucible:** a ceramic vessel designed to withstand high temperatures in which metal is smelted or melted.



**Chalcopyrite**  
An ore of copper  
Composition: copper, iron and sulphur



**Malachite**  
An ore of copper  
Composition: copper carbonate

### Experimental Archaeology

#### What is experimental archaeology?

Experimental archaeology is a field of archaeological investigation that uses experimental simulation and reproduction of archaeological processes., e.g.

- production of stone tools
- working of a metal furnace
- building a prehistoric house

Used to develop and test hypotheses derived from the clues left to us in the archaeological record.

#### How is it different from re-enacting or recreation?

- Involves systematic and detailed recording of data.
- Aimed at answering specific archaeological questions.
- Experimental work should simulate archaeological conditions as closely as possible.
  - Experiments should be reproducible.
  - Careful control of variables.

### Pyrgos-Mavroraki

Pyrgos-Mavroraki is an archaeological site on the southern coast of Cyprus, in the modern district of Limassol.

The site dates to c.2500-1800 BC a period known as the Early/Middle Bronze Age.

The site produced a large number of artefacts, materials and structures relating to metal working including:

Smelting and casting furnaces	Moulds
Slags	Anvils
Crucibles	Metalworking tools
Blowpipe-nozzles	

### The Experiments



A Bowl shaped furnace was constructed based upon those found at Pyrgos.



Chalcopyrite ore was roasted in a fire at approx. 800°C for 12 hours.



Roasting removes the sulphur and oxidises the ore.



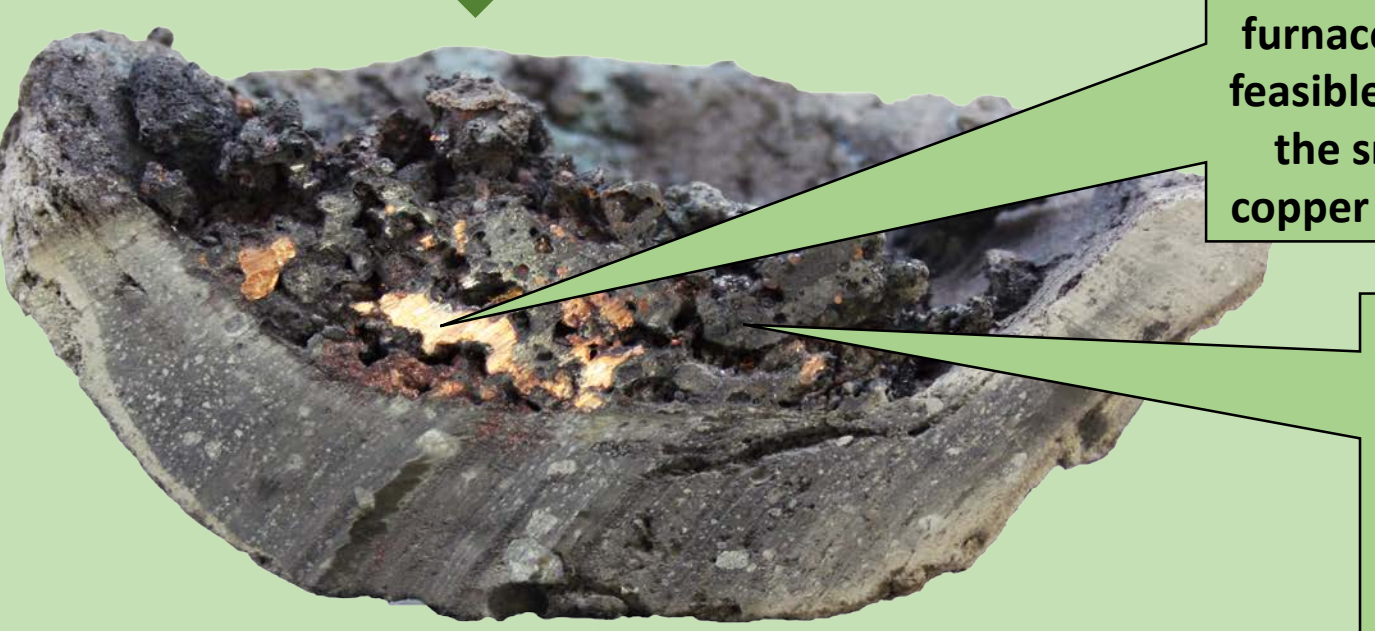
Blowpipes were used to raise the temperature of the furnace, in a similar manner to bellows. The blowpipes relied purely upon the lung-power of the users. However despite this it was found that if used efficiently temperatures of upto 1200°C could be reached,



A fire was lit within the bowl shaped furnace, and the crucible placed in the centre. The crucible was completely covered with charcoal in order to exclude oxygen.



The roasted ore was crushed, placed in a crucible and mixed with sand and charcoal. In three of the experiments the chalcopyrite was mixed with another ore: malachite.



Copper successfully separated from the ore. Suggests that the blowpipe bowl furnace model is a feasible method for the smelting of copper in antiquity.

Slag. Composition will be compared with those from Pyrgos

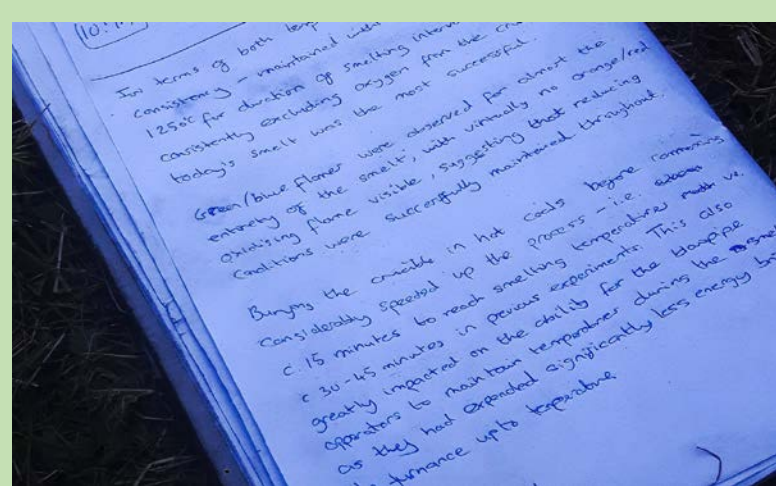
10cm

Once the crucibles were removed from the furnace they were left to cool. They were then sliced in half, these half sections will be analysed using chemical and microscopic analysis in order to compare the results to archaeological material from Pyrgos.

### Recording

Throughout the experiment data was recorded:

- Quantitative data**
  - Temperatures taken at 5 minute intervals.
  - Time to reach 1000°C.
  - Ratio of ore:sand:charcoal in crucible.
- Qualitative data**
  - A detailed record of what we have observed, inferred, and learnt throughout the process.



### Communicating the Past

In addition to answering archaeologically driven research questions, the main challenge envisaged by this project was to connect the University and its activities to the local area, disseminating the research in an accessible manner to a wider audience through public demonstrations and digital outcomes.

During the entire length of the experiment members of the Archaeological Team took turns in delivering explanations about the project and the experiment itself.

Setting our project within the grounds of Jarrow Hall allowed us to reach a wide range of people, including those who might not otherwise have had access to such experiences through the social aims of the museum.

A public lecture on experimental archaeology has been delivered at Jarrow Hall Anglo-Saxon Farm.



### The Documentary

The videos, sounds and interviews collected during the experiment have been collated by a team of students from the Culture Lab into a short documentary on experimental archaeology and its methods.

The documentary illustrates the unique and vital ability of experimental archaeology to connect people in an exciting, tangible, and meaningful way to the past.

#### To watch:

Scan the QR code on the right with either your phone's camera (iPhone and most android phones) or with a QR code reader app.

OR

Follow the URL below the QR code.



<https://tinyurl.com/y7skx9ha>