

Experiment Proposal

Experiment number GP2024009

Principal investigator	Professor Romolo Loreto, University of Naples Orientale, ITALY	
Co-investigator	Dr Giovanni Romanelli, University of Rome Tor Vergata, ITALY	
Co-investigator		
Experiment title	Archaeometric study of iron ingots from the North Arabian oasis of Dumat al-Jandal, Saudi Arabia	
MRF Instrument	SEM with correlative AFM	Days requested: 2
Access Route	Direct Access	Previous GP Number: -
Science Areas	Cultural Heritage	DOI: -
Sponsored Grant	None	Sponsor: -
Grant Title	-	Grant Number: -
Start Date	-	Finish Date: -
Similar Submission?	-	
Industrial Links	-	
Non-Technical Abstract	<p>Dumat al-Jandal stands as one of the main archaeological sites in the Kingdom of Saudi Arabia, currently on the UNESCO Tentative List. In the Nabataean-Roman era, and until the advent of Islam, the oasis was the hub of a caravan trade involving the Arabian oases, the Nabataean kingdom and Roman Imperial Arabia. Therefore, a complex picture of the development of the phases of ancient trade can be sketched out. The archaeometric study of ingots can thus contribute, for the first time, to shedding light on new dynamics of trade, particularly iron products (if only iron is involved).</p> <p>We propose a morphological and elemental characterization of a set of iron ingots from the North Arabian oasis of Dumat al-Jandal using the "SEM with correlative AFM" instrument, featuring both scanning electron microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDX).</p>	
Publications	-	

Instruments	IMAT	Days Requested: 2
Access Route	Direct Access	Previous RB Number:
Science Areas		DOI:
Sponsored Grant	None	Sponsor:
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Industrial Links		



Sample record sheet

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MRF Instrument **SEM with correlative AFM** **Days Requested: 2**
Special requirements:

SAMPLE

Material	iron ingots	-	-
Formula	Iron based	-	-
Forms	Solid		
Volume	20 cc		
Weight	50 g		
Container or substrate	-	-	-
Storage Requirements	-	-	-

SAMPLE ENVIROMENT

Temperature Range	300 - 300 K	-	-
Pressure Range	1000 - 1000 mbar	-	-
Magnetic field range	- T	-	-
Standard equipment	None	-	-
Special equipment	-	-	-

SAFETY

Prep lab needed	Yes	-	-
Sample Prep Hazards	-	-	-
Special equip. reqs	-	-	-
Sensitivity to air	No	-	-
Sensitivity to vapour	No	-	-
Experiment Hazards	-	-	-
Equipment Hazards	-	-	-
Biological hazards	-	-	-
Radioactive Hazards	-	-	-
Additional Hazards	-	-	-
Additional Details	-	-	-
Sample will be	Disposed by IS	-	-



1. Background and Context

Dumat al-Jandal stands as one of the main archaeological sites in the Kingdom of Saudi Arabia, currently on the UNESCO Tentative List and the subject of excavations and restorations by the Italian Archaeological Mission in Saudi Arabia (headed by R. Loreto). The site's archaeological landscape presents an extensive archaeological park composed of the medieval-era settlement that insists on the pre-Islamic era stratifications (Byzantine, Nabateoroman and Neo-Assyrian phases), the funerary area and an imposing fortified caravan station from the Roman era.

Known in 7th century Assyrian sources as Adummatu and in 1st century BC-2nd century AD Nabataean-Roman sources as Dumah/Dumatha, it is one of the main North-Arabian oases that emerged in historical times as caravan centres along the routes between the Levant, Mesopotamia and the South-Arabian kingdoms of pre-Islamic Yemen. Thus, together with the other oases of Tayma and Dadan, Dumat al-Jandal represents one of the main key sites in North-Arabia, an ecological niche in an environment, that of the 1st millennium BC - 1st millennium AD, which was arid.

In the Nabataean-Roman era, and until the advent of Islam, the oasis was the hub of a caravan trade involving the Arabian oases, the Nabataean kingdom and Roman Imperial Arabia. Fifteen years of Italian-Saudi research are contributing not only to the historical rediscovery of an oasis whose occupation is unbroken from the 8th century B.C. to the present day, but also make it possible to better recognise the oasis' commercial role thanks to surveys conducted in the North Arabian region of Jawf, for the recognition of the passage routes of ancient caravans.

At the current state of research, the material culture, especially ceramics and examples of terracotta figurines, show close trade contacts with Assyria (7th-7th c. BC), the Tayma oasis (6th c. BC) and Nabatene or Arabian Province from 105-106 AD. The latter period is characterised by a particular abundance of materials, such as painted ceramics produced in Petra and exported to the Near East, or fictile productions (statuary) and monumental architecture. Thus, an initial and complex picture of the development of the phases of ancient trade can be sketched out. This proposal is well suited to the state of the art as it would allow us to examine the earliest examples of iron ingots traded in North Arabia. Excavations of the Nabataean settlement have revealed, exceptionally, a 'treasure trove' of ingots preserved within a private dwelling located at the foot of the acropolis, thus in a privileged urban sector.

2. Proposed experiment

The archaeometric study of ingots can thus contribute, for the first time, to shedding light on new dynamics of trade, particularly iron products (if only iron is involved). This first research question would be followed by others equally refined: is it iron imported from distant or local areas? Is it transported or locally produced ingots? Are the ingots found in their place of use or are they destined for a later destination? If local, can these ingots prove the existence of a local iron craft? In case of previous datasets from other contexts can we define the chronology and date for this kind of ingots? To answer these questions, we propose a morphological and elemental characterization of a set of iron ingots from the North Arabian oasis of Dumat al-Jandal using the "SEM with correlative AFM" instrument, featuring both scanning electron microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDX). The morphological characterization will provide information on the manufacturing practices and original use of the artefacts, while the elemental analysis, providing



information on the additional elements and impurities on the ingots supposedly mainly containing iron, could provide information on the origin of the metallic ores or the commercial routes of this ancient civilization. Both pieces of information will be available concurrently using the SEM-EDX capabilities of the MRF instrument selected.

In addition to the SEM-EDX proposal, we plan to submit a related proposal at the ISIS Neutron and Muon Source to obtain a neutron tomography of some of these artefacts using the IMAT beamline. The artefacts, mainly containing iron and relatively thick, are not suitable for most X-ray tomography instrument, while neutrons would provide an optimal and non-invasive way to study their internal composition.

3. Justification of experimental time requested

We request 2 days of instrument time of the “SEM with correlative AFM” instrument to be used as follows: Up to 4 hours per sample of measurements, for a total of up to 6 samples.



Fig. 1. Top: The core of the ancient oasis of Dumah/Dumatha. To the left the acropolis, to the right the medieval village resting on the Nabataean phase. Bottom: Ingots found in a domestic unit dated to between the I cent. BCE – II cent. CE. Average diameter 8cm. Both complete and in fragmentary status

References

R. Loreto. 2017. *Alle origini degli Arabi. Un viaggio nell'archeologia dell'Arabia Saudita*. Mondadori Education.

