Cutting edge research: a new look at Iron Age swords from Iran

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Over recent years, a large assemblage of metallic artefacts from Iran has been intercepted by the UK Border Force and, thanks to our colleagues in Tehran, we have the opportunity to research these in great detail prior to repatriation. Among the objects are bracelets, pins, horse trappings and numerous weapons such as axe heads, arrowheads, spearheads, daggers and swords. The latter two categories, defined as bladed weapons, were chosen as the focus of a PhD project jointly funded by Cranfield University and ISIS Neutron and Muon Source entitled "Complex Metallurgy of the Bronze Age-Iron Age Transition in Iran: Archaeomaterials and Forensic Investigations". Being complex objects, swords lend themselves very well to investigations of ancient metal production and how that changed when bronze technology reached its peak in the region and iron began to be used for utilitarian purposes. The research explores bronze casting techniques, alloy choices, and bimetallic technology in the early Iron Age (circa 1250-550 BC).

As the objects had been trafficked, the first challenge was to work out their possible provenance. In Iran, weapons are predominantly found in burial contexts but it is impossible to say whether they were looted from known sites or a new location had been discovered and illicitly excavated. Stylistically the swords can be linked to sites in Luristan, Kermanshah, Gilan and Western Azerbaijan, but there are a few objects which still elude identification. It is likely that they were collected all over north-west Iran from different dealers, changing hands multiple times.

Scientific methods implemented in this project include LA-ICP-MS in an artefact chamber, X-ray µCT, p-XRF as well as Neutron Tomography and Neutron Diffraction at ISIS Neutron and Muon Source. So far, these techniques have revealed that a significant number of recovered swords are pastiches, which unfortunately is quite common with Iranian weaponry sought by private collectors.

While the most common methods of studying ancient metals involve metallography, SEM or LA-ICP-MS, which all require sampling, this project focuses on non-invasive techniques. Neutron Tomography allows us to study the internal structure of an object and is complementary to X-ray Tomography. In cases of modern repairs or pastiches, it reveals glue and corrosion products which would be invisible to X-rays due to their high hydrogen content. Neutron Diffraction is applied to examine the crystalline structure of materials, allowing for identification of iron phases without sampling the object, which can reveal whether the metal was hot- or cold-worked, and if there is evidence for intentional carburisation. An entire object is placed inside the instrument equipped with detectors that measure the scattering of the neutron beam and provide diffraction patterns which are then interpreted. With this technique, we were able to analyse an iron tang inside a bronze hilt completely non-invasively.

A paper discussing pastiches discovered during this project is due to be published soon and a small display at the British Museum is planned to showcase a few examples of pastiches alongside Neutron and X-ray Tomography images showing their internal structure and the extent of modifications. It will highlight the issue of heritage crime in Iran and the Museum's role in raising awareness of artefact trafficking. Hopefully, it will also introduce the public to the use of neutron science in archaeology and the heritage sector.

This research is jointly funded by Cranfield University and ISIS Neutron and Muon Source, Science and Technology Facilities Council.

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1. Analysing neutron tomography scans of a bimetallic sword at ISIS Neutron and Muon Source



2. Bimetallic pommel and an X-ray µCT slice through the object showing an iron tang and casting flaws



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2023-12-01
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Rodzinka A. (2023) Cutting edge research: a new look at Iron Age swords from Iran. British Museum Middle East Department Newsletter, Issue 8, 2023

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