Experimental archaeology

This is not an autonomous discipline, but a scientific research tool that can be described as an hourglass. On the upper part, the various classic disciplines dealing with the historical subjects. In the centre, experimental archaeology working on a precise topic and following a specific objective. In the bottom part, classical disciplines again, but providing new answers to new topics. We also learned that all our articles and theories are only projections of our thought, to be considered with caution.

Like the Egyptians, we appreciate the timing of melting; through the cherry-red colour of the crucible, through the continuous breathing of the fire, through the white colour of the charcoal, through the blue-green tin gas, through the vibrations in the degassing stick and through the mirror effect of the bronze.

The Egyptian metallurgy had limited means at its disposal. The bronze crucible was everything, including the tuyere heads, which explains their erosion. The pot bellows were activated through an alternative movement of the feet. Each crucible could have functioned with four tuyeres and was thus supplied with pressured air, thanks to the jets. This ventilation complex is mobile. First, the tuyeres were installed after the crucible was set. Then, during the handling of the crucible, one only needed to remove the tuyeres, which facilitated the use of the crucible extraction instruments.

Colorimetric stratigraphy found during the excavations

The crucible was a factor.

The crucible, set in the sand, is a mistaken interpretation. It should respond exactly to the Egyptian measure of 25 din (1 dbn = 91 g).

The hearth shows an angle of 135°. This drilling was made towards the centre of the fire, through the white colour of the charcoal, through the blue-green tin gas, through the vibrations in the degassing stick and through the mirror effect of the bronze.

De-waxing ovens, Qantir, Ramesside period, QI-ax/3, stratus B/3

Four cross-shaped ovens

They are geographically connected to the melting ovens. The interpretation of their exact use remains problematic; we suggest they were used for the de-waxing of the moulds.

Phase I 80% de-waxing, firing of the clay moulds, during X hours

Phase II Full de-waxing of the residual wax absorbed by the clay, during X hours

Phase III Maintaining the moulds hot before casting

Assumption of a pre-industrial production

Considering the amounts produced and the number of craftsmen (minimum estimation: 160 blowers, 160 metalworkers + craftsmen from other corporations), we believe we can refer to an organised and structured pre-industrial production. Next to the typical metallurgical installations, there were other workshops, which were exclusively in charge of by-products and subsequent activities. Workshops of charcoal men, potters, tanners, wax sculptors and moulders took care of the by-products. Logistics included masters and their assistants, scribes, weighers and suppliers. Small multifunctional and standardised refining workshops along with finishing casted artefacts workshops took care of the artefacts. In total, this activity must have regrouped 600 people working full-time. These “workshops” were attached to important administrative structures (such as temples or palaces).

Production: utilitarian typology of an open oven to obtain a first form of “continued casting”, estimating that each crucible could produce 1.9 kg of bronze every 45 minutes; hence the management of 80 crucibles and multiple casting funnels for each mould. (cfr TT100).

Profitability: simplification of the casting phases, limited number of instruments used, conception of moulds (the layers of matter render the casts useless and the breaking at high temperature, just after the casting, replaced the sawing), standardisation of the ceramics, mechanical and plastic resistance of these ceramics.

In conclusion, Egypt did not innovate in the field of metallurgy but maximised profitability while avoiding additional physical efforts for many workers.

OPEN QUESTIONS

• The cavities in the upper bricks would indicate, with the presence or not of an angle, that the tuyeres were set face to face (two per crucible) or in a cross position (four per crucible).

• Since the production had to be regulated, it seems it would have been two blowers per crucible instead of four blowers per three half-crucible.

• There are no explanations for the circular empty holes in the hearth. The crucible, set in the sand, is a mistaken interpretation. It should be at the same height as stratum III and not necessarily maintained with a support.

• An experiment should be undertaken again to define the charcoal consumption as well as the type of coal (mistake during the first reconstitution on the oven depth).

• Which temperature can we cast in the moulds? Would the size of the crucible be different?

• As the moulds cannot be transported, was a mobile wood pontoon needed to remove the tuyeres, which facilitated the use of the crucible extraction instruments.

All the artefacts are standardised allowing compatibility, control and management of the bronze casting

Crucibles Tuyeres Pot bellows

One of the various kinds, in the shape of a ship carina, is made in a local clay with sand. The hearth shows spherical traces. An average Qantir crucible of 250 cm³ corresponds exactly to the Egyptian measure of 25 din (1 dbn = 91 g).

Two distinct parts: the canal and the jet which goes through the outer side of the tuyere proximal part. This drilling was made following a pre-defined angle of 135°. The tuyere heads are greatly damaged by the fire with a diagnostical erosion.

Typical of the NE; they are made of two parts: one in terracotta, the other in leather. The leather bag was pulled up with a string and was then compressed by the blower’s foot. The blower always activated two bellows at a time.

Previous proposal of interpretation, Qantir, Ramesside period, status B3a. Experimental archaeology. Diverging Verfahren der Metallverarbeitung in Theben und Qanir?

PRE-INDUSTRIALISATION OF BRONZE MELTING DURING THE NEW EMPIRE PERIOD

Melting ovens, Qantir, Ramesside period, N-S, stratus B3a

Excavations and experiments

Four melting batteries

Structural dimensions

30cm deep 65cm large 15cm long

Functional dimensions

16cm deep 35cm large 15cm long

Simple structure with two parallel walls built in bricks, with no mortar; on a sand heart, in the bottom of the pit/ditch. These walls were likely of a maximum height of two bricks: since the upper part shows the colorimetric II orange stratum (due to a secondary firing) and a few tuyeres still resting on the upper part of these walls in small empty holes. This height would also determine the working surface receiving the bellows. From these tuyeres, bamboo would connect with the pot bellows. Since the tuyeres were on a horizontal position, jets, leaning towards the centre of the fire, were needed. This way, the oxygen went along the outer side in order to keep a semi-reductor environment.

Charcoal covered everything, including the tuyere heads, which explains their erosion. The pot bellows were activated through an alternative movement of the feet. Each crucible could have functioned with four tuyeres and was thus supplied with pressured air, thanks to the jets. This ventilation complex is mobile. First, the tuyeres were installed after the crucible was set. Then, during the handling of the crucible, one only needed to remove the tuyeres, which facilitated the use of the crucible extraction instruments.

Stratum Colorimetry Characteristics

These moulds a factor?

Stratum I Grey/black zone, burn-free

Upper part of the wall, no charcoal and no overflowing in oxygen, ± 300°C, oxidizing zone

Stratum II Orange zone Transition zone with occasional charcoal, light fire traces by radiation heat, ± 800°C, oxidizing zone

Stratum III Red/brown zone Presence of charcoal with a high level of oxygen supply, highest zone of heating with vitrification, ± 1200°C, semi-reductor zone, melting possible thanks to the Boudouard reaction = position of the crucible

Stratum IV Grey/white zone Presence of charcoal with a lesser oxygen supply, transition zone towards the slow-pace combustion zone, ± 790°C, oxygen lowering zone

Stratum V Black zone Lowered part of the wall, charcoal burning slowly, ± 600°C, oxygen-free zone

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