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The pottery production at Sumhuram (Khor Rori, Sultanate of Oman): an archaeometric study

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Abstract **– The aim of this paper is to present the preliminary results of the archaeometric characterization of a particular pottery production in the settlement of Sumhuram, in the area of Khor Rori (Sultanate of Oman), the easternmost port of ancient the caravan kingdoms, along the southern coast of Arabia (2nd cent BC – 5th cent AD).**
The inhabitants of Sumhuram provided to their needs through several local productive activities, as indicated by the presence of kilns and furnaces used for different purposes.
In the past, few studies speculated, and partially demonstrated, the possible occurrence, at Sumhuram, of a local pottery manufacturing; however, no kilns were ever found until recent years.
In 2015, archaeological investigations unveiled the first clear evidence of a local prottery production at the site through the discovery of a pottery kiln and some production wastes inside the city wall.The furnace discovered in Sumhuram is the only one suitable for firing pottery in the whole southern Arabia in pre-Islamic period.
Twenty-two potsherds from the productive area have been analysed with micro- and macro-photo, and thin sections, in order to illustrate the development of the whole pottery cycle, from the treatment of the raw materials to the final products.

I. INTRODUCTION

The site of Sumhuram (2nd cent. BC – 5th cent. AD), located along the south-western coast of Oman, was a key port in the Indian Ocean trade in pre-Islamic time.

Founded by the caravan kingdom of Ḥaḍramawt, the city was a natural harbour protected by two rocky spurs overlooking the Indian Ocean and offering a safe mooring in the lagoon formed by wādī Darbat.

Identified with the port of Moscha Limén mentioned in the *Periplus Maris Erythraei*, it was a rich hub involved in a wide network of commercial contacts with different parts of the ancient world.

Sumhuram was a small city protected by an imposing city wall and watchtowers. Along the northern side of the city wall, a monumental gate gave access to the city. On its eastern side, a second small entrance served as rapid passage, connecting the dock and the market square which was surrounded by frankincense storerooms.

The excavation activities carried out since 1999 by the Italian Mission To Oman (IMTO), University of Pisa, under the direction of Alessandra Avanzini, and the Office of the Adviser to His Majestry the Sultan for Cultural Affairs (Oman) have highlighted the characteristics of an urban settlement divided into different quarters (productive, residential and religious). Sumhuram provided for its needs through several local productive activities, as indicated by the presence of kilns and furnaces used for different purposes and by the occurrence of evidences related to dying process. The general plan of the site has been divided in different sectors indicated by capital letters (Fig. 1).

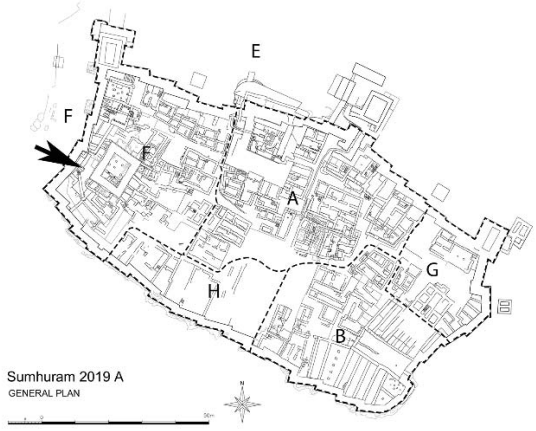

Fig. 1 General plan of Sumhuram with indication of the different areas (drawing ©IMTO) indicated by capital letters.

In the past, a few studies speculated on a possible local pottery manufacturing in Sumhuram; however, no kilns were ever found until recent years.
In 2015, the archaeological investigations unveiled the first evidence of a local pottery production through the discovery of a ceramic kiln and some production wastes inside the city wall. Moreover, some unfinished fragmentary potteryes were unearthed in area of the kiln itself. A fragment of unfinished pottery (probably fired at low temperature) made of a part of the globular body with a coil attached on the internal surface (from which probably the rim was shaped), led the authors to speculate about the possible local production of Wavy Rim Bowls (Fig. 2).

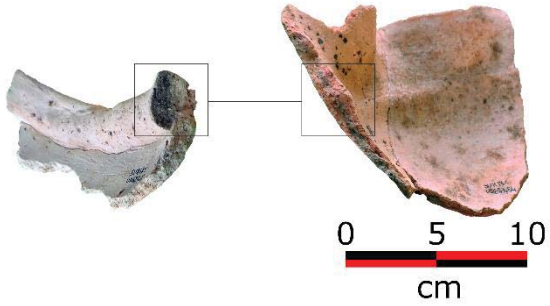

Fig. 2 On the left, a fragment of unfinished pottery and, on the right, a fragment of Wavy Rim Bowl from Sumhuram (Photo ©IMTO).

Named also as Bayḥān bowls because their high occurrence in the area of wādī Bayḥān [1], these hand-made vesselswere characterized by a wavy rim, a bulge or swelling visible on the interior, a globular body, a ring base and a simple smoothing of the surfaces [2]. Many examples of this type of vessels were found in Sumhuram, where, in general, they seem a marker for the earlier occupational levels [3,4]. Three main fabrics, distinguished by the occurrence or not of chaff and/or steatite, were recognized at Sumhuram [3].
The recent discovery of the pottery kiln and related pottery wastes and unfinished fragments mallow to consider this pottery typology not only as an importation from south-west Arabia [2], but also as a local manufacture.
Some samples of this pottery were selected to be analysed in order to verify the hypothesis and to underline the characteristics of the pottery productive cycle with an attention to the dynamics of the technological knowledge transmission.

II. GEOLOGICAL SETTING

The harbour of Sumhuram stands in the Dhofar region (southern Oman seacoast) at the edge of the Jabal Samhan plateau mainly composed by carbonate rock outcrops belonging to the Umm Er Radhuma Formation (UER) of Paleogene-Early Eocen age. The formation is made of compact limestone of marine origin, white or pale-pink fossil-like material, dolomitic limestone, biocalcareous rocks formed by fossil fragments cemented by a calcareous background, chalks and layers of silicate rocks [5,6]. On the estuaries of the rivers in the Dhofar region, there is an abundance of limestone clays, good for the pottery production, which give the finished products a very light yellowish colour due to the high limestone content [7,8].

II. MATERIALS AND METHODS

For the purpose of this study we have analysed 22 potsherds of Wavy Rim Bowl, coming from Area F (the "Cult Quarter") at the NE corner of the city wall of Sumhuram site [9]. Before cutting them for thin section we proceed with archaeological description of the potsherds.
The analysed samples were observed by mean of a ZEISS Stemi 2000-C stereomicroscope for macro observation and by a Zeiss Axioplan for petrographic analysis of thin sections.
The selected samples belong to the stratigraphic units (US) 623, 635, 753 and 776. From the typological point of view, the potsherds belong to the rims and ring bases of the so-called "Bayān Bowl" typology. For an automatic estimation of relative grain size distribution (GSD), a modified MATLAB script from Rabbani & Ayatollahi [10] have been applied.
From a macro observation on the fresh section of the potsherds, it can be seen that there are two main groups: one formed by potsherds with abundant porosity and clasts (A) and the other one characterised by micro porosity and no evidence of clasts (B) (Fig. 3).

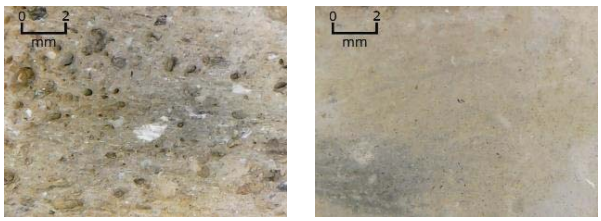

Fig. 3 On the left, an evident macroporosity in the sample US635_59 (Group A); on the right, no macroporosity in the sample US623_114 (Group B).

Before to proceed to the thin section analysis we subdivided the potsherds by evident macro-porosity in two groups as listed in *Table 1*: macro group A with evident macro-porosity and group B with no evident macro-porosity.

Table 1 List of analysed samples.

ID	US	Description	Macro-group
US623_114	US623	Ring base	B
US623_161	US623	Rim	B
US623_274	US623	Ring base	B
US623_84	US623	Rim	B
US623_88	US623	Ring base	B
US623_89	US623	Ring base	B
US623_93	US623	Ring base	B
US623_96	US623	Rim	B
US623_98		n/a	B
US635_100	US635	Ring base	A
US635_15A		n/a	A
US635_27		n/a	A
US635_59	US635	Ring base	A
US635_60	US635	Ring base	A
US635_79	US635	Rim	A
US635_95	US635	Rim	A
US753_24	US753	Ring base	B
US753_4	US753	Ring base	B
US753_nn	US753	Rim	B
US776_19	US776	Ring base	B

III. PRELIMINARY RESULTS

The surfaces of the potsherds are all well smoothed with colours that span from light brown to yellowish (Munsell 10YR 7/3; 2.5Y8/2) with no evident defects or decoration.

Based on petrographic features, the samples show from semi-isotropic to weakly anisotropic groundmass. In sample US753 the weakly anisotropy seems to be more accentuated. The groundmass colours span from light-grey to dark yellowish-brown (Munsell 10YR 6/1; 10YR 7/1; 10YR 8/2; 10YR 4/5) (*Fig. 4*). On the basis of the surface and inner colour, the firing atmosphere was determined to be oxidizing and the presence of organic temper in some potsherds determined the black heart phenomenon [11]. From the petrographic point of view, the ceramic fragments do not show striking differences (*Table 2*, *Fig. 4*). The differentiation in the fabrics is between fine grain and coarse grain. In the coarse grains, there are large fragments of micritic limestone that sometimes exceed 50 μm with rounded/sub-rounded edge.

Table 2 Petrographic analysis. Qtz=Quartz, Phyll=Phyllosilicates, Cal=calcite, Kfs-Pl=K-feldspar-plagioclase, Tlc=Talc, R=rock fragments, F=fossils, Px=piroxen, FT=approximative firing temperature.

ID	Qtz	Phyll	Cal	Kfs-Pl	Tlc	R	F	T (°C)
US623_114	X	X			X	X		600 - 850
US623_161	X	X				X	X	600 - 850
US623_274	X	X				X		600 - 850
US623_84	X	X		X		X	X	600 - 850
US623_88	X	X	X		X	X	X	600 - 850
US623_89	X	X				X	X	600 - 850
US623_93	X	X				X	X	600 - 850
US623_96	X	X		X	X	X	X	600 - 850
US623_98	X	X				X		600 - 700
US635_100	X	X			X	X	X	500 - 750
US635_15A	X	X		X		X		<500
US635_27	X	X		X	X	X		500 - 750
US635_59	X	X			X	X	X	500 - 750
US635_60	X	X			X	X	X	500 - 750
US635_79	X	X			X	X	X	500 - 750
US635_95	X	X			X	X	X	500 - 750
US753_24	X	X				X	X	600 -

								850
US753_4	X	X				X	X	<500
US753_nn	X	X				X	X	700 - 850
US776_19	X	X				X		500 - 700

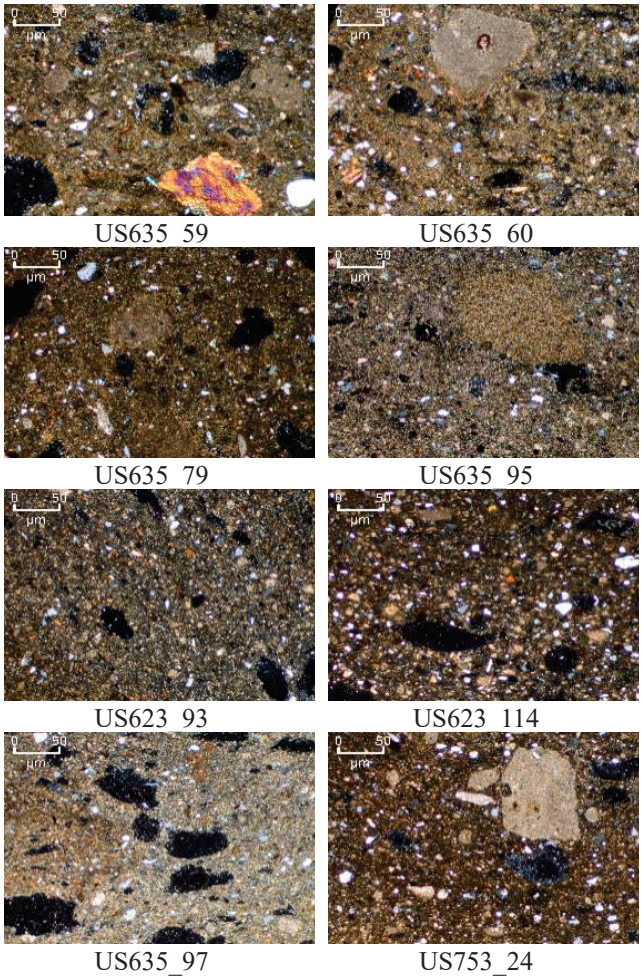

Fig. 4 Some micro-photo of the analysed samples: US635,59-60-79-95; US623,93-114; US635,97; US753,24.

In all the analysed samples, the skeletal fraction is abundant (~25%) with dimension that is not well sorted: the most part of the skeletal fraction is <15 µm, while few clasts are comprises between 30 and 70 µm. The boundaries vary from angular to sub-angular shape. The pores are elongated to sub-rectangular (rare). From an automatic GSD procedure (*Fig. 5*), the average grain radius for all the samples have been obtained (*Table 3*): the value is quite homogeneous (5.1 µm to 7.8 µm) with some peaks in the fragments US635_27 (10.9 µm), US623_98 (14.8 µm) and US776_19 (17.8 µm).

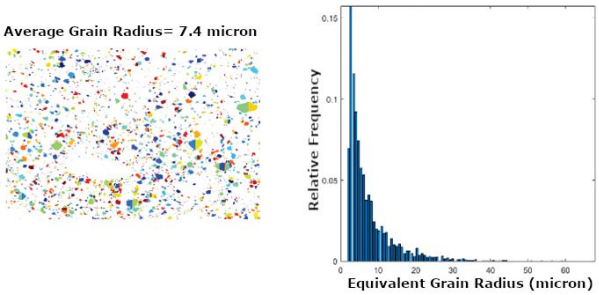

Fig. 5 Results of grain size distribution (GSD) for sample USM623_114.

Table 3 Average grain radius of each analysed sample (AGR).

ID	AGR (µm)
US623_114	7.4
US623_161	6.4
US623_274	4.7
US623_84	7.8
US623_88	6.6
US623_89	6.4
US623_93	6
US623_96	6.1
US623_98	14.8
US635_100	7.2
US635_15A	6.3
US635_27	10.9
US635_59	6.7
US635_60	7.2
US635_79	5.1
US635_95	5.7
US753_24	7.1
US753_4	6.2
US753_nn	6.5
US776_19	17.8

Considering the features preliminary determined by mean of petrography observations, it is possible to hypothesize that the firing temperatures of the analysed potsherds were between 500 °C and 850 °C, with probable temperature peaks around 950 °C. We report two fragments fired at very low temperature, one can be ascribed at macrogroup A (US635,15A) and the other one at macro-group B (US753,4).

The study could complete the information on technical knowledge and trade in the Sumhuram site. The Bayān Bowl, always considered an importation from Yemen, was probably locally imitated in Sumhuram by

workshops that were using the local raw materials, as testifies the presence of unfinished products. The used kilns could reach temperature between 500 °C and 850 °C.

IV. DISCUSSION

On the archaeological point of view, the presence of fragment of talc in the analysed potsherds is very interesting: at local level, there is no talc to be used as temper in pottery production, but the presence of Chlorite-talc-Schist is reported in North Oman, for the production of soft-stone vessels [12], and in Yemen [5,6]. Pallecchi and Pavan [13] noted the use of Chlorite-talc-Schist in some amphorae from the Sumhuram site and it is possible that similarly the talc imported from Yemen, to produce stone vases, can also be used as temper in local Bayḥān bowls productions. The standardization of surface treatments, the presence of a fixed kiln with many by-products around it reinforces the idea of local production, but in order to broaden the field of hypotheses, a statistically significant number of finished and unfinished products would be needed.

V. AKNOWLEDGEMET(S)

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