A Study on Faience Objects in the Ghaggar Plains during the Urban and Post-Urban Indus Periods

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Received: 19 August 2017; Revised: 18 September 2017; Accepted: 25 October 2017

Abstract: This article examines the morphological and compositional variations of faience objects collected from a number of Indus sites in the Ghaggar Valley. While no clear-cut variation was observed, the results exhibit homogenous features in the styles and production of faience objects that characterize the Urban and Post-Urban Indus periods in the Ghaggar Valley.

Keywords: Faience, Ghaggar Plains, Indus Period, Craft Production, Chemical Compositional Analysis, Regional Variation, Firing Technique

Introduction: Study on Craft Production during the Indus Period

In archaeology, the study on crafts focuses on a series of processes that consist of procurement of raw materials, transformation into objects, circulation and consumption. It aims at understanding the socio-cultural role of crafts in a given society of a specific period. With this purpose, the identification of raw materials and distributions of their sources, the reconstruction of technology that was used for their production, the excavation of workshops, morphological studies on objects, the understanding of the distribution patterns of specific artefacts, and patterns of consumption and disposal, are the subjects of study.

Focusing on the Indus urban period, a number of studies have been conducted on crafts. Especially, since the artefacts made of materials, which were distributed
unevenly from region to region, have been found quite uniformly over the region where the Indus urban system prevailed, the preceding studies have focused on revealing the provenience of raw materials (Law 2011), on the technology (Barthélemy de Saizieu and Bouquillon 1994, 1997, 2000; Barthélemy de Saizieu and Casanova 1993; Barthélemy de Saizieu and Rodière 2005; Bhan et al. 1994, 2002; Kenoyer 1984, 2005a; Miller 2008, etc.) and on the trade system that may have been controlled by social elites during the urban period (Kenoyer 1989, 1991, 1995, 1997, 2000, 2005b; Kenoyer and Miller 1999; Vidale 1995, 1989, 2000; Vidale and Miller 2000, etc.). These studies have made great contributions to our understanding of the Indus society.

Various raw materials were used for the craft production during the Indus period. But the archaeological evidence consists mainly of various stones, clay and faience. The variety of artefacts is also wide, but the ornaments of various materials are important for the study of the craft production system of the Indus society, because of the uneven distribution of raw materials and their possible role of symbolizing social structure of the Indus society.

This research project focuses on the Ghaggar plains, which occupies the north-eastern corner of the Indus society, in order to understand the temporal change of craft production through time from the Indus urban period to the post-urban period in this region. As a part of the project, faience objects have been subjected to a series of scientific analyses to identify their raw materials and production technology. This brief paper deals with the results of the analyses conducted in the season of 2010-2011, which focused on surface collections of faience objects from a number of sites in the Ghaggar plains.

Analyses on faience objects have been so far conducted only at Mohenjodaro (Ullah 1931), Harappa (McCarthy and Vandiver 1990; see also Kenoyer 1994), Mehrgarh and Nausharo (Barthélemy de Saizieu and Bouquillon 1997, 2000). Various analytical methods were applied in order to reveal raw materials and manufacturing techniques of faience objects. However, as the data from other sites have not been available, it is difficult to reconstruct the entire picture of faience production and use in the Indus region.

The Ghaggar plains have been well known for its dense distribution of archaeological sites that are datable to the urban and post-urban periods. In this sense, this region is very suitable for reconstructing a series of changes of craft production through time and space, in parallel with the development and decline of the urban system. It is also one of the aims of this project to better understand the historical significance of this region by means of multi-faceted studies on the craft production system.

**Faience Objects in the Ghaggar Plains**

In the Ghaggar plains, a number of faience objects have been collected from many sites. Vivek Dangi, one of the authors, made a series of extensive explorations in this region
and collected faience objects from more than 50 sites (Figure 1). So far, 53 sites, which cover northern Rajasthan and central and northern Haryana, have been registered for faience objects. The southernmost part of Punjab also falls in the explored area.
Figure 3: Distribution of sites from where faience bangles were collected

Figure 4: Distribution of sites from where faience vessels and balls were collected
Figure 5: Faience objects from the Farmana settlement (after Konasukawa et al. 2011)
Figure 6: Size distribution of faience beads from the Farmana settlement (left: type-wise distribution, right: distribution with stone beads)

Figure 7: Size distribution of faience bangles from the Farmana settlement
Figure 8: Representative specimens of faience objects in the Ghaggar plains  
(Surface collection by V. Dangi)
The faience objects from this region consist mainly of beads and bangles, and a few vessels and balls can be added to the repertoire (for their distribution, see Figures 2 - 4). Since unfortunately many excavations at sites in this region have not been fully reported, the temporal change of repertoire and morphological assemblage cannot be well understood. However, Farmana, an urban period site (Shinde et al. 2011), and Bhagwanpura, a post-urban site (Joshi 1993), can give us a brief outline of repertoire and assemblage in these two periods, as full reports are available for these two sites.

At Farmana-1 (a settlement site), the excavations were conducted in the seasons of 2006-07, 2007-08 and 2008-09 and revealed a mud-brick structural complex on the uppermost level. Below this level, cultural deposits of 3.5 m in thickness were confirmed, although the structural plan of earlier levels was not unveiled. Since Harappan pottery occurred from the lowest level to the uppermost level, the entire stratigraphy can be dated to the Indus urban period. In addition, a series of C14 dates give a range of 2500 cal BC to 2300 cal BC. The entire stratigraphy can be broadly divided into five phases based on structure levels.

At this site, faience beads are relatively limited in number, whereas stone beads were abnormally found counting 4090. For faience beads, three specimens were found in Phase 3, 13 in Phase 4 and 29 in Phase 5 (Figure 5: 1-24).

The beads consist in form of cylindrical, long barrel, globular, short biconical, compartmented cylindrical, etc. In terms of their size, the faience beads measure less than 1.0 cm in diameter and less than 2.0 cm in length (Figure 6: left). For cylindrical beads, there is a variation from shorter ones to longer ones, and for others relatively longer ones are dominant. Especially in the barrel shape, the ones longer than 1.0 cm in length are distinctive. The formal variety and size are similar to those of stone beads (Figure 6: right), although some shapes of stone beads are not observed in faience beads. This fact may indicate that the faience beads were made with a model of stone beads.

The specimens exhibit green, black, red and dark blue in colour. As no scientific analysis has been done on the chemical composition of glaze and body, its material and glazing technique are unknown. However, it is noteworthy that there are some specimens that are likely to have imitated banded agate and jasper beads (Kenoyer 1994).

For bangles, one specimen was found each in Phase 2 and in Phase 4, and six in Phase 5. There are two types in size; one type is thin having width and thickness less than 0.5 cm and a ratio between the two of 1.0 to 1.33, and the other type has a wider thickness with a thickness/width ratio of 1.57 to 2.21 (Figure 7). Both types are decorated with incised designs.

At Bhagwanpura where the excavations revealed occupations of post-urban and PGW periods, 32 beads and 99 bangles were found (Joshi 1993). Among beads, humped bull-
shaped, cylindrical, long barrel, short biconical, short cylindrical, etc. can be confirmed. Although their colours are not reported, there are some specimens that are coloured with different colourants in bands. The bangles consist of thin and wide ones like the specimens from Farmana. The thin examples include the heart-shaped plan. Most of the wide ones are decorated with incised designs.

Figure 9: Size distribution of faience beads from the V. Dangi collection
(left: type-wise distribution; right: region-wise distribution)

Figure 10: Size distribution of faience bangles from the V. Dangi’s collection
(above: plan-wise; below: section-wise)
Figure 11: Representative specimens of faience objects in the Ghaggar plains
(Surface collection by V. Dangi)

Figure 12: Representative specimens of faience objects in the Ghaggar plains
(surface collection by V. Dangi)
Figure 13: Representative specimens of faience objects in the Ghaggar Plains (Surface Collection by V. Dangi)

Figure 14: Representative specimens of faience objects in the Ghaggar plains (Surface Collection by V. Dangi)
In the surface collection by V. Dangi, beads and bangles are predominant, but there are a few specimens of balls and vessels (Figures 8, 11-14). Among beads, various shapes like long and short cylindrical, barrel, floral, animal-shaped can be observed.

Except for the animal-shaped bead, they measure less than 1.0 cm in diameter and less than 2.6 cm in length showing a distribution pattern similar to that of Farmana (Figure 9: left). Also in terms of shapes, they exhibit a formal variation similar to that of Farmana. However, constricted globular beads and floral-shaped beads are not seen in the stone bead shapes indicating that these shapes are unique to faience beads. These two types are small in both length and diameter. The cylindrical type includes shorter and longer ones. The barrel ones are represented by longer ones. The shapes and size are more or less uniform among regions showing a similar distribution pattern, though it can be noted that the specimens from the Bhiwani region contain longer ones in more number (Figure 9: right).

Some specimens are coloured with different colourants like pale and deep green, white, dark reddish brown, etc (Figure 8: 12-15; Figure 11).

As to bangles, there are two types on plan, that is circular and heart-shaped. Although it is difficult to identify the plan shape in fragments, eight specimens clearly have heart-shape. The circular ones count 49, but it may contain heart-shaped ones.

In the section size, most of them have width of less than 1.2 cm and thickness of less than 2.0 cm and the thickness/width ratio of 0.35 to 3.56 (Figure 10). Among them, the heart-shaped ones have a thickness/width ratio of less than 1.5 and thickness of less than 1.1 cm. In other words, no wider one is attested in the heart-shaped ones. In contrast, the circular ones exhibit a wider variation from 0.5 cm to more than 2.0 cm in thickness and from 1.0 to 5.5 in the thickness/width ratio.

The section shapes can be classified into the following types (Table 1; Figure 10: below).

Type 1 Circular/oblong
Type 2 Lenticular
Type 3 Rectangular
Type 4 Triangular
Type 5 Flat external face and convex internal face
Type 6 Flat rectangular

Type 1 ranges from thin to relatively wider in thickness, but the thickness/width ratio is not so large. For Type 2 and Type 5, the thickness/width ratios are distinctly larger with wider thickness. Type 6 has the extraordinary thickness/width ratio having a flat rectangular profile. Type 4 varies in the thickness/width ratio with a great variation in thickness. Type 3 is intermediary in the thickness/width ratio and thickness. Based on the reconstructed inner diameter, Type 6 can be considered not bangles but finger rings.
Although it is difficult to explain these variations, it can be noted that the ones with wider profiles tend to be decorated by complex incised patterns. It may suggest that the wider profiles were intended for decorations.

Based on these evidences, it can be stated that the faience in the Ghaggar plains developed in the urban phase and continued into the post-urban phase and that the dominant objects are ornaments like beads and bangles, although other objects, such as vessels, are also represented in a few number. Regarding their colours, green or blue colours are predominant. For shapes, there is a strong similarity among specimens of the urban phase and the post-urban phase. The incised decorations are prominent on bangles.

One of the problems to be scrutinized is the origin of the faience production in this region. Did it appear indigenously in the region, was it imported from the surrounding regions or locally made, and was there any technological influence from other regions for the local production? To answer these questions, many relevant issues should be understood. Since any workshop or kilns for the faience production have not been identified in the Indus region so far (Miller 2008) and not so many faience objects have been reported with their stratigraphic positions, it is difficult to compare faience objects among sites and regions in terms of their time-period and repertoire, and in terms of technological relations.

In this situation, it is urgently significant to document and characterize faience objects from both excavated and explored sites and to identify regional traits. Although no clear spatial and chronological variations have not been identified based on the data that have been analyzed in this project, more data should be systematically analyzed to testify this hypothetical conclusion.

**Chemical Compositional Analysis of Faience**

In understanding the faience production, the chemical composition of body and glaze is significant. Faience objects consist of a pasted body and a glaze. Two types of pasted bodies have been identified in the Indus region, viz. quartz and steatite. However, at present, the scientific analysis on the faience has been conducted at very few sites. Besides, the manufacturing process and techniques have also yet to be revealed.
In the Ghaggar plains also, no scientific analysis has been done. Therefore, it is a very first step to identify the variety of raw materials used for the faience production using various methods.

**Samples for Analyses**

In the season of 2010, 67 specimens of blue faience and three white faience, that is 70 specimens in total, were analyzed.

**Conditions for Analyses**

All the analyses were conducted indoor. Before the analyses, the surfaces of samples were cleaned with ethanol, and Chemical composition of the sample was determined by X-ray fluorescence spectrometer. Quantification of the result was made by calibration curve method. Identification of crystalline phase was made by X-ray powder diffractometer (Figures 15 and 16).

**Results of Analyses**

The average chemical composition of analyzed samples is shown in Figures 17 - 19. Figure 17 shows the results of blue faience bangles, Figure 18 blue faience vessels and Figure 19 white faience. Figures 17 and 18 demonstrate that blue faience bangles contain 1.9 wt% of copper (CuO) and blue faience vessels 1.1 wt% of copper (CuO) in average, indicating that the amount of copper is less in vessels than in bangles. In other elements, there is no clear difference between bangles and vessels. As to white faience, copper (CuO) content is only 0.037 wt% showing a contrast with blue faience. One blue faience fragment (sample no. F120) has a pattern in a black colour that contains 15 wt% of iron (Fe2O3), much larger than other samples. It can be assumed that iron oxide was used for colouring the black pattern, as manganese (MnO) is prominently less observed (0.047 wt%) than iron (Fe2O3).

Generally, three techniques of faience glazing have been proposed, i.e. efflorescence, cementation and direct application. Among these, in the efflorescence technique, the
body, which is made of quartz powder, lime powder, natron or plant ash, is mixed with colouring agent like copper compounds. In the process of drying, the alkali comes out and forms a fluffy outermost layer which transforms into glassy surface when fired.

**Figure 17:** Average elemental composition of blue faience bangles (wt%)

**Figure 18:** Average elemental composition of blue faience vessels (wt%)
With respect to the analyzed samples, it was found that the amount of copper (CuO) derived from a colour agent and potassium (K2O) from the flux are approximately equal in amount between the glaze and the body. This result suggests that the analyzed samples were produced by the efflorescence technique.

According to Kaczmarczyk et al (1983), in the case of faience from Egypt in the third millennium BCE, then aluminum (Al2O3) contents are 0.26 - 0.46 % and potassium (K2O) contents are 0.18 - 0.28 %. In contrast, the samples from the Ghaggar plains are found to contain 5.2 wt% of aluminum (Al2O3) and 2.7 wt% of potassium (K2O). This fact indicates that the source of silica used for making the body of faience objects in the Ghaggar plains contained a larger amount of aluminum (Al) than those in Egypt. As for potassium (K), it is difficult to determine whether it is derived from silica source or alkali source.

In the faience objects from the Ghaggar plains, it can be presumed that the source of copper colourant was copper rust. In samples analyzed, arsenic (As) is often detected in a small amount. Probably, arsenic (As) was contained in the colouring agent of copper, indicating that rusts of arsenic copper were used. In contrast, the Egyptian faience usually does not contain arsenic (As). Besides, there is no tin (Sn) detected in the analyzed samples from the Ghaggar plains indicating that not bronze but arsenic copper was used as a colouring agent in the faience objects in the Ghaggar plains.

**Firing Technique of Faience**
As noted earlier, faience is produced by firing quartz powder with flux resulting in glassy surface and inner core with unmelted quartz grains. The X-ray powder
diffraction pattern (Figure 23) on a blue faience demonstrates that quartz exist as a main crystalline phase. Comparing the surface and the core of the object, it turns out that the surface layer exhibits a high background over a $2\theta$ range=20-30° and the S/B ratio is less than the core. This high background is due to the existence of amorphous material, which indicates that the glazed surface layer is close to glassy state.

![Diffraction Pattern](image)

Figure 20: X-ray powder diffraction pattern of a blue faience (F104)

![Scattergram](image)

Figure 21: Scattergram of AS$_2$O$_3$ vs. CuO
Figure 22: Scattergram of PbO vs. CuO

Figure 23: Scattergram of K₂O vs. MgO

Figure 24: Scattergram of ZrO₂ vs. Al₂O₃
Although we have not conducted a microscopic observation of sliced sections of the analyzed faience, it is obvious that the core of Ghaggar faience is more compact and better sintered than that of Egyptian faience. The cause of compactness is, however, not yet determined.
Regional Variation of Faience in the Chemical Composition

In order to see whether there is any regional variation or not, nine regional divisions are defined (Figure 1).

Figure 21 shows a plot of As2O3 content vs. CuO content and Fig.22 shows PbO vs. CuO plot. Both arsenic (As) and lead (Pb) can be considered as impurities of copper (Cu). In regards to arsenic (As), its concentration value at the core is used, as it may have been vaporized. In copper (Cu) and arsenic (As), a weak correlation can be observed, but the dots scatter widely. There is no correlation between copper (Cu) and lead (Pb). Thus, it is difficult to discuss any regional variation in terms of the ratio between copper (Cu) and arsenic (As), lead (Pb).

Secondly, the relations between K2O and MgO are examined in Figure 23. In order to make the melting point lower, alkali flux is added in the production of faience and glass. It is generally understood that if both potassium (K2O) and manganese (MgO) are less than 1.5 wt%, the flux would be natron, and if both are more than 1.5 wt%, the flux can be regarded as plant ash. Figure 23 demonstrates that whereas potassium (K2O) content is relatively high, manganese (MgO) tends to be less than 1.5% wt%. Based on this result, it is difficult to identify the flux. It may be that potassium (K) is derived from the impurities of silica, not from alkali.

Figure 24 shows the ratio of aluminum (Al2O3) and zirconium (ZrO2). These elements can be regarded as impurities of silica. Although there is no clear regional difference, one specimen has a silica composition different from others. This specimen has a
notched edge giving a floral shape on plan. Both its silica composition and shape suggest its uniqueness among the analyzed samples.

**Analysis of Unique Faience Objects**

Among the analyzed samples, some specimens have a unique pattern of decoration. Two specimens of beads with banded colours (F055 and F082) and one specimen of bead with a circlet pattern were subjected to the chemical analysis. F055 (Figure 25) has a banded pattern of green and white, and F082 (Figure 26) has borders in dark reddish colour as well as green-whitish portion in the centre.

F056 (Figure 27) is decorated with greenish circlets on blackish background. Although the general composition is the same as other monochrome faience, there is a tendency that copper (Cu) is less in the area of whitish colour. In the blackish area of F082 and F056, Fe is dominantly observed, whereas manganese (Mn) is negligible.

**Tentative Conclusion for the Results of Analyses**

The following conclusion can be drawn from the analyses:

1) Blue faience is coloured by copper (Cu). Arsenic (As) is also detected in limited quantity. Tin (Sn) is not observed. Iron (Fe) is responsible for the black colour and the white colour is made by the lack of copper (Cu). Although monochrome blue faience is predominant, but various unique colourization is also developed by combining these elements derived from various sources.

2) It is likely that the faience objects from the Ghaggar plains were fired at a higher temperature for a long period, because not only the surface but also the core has also become glassy state and bluish in colour.

In comparing with the Egyptian faience, several technological differences can be observed. In the Egypt faience, bronze rust was generally used for colouring it from the New Kingdom onward. As a result, tin (Sn) can be detected in analyses. However, the samples from the Ghaggar plains contains no tin (Sn) but small amounts of arsenic (As) indicating that not bronze but arsenic copper was used as colouring agent.

Secondly, the core of Ghaggar faience exhibits that thicker glass matrix is holding quartz particles stronger together than that of Egyptian faience. This may indicate a difference in the firing techniques between the two regions. The faience from the Ghaggar plains was fired at a temperature higher than the Egyptian faience.

**Future Tasks**

Based on the morphological and chemical analyses of samples above, the following points can be summarized as tentative conclusions.

1) Although it is difficult to determine the dates and cultural periods, to which the samples are assigned, as these samples analyzed are from surface collections, the
circumstantial evidence that the faience objects were associated with the Harappan and Bara (Late Harappan or post-urban Indus) potsherds on the surface of sites can allow us to give rough dating of these cultural periods to the faience objects. The results of some excavated sites like Farmana and Bhagwanpura can also corroborate this dating of faience objects in the region.

2) The sites where the faience objects have been collected do not cover the entire Ghaggar region, but the number of collected faience objects from sites points to a general distribution pattern of faience objects in the region, that is a high frequency of occurrence in the eastern region of the Ghaggar plains.

3) The faience objects from the Ghaggar plains consist dominantly of bangles and beads, while other objects like vessels and balls are very limited in number. This feature is commonly observed in the entire region.

4) The bangles have two types of shapes, i.e. circular and heart-shaped on plan. The former type tends to have broader profile, having incised decorations on its external side. The heart-shaped bangles are generally thin and decorated with small notches or thin incised lines. The samples analyzed are all glazed in greenish blue.

5) The beads are also generally glazed in greenish blue, but some specimens are glazed in bands with different colours, i.e. blue and white. Morphologically, they include various shapes like short cylindrical of micro size, floral, lenticular, cylindrical and barrel-shaped. As these shapes are common to stone beads, it is probable that the faience beads were made to imitate stone beads. Especially, the banded beads seem to have imitated banded agate beads, which commonly occur in the urban Indus period.

6) The body of samples analyzed, both beads and bangles, are made of fine-grained quartz, that is compact quartz. As to the blue faience, the colorant is copper (Cu) containing a small amount of arsenic (As) and it seems probable that the objects were glazed by the efflorescence technique. Regarding the banded beads, the blue band is coloured with copper (Cu) and the white band is characterized by the lack of copper (Cu). The technique for making bands is still unknown, but complicated techniques of glazing by adjusting the amount of colorants and flux (Kenoyer 1994: 39).

7) The features of faience objects from the Ghaggar plains clarified by morphological and chemical analyses are mostly the same as those of faience objects from Harappa (McCarthy and Vandiver 1990; Kenoyer 1994).

In future, it is necessary to conduct the same analyses, both formal and chemical, on the samples from excavated sites where the stratigraphic and chronological contexts of faience can be defined. Besides, the relationship between faience and stone ornaments, that is the significance of faience ornaments in the entire ornament culture in the Indus Civilization, should be scrutinized.
As to the former task, we have conducted excavations at an urban and post-urban site of Mitathal (Manmohan Kumar et al. 2011) and the analyses are under way. The results of these ongoing analyses on the evidence from Mitathal will be correlated with the samples from surface collections in order to better understand the chronological and spatial features of the faience objects from the entire Ghaggar region and to reconstruct the ornament culture and its significance in the Indus Civilization.

Acknowledgements
The authors are thankful to the authorities of the Maharshi Dayanand University, Rohtak, for providing foreign scholars with certificates of affiliation for enabling them to obtain research visas. It is noted that this project was conducted with the Grant-in-Aid for Scientific Research, Japan Society for the Promotion of Science.

Notes
1In the season of 2010-2011 and 2011-12, excavations were conducted by the authors at the site of Mitathal, which was located 20km south to Farmana (Manmohan Kumar et al. 2011). The excavations revealed that this site had been occupied from 2200 cal BC to 1900 cal BC, that is the later part of the Indus urban phase, clearly later than the Farmana settlement. From this site, a number of faience objects, more than 500 in number, were retrieved. Based on the evidence from Farmana and Mitathal, it appears that faience objects increased in the late phase of the urban phase. Especially, the topmost level that can be dated to 2000 - 1900 cal BC yields the most numerous number of faience objects. Chemical analyses were conducted on the samples from these excavations, although their results are not included in this paper. The evidence from this site enables us to discuss the faience objects in terms of a chronological sequence.

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