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The Provenance of Early Islamic Lustre Wares

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Glazed ceramics decorated with overglazed lustre painting first appear in the ninth century in the Near East. From the beginning they appear fully developed, and among the earliest found are the very sophisticated polychrome lustres in which a variety of lustre and non-lustrous glazes are combined on a single vessel. This is a technical tour de force that indicates a long experience with this difficult process. The generally accepted assumption is that lustre decorating of earthenwares grew out of lustre glass painting which has a history beginning in the fourth or fifth century A.D. in the Near East and which was in a fully developed state before the eighth century.[1]

Lustre wares were not only very widely dispersed but in rather impressive quantities. Such extensive trading patterns were not unusual. It has been shown at Sīrāf for example, that the enormous trade in fine "Sāmarrā" wares was at least equalled by trade in blue-green common wares.[2] The polychrome lustres appear in the first half of the ninth century in Iraq and are abandoned towards the end of that century in favor of the technically less demanding monochrome lustres.[3] At some point in the eleventh century faïence[4] bodies begin to replace earthenware as the base for lustre decoration. However, for special purposes, lustre on tin opacified lead glazed earthenware bodies continued; the famous Kāshān tiles of the thirteenth century are an example.

In the present work, neutron activation analyses on a limited sampling of sherds results in a number of suggestions which measurements on a large sampling could evaluate. These possibilities are that the earthenware lustres of the ninth and tenth centuries may have been made in Iraq, <u>wherever excavated</u>; that in the eleventh century the technique of lustre painting was introduced into Egypt; and that by the end of the twelfth century it was being used in Egypt, Syria, Iraq, and Iran. Because of this trend the work also suggests that the innovation which caused lustre painting on glass to be used on glazed ceramics took place in Mesopotamia. The archaeological data presently available to support this latter contention, however, is modest.

The Process

Lustre painting is an overglaze technique of considerable technical sophistication which can be applied to either glazed faïence or glazed earthenware.[5] The normal practice seems to have been to first fire the unglazed body. In the case of faïence, where underglaze decoration is employed, the pigment colorants are next applied and the fired pots are then glazed; if they are earthenware - usually a white tin opacified lead glaze is used, and if faïence - either a transparent or an opacified glaze. In either case a slip is unnecessary, the tin-lead glaze being opaque and the faïence body generally being pure white. This is followed by a second firing after which the pots are ready for the application of the lustre paint. The final firing was in a kiln reserved for this purpose, having a reducing atmosphere, and at a temperature below that required to make the glaze fluid.

The lustre paint has been described as a mixture of natural and artificially produced oxides and sulfur compounds of copper, silver, iron, and arsenic which were finely ground and mixed with either vinegar or grape juice.[6] In the reducing atmosphere of the lustre firing kiln, the copper would be reduced to the metallic state suspended in colloidal form in the glassy surface of the glaze, and would appear to the eye as a reflecting metal film.

The Problem

There has been much speculation on the place of manufacture of the Early Islamic lustre wares. These speculations are based on the only methods of provenance determination previously available – stylistic studies and historical data. Lane felt that Iraq was the source and Baghdad the likely place of manufacture.

> But the point at which lustre-painting on pottery
> began in Egypt cannot be determined by literary
> or historical records.[7]

Kühnel had originally shared this view, but in later years he believed that the process was introduced into Egypt before the end of the ninth century.[8] Schnyder in his definitive article fully discusses these opinions.[9] He also supported the early introduction of lustre manufacturing into Egypt.

The problem has been compounded by the wide use of samples of unknown provenance, the small number of medieval Near Eastern sites which have been carefully excavated and reported, and the lack of published kiln wasters or other definitive data from many of the most important sites. To these problems must be added the enormous amount of trade in ceramics which we see throughout the Early Islamic world.[10] In most large sites we are confronted with a bewildering array of indigenous styles, imports and locally-made imitations.

Method

In recent years, neutron activation analysis has offered us analytical techniques which can be of great usefulness in the objective determination of the provenance of ceramics.[11] A small sample (100 miligrams) is removed from the cleaned body of the sherd with a synthetic sapphire drill; the powder is mixed with cellulose binder and pressed into a pill of uniform size. The sample pills together with pills of a "Standard Pottery" whose chemical composition is precisely known are then placed in a nuclear reactor and irradiated with neutrons. This causes the chemical elements in the samples to become radioactive and to emit gamma rays that have characteristic energies, and which decay with characteristic half-lives. The energy of the emitted gamma rays identifies the specific chemical element, and by measuring the intensity of the gamma ray in the standard pottery and the sample, approximately 40 elements may be quantitatively determined. The radioactive samples are analyzed with germanium gamma-ray spectrometers at five different times selected to achieve the best data for nuclides with a variety of half-lives from a few minutes to several years in length. In practice, 18 to 20 elements are used to establish a chemical "fingerprint".

As the procedure for developing the chemical fingerprint[12] has been previously described, we will only give a brief explanation at this time. Ideally the pottery for the reference group should be excavated material, that is, for stylistic or other reasons, believed to be of local manufacture and which, when subjected to neutron activation analysis, is chemically homogeneous. Taking the 18 to 20 selected elements for each sample, the mean value of each elemental abundance for the reference group is determined, and the root-mean-square deviation (σ) from this mean value is calculated for the individual sherds or pots in the reference group. If the average value of the root-mean-square deviation (σ) for approximately 20 elements is 10% or less, the group is considered a good (i.e., sufficiently homogeneous) reference group suitable for classification purposes. When applied to a sample of unknown provenance, agreement with the reference group requires that about 2/3 of the elements should agree within one σ, and very few disagree by more than two σ.

In the course of studies on the provenance of ceramics from Egypt, Iran, and Iraq, 16 lustre ware sherds were analyzed. All of these were archaeologically excavated and this aspect of their history is known. They are stylistically of well-known types that have been discussed in the literature.[13] The 16 sherds consist of eight excavated at Fustāt (old Cairo), Egypt; one at Sāmarrā; Iraq; four at Sīrāf, one at Muveh, and two at Jīruft, these last three sites are in the Fars district of South Iran. As a result of extensive studies of medieval ceramics from Fustāt, Sīrāf, and of the "Sāmarrā" type wares, we have some reference chemical fungerprint groups for provenance determination (Table 1).

Lustre Glazes on Clay Bodies

Nine of our samples have clay bodies, four are ninth century polychrome lustres (FUST-8, JIRF-1, 2, and MUVE-1), and five are tenth and eleventh century monochrome lustre wares (FUST-27, 28, 29, 30, and SIRF-7). (See Table 3).

Fabrics

Eight of the sherds have the typical pale yellow to white "Sāmarrā" clay body. FUST-30 has a light brownish gray color and is chemically unlike the other eight. The hardness for all sherds is 2.5 (Moh's scale, scratch test) taken from a freshly broken surface. This is midway between gypsum (2) and calcite (3). The texture is uniformly very fine, the only inclusions noted are occasional grains of translucent clastic quartz up to 0.5 mm. in diameter (FUST-29, SIRF-7); these clays appear to be carefully levigated. The vessels were all made on the fast potter's wheel and are evenly and thoroughly kiln fired. The body thicknesses average 4.0-5.0 mm. with the exception of FUST-29 which is a rather heavy base sherd, 7.0-15.0 mm. thick.

Glazes

The glazes (see Table 3) are in excellent condition except for the Iranian samples which are much devitrified presumably by the heat, salinity and humidity of the Persian Gulf environment, but even these still show excellent adhesion between lustre, glaze, and body, and retain much of their structure. The glazes tend to be thick, 0.3-1.0 mm., tin opacified lead glazes except for MUVE-1 which is an alkali-silicate glaze. The opacity is variable; FUST-30 is completely opaque while others, when examined under a 30X binocular microscope reveal that the apparent opacity is due to small irregular opaque white masses and thin veils in a transparent glaze. With the microscope it is generally possible to see between these opaque masses to the interface between the body and the glaze. However, to the naked eye they seem completely opaque.

FUST-27, 28, 29, and 30 are in excellent preservation and the color of the metallic lustre is a yellow gold by reflected light; at 30 power magnification they have a distinctly olive green undertone. FUST-8 is a polychrome lustre of transparent garnet, brownish red and yellow gold. SIRF-7 and FUST-27 are stylistically close, both are monochrome lustre ware, but the Sīrāf glaze is almost completely devitrified. The Muveh and Jīruft polychrome lustre wares show moderate deterioration but still preserve some glaze especially in the lustred areas. They are all green-and-brown-metallic polychrome lustres (JIRF-1, 2, MUVE-1).

Lustre Glazes on Faïence Bodies

The seven faïence sherds are an extremely diverse group. Three were excavated at Fustāt (FUST-9, 17, 31), one at Sāmarrā (SAM 120), and three at Sīrāf (SIRF-121, 122, 130). FUST-9 and 31 are probably Egyptian[10] of the eleventh and twelfth centuries. FUST-17 and SAM-120 have designs that are close to North Syrian faïence of the Rusafa-Raqqa type and may be from the late 12th to the first half of the 13th century. The Sīrāf faïence lustres are similar to Iranian or Iraqi Saljuq wares which date from the latter part of the twelfth to the first third of the thirteenth century.

Fabrics

The two Egyptian sherds (FUST-9 and 31) have coarse bodies, 9 is creamy white and 31 is light gray. FUST-17 and SAM-120 have pure white, coarse sugary textured bodies. SIRF-121, 122, 130 have pure white, fine sugary textured bodies which are minutely porous, they are of the same provenance as some monochrome glazed faïences excavated at Sīrāf (SIRF-131, 132, 134, 135). The hardness taken from a freshly broken surface is 3.5 (Moh's Scale) which is between calcite (3) and fluorite (4) and is low for such fine thin ware. At 30 power magnification little vitrification is visible which probably explains the rather low hardness. It is possible that the low hardness may point to a somewhat earlier date for it seems that the faïences of the earlier part of the twelfth century tend to be less highly vitrified than the later works.[14]

Glazes

The glazes are in good to excellent condition on all sherds, with excellent adhesion between glaze and body. FUST-9 has a glaze that is somewhat runny and has gathered in thick drops near the base. Since this faïence bowl has a tin opacified lead glaze which is hardly necessary on the pure white faïence, it may be a transitional form between clay body lustre and faïence body. The potter's lack of experience manifests itself in this too fluid glaze. The glaze on FUST-9 is softer than the others which have an average hardness of 6.5 (Moh's scale), between feldspar (6) and quartz (7), the interior is 4.5 and the exterior 3.5. There is some slight surface deterioration visible under the microscope.

Fust-31 has an attractive turquoise glaze which contains little lead and is slightly opacified with time. It contains many bubbles and undigested transparent quartz or glass frit particles up to 0.5 mm. in diameter. The umber brown lustre with slight metallic quality is in the form of a kufic inscription. The colors are very attractive. The glaze penetrates the very coarse body and is 0.3 mm. thick.

The two probably Syrian sherds, FUST-17 and SAM-120, have transparent clear alkali-silicate glazes. FUST-17 has an ultramarine-blue colored cobalt under-glaze and SAM-120 has a turquoise-blue copper under-glaze. The lustre paintings are purple brown with some metallic reflections. The glazes are 0.4 to 0.5 mm. thick. Their hardness is 6.5 (Moh's), however, the Sāmarrā sherd had areas that are moderately devitrified and quite soft.

SIRF-121, 122, and 130 are Saljūq faïences probably of the twelfth century. The glazes are slightly tin opacified giving them a milky translucence. The lustre is of rather poor quality, light green to light olive with pale brown markings in the center of the broad lines and a very thin faint red areole at the edges. The glazes are 0.5 to 1.0 mm. thick with the exception of the very thin SIRF-130 whose total thickness is 3.0 mm. for interior and exterior glazes and body. In this case the glaze is 0.2 mm. thick. The glaze hardness is 6.5 for SIRF-121, 122 and 7.0 for SIRF-130.

Results

The four Fustāt earthenware sherds, FUST-8, 27, 28, 29, have chemical composition patterns which are in excellent agreement with Sāmarrā ware sherds excavated at Sīrāf which have been demonstrated[10] by neutron activation analysis to be of Mesopotamian origin. The 4 Iranian sherds also have the same chemical composition as the Fustāt pottery and Sāmarrā ware and thus the same provenance. Twenty-one elements were used in the comparison (Table I). Besides the Fustāt lustre wares, data is shown for the reference group of Sāmarrā ware sherds from Sīrāf and the lustre wares from Sīrāf, Muveh, and Jīruft. For comparison FUST-30, an eleventh century lustre is also shown. This has a calcareous clay body unlike the other groups but similar to several Egyptian sherds. Fig. 1 shows the abundance of aluminum for the various groups of sherds. The first bar indicates the average aluminum content for the twenty-nine peices of Sāmarrā ware as 6.40%. The hatched area shows the root-mean-square deviation (σ) for the twenty-nine. Generally the spread is substantially larger than the experimental error and represents the variation in the pottery. The second bar shows the same information for a group of four lustre sherds excavated in Iran, SIRF-7, JIRF-1, 2, and MUVE-1. The third bar shows values for the four Fustāt earthenware lustres FUST-8, 27, 28, 29. The last bar shows the value for a single eleventh century earthenware sherd FUST-30. The blacked-in area shows the experimental uncertainty and is typical of the measurements. The elemental abundances are in parts per million, those in percent are so indicated after the element name.

As seen in Table I, our Fustāt and Iranian ninth-tenth century earthenware lustres agree very well with the Sāmarrā ware from Sīrāf of Iraqī origin. They also agree with the Sassanian glazed ware and Early Turquoise ware found at Sīrāf which were also imported from Iraq.[15] They are distinctly different from FUST-30 an eleventh century earthenware lustre sherd (see Chromium, Samarium, and Tantalum, Fig. 1). They are also different from Egyptian pottery made from Nile silt. Thus, it would appear that the Fustāt and Iranian ninth and tenth century earthenware lustre sherds are very likely to share an Iraqī origin. The chemically different FUST-30, eleventh century earthenware lustre, is roughly similar to a few pieces from Nag-ed-Deir and maybe of Egyptian origin although we cannot make a definite assignment.

The comparisons are not as definite for faïence as for pottery because the synthetic faïence bodies form groups whose compositions are not as homogeneous i.e., 20-25% standard deviation for twenty elements, as pottery. In addition many fewer sherds have been subjected to neutron activation analysis.

In Table 2 are shown data for a group of four waster sherds of Egyptian faïence excavated at Fustāt (Fustāt Fatimid Sgraffiato and Monochrome Celadon ware) and lustre ware FUST-9 and 31, and the stylistically different Under Glaze Painted Faïence excavated at Fustāt but probably of Iranian origin.[10] The Egyptian faïence is easily distinguishable chemically from the Under Glaze Painted Faïence and FUST-9 and 31 are probably of Egyptian origin; chemically similar to the four Fustāt waster sherds.

FUST-17 and SAM-120 are stylistically and chemically similar. As seen in Table II, they are distinctly different in chemical composition from Egyptian faïence or the probable Iranian Under Glaze Painted Faïence. They are typical of the North Syrian Raqqa - Rusafa type wares of the late twelfth and early thirteenth centuries in both technique and design.

The Saljūq faïence sherds from Sīrāf, SIRF-121, 122, 130 are members of a larger chemical group of clear and turquoise glazed faïences excavated there. There is no evidence of their manufacture at Sīrāf and they do not match the Egyptian and Underglaze Painted Faïence. It is interesting to note that the same manufacturers produced both the monochrome glazed and the lustre decorated vessels excavated at Sīrāf. The analyses are roughly like the main group of faïences although they do not conform as closely as the earthenware group members do. Such variations have been observed in the Egyptian faïence, the probably Iranian Under Glaze Painted Faïence and the North Syrian Raqqa - Rusafa faïence. This is the result of the nature of the faïence bodies being synthetically made by mixing ingredients - quartz or quartzite, frit and clay from various sources.

Although this is not a large sample it does offer some objective answers to the vexatious problem of the origin of Early Islamic lustre wares.

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1. A. Lane, Early Islamic Pottery, (London: Faber and Faber, 1965) p.14. R.H. Brill, "Chemical Studies of Islamic Luster Glass", in R. Berger, ed., Scientific Methods in Medieval Archaeology (Berkeley: University of California, 1970), pp.351-377.

2. D. Whitehouse, "Neutron Activation and the Provenance of Islamic Pottery from the Persian Gulf." Paper read at Conference on the Applications of the Physical Sciences to Medieval Ceramics, March 18-22, 1975.

3. Lane, 1965, pp.14-15

4. Faïence in this context refers to any of a variety of synthethic ceramic bodies consisting of ca. 80% silica, 10% clay and 10% frit or alkaline flux.

5. J.W. Allan, "Abū'l-Qāsim's Treatise on Ceramics", Iran Vol. 11 (1973), pp. 111-120.

6. Ibid, p. 114 § 27.
Brill, 1970, p. 377
Hans E. Wulff, The Traditional Crafts of Persia, (Cambridge: Massachusetts Institute of Technology, 1966), p. 145.

7. Lane, 1974, p. 21

8. Encyclopedia of World Art, Vol. 8, col. 357.

9. R. Schnyder, "Tulunidische Lüsterfayence," Ars Orientalis Vol 5 (1963), pp. 49-78.

10. See note 2
H.V. Michel, J.D. Frierman, F. Asaro "Chemical Analysis of Ceramic Wares from Fustāt, Egypt," Lawrence Berkeley Laboratory preprint 2387, Archaeometry, Vol 18, no. 1 (1976) p. 85-92.

11. I. Perlman, F. Asaro, "Pottery Analysis by Neutron Activation", Archaeometry, Vol. 11 (1969), pp. 21-52.

12. F. Widemann, M. Picon, F. Asaro, H.V. Michel, and I. Perlman, "A Lyons Branch of the Pottery-Making Firm of Ateius of Arezzo," Archaeometry Vol 17, no. 1, 1975, pp. 49-59.

13. Table 3

14. J.W. Allan, L.R. LLewellyn, F. Schweizer, "The History of so-called Egyptian faïence in Islamic Persia: Investigations into Abū'l-Qāsim's treatise", Archaeometry vol. 15 no. 2, 1973, pp. 165-173.

___________________, "Some observations on the origins of the medieval Persian faience body", in W. Watson, ed., Art of Iran and Anatolia from the 11th to the 13th century A.D. (Colloquies on Art and Archaeology in Asia No. 4), (London: Sir Percival David 1973), pp. 60-67.

These articles hypothesize the possibility of separating the eleventh and earlier twelfth century faïence from the well known products of the late twelfth and early thirteenth century. In the light of the inconclusive results of the chemical analysis, we would suggest that there is some evidence to indicate that the change may be in the degree of vitrification which can be easily determined by a simple hardness test, and verified by scanning electron microscopy. A survey of this sort may indeed yield useful information.

15. F. Asaro, H.V. Michel, J.D. Frierman, "Provenance of Glazed Near Eastern Pottery from Sīrāf." Lawrence Berkeley Laboratory preprint 2955 to be published. Paper presented at the Annual meeting of American Oriental Society, March 1974, Santa Barbara, California.

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TABLE 1

Chemical Composition of Clay-Bodied Lustre Ware and Reference Groups

	Lustre Ware and polychrome lustre	Iran Lustre Ware	FUST-30	Siraf "Samarra" Ware	Egyptian "Nile Mud"[1]
No. of pieces in group	4:FUST-8,27,28,29	4:JIRF-1,2, Muve-1, SIRF-7	FUST-30	12	32
	7%	11%		8.4%	8%
Element					
Al%	6.07±.12[2]	6.34±.55[2]	7.36±.12[3]	6.36±.30[2]	–
Ca%	13.9±.3		10.2±.6	13.2±1.0	2.58±.84[2]
Mn	950±50	951±72	724±8	899±40	1204±68
Na%	1.41±.16	1.28±.35	1.44±.02	1.65±.11	1.355±.215
K%	.92±.33	.99±.31	.93±.23	.87±.48	–
U	1.96±.05	2.18±.13	2.41±.03	2.11±.15	2.26±.41
Ba	172±14	245±52	343±15	182±47	493±74
Sm	4.04±.11	4.10±.27	6.86±.01	4.05±.12	-
La	21.7±1.0	23.1±1.2	35.4±.7	22.6±.7	32.8±1.2
Ti%	.40±.03	.50±.15	.76±.02	.43±.04	.996±.049
Lu	.316±.017	.308±.026	.429±.019	.313±.02	.512±.027
Co	26.9±1.9	28.1±2.1	25.5±.4	26.9±1.5	34.96±1.60
Sc	19.16±.56	19.00±1.61	18.57±.06	18.72±.52	23.11±.96
Fe%	5.01±.12	5.04±.39	5.91±.08	4.91±.19	6.82±.24
Cs	3.2±1.1	2.9±.6	1.4±.2	3.5±1.2	1.39±.21
Cr	260±13	268±23	136±3	257±22	181±16
Th	7.125±.031	7.33±.58	8.12±.12	7.15±.11	6.94±.49
Eu	1.019±.025	1.041±.070	1.782±.015	1.007±.030	–
Ce	46.4±1.1	48.2±3.1	76.3±.9	46.2±1.2	–
Hf	3.34±.06	3.26±.25	6.59±.11	3.26±.16	8.67±.75
Ta	.814±.018	.825±.051	1.388±.007	.799±.035	1.445±.106

[1]Data taken from I. Perlman and F. Asaro, Archaeometry Vol. 11, no. 21 (1969), pp.

[2]The values in this column are the average abundances in parts-per-million (or % if so indicated) and the standard deviation of the abundances.

[3]The values in this column are the abundance in parts-per-million (or % if so indicated) and the counting error.

TABLE 2

Chemical Composition of Faïence-Bodied Ware Excavated in Fustāt, Egypt and Reference Groups

No. of pots in group σ	"Fustāt Waster and Lustre Ware 6:(Fust-3,4,9,10,15,31) (20 elements)	"Underglaze" "Painted" faïence 5:(Fust-12,13,14,19,20) 25%(20 elements)	1:(Fust-17)	1:(Sam-120)	3:(SIRF-121,122,130)
SiO_2%	[87] [1]	[89] [1]			
Al%	2.40±.36 [2]	.81±.18 [2]	1.34±.05	1.59±.13	4.34±.26 [2]
Mg%	<2.	<1.8	<2.	<2.	<2.
Ca%	2.6±.9	4.8±1.6	3.1±.5	2.47±.4	1.89±.6
Mn	148±62	420±180	179±3	181±3	89±6
Na%	2.05±.25	1.08±.26	1.67±.02	1.70±.02	2.71±.46
K%	.78±.15	.51±.10	.69±.17	.61±.18	1.35±.19
U	1.06±.21	1.15±.17	.55±.02	.54±.02	2.07±.14
Ba	99±41	116±20	60±9	52±8	154±40
Sm	1.97±.23	1.06±.18	.748±.005	.727±.005	4.98±.97
La	12.3±1.1	7.0±1.6	3.6±.4	4.1±.4	26.7±.5
Ti%	.189±.044	.049±.020	.063±.015	.057±.012	.657±.047
Lu	.125±.015	.079±.014	.077±.010	.066±.010	.488±.026
Co	4.4±1.9	6.5±3.0	6.5±.1	6.1±.1	2.06±.09
Sc	4.69±.57	1.91±.56	3.57±.02	3.45±.02	15.1±4.0
Fe%	.99±.19	.39±.10	.99±.02	.93±.02	.43±.03
Cs	.57±.15	.34±.13	.80±.10	.80±.10	1.66±.15
Cr	33.0±2.5	138±91	80±2	116±2	19.2±.3
Th	2.92±.38	1.44±.29	1.28±.05	1.30±.05	10.66±.21
Eu	.458±.043	.239±.037	.197±.004	.199±.004	1.182±.018
Ce	24.1±2.7	12.1±2.3	8.4±.3	7.9±.3	56.1±2.7
Hf	2.24±.56	2.57±.53	.55±.04	.59±.04	8.71±.01
Ta	.48±.07	.16±.02	.134±.002	.128±.002	.92±.04

[1]The SiO_2 content was determined by difference to 100%.

[2]The values in this column are the average abundances in parts-per-million (or if so indicated) and the standard deviation of the abundances.

[3]The entries in this column are the composition and the countin error.

TABLE 3

	CENTURY	BODY: HARDNESS (MOH's)	BODY: COLOR (MUNSELL)	BODY: MUNSELL NAME	BODY: TEXTURE	BODY: THICKNESS (mm)	GLAZE: HARDNESS Interior	GLAZE: HARDNESS Exterior	GLAZE: THICKNESS (mm)	GLAZE: SLIP (mm)	GLAZE: TYPE[2] (By XRF)	REMARKS	REFERENCE TO SIMILAR POTTERY
EARTHEN WARE polychrome lustre													
FUST-8	9th	2.5	5Y8/3	pale yellow	very fine	5.0	6.0	6.0	1.0	0.1	Pb-Sn	Rim sherd	Schnyder, Taf. 1, abb. 2.
JIRF-1	9th	2.5	2.5Y8/4	pale yellow	very fine	5.0	2.5[1]	2.5[1]	0.5	None	Pb-Sn	Rim sherd	V & A, p. 12, fig. 14.
JIRF-2	9th	2.5	2.5Y8/4	pale yellow	very fine	3.0-5.0	2.5[1]	2.5[1]	0.5	0.07	a little Pb-Sn	Base sherd	Schnydar, Taf. 4, abb. 19. V & A, p. 12, fig. 16.
MUVE-1	9th	2.5	2.5Y8/2-4	white/ pale yellow	very fine	4.5-6.5	2.5	Unglazed foot	0.8	0.05	Alk-Sil	Base sherd	V & A, p. 12, fig. 14.
EARTHEN WARE monochrome lustre													
FUST-27	10th	2.5	5Y8/3	pale yellow	very fine	4.0-5.0	6.75	6.75	Int. 0.7-1.0 Ext. 0.3-0.8	0.02	Pb-Sn	Base, side and rim	Atil, p. 18-19, 20-21. Lane, p1. 13, B.
FUST-28	10th	2.5	2.5Y8/2	white	very fine	4.0-5.0	6.5	5.75	0.3-0.6	0.07	Pb-Sn	Base sherd	Baghat, Pl. VI, 5: Pl. IV, 1 bis.
FUST-29	10th	2.5	5Y8/3	pale yellow	very fine	7.0-15.0	6.5 (3.5)[1]	6.5	0.7	None	Pb-Sn	Base sherd,	Baghat, Pl. VI, 3.
SIRF-7	10th	2.5	5Y8/3	pale yellow	very fine	4.0	2.5[1]	2.5[1]	0.3	None	Pb-Sn	Rim sherd	Atil, p. 18-19 Lane, pl. 13, B.
FUST-30	11th	2.5	2.5Y7/2	light gray/light brownish gray	very fine	4.0-5.0	7.0	7.0	0.5-1.0	0.03	Pb-Sn	Base sherd	Lane, pl. 23, B. Baghat, Pl. XV, 3 & 3 bis.
FAIENCE lustre													
FUST-9	11th (or later)	3.5	10YR8/2	white	coarse	3.0-4.0	4.5	3.5	0.3-0.6	None	Pb-Sn	Base sherd	Baghat, Pl. XXVI, 1; Pl. XXIX, 2-3.
FUST-31	11th-12th	3.5	10YR7/2	light gray	coarse	4.5	6.75	6.75	0.3	None	Pb-Sn	Rim sherd	Lane, pl. 25, A.
FUST-17	12th-13th	3.5	N10/	white	fine	4.0	6.5	6.5	Int. 0.4 Ext. 0.5	None	Alk-Sil	Body sherd	Atil, p. 140-141.
SAM-120	12th-13th	3.5	N10/	white	fine	4.0	6.5	1.5[1]	0.5	None	Alk-Sil	Rim sherd	Ibid.
SIRF-121	12th-13th	3.5	10YR8/2	white	very fine	5.0	6.5	6.5	0.5	0.1	Pb-Sn	Body sherd	S.P.A., pl. 631, B. Wilkinson, p. 65, 13C.
SIRF-122	12th-13th	3.5	10YR8/2	white	very fine	6.5-8.0	6.5	6.5	Int. 1.0 Ext. 0.7-0.8	0.1	Pb-Sn	Rim sherd	Ibid.
SIRF-130	12th-13th	3.5	N10/	white	very fine	3.0	7.0	6.75	0.2	None	Pb-Sn	Body sherd	Ibid.

[1] Devitrified glaze deterioration

[2] XRF x-ray fluorescence spectroscopy

References for Table 3

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