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New information on late antique to early Islamic ceramic production and distribution in the Gulf. Petrography of samples from Siraf, Bushehr, and Fulayj

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Summary

In this paper a new petrographic study of ceramics from the late antique to the early Islamic period in the Gulf is presented. The paper considers samples from Siraf (Iran), excavated by David Whitehouse (from the Ashmolean Museum, Oxford, UK), samples from the Iranian coast (recovered by Andrew Williamson, Durham University, UK), and samples from Fulayj, Oman (excavated by a team co-directed by Seth Priestman, Nasser Al-Jahwari, Eve MacDonald, and Derek Kennet). The technique of analysis is petrography, which offers compositional (mineralogy and petrology) and textural information (distribution and arrangement of inclusions). This technique can be used to interpret the technological procedures involved in the manufacturing of ceramics and to characterize products from particular areas, thus helping to clarify trends of distribution of wares across time.

The samples of these collections have been classified according to Priestman's Indian Ocean Pottery Classification (IOPC; Priestman 2021), providing an important link between macroscopic and microscopic analyses. The results are also compared with samples previously analysed from Murwab and the Old Doha excavations, providing an overview of the production technology and exchange of ceramics in the early Islamic Gulf over the longue durée.

Keywords: petrography, Islamic ceramics, Siraf, Iran, Oman

Introduction

The purpose of this paper is to present the latest results of scientific analysis of ceramics made and distributed around the Gulf, roughly during the late pre-Islamic to the early Islamic period. In particular, the chronology can be defined to the interval between the sixth and the tenth centuries AD. Most of the ceramics for this study come from southern Iran and they have been selected from two collections kept in the UK: the Siraf (Sīrāf) collection at the Ashmolean Museum in Oxford and the Williamson Collection kept at Durham University. Additionally, a small number of ceramics recently recovered at the site of Fulayj in Oman have been included for comparison. This piece of research should be considered part of a wider project of analysis of Islamic ceramics undertaken by two of the authors of this paper (J.C. Carvajal López and M. Georgakopoulou) and should be read in combination with previous studies on ceramics from Doha (al-Dawḥa) (Carvajal López et al. 2019) and Murwab (Carvajal López, Guérin & Georgakopoulou 2022). The last part of this paper will, in fact, explore the advantages that the combination of these insights will offer, although a fully integrated study (combining all the results, including those of chemical analysis) will have to wait until all the data have been processed and assimilated. Other studies are in preparation for the future, with the aim of offering an advanced picture of ceramic technology and circulation in the Gulf in the Islamic period.

Selection of samples and methods of analysis

All the samples considered within this study have been directly selected by the authors from three collections. The samples come from sherds that were previously classified by Seth Priestman within the categories of his Indian Ocean Pottery Classification (IOPC; Priestman 2021). The IOPC is based on a classification originally defined by Derek Kennet (2004) and subsequently developed by Seth Priestman (2005; 2013; 2021), and

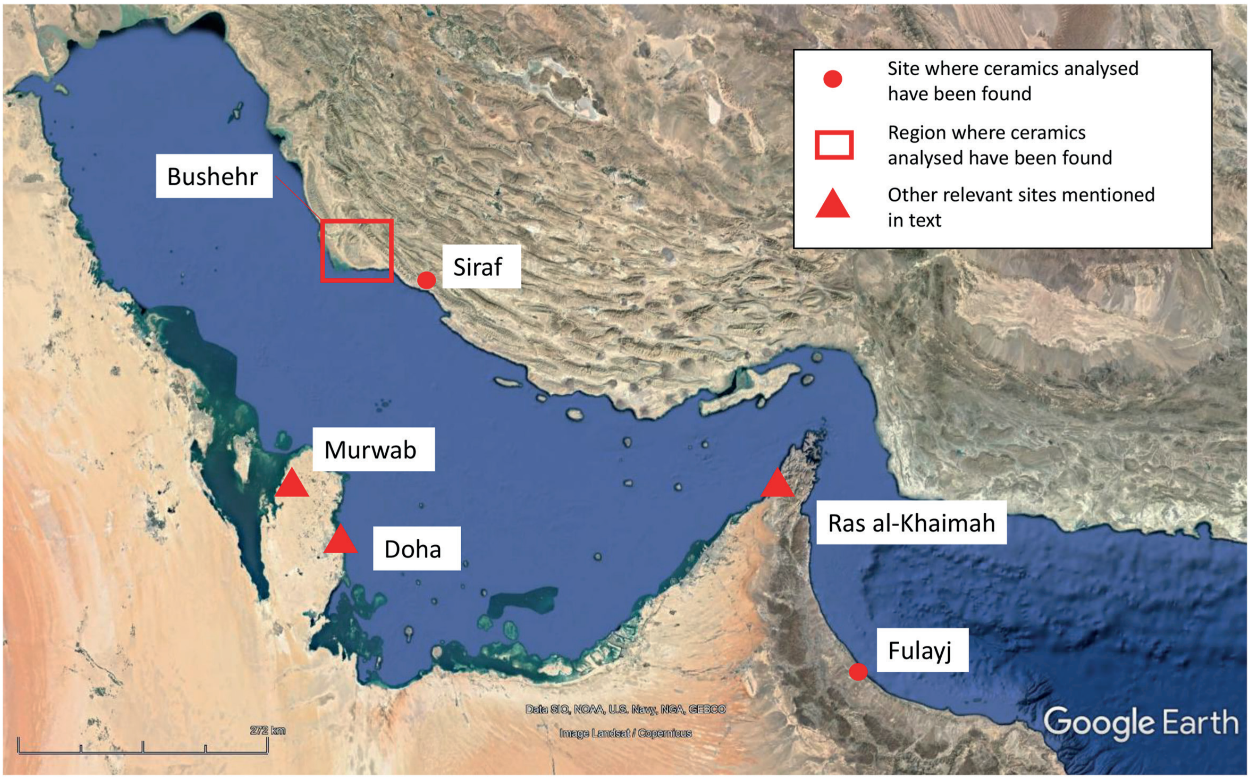

Figure 1. *A map of the Gulf, indicating the location of the places where the analysed ceramics were recovered and other relevant places mentioned in the text (70 mm = 272 km; the map is orientated north and has been obtained from Google Earth).*

contains work on the progressive refinement of a set of categories based on macroscopic analysis of variables such as fabric composition, firing, mode of production, surface treatment, and vessel forms. The work attempts to capture the broad range of ceramics in circulation within the Gulf and the wider western Indian Ocean during the late antique and Islamic periods.[1]

Most of the samples derive from ceramics contained within the Williamson Collection. Andrew Williamson undertook an extensive surface survey of southern Iran between 1968 and 1971. He focused on settlement of the Sasanian and Islamic periods (up to the seventeenth century) distributed along much of the Iranian littoral between Bushehr (Būshehr) and Jask (Jāsk) and through the inland areas of Fars (Fārs) and Kerman (Kirmān) (Williamson 1970). A large sample of finds from the survey (close to 17,000 sherds) together with the associated archives have been the subject of study and analysis by Seth Priestman under the supervision of Derek Kennet at Durham University between 2001 and 2004 (Priestman & Kennet 2002; Priestman 2003; 2005). The results of this work are currently being prepared for final publication (Priestman & Kennet, forthcoming). Ceramic samples analysed within the frame of the current project come from a number of coastal sites, although with a particular concentration of material from the Sasanian period settlement at Bushehr (Williamson 1972; Whitehouse & Williamson 1973). A second batch of twenty sherds was selected among the Siraf collection at the Ashmolean Museum in Oxford. This collection is the second largest within the UK division of finds from Siraf from the excavations undertaken by David Whitehouse (1968; 1969; 1970; 1971; 1972; 1974; 2009) and has been the object of a study by Moira Tampoe (1989). Seth Priestman has previously registered and recorded the largest division of finds from Siraf in the UK, at the British Museum (Priestman 2007;

[1] For clarity in this paper, the term 'fabric' will refer by default to fabrics defined with petrography. The categories of the IOPC are defined by the term 'class'.

Macroscopic fabric	Full name	Reference	Provenance and dating in IOPC (Priestman 2021)	Petrographic fabrics in which present (and numbers, in order of abundance)
CLINKY	Clinky-fired earthenware	Priestman 2021: 19	Southern Iran, 4th to 6th century	2 (16), 1.1 (2), 1 (1), 3.1 (1)
HARLIM	Hard lime-spalled ware	Priestman 2021: 19–21	Southern Iran, 6th to 8th century	1 (26), 2 (10), 1.1 (6), 3 (2), 3.1(1)
REBROS	Gritty red/brown-slipped ware	Priestman 2021: 32–34	Siraf, southern Iran, late 8th to 10th century	3 (13), 1 (5), 1.1 (5), 3.1 (5), 1.2 (2)
CREAC	Cream coated red ware	Priestman 2021: 25–26	Siraf, southern Iran, late 8th to 10th century	3 (15), 3.1 (6), 1.3 (3), 1 (2), 1.1 (2), 1.2 (2)
TORP-S	Sandy torpedo jar	Priestman 2021: 41–42	Southern Iraq/south-west Iran, 3rd to mid-8th century	4 (10)
TORP-C	Cream coloured torpedo jar	Priestman 2021: 42–44	Southern Iraq/south-west Iran, mid-8th to 10th century	4 (1)
HONEY	Honeycomb ware	Priestman 2021: 45–46	Southern Iraq, 7th to 8th century	5 (10)
COB and kiln wall	Coarse buff ware tubes and kiln wall material	Al-Jahwari et al. 2018	Fulayj, 5th to 7th century	6 (4), Loner F008

Figure 2. *Macroscopic classes and their relation to petrographic fabrics.*

Priestman & Simpson, forthcoming). For the purposes of this study, he revised the Ashmolean collection and updated Tampoe's classification to harmonize the recording within the IOPC and British Museum online database. The final part of the set for this study comes from Fulayj, a fort on the Batinah (al-Bāṭinah) coastal plain of Oman. It was constructed, most likely, under the authority of the Sasanian Empire, between the early fifth and mid-sixth century, and then reoccupied with activity continuing in the decades following the Islamic conquest during the seventh century (Al-Jahwari et al. 2018; Priestman 2019). The pottery assemblage from Fulayj has also been studied and recorded by Priestman during the course of the project. In total, in this study we have analysed 152 sherds: 124 from the Williamson Collection, twenty from Siraf, and eight from Fulayj. The samples selected by Priestman belong to categories of common unglazed ceramics that range in date between the fourth and the tenth centuries AD (Fig. 1). These categories are important because they trace a period of gradual shift and evolution, although with strands of continuity, through the transition from the late antique to the early Islamic period. The latter period, which forms the primary focus of the project, cannot really be understood without taking this broader diachronic perspective.

The techniques of analysis intended for this study are ceramic petrography and chemical analysis with Wavelength Dispersive X-Ray Fluorescence spectrometry (WDXRF). Chemical analysis of the samples has been planned in collaboration with the Fitch Laboratory of the British School at Athens. As the results of the chemical analysis were not yet available at the time of writing, this type of analysis will only be mentioned in passing, to make readers aware of the full scope of the study. The technique to which this text is dedicated is ceramic petrography. With this technique, a thin section, a slice of a ceramic sherd the thickness of 30 μm, is prepared and studied under a polarizing microscope. The thin sections for this paper were made in the laboratories of the School of Archaeology and Ancient History of the University of Leicester by J.C. Carvajal López (with the invaluable help of Giulia Bison and Tom Clayton). The analysis was performed by Carvajal López under a polarizing microscope Axio Scan 5 POL, following the Whitbread method (1995: 365–396; 2001; see also Quinn 2013). This method requires an adequate sampling strategy, which usually involves relatively large numbers of thin sections, and allows the exploration and characterization of different fabrics. This information can be used to add an additional layer of pottery classification to the typologies based on shapes and the macroscopic classification of classes (Fig. 2). The advantage of petrography lies not in that it is a 'more scientific' and therefore more rigorous method of analysis, but on its possibilities for a precise identification of rocks, minerals and ceramic recipes, and production technologies more generally. This guarantees a better understanding of the mineralogical and petrological make-up of the pottery, and therefore makes it possible to link it with clay beds in a geological background. With much more intensive research, the provenance of the pottery can be precisely established. Finally, petrography allows for technological studies, as it provides insights into the clay recipes used by the potters and the temperatures reached by the kilns.

Results of the petrographic analysis

The results of the petrographic analysis reveal that the whole set of pottery under analysis in this study can be classified into six fabrics, although two of them show a particularly wide range of variation and need to be considered carefully in the future. An overview of the fabrics is presented in Figure 3 and below, while the association between sherds and fabrics is presented in Figure 4.

Figure 3. *Description of petrographic fabrics identified in the assemblage studied in this paper.*

Fabric number and name	Textural characteristics	Main inclusions	Technological implications
Fabric 1: Coarse fabric with shale and mudstone. Sub-fabrics 1.1 (with shale and mudstone and limestone); *1.2* (with quartz and oolites in the fine fraction) and *1.3* (with optically active shale)	Moderate number of pores (5–30%) and abundant inclusions (5–35%) (more abundant in Sub-fabric 1.3: 20–40%). Poorly sorted, generally non-aligned inclusions, weakly unimodal	Shale and mudstone (Predominant-Common, often optically active in Sub-fabric 1.3); <3.2 mm); calci-mudstones (Dominant-Common; <5 mm). Other inclusions in the coarse and fine fractions include fossiliferous limestone (Common-Few in Sub-fabric 1.1), evaporitic rocks, quartz (Dominant-Common in the fine fraction of Sub-fabric 1.2) and birefringent minerals	Clay mixing with a more calcareous clay is a possibility (much less in Sub-fabric 1.3). The estimated firing temperature would have been between 900° and 1000° Celsius (except in the case of the sub-fabrics, particularly 1.3, which are more optically active and probably had a lower estimated firing temperature: 700°–900°C)
Fabric 2: Coarse-fine fabric with quartz and oolites	Moderate number of pores (3–15%) and abundant inclusions (20–40%). Poorly sorted, generally non-aligned inclusions, weakly unimodal	Limestone (often fossils, often oolitic; Predominant-Common, <2 mm); monocrystalline quartz (Predominant-Common; <0.3mm); shale-mudstone (Common-Few; <2.2 mm). Other inclusions in the coarse and fine fractions include calci-mudstones, polycrystalline quartz, siltstone, feldspar, evaporitic rocks, birefringent minerals, serpentinite	Clay mixing unlikely, well-fired ceramic. Optical activity is very low or none, but calcite is not depleted. The estimated firing temperature would be slightly lower than that of Fabric 1, but higher than those of the sub-fabrics of Fabric 1.
Fabric 3: Coarse calcareous fabric with shale and mudstone. Sub-fabric 3.1: with shale and mudstone and quartz and evaporites	Low number of pores (5–10%) and abundant inclusions (5–30%). Poorly sorted, generally non-aligned inclusions, weakly unimodal	Shale and Mudstone (Predominant-Dominant); <4 mm), calci-mudstones (Common; <4 mm), fossiliferous limestone (Common, <9 mm). Other inclusions in the coarse and fine fractions include evaporitic rocks (Common-Few in Sub-fabric 3.1), quartz (Common-Few in Sub-fabric 3.1), serpentinite and birefringent minerals	Similar to Fabric 1, but the calcareous component is more abundant. This may be the result of different proportions in clay mixing, or the use of a different quarry altogether. Similar estimated firing temperature to Fabric 2, for the same reasons

Fabric number and name	Textural characteristics	Main inclusions	Technological implications
Fabric 4: Sandy Fabric with quartz and intermediate to mafic rocks and serpentinite **(Torpedo jars)**	Low number of pores (3–7%) and high number of inclusions (30–40%). Well-sorted, poorly aligned inclusions, strongly unimodal	Monocrystalline quartz (Dominant <0.4 mm), metamorphosed basalt into serpentinite (Dominant, <2.4 mm); fossiliferous limestone (Common-Few; <1.2 mm), feldspar (Common-Few, <0.3 mm), birefringent-intermediate mafic minerals (Common-Few, <0.3 mm), opaques (Common-Few, <1.2 mm). There are also clay pellets in the coarse and fine fraction	This fabric seems to be the result of an elaborated clay recipe, probably including a careful selection and grinding of components. A large clay pellet in Sample W042 suggests some clay mixing too. The firing is very homogeneous (but no overfired sherds). Some samples show bitumen. Similar estimated firing temperature to Fabric 2, for the same reasons
Fabric 5: Sandy fabric with quartz and intermediate to mafic rocks **(Honeycomb wares)**	Low number of pores (5–10%) and abundant inclusions (20–30%). Well-sorted, poorly aligned inclusions, strongly unimodal	Monocrystalline quartz (Predominant-Dominant <0.3 mm), metamorphosed basalt into serpentinite (Common-Few, <0.3 mm); feldspar (Common-Few, <0.3 mm), birefringent-intermediate mafic minerals (Common-Few, <0.3 mm), opaques (Common-Few, <1.2 mm). There is also fossiliferous limestone in the coarse and fine fraction	This fabric is very similar to Fabric 4, but the mineral component is slightly different and there are no signs of clay mixing. Similar estimated firing temperature to Fabric 2, for the same reasons
Fabric 6: Coarse calcareous fabric with pyroxene	Low number of pores (3–7%) and abundant inclusions (20–30%). Poorly sorted, generally non-aligned inclusions, weakly unimodal	Limestone (Dominant; <2.8 mm); pyroxene (Frequent; <2 mm); clay pellet (Frequent, <0.4 mm); serpentinite (Common, <1.6 mm); birefringent-intermediate mafic minerals (Common, <0.3 mm). There are also monocrystalline quartz (Predominant in fine fraction), opaques, and mudstone in the coarse and the fine fraction	This fabric does not seem to be the result of any mixing or very highly fired. Calcite not depleted, but samples are optically inactive, which suggest similar temperature to that of Fabric 2

Figure 4. *A list of samples analysed during the study showing their attribution to petrographic fabric (PF) and macroscopic class, form, type, and associated find-spot details. For associated classification codes see Priestman 2021.*

Sample	PF	Class	Form	Part	Type	Site	Trench/ Area	Find no.
W001	1.1	CLINKY	Jar	Rim	HAR-CR1	Ziarat	D18C	14627
W002	2	CLINKY	Jar	Rim	HAR-CR1	Rishahr	H11	2373
W003	2	CLINKY	Jar	Rim	HAR-CR1	Rishahr	H18A	1950
W004	2	CLINKY	Jar	Rim	HAR-CR2	Bushehr area	H	2008
W005	2	CLINKY	Jar	Rim	HAR-CR2	Bushehr area	H13	2491
W006	2	CLINKY	Jar	Rim	HAR-CR2	Minab area	K102B	11721
W007	2	HARLIM	Jar	Rim	n/a	Neran	D10	1442
W008	2	HARLIM	Jar	Rim	n/a	Ziarat	D18B	14638
W009	2	HARLIM	Jar	Rim	n/a	Neran	D30	13567
W010	2	HARLIM	Jar	Rim	n/a	Bostanu	D22	1449
W011	2	HARLIM	Jar	Rim	n/a	Sabzabad	H44	2010
W012	2	HARLIM	Jar	Rim	n/a	Moghun	D14C	1393
W013	2	HARLIM	Jar	Rim	n/a	Bushehr area	H73	14736

Sample	PF	Class	Form	Part	Type	Site	Trench/ Area	Find no.
W014	2	HARLIM	Jar	Rim	n/a	Bushehr area	H82	2480
W015	3	HARLIM	Jar	Rim	n/a	Hakemi	K68	13139
W016	3	CREAC	Bowl	Rim	HAR-OR8	Ruvan	B10A	15028
W017	1	CREAC	Bowl	Rim	HAR-OR8	Ruvan	B10A	15010
W018	1	CREAC	Bowl	Rim	HAR-OR8	T. Muveh	B17	15029
W019	3	CREAC	Bowl	Rim	HAR-OR9	Ziarat	D18C	14467
W020	3.1	CREAC	Bowl	Rim	HAR-OR17	Ruvan	B10C	15024
W021	1.1	CREAC	Jar	Rim	HAR-CR13	Akhtar	F16	1885
W022	1.1	REBROS	Bowl	Rim	HAR-OR22	Gurzeh	B19	15027
W023	3	REBROS	Jar	Rim	HAR-CR18	Ziarat	D18C	14481
W024	3	REBROS	Jar	Rim	HAR-CR12	Kish	AE2	293
W025	3	REBROS (LISV)	Storage jar	Rim	HAR-LISV1	Kal'at 'Abd al-Rahman	B20A	15031
W026	3	REBROS (LISV)	Storage jar	Rim	HAR-LISV1	Rishahr	H20C	2266
W027	1.1	REBROS (LISV)	Storage jar	Rim	HAR-LISV1	Nakhl Ibrahim	K36	3609
W028	1	REBROS (LISV)	Storage jar	Rim	HAR-LISV3	Moghdan area	D	13536
W029	5	HONEY	TCV	Side	BUF-F4		H94	2875
W030	5	HONEY	TCV	Side	BUF-F4	Rishahr	H17	12911
W031	5	HONEY	TCV	Side	BUF-F4		H94	2872
W032	5	HONEY	TCV	Side	BUF-F4		H94	2858
W033	5	HONEY	TCV	Side	BUF-F4	Tangac	H22	12913
W034	5	HONEY	TCV	Side	BUF-F4		NSC	12916
W035	5	HONEY	TCV	Side	BUF-F4		H94	2859
W036	5	HONEY	TCV	Side	BUF-F4	Ziarat	D18	14461
W037	5	HONEY	TCV	Side	BUF-F4	Rishahr	H18	12906
W038	5	HONEY	TCV	Side	BUF-F4		H94	2874
W039	4	TORP-S	TCV	Rim	TOR-CR1		H94	2954
W040	4	TORP-S	TCV	Rim	TOR-CR1	Sabzabad	H35	2024
W041	4	TORP-S	TCV	Rim	TOR-CR1		H94	2862
W042	4	TORP-S	TCV	Rim	TOR-CR1		H94	2861
W043	4	TORP-S	TCV	Rim	TOR-CR1	Deh Ali & Kolebi	K17	3890
W044	4	TORP-S	TCV	Rim	TOR-CR1		H201	2966
W045	4	TORP-S	TCV	Base	TOR-CR1		H94	1823
W046	4	TORP-S	TCV	Base	TOR-CR1	Halileh	H65	2472
W047	4	TORP-S	TCV	Rim	TOR-CR1	Halileh	H65	15267
W048	4	TORP-S	TCV	Rim	TOR-CR1	Tepe Mauru	Q17	6401
W049	3	CREAC (LISV)	Storage jar	Rim	n/a	Sabzabad	H44	2226
W050	3	CREAC (LISV)	Storage jar	Rim	n/a	Moghun	D14	13557
W051	3	CREAC (LISV)	Storage jar	Rim	n/a		H94	2252
W052	3	CREAC (LISV)	Storage jar	Rim	n/a	Neran	D10	13541
W053	3	CREAC (LISV)	Storage jar	Rim	n/a	Gust-i Burjan	P6	5645
W054	1.2	CREAC	Large basin	Rim	n/a		H92	2038

Sample	PF	Class	Form	Part	Type	Site	Trench/ Area	Find no.
W055	3	CREAC	Large basin	Rim	n/a	Shilau	F7	14809
W056	3.1	CREAC	Bowl	Rim	n/a	Shilau	F7	14817
W057	3	CREAC	Bowl	Rim	n/a	Sabzabad	H44	2269
W058	3	CREAC	Bowl	Rim	n/a	Shilau	F6	1898
W059	1.3	CREAC	Bowl	Rim	n/a	Shenas	B4	15049
W060	3.1	CREAC	Bowl	Rim	n/a	Shilau	F6	1881
W061	1.2	CREAC	Bowl	Rim	HAR-OR21	Ziarat	D18	14608
W062	3	CREAC	Bowl	Rim	n/a	Bushehr	H4	2701
W063	3.1	CREAC	Jar	Rim	n/a	Kish	AE1	292
W064	3.1	REBROS	Large basin	Rim	n/a	Rishahr	H17	2251
W065	3	REBROS	Large basin	Rim	n/a	Shilau	F6	14808
W066	3.1	REBROS (LISV)	Storage jar	Rim	n/a	Rishahr	H20	2221
W067	1	REBROS	Closed bowl	Rim	n/a	Ziarat	D18	1367
W068	3	REBROS	Bowl	Rim	n/a	Halileh	H65	2421
W069	3	REBROS	Jar	Rim	n/a	Mashiran	K27	3631
W070	1.1	REBROS	Bowl	Rim	n/a	Shiwu	D16	1402
W071	3	REBROS	Bowl	Rim	n/a	Ziarat	D18	1456
W072	3.1	REBROS	Bowl	Rim	n/a	Sabzabad	H36	2943
W073	3	REBROS	Bowl	Rim	n/a	Ziarat	D18	1457
W074	3	REBROS	Jar	Rim	n/a	Shilau	F7	1890
W075	3.1	REBROS	Jar	Rim	n/a	Jangin	Q6	7182
W076	1.1	REBROS	Bowl	Rim	n/a	Tavuneh	B15	15057
W077	3	REBROS	Bowl	Rim	n/a	Ziarat	D18	14685
W078	3	REBROS	Bowl	Rim	n/a	Akhtar	F12	1901
W079	2	CLINKY	Jar	Rim	HAR-CR1	Rishahr	H17	2492
W080	2	CLINKY	Jar	Rim	HAR-CR1	Sabzabad	H40	2703
W081	1	CLINKY	Jar	Rim	HAR-CR2	Sabzabad	H40	2103
W082	2	CLINKY	Jar	Rim	HAR-CR2	Rishahr	H17	1991
W083	2	CLINKY	Jar	Rim	HAR-CR2		H13	1993
W084	3.1	CLINKY	Jar	Rim	HAR-CR1		D1	14648
W085	2	CLINKY	Jar	Rim	HAR-CR1	Rishahr	H17	2947
W086	Loner	CLINKY	Jar	Rim	HAR-CR1		H75	2762
W087	2	CLINKY	Jar	Rim	HAR-CR1		K109	3595
W088	2	CLINKY	Jar	Rim	HAR-CR1	Sabzabad	H44	2356
W089	2	CLINKY	Jar	Rim	HAR-CR1		H13	2166
W090	Loner	CLINKY	Jar	Rim	HAR-CR1	Rishahr	H17	2722
W091	2	CLINKY	Jar	Rim	HAR-CR1	Tombakanat	K102	2707
W092	2	CLINKY	Jar	Rim	HAR-CR1	Sabzabad	H40	2113
W093	2	CLINKY	Jar	Rim	HAR-CR1		H14	1955
W094	1	HARLIM (LISV)	Storage jar	Rim	n/a	Akhtar	F15	1855
W095	1.1	HARLIM	Jar	Rim	n/a		H201	2967

Sample	PF	Class	Form	Part	Type	Site	Trench/ Area	Find no.
W096	1.1	HARLIM	Jar	Rim	n/a	Kal'at 'Abd al-Rahman	B29	15085
W097	1	HARLIM	Jar	Rim	n/a	Moghun	D14	1346
W098	1	HARLIM	Jar	Rim	n/a		K122	15132
W099	1	HARLIM	Jar	Rim	n/a	Gurzeh	B19	14039
W100	1	HARLIM	Jar	Rim	n/a	Moghun	D14	312
W101	3	HARLIM	Jar	Rim	n/a	Rishahr	H11	2061
W102	1.1	HARLIM	Jar	Rim	n/a	Shiwu	D16	14037
W103	1	HARLIM	Jar	Rim	n/a		H81	1979
W104	1	HARLIM	Jar	Rim	n/a		H81	1961
W105	1	HARLIM	Jar	Rim	n/a	Rishahr	H17	1963
W106	1	HARLIM	Jar	Rim	n/a	Sabzabad	H42	14398
W107	1	HARLIM	Jar	Rim	n/a	Bostanu	D22	1406
W108	1.1	HARLIM	Jar	Rim	n/a	Akhtar	F13	14042
W109	2	HARLIM (LISV)	Storage jar	Rim	n/a	Minab	K170	4078
W110	1	HARLIM (LISV)	Storage jar	Rim	n/a	Neran	D10	13534
W111	2	HARLIM (LISV)	Storage jar	Rim	n/a	Bushehr area	H	2068
W112	2	HARLIM (LISV)	Storage jar	Rim	n/a	Rishahr	H17	2273
W113	2	HARLIM (LISV)	Storage jar	Rim	n/a	Akhtar	F18	3460
W114	1	HARLIM (LISV)	Storage jar	Rim	n/a	Nakhl Ibrahim	K36	3610
W115	1	HARLIM (LISV)	Storage jar	Rim	n/a	Moghun	D14	13554
W116	1.1	HARLIM (LISV)	Storage jar	Rim	n/a	Halileh	H63	2280
W117	1	HARLIM (LISV)	Storage jar	Rim	n/a	Ziarat	D18	13561
W118	1	HARLIM (LISV)	Storage jar	Rim	n/a		D1	1425
W119	1	HARLIM (LISV)	Storage jar	Rim	n/a		D1	13543
W120	1.1	HARLIM (LISV)	Storage jar	Rim	n/a	Shiwu	D17	14639
W121	2	HARLIM (LISV)	Storage jar	Rim	n/a	Bushehr area	H	2001
W122	2	HARLIM (LISV)	Storage jar	Rim	n/a	Rishahr	H17	2261
W123	1	HARLIM (LISV)	Storage jar	Rim	n/a	Ziarat	D18	1420
W124	4	TORP-C	TCV	Rim	n/a	Gishnau	K143	12912
SRF003	3.1	REBROS	Bowl	Rim	HAR-OR20	Siraf	C/1EXT/15	697
SRF004	1	REBROS	Bowl	Rim	HAR-OR8	Siraf	C/2/21	None
SRF011	1	REBROS (LISV)	Storage jar	Rim	HAR-LISV3	Siraf	M/A/2	1182
SRF013	3	REBROS (LISV)	Storage jar	Rim	HAR-CR11	Siraf	E/N/1	65
SRF015	1.2	REBROS	Bowl	Rim	HAR-OR2	Siraf	A/-/31	1619
SRF017	3.1	HARLIM	Bowl	Rim	n/a	Siraf	F/-/161	1925
SRF024	1.1	REBROS (LISV)	Storage jar	Rim	HAR-LISV5	Siraf	A/-/13	1085
SRF025	1	HARLIM	Bowl	Rim	n/a	Siraf	A/-/1	186
SRF026	1	HARLIM	Jar	Rim	n/a	Siraf	F/-/151	1584
SRF030	2	HARLIM	Jar	Rim	HAR-CR1	Siraf	A/-/1	186
SRF057	1.2	REBROS	Bowl	Rim	HAR-OR2	Siraf	E/S/9	273
SRF082	3	CREAC	Jar	Rim	HAR-CR5	Siraf	F/-/104	1893

Sample	PF	Class	Form	Part	Type	Site	Trench/ Area	Find no.
SRF083	3	CREAC	Jar	Rim	HAR-CR5	Siraf	F/-/104	1893
SRF090	3.1	CREAC	Bowl	Rim	HAR-CR10	Siraf	C/1EXT/15	697
SRF133	1.3	CREAC	Bowl	Rim	HAR-OR8	Siraf	F/-/161	1925
SRF161	3	CREAC	Jar	Rim	HAR-CR12	Siraf	C/2/9	1660
SRF164	3	CREAC	Bowl	Rim	HAR-OR8	Siraf	C/2/21	None
SRF166	1	REBROS (LISV)	Storage jar	Rim	HAR-LISV3	Siraf	F/-/151	1584
SRF181	3.1	CREAC	Jar	Rim	HAR-CR12	Siraf	F/-/136	2508
SRF189	1.3	CREAC	Bowl	Rim	HAR-OR1	Siraf	B/-/134	2767
F1	6	COB	Tube	Side	n/a	Fulayj	Surface	SC231
F2	6	COB	Tube	Side	n/a	Fulayj	Surface	SC290
F3	6	COB	Tube	Side	n/a	Fulayj	Surface	SC429
F4	2	HARLIM (LISV)	Storage jar	Side	n/a	Fulayj	Surface	SC168
F5	2	HARLIM (LISV)	Storage jar	Side	n/a	Fulayj	Surface	SC39
F6	2	HARLIM (LISV)	Storage jar	Side	n/a	Fulayj	Surface	SC903
F7	6	Kiln wall	n/a	n/a	n/a	Fulayj	Kiln 1 (south)	n/a
F8	Loner	Kiln wall	n/a	n/a	n/a	Fulayj	Kiln 2 (north)	n/a

Fabric 1: coarse shale and mudstone (Fig. 5/A)

As the name indicates, this is a coarse fabric characterized by the high presence of shale and mudstone. The features and colours of the clay matrix suggest that two different clays were used in its manufacture, although this needs to be confirmed by future studies. The estimated firing temperature used in the pots seems to be generally high, between 900° and 1000°C. In terms of its representation within the sample, this is a very important fabric, with fifty-six sherds. It is one of the fabrics that shows a wider range of variation. Three additional sub-fabrics that show specific characteristics that are different from those of the main fabric have been highlighted. Sub-fabric 1.1 contains a higher amount of quartzitic rocks (Fabric 1, Fig. 5/B), while Sub-fabric 1.2 displays more noticeable amounts of limestone and/or fossils (Fabric 1, Fig. 5/C). A loner (Sample W086), has been considered very similar to Sub-fabric 1.2. A third sub-fabric, 1.3, has been defined by a higher content of birefringent minerals in shale (Fabric 1, Fig. 5/D). The reason for this is still unclear. It may be due to a diverse composition (and therefore provenance) of the shale, or alternatively a lower firing temperature (which keeps the shale optically active).

Fabric 2: coarse fabrics with shale, quartz, and oolites (Fig. 6/A–B)

Fabric 2 is very similar to Fabric 1, but it has two distinctive components: fine but consistent quartz grains and microfossils, particularly oolites. In principle this makes it closer to Sub-fabrics 1.1 and 1.2, but Fabric 2 shows more consistency and homogeneity in its contents, and this suggests that the clay recipe is altogether different. Another important difference with the sub-fabrics of Fabric 1 is that the colours and features of the clay matrix do not suggest clay mixing. This fabric has been identified in twenty-six samples.

Fabric 3: coarse calcareous fabric with shale and other sedimentary rocks (Fig. 6/C)

It is also similar to Fabric 1, but is much more calcareous, and this suggests that a different clay recipe has been

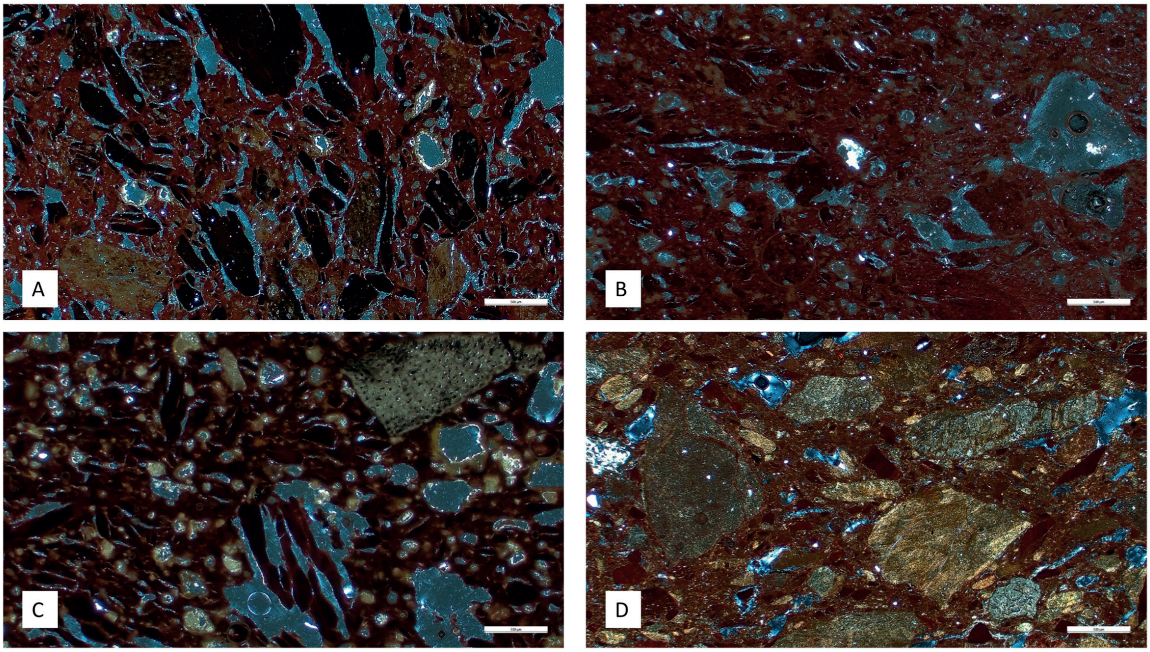

Figure 5. A. *Fabric 1, Sample W001 (XP), showing abundant mudstone and shale;* **B.** *Sub-fabric 1.1, Sample W117 (XP), with quartzitic rocks (showing polycrystalline quartz grain in the centre);* **C.** *Sub-fabric 1.2, Sample X022 (XP), with more abundant calcareous rocks;* **D.** *Sub-fabric 1.3, Sample SRF057 (XP), with abundant optically active shale. All scales are 500 µm.*

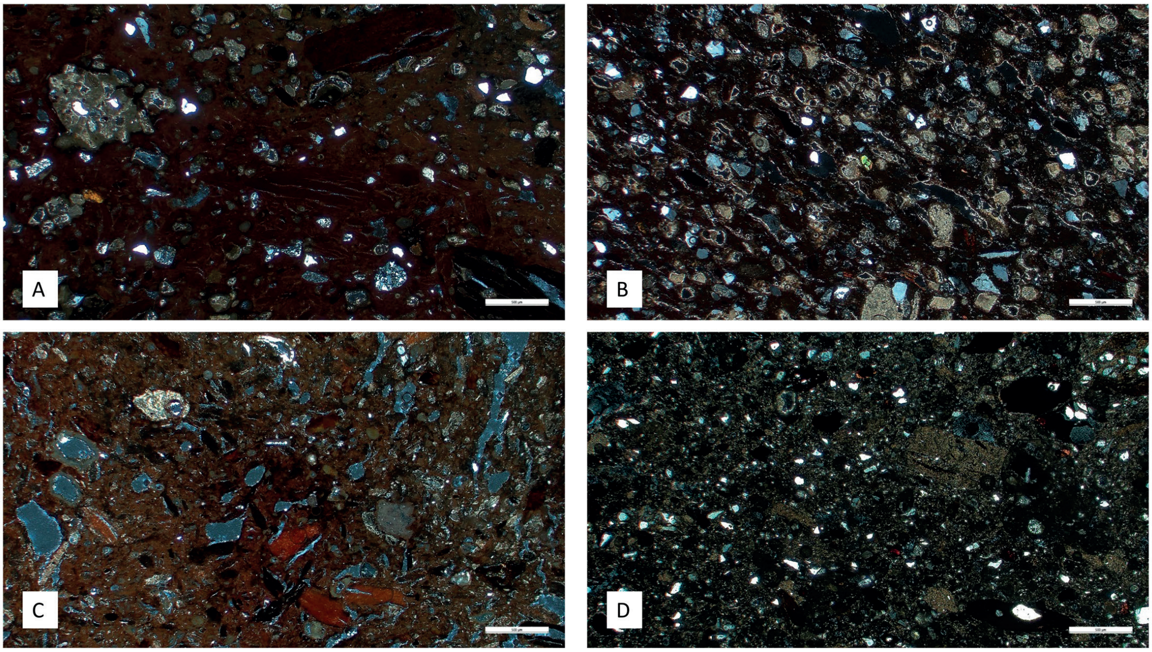

Figure 6. A *and* **B.** *Fabric 2, Sample SRF030 (XP) and Sample F006 (XP) respectively, showing shale and calcareous rocks over a quartz-rich background;* **C.** *Fabric 3, Sample W015 (XP), showing shale and calcareous rocks over a calcareous matrix;* **D.** *Sub-fabric 3.1, Sample W111 (XP), showing the same, but with more abundant quartz in the background. All scales are 500 µm.*

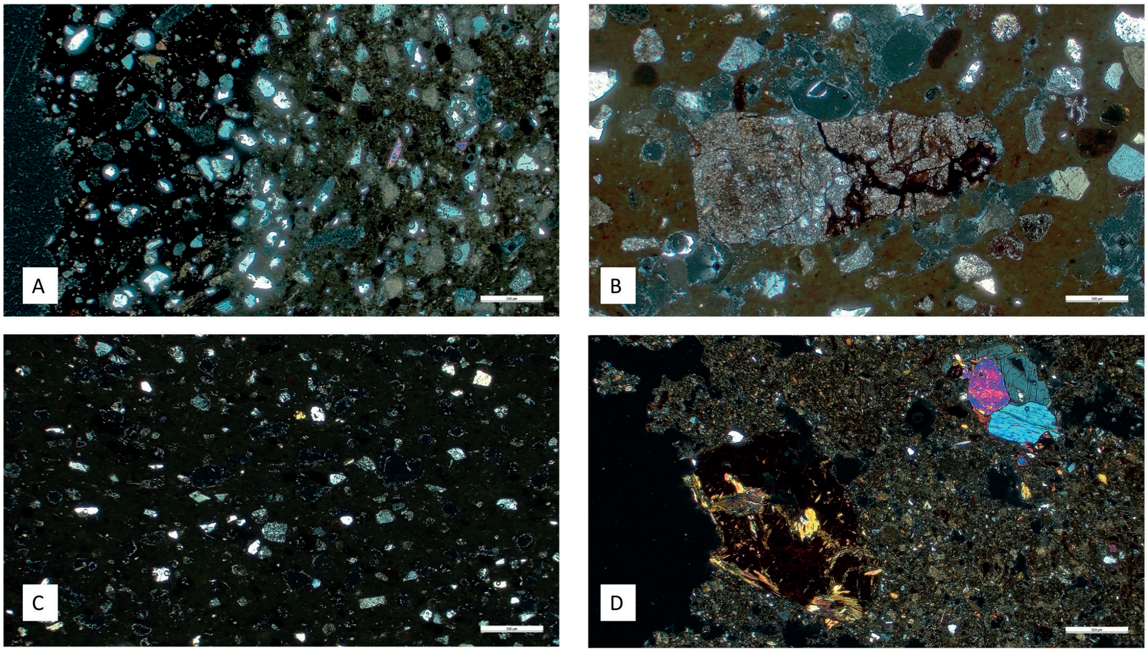

Figure 7. A. *Fabric 4, Sample W045 (XP), showing abundant angular sand made of quartzitic and igneous rocks. The margin and surface show a darker colour, possibly an effect of bitumen;* **B.** *detail of Fabric 4, Sample WQ040 (XP): angular fragment of serpentinite, unusually large for this type;* **C.** *Fabric 5, Sample W031 (XP), showing quartzitic and igneous sand grains over a dark matrix;* **D.** *Fabric 6, Sample F007 (XP), showing pyroxene and serpentinite over a calcareous matrix. All scales are 500 µm.*

used. At the very least, the clays that were used in Fabric 1 are mixed in a different proportion. The temperature reached for the firing of the vessels in this fabric seems to be similar too. Fabric 3 represents forty-three samples, and also contains wide variation, with one sub-fabric (3.1, 13 samples, Fig. 6/D) defined by the presence of more sedimentary quartz.

Fabric 7: sandy fabric with intermediate and mafic igneous rocks and serpentinite (Fig. 7/A)

This fabric is represented by eleven samples, all of them torpedo jars (Kennet 2004: 85 'TORP'; Priestman 2021: 41–44, 'TORP-S' or 'TORP-C'). Of these, ten are TORP-S and one is TORP-C. The fabric is defined by the abundant presence of sand made of very angular quartz, intermediate and mafic igneous rocks, and serpentinite. It shows some interesting textural features that suggest that the fabric was manufactured through a complex process, which could include grinding of minerals and clay mixing. This would explain the angularity of the rocks (sometimes unusually large, e.g. Fig. 7/B) and the occasional lumps of clay (textural features) that appear inserted in the matrix.

Fabric 5: sandy fabric with intermediate and mafic igneous rocks (Fig. 7/C)

The group defined by this fabric is composed of ten sherds of honeycomb ware jars (Kennet 2004: 80, 'HONEY' and 'HONEYF'; Priestman 2021: 45–46, 'HONEY'), all of which have a very homogeneous composition. The fabric is quite similar to Fabric 4, although with distinctively smaller amounts of serpentinite. The rock inclusions are quite angular too.

At this point it is worth noting that there is another loner (W090), which could be classified as close to Fabrics 4 and 5, because its composition is similar, although it does not fit entirely with any of them.

Fabric 6: calcareous fabric with pyroxenes (Fig. 7/D)

This is the scarcest and yet the most clearly distinct of the fabrics. It is rich in limestone and pyroxenes and is found in technological ceramics from Fulayj: three coarse buff ware tubes and one kiln wall fragment.

The last sherd, F008, belonging to another kiln wall fragment from Fulayj, is probably of the same fabric but it has a slightly different amount and size of pyroxenes and for that reason, has been classified as an outlier.

In the remainder of this paper Fabric 6 and Loner F008 will be set aside, as they are clearly a distinctive fabric, very different to everything else. This is most likely because these fabrics represent raw materials from the environs of Fulayj itself.

Macroscopic and petrographic fabrics

This study offers the possibility of a direct comparison between the IOPC (Priestman 2021) and the petrographic results (Figs 8 & 9). It is important to emphasize that the point of this exercise is not to verify the macroscopic classes with a 'more scientific' analysis. Macroscopic classes are perfectly valid ways of classifying pottery, because they take into account a range of information that the petrographic analysis cannot encompass. What the petrographic analysis can offer is further insight into the composition of the fabric and associated technologies, so that archaeologists have an additional layer of information to consider.

The results displayed on Figures 8 and 9 show that without any doubt, Fabrics 4 and 5 correspond respectively to torpedo jars and honeycomb ware classes. The correlation between Fabrics 1, 2, and 3 and the class categories defined within the IOPC is more complex, as they cross over several categories: clinky-fired earthenware (CLINKY; Priestman 2021: 19; see also Kennet 2004: 84); hard lime-spalled ware (HARLIM; Priestman 2021: 19–21); gritty red/brown slipped ware (REBROS; Priestman 2021: 22–24); and cream coated red ware (CREAC; Priestman 2021: 25–26). However, this is not entirely surprising. Both Kennet and Priestman have often noted the similarity between several of these classes, and they have merged together categories that existed before. For example, the category of HARLIM encompasses two previously separated categories,

Petrographic fabric	Macroscopic class	Total number of fabrics per class	Total number of fabrics
Fabric 1	HARLIM	26	34
	REBROS	5	
	CREAC	2	
	CLINKY	1	
Sub-fabric 1.1	HARLIM	6	13
	REBROS	5	
	CREAC	2	
	CLINKY	1	
Sub-fabric 1.2	REBROS	2	4
	CREAC	2	
Sub-fabric 1.3	CREAC	3	3
TOTAL FABRIC 1			**56**
Fabric 2	CLINKY	16	26
	HARLIM	10	
TOTAL FABRIC 2			**26**
Fabric 3	CREAC	15	30
	REBROS	13	
	HARLIM	2	
Sub-fabric 3.1	CREAC	6	13
	REBROS	5	
	HARLIM	1	
	CLINKY	1	
TOTAL FABRIC 3			**43**
TOTAL FABRIC 4	TORP-S	10	**10**
	TORP-C	1	**1**
TOTAL FABRIC 5	HONEY	10	**10**
TOTAL FABRIC 6	-	4	**4**
LONERS	CLINKY	2	2
	-	1	1
TOTAL LONERS			**3**

FIGURE 8. *Comparison between petrographic fabrics and macroscopic classes (from more to less abundant).*

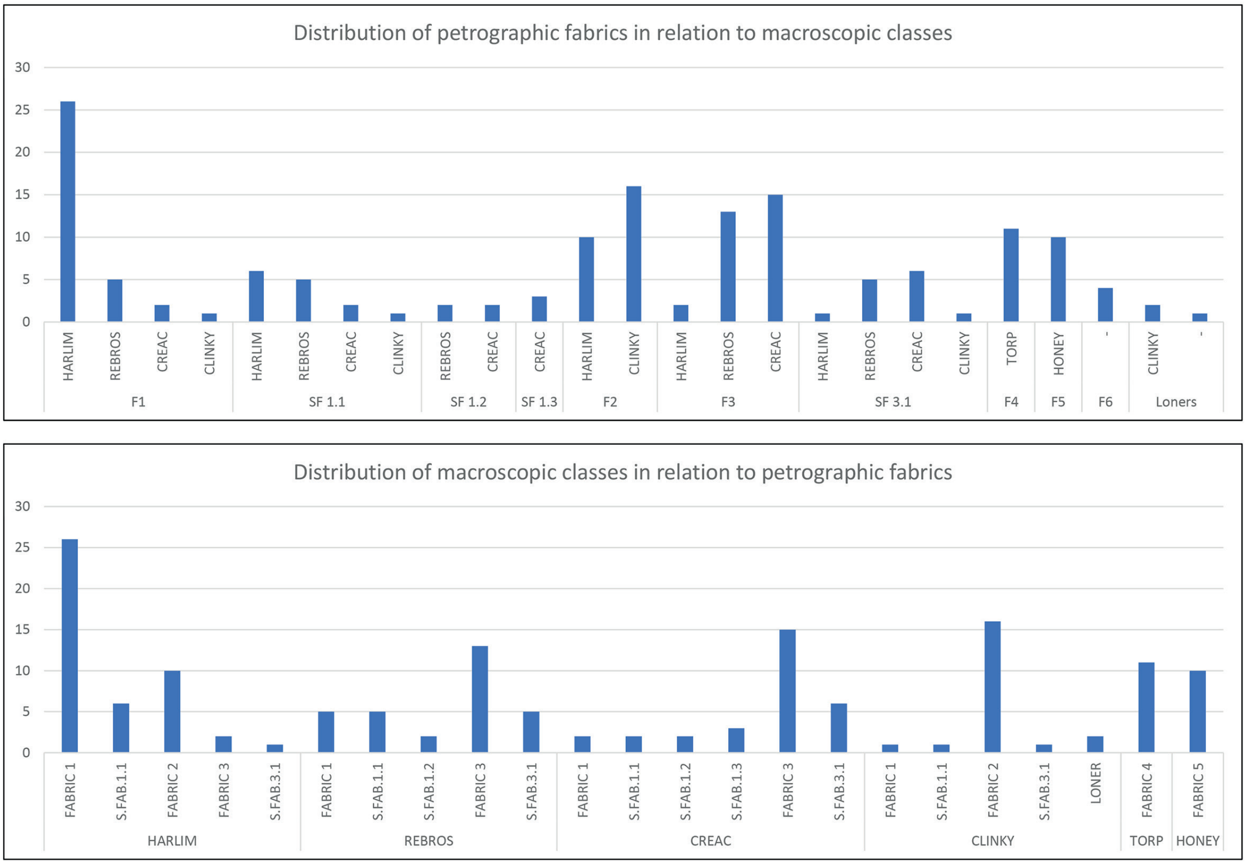

FIGURE 9. *Two graphs showing the distribution of petrographic fabrics in relation to macroscopic fabrics, and vice versa.*

SMAG (small grey vessels) (Kennet 2004: 86) and LISV (large incised storage vessels) (2004: 79). This analysis offers a potential alternative way to structure the differences between all these categories. In general, the main Fabric 1 is very strongly identified with HARLIM wares, whereas the sub-fabrics of Fabric 1 have less connection with HARLIM and more with REBROS and CREAC. Fabric 3 is associated almost exclusively with REBROS and CREAC. Fabric 2, however, is clearly distinctive. It contains almost all the samples of CLINKY ware and a good number of HARLIM sherds.

This suggests that petrographic fabric and macroscopic class should not necessarily be understood as the output of a specific workshop, but rather as different areas of a spectrum of technical possibilities involving a number of workshops in a given area operating over a protracted period. In the current state of knowledge, it is not possible to establish the precise limits between these classes, but we have a good chance of establishing the approximate area of the spectrum in which the pottery that we are looking at stands. For example, we do not know the precise technical difference between the fabric recipe of HARLIM and CREAC, but we do know that CREAC tends to be more calcareous and contains a higher amount of sedimentary rocks different from shale. There is also a chronological difference that may prove to be relevant in future analysis: CLINKY and HARLIM (=SMAG/LISV) can be dated to the *c.* fifth to eighth century, whereas REBROS and CREAC can be dated from the *c.* mid-eighth to tenth century (Priestman 2021). This would suggest that the technical differences that differentiate areas of the spectrum can be a reflection of either/or changes in manufacturing techniques over time or shifts in the locations of production.

There are areas of the spectrum that are better defined than others. To offer an example of what we still do not know, we have no way of telling the difference between CREAC and REBROS with petrography only, as they seem to fit within the same petrographic fabrics, even if it appears that samples within REBROS tend to have a more calcareous matrix than those within CREAC (which are already quite calcareous themselves). It is important to note here that this does not mean that the difference between CREAC and REBROS has no basis in archaeological reality. It simply means that we cannot establish the technical distinction between the two on the basis of petrography. This is in fact not surprising as both categories correspond to the ceramics manufactured within the vicinity of Siraf, both as the staple 'kitchenware' used within the city itself during its main period of prosperity (Whitehouse 1968: 5, 16, n. 48), and as a product for large-scale export. Substantial quantities of Sirafi coarse wares occur particularly on sites in East Africa and elsewhere (Chittick 1984). Another case shows a stronger correlation: we have a much clearer idea of the difference between CLINKY and HARLIM. Even when there is much overlap in their correspondence with petrographic fabrics, CLINKY is characterized by the presence of quartzitic and oolitic sands, and that is something that can be traced back to the technical procedures that the potter followed to make one or other of the fabrics.

Issues of comparison and provenance

A comparison of the results of this analysis with those of the previous studies undertaken on the ceramics from Murwab (Carvajal López, Guérin & Georgakopoulou 2022) (Fig. 10) is considered first. The analysis of the ceramics of Murwab showed twelve petrographic fabrics. Of those, Fabrics 1 to 4[2] had an abundance of sandy inclusions (mostly quartz and feldspars) and the remaining eight were considered a macrogroup defined for its abundance in shale (Shale Macrogroup). One of the conclusions of the study was that the provenance of the wares was related to their composition. Fabrics 1 to 4, sandy, were most likely from Kuwait or southern Iraq (Carvajal López, Guérin & Georgakopoulou 2022: 65–66), whereas the Shale Macrogroup was more likely to be from southern Iran (2022: 66–67). We can apply the same broad distinction to the samples under analysis here quite successfully: the torpedo and honeycomb wares, Fabrics 4 and 5 respectively, have a predominance of felsic inclusions and are considered more likely to be from southern Iraq or south-west Iran (Priestman 2021: 41–44 and 45–46 respectively). Fabrics 1 to 3, characterized by their abundance in shale, are identified with macroscopic classes (CLINKY, HARLIM, REBROS, CREAC) that are considered — potentially — to be from the areas of Bushehr and Siraf, in southern Iran (2021: 19, 19–21, 22–24 and 25–26 respectively).

Another interesting observation emerges when comparing the structure of the fabrics of Murwab with those of the Williamson-Siraf batch. The Shale Macrogroup of Murwab shows the same features and variations that are observed among Fabrics 1–3 of the Williamson-Siraf wares. These parallel associations need to be studied in more detail, but it seems very likely that Fabrics 1–3 of the Williamson-Siraf batch are the same as the Shale Macrogroup defined at Murwab. In the future both assemblages should be subjected to more detailed comparisons but in the meantime, it is possible to suggest that Fabric 1 of Williamson-Siraf is the same as Fabric 8 of Murwab, and Fabric 3 of Williamson-Siraf is the same as Fabric 9 of Murwab. Fabric 2 of Williamson-Siraf would be close to Fabric 11 of Murwab, but it is not identical.

Beyond the Shale Macrogroup, the fabrics documented at Murwab are not especially similar to the other Williamson-Siraf fabrics. That is of interest too. Fabrics 1 and 2 of Murwab are similar to Fabric 5 of Williamson-Siraf (the honeycomb wares), but they still remain different because they are considerably less rich in inclusions. Only one sample of Murwab Fabric 1 (MRW002), seems very similar to Williamson-Siraf Fabric 4, but this is quite exceptional, as the rest of the members of these two fabrics are in general very different. As for Murwab Fabrics 3 and 4, they do not resemble either Williamson-Siraf Fabrics 4 (the torpedo jars) or 5 (the honeycomb wares), even when their mineralogical composition is similar. The provenance of all these fabrics is thought to be in southern Iraq or south-west Iran, and yet their variation is quite remarkable. This again suggests that we need to consider all these fabrics as parts of the spectra

[2] For economy of space fabric numbers are used in this section, but it is important to remind readers that the actual denomination of the fabrics is given by their names, shown in Figure 10. This is to avoid mixing fabric numbers across different collections.

Assemblage	Fabric number (in collection) and name	Abundant in sand or shale?	Suggested provenance
Murwab (9th–10thC)	F1: Fine calcareous with intermediate-mafic igneous rocks	Sand	Southern Iraq?
	F2: Fine sandy and fossiliferous	Sand	Southern Iraq?
	F3: Sandy with felsic-intermediate rocks	Sand	?
	F4: Sandy with fossiliferous and micritic limestone	Sand	?
	F5: Calcareous with shale and evaporites	Both	Southern Iran
	F6: Sandy with shale and evaporites	Both	Southern Iran
	F7: With shale and evaporites	Shale	Southern Iran
	F8: With shale	Shale	Southern Iran
	F9: Calcareous with shale	Shale	Southern Iran
	F10: Sandy with shale	Both	Southern Iran
	F11: Calcareous with sand and shale	Both	?
	F12: With oolites	None	?
Williamson-Siraf (6th–10thC)	F1: With coarse shale and mudstone	Shale	Southern Iran
	F2: With coarse shale, quartz, and oolites	Both	Southern Iran
	F3: Coarse calcareous with shale and other sedimentary rocks	Shale	Southern Iran
	F4: Sandy with intermediate and mafic igneous rocks and serpentinite	Sand	Southern Iraq
	F5: Sandy with intermediate and mafic igneous rocks	Sand	Southern Iraq
	F6: Calcareous with pyroxenes	None	Fulayj?
Old Doha (19th–20thC)	F1: Coarse with shale and mudstone	Shale	Julfar
	F2: Coarse calcareous with mudstone and shale	Shale	Musandam?
	F3: Calcareous with serpentinite	Shale	Musandam?
	F4: Argillaceous with mudstone	Shale	Julfar
	F5: With coarse rounded monocrystalline quartz	Sand	?
	F6: Fine ophiolitic	None	?
	F7: Fine calcareous ophiolitic glazed	None	Bahla
	F8: Fine with rounded crystalline quartz	Sand	Aali?
	F9: Fine glazed with rounded crystalline quartz	Sand	Southern Iran?

Figure 10. *Comparison between the fabrics of Murwab (Carvajal López et al. 2022) and Old Doha (Carvajal López et al. 2019), and the assemblage in this paper (Williamson-Siraf).*

of wide ranges of technical possibilities within a region.

Finally, we can turn to a comparison between the Williamson-Siraf sherds analysed here and the assemblage studied from the Old Doha excavations (Carvajal López et al. 2019) (Fig. 10). The general differentiation between sandy wares and wares with shale that was noted for the Murwab and the Williamson-Siraf fabrics can be clearly seen in the Old Doha wares, that were manufactured much later, in the nineteenth or twentieth century. This is interesting because it shows a certain degree of continuity of technologies between the early and late Islamic periods. It is also a good example of one of the weaknesses of petrography. Because of their high content in shale, the Old Doha Fabrics 1, 2, 3, and 4 are the equivalent of the Murwab Shale Macrogroup and Williamson-Siraf Fabrics 1, 2, and 3. However, the study of the fabrics recovered in Old Doha suggests that they come from the Musandam peninsula. The Old

Doha Fabric 1 corresponds to Julfar ware, for which we have an established provenance in Ras al-Khaimah (Raʾs al-Khaymah) (Mitsuitshi & Kennet 2013), and Fabrics 2, 3, and 4 appear to be very similar to it. Petrography has hit a limit in its possibilities for distinguishing wares from two distant places like Musandam and southern Iran, because the composition of the fabrics with shale is very similar in both areas. Once again, this is not surprising. This situation mirrors an earlier dated category of ceramics widely distributed in eastern Arabia and the Gulf dated to the c. first century BC to third century AD (Mouton 1992: 103–104, fig. 84 céramique noire épaisse). Like the fabrics being discussed here, it is rich in shale. The precise relationship between this and the later Shale Macrogroup discussed here remains to be examined. It is possible that more targeted analysis in the future will offer more insight on how to differentiate wares from the northern Emirates and southern Iran. For the moment, there is hope that chemical analysis can offer an additional layer of information that will allow a better calibration of the petrographic results.

Two conclusions can be drawn from this. The first is the need to analyse ceramics with as many techniques and methods as possible, with the aim of offering a range of perspectives that can lead us to a better understanding of their production and distribution. The second is a line of research for the future: we are starting to see the similarities and differences of a range of pottery-making traditions in the Gulf, and that should make us aware of the possibility to look at how the different technologies are connected and associated.

Conclusions

This study is one more step in the development of a study of ceramic technology, provenance, and distribution of common categories of late antique and early Islamic ceramics across the Arabian Gulf. The petrographic study of a batch of 152 samples from Siraf, survey sites on the Iranian littoral, and Fulayj has provided a better understanding of the technological background of some well-known ceramics of the period c.300–1000 AD, classified in the IOPC as CLINKY, HARLIM, CREAC, REBROS, TORP-S/C, and HONEY (Priestman 2021). The correspondences between macroscopic classes and petrographic fabrics are not always clear, and this indicates that there is a wide range of technological variation that is probably due to the coexistence of diverse workshops and craftsmen operating in the same regions for relatively long periods of time.

Additionally, the comparison of these fabrics with other well-studied assemblages, those of Murwab and the one from the Old Doha excavations, is useful to start drawing a landscape of the technological development in pottery-making in the Gulf. An important observation is the clear separation between techniques of pottery made from sand-rich clay recipes, and those that use shale-rich recipes. This separation is relevant both in the upper Gulf (southern Iran and southern Iraq/Kuwait) and in the Musandam peninsula, according to the provenance proposed so far for all the wares under analysis. It is also relevant across time, as it is found in wares of the late antique and early Islamic period (*c.*300–1000) and of the late nineteenth and early twentieth centuries. This links different pottery traditions in the technological landscape of the Gulf across many centuries. The availability of easily workable clays was paramount for the shale/sand divide, but the commonality and similarity of techniques may be also a result of contacts, perhaps even population movements, in between the different shores of the Gulf. It is not known when the dichotomy in ceramic technology in the Gulf began, but it is important to note that its earliest occurrence in the Gulf attested with petrographic analysis is in the PIR B–C (late first century BC to early second century AD) assemblage of ed-Dur (al-Dawr) in the UAE. The analysis of the céramique noire épaisse, as discussed above, reveals a shale-rich composition that contrasts with the sand-rich local buff sandy ware and with the imported Thāj ware (De Paepe et al. 2003). Moreover, the analysis suggests strong similarities with later Julfār wares (De Paepe et al. 2003: 223; Rutten 2009: 362). Katrien Rutten suggests that the growth of maritime trade in the first century BC had a profound impact on the production of local pottery in ed-Dur (Rutten 2009: 368), and that may be the context in which this type of shale-rich fabric first emerged in the northern Emirates. There seems to be no earlier evidence of shale-rich fabrics in the Gulf, although we have evidence of sand-rich ceramics as early as in the Bronze Age assemblage of Failaka Island (Jazīrat Faylakā), Kuwait (Ashkanani 2014: 209–217 'Fabric A'; Ownby 2014: 292–293). This, however, may be a reflection of the current lack of knowledge.

This study has presented research on late antique to early Islamic ceramics from the Gulf by combining insights of macroscopic study and petrographic investigations, soon to be complemented with chemical compositional analysis. The aim of this exercise is to start drawing a map of technological characteristics and raw materials identification that will help researchers to trace the provenance, flows, and distribution of ceramics and techniques across the Gulf.

Acknowledgements

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Postscript

Myrto Georgakopoulou sadly died while this text was being prepared. The other authors would like to pay tribute to her exceptional work and scholarship during her life, and in particular for the preparation of this text. Future works on ceramic technology and distribution in the Gulf will have a solid base to build on thanks to her but her family, friends, and colleagues will continue to miss her immensely.

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