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Petrographic analysis of ceramics from Murwab, an early Islamic site in Qatar

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Summary
Murwab is one of the most important early Islamic archaeological villages in the Arabian Peninsula and the Persian Gulf, and one of the best-known. Excavated since the 1950s, the site has yielded a complete pottery assemblage which allows the site to be dated from the late eighth to the late ninth century AD.

This paper presents an analysis of the ceramics of Murwab. The analysis is undertaken on a selection of 134 pottery sherds of common ware/'kitchen' ware without glaze and encompasses a petrographic study and elemental analysis using wavelength dispersive X-ray fluorescence spectrometry (WDXRF). The results of the petrographic analysis and some preliminary thoughts on the chemical analysis are discussed in the text. Twelve ceramic fabrics have been detected in the assemblage studied. The composition of the fabrics allows some preliminary suggestions about provenance to be drawn: none of the fabrics was locally made in Qatar and most of them seem to come from Mesopotamia, eastern Arabia, and southern Iran.

The technology of the ceramics reveals an approach to the manufacture of common wares that is characteristic of the Upper and Central Gulf (corresponding roughly to the Gulf coast west of the Musandam Peninsula, including Khuzestan and Bushehr in Iran). It is not known when this technological approach started, but it does not seem to be documented in the Bronze Age.

Keywords: Qatar, Gulf archaeology, Islamic archaeology, early Islam, pottery analysis

Introduction: the site of Murwab and its pottery

In this paper we aim to present some reflections on the provenance and technology of the pottery found in Murwab. This village is a large settlement of more than 220 cells divided into about forty-two houses and workshops organized in a long east–west alignment. A fort with two phases of occupation and two mosques complete the settlement. The whole village covers a surface of 1.4 x 0.5 km (Figs 1 & 2). The site was discovered and excavated in 1958–1959 by Eigil Knuth of the Danish Expedition (Frifelt 1974; Knuth 2017), and was subsequently excavated by a French team led by Claire Hardy-Guilbert (1984; 1991), followed by the Qatari-French Mission led by Faysal Al-Na'īmī and Alexandrine Guérin (Guérin & Al-Na'īmī 2009; 2010; see also Guérin, this volume).

Murwab is located in an alluvial depression about 5 km from the north-western coast of Qatar, an area renowned for its 'green rawḍa' areas, criss-crossed by temporary wadis and a network of wells. This area is still used by pastoralists as grazing land. Observations, excavations, and architectural surveys suggest that the spatial and social organization of the settlement was seasonal, revealing five phases of sedentarization (Guérin 1989; 1994). The economy of this village was a mixture of pastoralism and fishing.

During the most recent excavation campaigns (2007–2009), Guérin carried out a preliminary macroscopic classification of the pottery from the site, and defined twenty-six ware categories, of which only six (chosen for their relationship to glazed ceramics) have been published (Guérin & Al-Na'īmī 2010). The proportion of glazed ceramics present at Murwab is relatively high (32%) and is represented by a wide range of imported tableware from the provinces of the Arabian Peninsula, Iran, and as far as Central Asia (Guérin & Al-Na'īmī 2009; 2010).

The focus of this work, however, is the study of common (generally unglazed) ceramics, which were also identified in the preliminary study (although the full classification will be published at a later date). Common ceramics, representing 68% of the assemblage, are grouped in twenty wares and are essential to

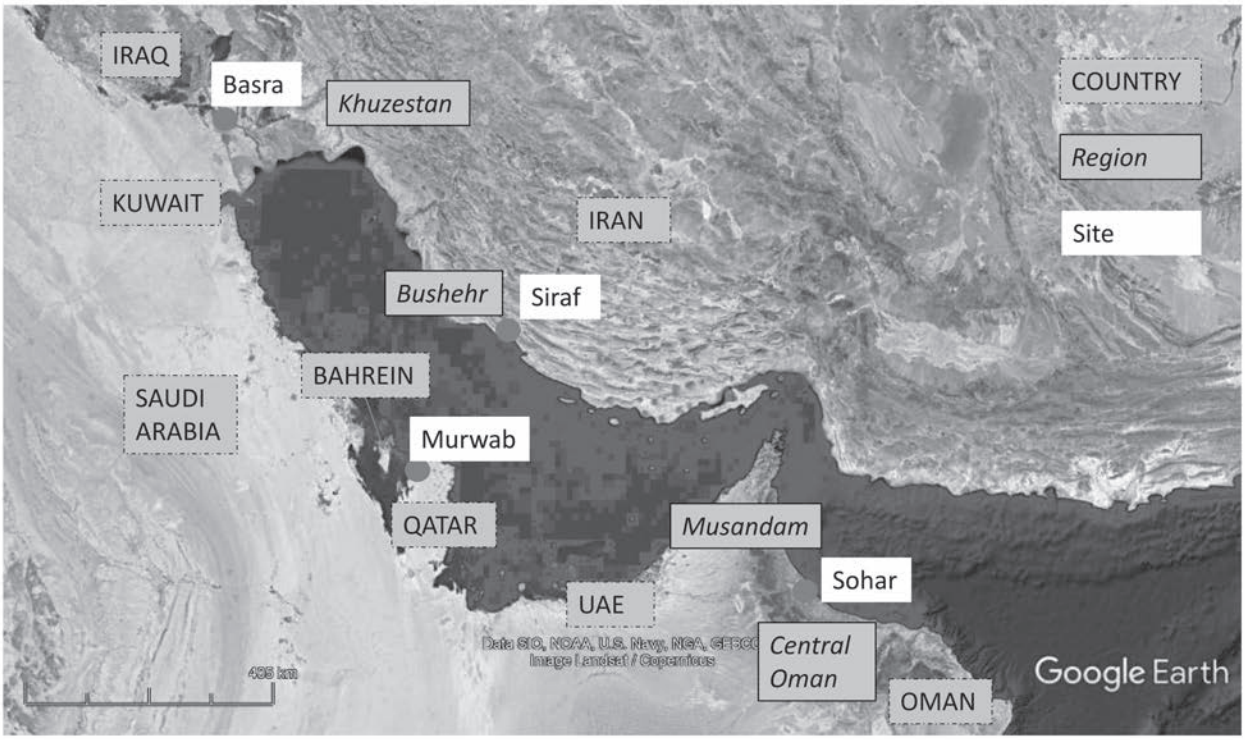

Figure 1. *A map of the Gulf showing the sites and regions considered.*

understand the use of everyday wares in their contexts, which include cooking and storage places, reception areas, etc. For this article, 134 samples of the most widely used wares were selected.[1]

The aims of the study are twofold. The first involves the question of provenance. Since no pottery production workshops are known in Qatar, our aim is to try to determine, within the limitations of the currently available database of comparative material, whether some of the common pottery of Murwab was manufactured locally (i.e. within the site or in its close proximity) or whether it was all imported and if the latter, from where. Second, the study sheds light on the technological aspects of pottery manufacture, generating data that allows us to consider these wares in comparison with technological traditions attested in the broader region.

[1] Most of the pottery recovered during all the archaeological campaigns at Murwab (1959–2009) is kept in the storage facilities of the Archaeology Department of Qatar Museums. Following a study in 2017, Guérin provided a selected sample from all the artefacts in order to showcase the most representative objects from this site in the Archaeology Gallery of the National Museum of Qatar.

Methods and strategies

Ceramic petrography and chemical analysis of selected wares are the techniques used in this paper. The results of petrography are discussed here in more detail, while only preliminary remarks are given on the chemical data, which are currently being processed and will be published fully at a later date.

Ceramic petrography is the study of the mineralogical and petrological components of the ceramics and of their textural arrangement. The analysis was made on thin sections *c.*30 μm-thick, on a polarizing microscope with a rotating platform and with two polarizing crystals that can offer two different views on the sample: one in crossed polars and one in plane polarized light. The thin sections were studied at the School of Archaeology and Ancient History of the University of Leicester by Carvajal López on two different models of polarizing microscope, a Nikon Eclipse E600 POL and a Zeiss Axio Scope 5 POL. The methodology followed, in particular for the textural analysis, was developed by Ian Whitbread (1995: 365–396; 2001; see also Quinn

FIGURE 2. *A plan of Murwab site, Qatari-French Mission, A. Guérin and F.A. Al-Naʿīmī, 2009 (based on Hardy-Guilbert 1982, photogrammetry, Mission Archéologique Française au Qatar, and Guérin 1989).*

2013). The aim of this analysis is to identify key minerals and rocks that can help to ascertain the provenance of the raw materials, and thus of the pottery itself, and to learn about the technological processes used to make the pottery. Textural analysis can tell us about the clay selection and treatment, levigation, the addition of temper and, with some limitations, the temperature and atmosphere of the kiln.

Elemental analysis was performed using a wavelength dispersive X-ray fluorescence spectrometer at the Fitch Laboratory of the British School at Athens following the analytical protocol outlined in Georgakopoulou et al. (2017).[2] Data processing and interpretation have been undertaken by Georgakopoulou and will be presented in detail in a future paper. Only some preliminary observations are given here.

Petrographic analysis of ceramics from Murwab: results

Sample	Context exc.	Macrosc. Fabric	Fabric	Sample	Context exc.	Macrosc. Fabric	Fabric
MRW003	MRW59 H03.e	Z	1	MRW083	MRW09 631.02	N	8
MRW005	MRW81 4002.8	X	1	MRW096	MRW09 623.04	I	8
MRW006	MRW07 301.03 B	X	1	MRW113	MRW09 621.03	G2	8
MRW007	MRW07 302.03 b	X	1	MRW115	MRW09 633.02	G2	8
MRW015	MRW09 633.02	X	1	MRW123	MRW07 302.03	F	8
MRW026	MRW07 302.03	V	1	MRW124	MRW07 610/611.02.B	F	8
MRW027	MRW07 302.03	V	1	MRW125	MRW07 610/611.02.B	F	8
MRW129	MRW81 5118.15.6	X	1	MRW114	MRW09 633.02	G2	8
MRW130	MRW81 5118.15.6	X	1	MRW121	MRW07 614.02	G3	8
MRW002	MRW07 301.03 B	Z	1b	MRW022	MRW09 623.04	W	9
MRW004	MRW09 619.05	Z	1b	MRW024	MRW09 630.02	W	9
MRW013	MRW09 630.02	X	1b	MRW025	MRW09 633.02	W	9
MRW014	MRW09 631.02	X	1b	MRW029	MRW07 604.01	U	9
MRW011	MRW07 613.03	X	1b	MRW031	MRW09 631.02	U	9
MRW008	MRW07 604.01	X	2	MRW040	MRW59 HO1.a	S	9
MRW009	MRW07 604.01	X	2	MRW074	MRW07 301.03	N	9
MRW010	MRW07 604.01	X	2	MRW075	MRW07 301.03B	N	9
MRW012	MRW07 614.02	X	2	MRW105	MRW09 620.05	G1	9
MRW052	MRW07 604.01	R	3	MRW106	MRW09 622.03	G1	9
MRW053	MRW07 611.01	R	3	MRW111	MRW07 301.03	G2	9
MRW055	MRW07 611.03.A	R	3	MRW116	MRW07 302.02	G3	9
MRW056	MRW09 619.05	R	3	MRW117	MRW07 302.03	G3	9
MRW060	MRW59 HO3.a	R2	3	MRW122	MRW07 614.02	G3	9
MRW061	MRW59 HO3.a	R2	3	MRW041	MRW07 302.03.B	S	9
MRW062	MRW59 HO3.a	R2	3	MRW043	MRW07 610/611.02.B	S	9
MRW064	MRW59 HO3.a	R2	3	MRW044	MRW07 611.01	S	9
MRW001	MRW07 301.03 b/01	Z	4	MRW047	MRW09 620.04	S	9
MRW051	MRW07 302.03	R	4	MRW050	MRW09 632.03	S	9
MRW059	MRW09 630.02	R1	4	MRW073	MRW09 630.02	Q	9

[2] We are grateful to Noemi Müller and Evangelia Kiriatzi for facilitating and running these analyses.

Petrographic analysis of ceramics from Murwab: results							
Sample	Context exc.	Macrosc. Fabric	Fabric	Sample	Context exc.	Macrosc. Fabric	Fabric
MRW063	MRW59 HO3.a	R2	4	MRW089	MRW07 301.03A	I	9
MRW017	MRW59 H03.e	W	5	MRW128	MRW09 630.02	F	9
MRW018	MRW07 302.02	W	5	MRW072	MRW09 623.04	Q	9
MRW019	MRW07 604.01	W	5	MRW054	MRW07 611.02.B	R	10
MRW045	MRW07 611.02	S	5	MRW066	MRW59.3.E	Q	10
MRW049	MRW09 621.03	S	5	MRW069	MRW07 301.03	Q	10
MRW071	MRW09 619.05	Q	5	MRW086	MRW59 HO1.a	I	10
MRW082	MRW09 631.02	N	5	MRW087	MRW59 HO1.a	I	10
MRW094	MRW07 613.03	I	5	MRW091	MRW07 302.03	I	10
MRW077	MRW07 302.03	N	5	MRW093	MRW07 611.02B	I	10
MRW078	MRW07 604.01	N	5	MRW103	MRW09 619.05	G1	10
MRW079	MRW09 630.02	N	5	MRW104	MRW09 619.05	G1	10
MRW095	MRW07 614.02	I	5	MRW110	MRW09 632.02	G1	10
MRW119	MRW07 611.03	G3	5	MRW112	MRW07 301.03A	G2	10
MRW035	MRW59 HO5.a	U1	5	MRW023	MRW09 630.02	W	11
MRW120	MRW07 611.03A	G3	5	MRW057	MRW09 620.04	R	11
MRW131	MRW59 HO3.b	W	5	MRW067	MRW59.3.E	Q	11
MRW058	MRW09 621.03	R	6	MRW068	MRW59 HO3.e	Q	11
MRW020	MRW07 610/611.02.B	W	6	MRW085	MRW59 HO1.a	I	11
MRW100	MRW07 611.02b	G1	6	MRW092	MRW07 611.02B	I	11
MRW108	MRW09 630.02	G1	6	MRW097	MRW09 623.04	I	11
MRW030	MRW09 620.05	U	7	MRW132	MRW59 HO1.c	V	11
MRW032	MRW09 632.02	U	7	MRW134	MRW81 3052.10	Q	11
MRW033	MRW59 HO4.a	U1	7	MRW016	MRW59 H01.b	W	11
MRW037	MRW59.3.E	U4	7	MRW021	MRW09 620.04	W	11
MRW039	MRW59 HO5.a	U4	7	MRW034	MRW59 HO4.a	U1	11
MRW042	MRW07 609/610.B	S	7	MRW065	MRW81 4002.1	R2	11
MRW048	MRW09 620.04	S	7	MRW080	MRW09 631.02	N	11
MRW081	MRW09 631.02	N	7	MRW084	MRW09 632.03	N	11
MRW098	MRW07 302.03b	G1	7	MRW088	MRW07 301.03	I	11
MRW107	MRW09 623.05	G1	7	MRW099	MRW07 302.03b	G1	11
MRW127	MRW07 613.03.A	F	7	MRW109	MRW09 632.02	G1	11
MRW126	MRW07 613.03	F	7	MRW133	MRW59 R01	Q	11
MRW028	MRW07 302.03	U	8	MRW070	MRW07 302.03	Q	12
MRW036	MRW59 HO5.a	U3	8	MRW118	MRW07 302.03b	G3	12
MRW038	MRW59 HO4.a	U4	8	MRW090	MRW07 301.03B	I	12
MRW046	MRW09 620.04	S	8	MRW101	MRW09 619.04	G1	12
MRW076	MRW07 302.03	N	8	MRW102	MRW09 619.04	G1	12

FIGURE 3. *An overview of fabric distribution and samples.*

Fabric number, name and grouping	**Textural characteristics**	**Main inclusions**	**Technological implications**
Fabric 1: Fine Calcareous Fabric with intermediate-mafic igneous rocks. (**Fabric Group A**) Includes Fabric Variant 1b, more sandy.	Moderate number of pores (5-20%) and scarce inclusions (3-15%) (more abundant in Fabric 1b: 20-35%). Well sorted, non-aligned inclusions, strongly unimodal.	Round clay pellets with micrite (Dominant-Frequent; <3.2 mm), Calci-mudstones (Dominant-Frequent; <4 mm); Monocrystalline quartz (Common-Very Few, except for Fabric 1b, where it is Predominant; <0.4mm). Other inclusions in the coarse and fine fractions include plagioclase, pyroxene, amphibole and other igneous minerals.	Very fine texture with two types of textural features, suggesting that clay mixing is possible. The temperature reached a very high firing temperature in some sherds, which show sintering of the clay, but it was less important in others, and did not deplete completely all the calcareous rocks. Similar technology to Fabric 2.
Fabric 2: Fine Sandy and Fossiliferous Fabric. (**Fabric Group A**)	Moderate number of pores (10-15%) and of inclusions (10-30%). Well sorted, crudely aligned inclusions, strongly unimodal.	Fossiliferous limestone (Dominant, <1.8 mm); Round clay pellets with micrite (Common; <3.6 mm), Calci-mudstones (Common; <3.6 mm); Monocrystalline quartz (Few-Absent; <0.2mm). Other inclusions in the coarse and fine fractions include plagioclase and other igneous minerals.	Same as Fabric 1. The difference in fossil content may indicate a different quarry, rather than tempering.
Fabric 3: Sandy Fabric with felsic-intermediate rocks. (**Fabric Group B**)	Moderate number of pores (10-30%) and high number of inclusions (30-40%). Well sorted, crudely aligned inclusions, strongly unimodal.	Monocrystalline quartz (Predominant; <0.75 mm), Mudstone (Frequent; <7.6 mm), Fossiliferous limestone (Frequent; <1 mm); there are feldspars, grano-dioritic rocks, chert, amphiboles and other igneous rocks in the coarse and fine fractions. Evaporites detected in Sample 53	The sand component seems definitely a temper addition because of its good sorting. The temperature of firing was high enough to deplete most calcareous minerals, but not to produce any clay sintering.
Fabric 4: Sandy Fabric with fossiliferous and micritic limestone. (**Fabric Group B**)	Moderate number of pores (10-20%) and high number of inclusions (20-40%). Moderately sorted, crudely aligned inclusions, moderately unimodal.	Monocrystalline quartz (Dominant-Frequent; <0.75 mm), Fossiliferous limestone (Dominant-Frequent; <0.5 mm), Micritic limestone (Common; <3 mm); there are feldspars, grano-dioritic rocks, chert, amphiboles, shale and anhydrite and other igneous rocks in the coarse and fine fractions.	The technology is the same as Fabric 3. The differences may be due to a different quarry of the clay, but also, if tempering is confirmed, a different tempering strategy.
Fabric 5: Calcareous Fabric with Shale and Evaporites (**Fabric Group C, Shale Fabric Macro-Group**)	Low number of pores (3-10%) and high number of inclusions (20-30%). Poorly sorted, crudely aligned inclusions, weakly unimodal.	Shale (Dominant; <4 mm); Calci-Mudstone (Frequent; <5 mm); Evaporites (Frequent-Few; <1.75 mm); Fossiliferous limestone (Frequent-Few; <7 mm). Other inclusions in the course and fine fractions are monocrystalline and polycrystalline quartz, biotite, plagioclase.	The heterogeneity of this fabric and its overlapping with other similar fabrics (especially Fabrics 9 and 11) suggest that it could be the result of clay mixing and tempering, or at least the quarries presented very similar materials. The firing temperature was high enough to end most optical activity of the matrix (but not of all shales) and to degrade some calcareous rocks.

Fabric number, name and grouping	**Textural characteristics**	**Main inclusions**	**Technological implications**
Fabric 6: Sandy Fabric with Shale and Evaporites (**Fabric Group C, Shale Fabric Macro-Grou**p)	Low number of pores (3-7%) and of inclusions (10-20%). Poorly sorted, crudely aligned inclusions, weakly unimodal.	Shale (Dominant; <1.75 mm); Calci-Mudstone (Dominant-Few; <2 mm); Fossiliferous limestone (Dominant-Few; <1.75 mm); Monocrystalline quartz (Frequent-Few; 1.25 mm); Evaporites (Frequent-Very Few; <0.8 mm). Other inclusions in the course and fine fractions are polycrystalline quartz, chert, biotite, plagioclase, grano-dioritic rock.	Very similar to Fabric 5, but it overlaps more with Fabrics 7, 8, and 10. The firing temperature was high enough to deplete all calcareous rocks (although not all the calcite has disappeared) and sinter the clay in different sherds.
Fabric 7: Fabric with Shale and Evaporites (**Fabric Group C, Shale Fabric Macro-Group**)	Moderate number of pores (3-20%) and high number of inclusions (30-40%). Poorly sorted, crudely aligned inclusions, weakly unimodal.	Shale (Predominant; <5 mm); Evaporites (Frequent-Few; <2 mm). Other inclusions in the coarse and fine fractions include calci-mudstone, fossiliferous limestone, micritic limestone, monocrystalline quartz, feldspar, and grano-dioritic rock.	Same observations as Fabric 6.
Fabric 8: Fabric with Shale (**Fabric Group D, Shale Fabric Macro-Group**)	Low number of pores (5-15%) and high number of inclusions (5-40%). Poorly sorted, well- to no aligned inclusions, weakly unimodal.	Shale (Predominant-Dominant; <3 mm); Calci-Mudstone (Dominant-Common; <3.2 mm). Other inclusions in the coarse and fine fractions include fossiliferous limestone, evaporites, calci-mudstone; monocrystalline quartz, feldspars and metamorphosed grano-dioritic rock.	Same observations as Fabric 6.
Fabric 9: Calcareous Fabric with Shale (**Fabric Group D, Shale Fabric Macro-Group**)	Low number of pores (3-15%) and high number of inclusions (10-40%). Poorly sorted, well- to no aligned inclusions, weakly unimodal.	Shale (Dominant-Common; <7 mm); Calci-Mudstone (Dominant-Common; <5 mm); Fossiliferous limestone (Common-Few; <3.75 mm). Other inclusions in the coarse and fine fractions include metamorphosed grano-dioritic rock, monocrystalline quartz fossiliferous limestone, feldspars and chert.	Same observations as Fabric 5. The abundance of some types of calcareous rocks suggests that there could be clay mixing or tempering in the composition of this Fabric.
Fabric 10: Sandy Fabric with Shale (**Fabric Group E, Shale Fabric Macro-Group**)	Low number of pores (5-15%) and moderate number of inclusions (5-20%). Moderately sorted, poorly aligned inclusions, moderately unimodal.	Shale (Dominant-Common; <2.25 mm); Monocrystalline quartz (Dominant-Common; <1 mm); Calci-Mudstone (Frequent-Common; <1.75 mm). Other inclusions in the coarse and fine fractions include euhedral metamorphosed plagioclase; grano-dioritic rock; fossiliferous limestone, polycrystalline quartz.	Same observations as Fabric 6. The firing temperature was high, because there is no optical activity.

Fabric number, name and grouping	Textural characteristics	Main inclusions	Technological implications
Fabric 11: Calcareous Fabric with Sand and Shale (**Fabric Group E, Shale Fabric Macro-Group**)	Low number of pores (1-10%) and high number of inclusions (10-40%). Poorly sorted, well- to non-aligned inclusions, weakly unimodal.	Shale (Dominant-Frequent; <5 mm); Monocrystalline quartz (Dominant-Frequent; <1.25 mm); Calci-Mudstone (Common; <5 mm); Fossiliferous limestone (Common; <6 mm). Other inclusions in the coarse and fine fractions include grano-dioritic rock, feldspars, chert, polycrystalline quartz.	Same observations as Fabric 9.
Fabric 12: Fabric with Oolites (**Fabric Group E, Shale Fabric Macro-Group**)	Low number of pores (3-5%) and moderate number of inclusions (10-20%). Poorly sorted, well-aligned inclusions, weakly unimodal.	Oolites (Predominant; <0.75 mm); Shale (Common; <2.75 mm); Calci-Mudstone (Common; <1.75 mm). Other inclusions in the coarse and fine fractions include mono- and polycrystalline quartz, plagioclase.	Same observations as Fabric 9. The abundance of oolites suggests that these are added as a sand tempering to the clay.

Figure 4. *Description of fabrics identified in the assemblage of Murwab.*

Results

Twelve fabrics were detected in the petrographic study, which are represented in Murwab with different degrees of abundance. The details about these fabrics and their distribution can be seen in Figures 3–7.

Although the fabrics are quite distinctive, in terms of their texture and composition it is possible to cluster them into larger fabric groups that are more useful to discuss provenance.

The fabric groups are as follows:

- Fabric Group A: fine sandy fabrics with igneous intermediate to mafic rocks, comprising Fabrics 1 and 2;
- Fabric Group B: coarse sandy fabrics with igneous felsic to intermediate rocks, comprising Fabrics 3 and 4;
- Fabric Group C: fabrics with shale and evaporitic rocks, comprising Fabrics 5, 6, and 7;
- Fabric Group D: fabrics with shale, comprising Fabrics 8 and 9;
- Fabric Group E: Sandy Fabrics with shale, comprising Fabrics 10, 11, and 12.

In addition, Fabric Groups C, D, and E will be considered together as the Shale Fabric Macro-Group. As will be explained below, the shared characteristic in all these fabrics is primarily (but not exclusively) the documentation of shale in all. This may represent a common technical understanding of how pottery should be made, and perhaps even a range of provenances.

Preliminary assessment of the chemical data has supported this distinction with Group A and particularly Group B, showing a distinctively different chemical composition for the majority of the fabrics grouped under the Shale Fabric Macro-Group.

Some thoughts on provenance

With the information gathered from the analysis of the petrographic fabrics it is possible to offer some thoughts on the provenance of the ceramics. In general, it must be noted that it is possible to link the petrological (mineral and rock) content of fabrics with geological environments. This makes it possible to conclude that none of the ceramics analysed in this paper was made in Qatar. All the fabrics contain more or less small amounts of igneous rocks and shale. Igneous rocks have never been documented in mainland Qatar. Shale could theoretically exist in scarce outcrops, but not in the abundance in which it is documented in the ceramic fabrics.

Pinpointing the area where the ceramics were made is a different question altogether. All of the fabrics

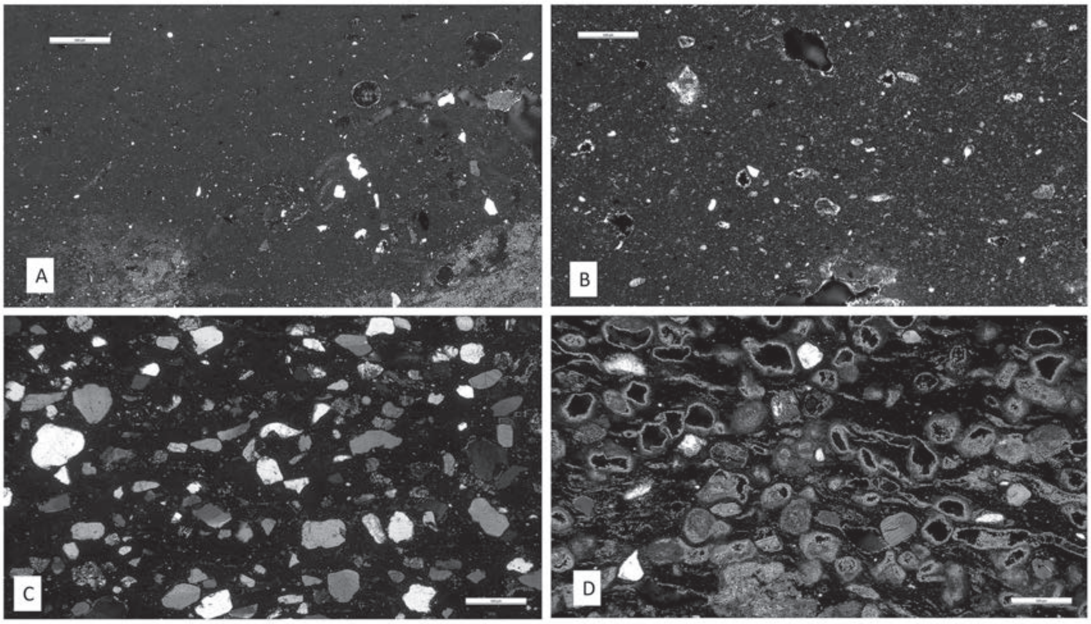

Figure 5. *Microphotographs of Fabric Group A and B (all scales represent 0.5 mm).* **A.** *Fabric 1, showing calcareous mudstone and fine grains of quartz (white and grey) and igneous rocks (mottled, angular) over a fine groundmass;* **B.** *Fabric 2, showing fine fossiliferous limestones and grains of quartz over a calcareous groundmass;* **C.** *Fabric 3, showing well-sorted rounded and sub-rounded sand grains composed of quartz and igneous rocks (mottled or showing twinning);* **D.** *Fabric 4, showing oolites and sand grains (quartz and igneous rocks) over a calcareous groundmass.*

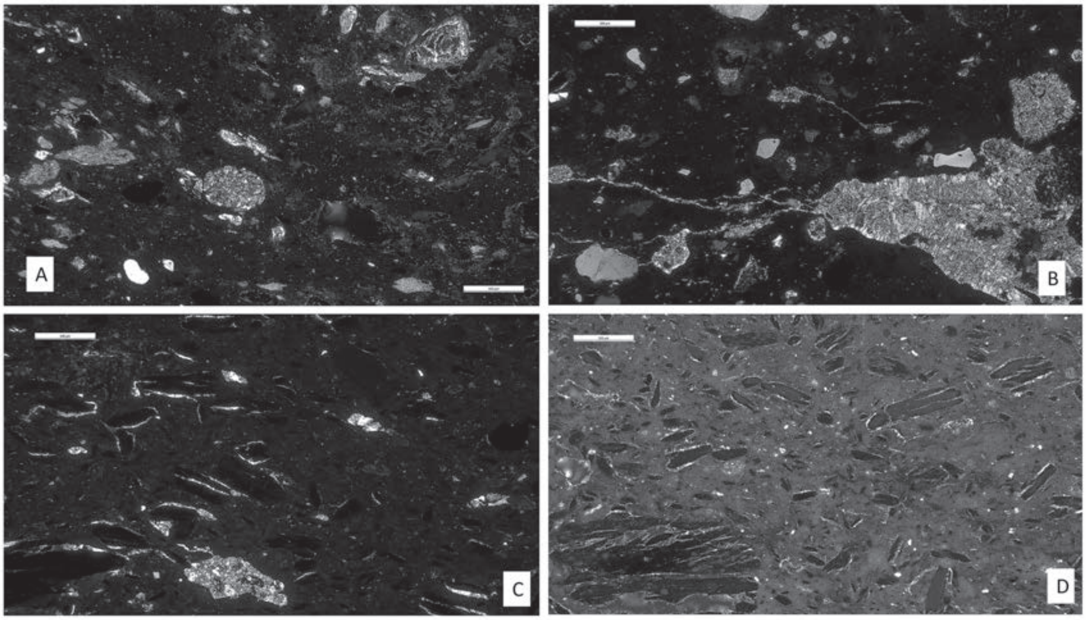

Figure 6. *Photomicrographs of Shale Fabrics Macro-Group (1) (all scales represent 0.5 mm).* **A.** *Fabric 5, showing calcareous mudstone, shale (dark inclusions) and evaporites (anhydrite, in the centre of the image) over a calcareous groundmass;* **B.** *Fabric 6, showing shale, grains of quartz and evaporites (anhydrite) over a fine groundmass;* **C.** *Fabric 7, showing shale and evaporites;* **D.** *Fabric 8, showing abundant shale over a matrix with milky texture due to local sintering.*

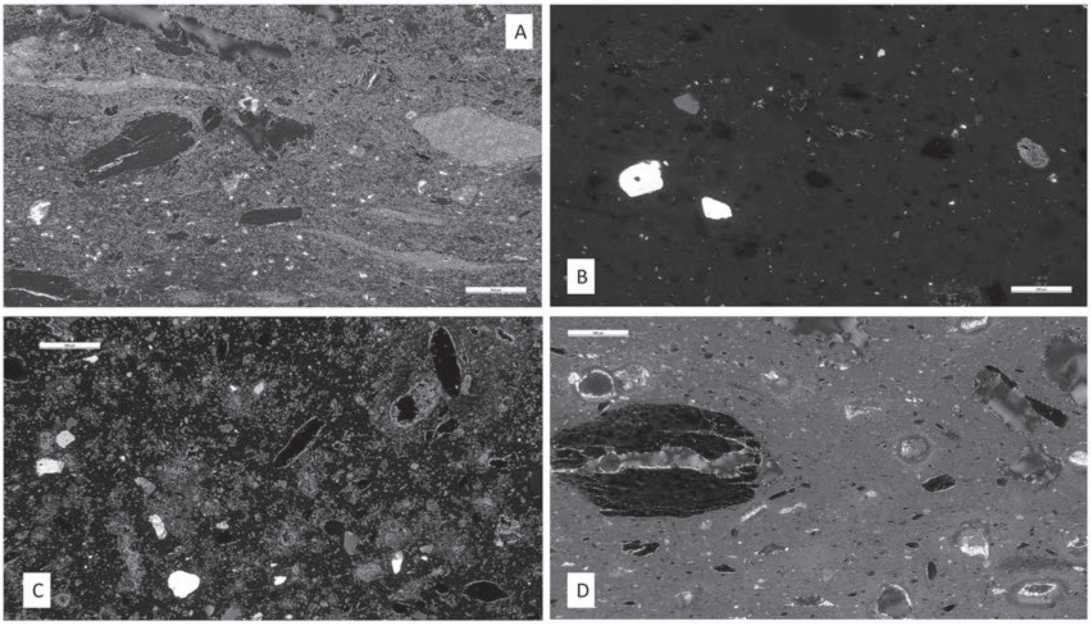

Figure 7. *Photomicrographs of Shale Fabrics Macro-Group (2) (all scales represent 0.5 mm).* **A.** *Fabric 9, showing calcareous mudstone and shale (dark inclusions) over a calcareous groundmass with textural features that suggest some degree of clay mixing;* **B.** *Fabric 10, showing shale and grains of quartz and igneous rocks (centre right) over a fine groundmass with milky texture due to sintering;* **C.** *Fabric 11, showing shale and sand grains of quartz and feldspar over a calcareous groundmass;* ***D.*** *Fabric 12, showing shale and oolites over a fine calcareous matrix.*

contain a range of minerals and rocks that are not rare in the area of the Gulf, and therefore a number of possible provenances can be contemplated. In theory, it should be possible to use more features of the pottery to draw parallels and suggest provenance. After all, pottery is more than an artificial rock; any sherd can be studied to find valuable information on technological processes, such as raw material collection and mixing, modelling, and firing, just to mention the parts of the *chaîne opératoire* (production sequence) most frequently considered. Post-depositional alterations, such as the documentation of secondary calcite, can also be detected in the analysis. For this reason, the most complete strategy of provenance using petrographic data should ideally be based on comparison with well-contextualized assemblages (which can be complemented with experimental studies and chemical data). However, there is a lack of comparative petrographic data from pottery of the same period in the Gulf. Some research has been concentrated in the Lower Gulf, and Oman in particular (Blackman, Méry & Wright 1989; Méry 1991; 1995; 2000; and more recently, Živković et al. 2019). More relevant for this study are some analytical results from assemblages in the Upper and Central Gulf: Ashkanani 2014; Ashkanani & Kovar 2021; Ownby 2014; and Stremtan et al. 2012 for Failaka (Kuwait); Carvajal López et al. 2019 for ceramics from Doha; and Mynors 1983 for ceramics from Iran and Iraq. The most relevant comparison for the purposes of this paper, however, can be drawn with the results of R. Mason and E. Keall (1991), who looked at ceramics from Basra (Iraq) and Siraf (Iran) of the same chronological range as that of Murwab, the early Islamic period (see also Mason 2004, where the same results are presented in more detail and in comparison with other ceramic analyses from Near Eastern assemblages from places other than the Gulf).[3] The remaining papers are used throughout this contribution when some relevant inferences can be extracted from them.

[3] Additional contributions by Mason to the petrography of ceramics from the nearby area of Kirman (South Iran) are in Mason 2003 and Mason & Golombek 2003, but they have not been considered in this study because they deal with stone paste, which has a clearly different composition.

Mason and Keall undertook a petrographic analysis of pottery from Basra and Siraf with the aim of shedding light on the trade between the two cities. In their work, they established a basic 'Basra Petrofabric'[4] by analysing sherds and kiln furniture recovered in the historic town by a dealer, dated to the ninth–tenth centuries and conserved in the Metropolitan Museum of Art (New York) (Mason & Keall 1991: 53). Although this type of ceramic would hardly count as well-contextualized, there is in principle no reason to doubt the documented story of the recovery. The fact that kiln furniture was analysed would also be a factor supporting the Basri origin of the fabric. In addition to those sherds, Mason and Keall studied pottery recovered in Siraf by David Whitehouse's famous expedition and defined as Siraf Petrofabric on the basis of two unglazed sherds recovered from Site D, a tenth-century potters' quarter (Mason & Keall 1991: 55–57; Whitehouse 1968; 1971; 1972; 2000: 42–46). They went on to analyse glazed pottery from the Iranian trade centre, and this allowed them to define a total of fourteen petrofabrics. These were in turn compared to the baseline provided by the Basra and the Siraf Petrofabrics. Of the fourteen groups, Petrofabrics 1 to 7 are of turquoise-glazed ceramics, with very similar features to those of the Basra Petrofabric, and were therefore considered of Mesopotamian provenance. Petrofabric 8, also similar to the Basra Petrofabric, was used in Opaque-White Glazed ceramics and in Splashed-Lead Glazed ones. Petrofabric 9 was only used in Splashed-Lead Glazed ceramics and is also related to the Basra Petrofabric. The rest of the Splashed-Lead Glazed sherds were all considered to be made of Petrofabrics 10 to 15. All of them are considered to be of Iranian origin due to their similarity with the Siraf Petrofabric, with the only exception of Petrofabric 12, which is considered to be of East Asian origin. In summary, Mason and Keall were able to define two baselines of ceramic provenance and then assign regions of provenance to them, based on the similarity of each analysed sample.

Comparisons that can be established between the fabrics of this paper and Mason and Keall's petrofabrics are limited. On the one hand, although the petrographic technique used for analysis is the same, the methodology for sampling and characterizing textures and fabrics is different to the one developed by Ian Whitbread and followed in this article. On the other hand, Mason and Keall sampled glazed ceramics and kiln furniture and wasters, which are by definition quite different from the everyday common pottery that this study targets. Kiln furniture elements are designed to withstand extreme thermal shock, and that may require particular clay recipes. Glazed ceramics, in contrast, are considered fine ceramics in many cultures and may be specially designed to provide a smooth surface where glaze will adhere more easily. In both cases, there might be differences in the technological expertise involved in the production of everyday wares. In the best possible case, the technological procedures followed to manufacture them would be similar, but this is an assumption that remains to be tested.

Despite all these differences, however, it is possible to extract basic observations from the two basic petrofabrics defined for Basra and Siraf. The Basra Petrofabric has a fine texture, with a very fine fraction of 'angular quartz, trace feldspar and amphibole', and with a scarce coarse population (0.25 to 1 mm, up to a 10% of the total volume) of 'rounded grains of quartz, cloudy untwinned feldspar [probably orthoclase], clear plagioclase, and occasionally felsite' (Mason & Keall 1991: 53–54). With respect to the Siraf Petrofabric, Mason and Keall characterize it as made of 'fine quartz, coarser grains of a poorly indurated shale and micritic carbonate' (1991: 57). It is easy to see that the main opposition established between Basra and Siraf is based on the documentation of igneous rocks (most probably of felsic to intermediate chemistry) for the former, and of shale and micritic carbonates for the latter. This opposition is also well reflected in the fabric groups presented here. Fabric Groups A and B are characterized by the presence of sands with an igneous component in different amounts, whereas the Shale Fabric Macro-Group, composed of Fabric Groups C, D, and E, is precisely dominated by shale and has an important presence of calcareous rocks.

This information must be used with caution, as more studies need to be undertaken before provenance can be firmly established. However, some additional observations are in order.

With regards to Fabric Group A, the fineness of Fabrics 1 and 2 makes them excellent candidates to be considered within the wide range of the 'Mesopotamian origin' defined by Mason and Keall with their Basra

[4] Mason and Keall's concept of a petrofabric is essentially similar to what we discuss here as fabrics, with the caveat that the two studies show significant differences on how petrofabrics and fabrics are identified and described, as discussed below.

Petrofabric and the associated Petrofabrics 1–8. However, it should also be noted that in general these fabrics have considerably more inclusions (3–15% for Fabric 1, 20–35% for Fabric 1b, and 10–30% for Fabric 2) and have a more important presence of calcareous rocks, in the form of calci-mudstones or fossils. It is perfectly possible that Fabrics 1 and 2 are related to the Basra and associated petrofabrics, but it is not clear if this is related to a different quarry of raw materials or to a variation in the processes of clay mixing.

Fabric Group B, on the other hand, is clearly different from the Basra Petrofabrics because of its coarseness. This is also noted in the chemical analysis, where most samples of Fabrics 3 and 4 stand distinctly separate from the rest. It is possible to suggest that these fabrics have been tempered with sand. The relatively low variety in the composition, sorting (well-sorted), size (around the medium and fine ranges of the Wentworth scale), and shapes (well-rounded) of the sand of this group indicate a very distinctive aeolian origin. A sandy type of ceramic fabric, which was considered to be tempered, was defined in prehistoric pottery samples from Failaka Island, Kuwait (Fabric A in Ashkanani 2014: 209–217; Ownby 2014: 292–293). Other sandy fabrics, possibly tempered, have been analysed in the assemblage recovered in nineteenth- to twentieth-century levels of Doha, Qatar (Fabrics 5 and 8, in Carvajal López et al. 2019: 57–58). Fabrics 3 and 4 of the present study form a much more cohesive group compared to the samples that were considered in these studies. The presence of igneous rocks of the felsic to intermediate chemical range among the sand grains would suggest a relation with the Arabian Shield, and this in turn would point to the dunes of eastern Arabia as a possible origin for these materials. In principle, this would leave Bahrain out of the list of possible sources, as igneous rocks are very scarce or absent in its geology (Willis 1963) and the few analyses done on Bahraini fabrics show their absence as well (cf. Carvajal López et al. 2019: fig. 10/B and C). However, it would be advisable to have more data for comparison before ruling out Bahrain completely as a possible source. As a preliminary hypothesis (which needs testing), it is perhaps possible to look for the provenance of this fabric in aeolian sands from the Dibdibba formation or the Al-Batin Fluvial Fan, sedimentary formations that have formed from the deposition of gravels and sands weathered from the core of the Arabian Peninsula (Milton 1967: 5; Yacoub 2011). This would place the catchment area of the sand in the area of Kuwait.

The most distinctive characteristic of the samples clustered in Fabric Groups C, D, and E is the presence of shale as a relevant component of the ceramic, and it is for this reason that they have been lumped together in the Shale-Fabric Macro-Group. In principle, this can be considered a relevant feature to determine provenance, as Mason and Keall noted the predominance of shale in the Siraf Petrofabric. However, the inclusion of shales in ceramics (usually identified as grits by macroscopic observation) is not at all unusual in the Gulf technological tradition of pottery production. The study of ceramics from nineteenth- and twentieth-century levels from Doha revealed a number of wares with abundant shale (Fabrics 1, 2, 3, and 4 of Carvajal López et al. 2019: 58), which were reasonably traced to the Musandam Peninsula based on both archaeological and geological arguments. Fabric 1 was completely coincident with Julfar wares and the Musandam Peninsula is the area where the Fiqa formation (with abundant shale) is exposed. The rest of the fabrics with shale were attributed to the same area because of their similar composition (Carvajal López et al. 2019).[5] It is therefore possible to conceive a provenance other than Siraf for the fabrics of the Shale Macrogroup. In spite of this caveat, it does make sense to suppose that this large sample of ceramics recovered in Murwab was made in southern Iran, just across the sea and quite densely populated in the Sasanian and early Islamic periods (cf. Priestman 2005; 2021). After all, archaeological work has not identified any distribution of Lower Gulf wares in the early Islamic Upper and Central Gulf. An additional reason to support the southern Iranian provenance of these wares is the documentation of evaporitic rocks (anhydrite and gypsum) in some of the fabrics of the Shale Macrogroup (in particular, Fabrics 5, 6, and 7). Evaporites are abundant in the salt domes of southern Iran, although they can crop up in geological formations in Iraq and eastern Arabia too. Siraf is a clear centre of interest, because more than thirty kilns were excavated in the Iranian town (Mason & Keall 1991: 55; Whitehouse 1968; 1971; 1972; 2000: 42–46). However, the Murwab

[5] More recently obtained chemical results have opened other possibilities for Fabrics 2 and 3 of Doha, but that is a matter for a different publication.

ceramics, although similar, are quite technologically varied, as described below. For this reason, it makes sense to think that rather than coming from a single centre, they may come from a range of areas in southern Iran. As everything else in this section, this must be subjected to future testing, and none of the potential sources discussed in this paragraph should be excluded until more information is available.

Technology of pottery production

Since no locally produced ceramics have been identified in Murwab, the assemblage under study can be considered as representative of a range of different sites from the early Islamic Gulf. The suggested provenance of the common wares under study is the Upper and Central Gulf, between Mesopotamia, eastern Arabia (including Bahrain and Qatar), and southern Iran (without prejudice for considering the possibility of contacts with more distant places, as noted in the analysis of the glazed wares from Murwab undertaken by Guérin and Al-Naimi [2010], and the wider range of sites considered in Kennet 2004 and Priestman 2021). It is therefore possible to offer some observations on the technological procedures of pottery production in the early Islamic Gulf.

The pottery fabrics analysed in this study reveal a number of different approaches to clay recipes followed by potters in the region, ranging from the use of fine muds, perhaps levigated, to the use of material with larger numbers of inclusions, which could be products of tempering or clay mixing. The raw clays of the two fine fabrics of this study (1 and 2, or Fabric Group A), possibly of Mesopotamian origin, do not seem to have required much treatment before modelling (although levigation and a clay mixing to a certain extent cannot be discarded yet, as the range of inclusions and some textural features seem to suggest). The addition of temper is very clear in the case of Fabric Group B (Fabrics 3 and 4) which, as discussed above, are thought to have been made in eastern Arabia because of the composition and characteristics of their sand fraction.

A case for tempering and clay mixing can also be made for the Shale Macro-Group, on the basis of its compositional characteristics and its suggested provenance from southern Iran. All the fabrics within this macro-group (Fabrics 5, 6, and 7 of Fabric Group C, Fabrics 8 and 9 of Fabric Group D, and Fabrics 10, 11, and 12 of Fabric Group E) have overall a very similar composition in terms of the presence of certain rocks and minerals: they all contain shale (in different degrees of foliation and with different levels of optical activity), evaporitic rocks (gypsum or anhydrite), sand (mostly quartz, but with small amounts of feldspars too), and calcareous rocks (represented by fossiliferous and micritic limestone and mudstones with high or medium micritic content), all over a groundmass with trace amounts of sedimentary, metamorphic, and igneous silicic rocks. The differences between the fabrics within the group are defined by different proportions of the rocks and minerals listed above. Much overlapping is detected across the different fabrics, suggesting that there is a close relation between them. They could easily be the result of different clay recipes used by one or several potters living within the same range of available raw materials, or of the use of different quarries within the same geological environment or, more likely, a combination of the two. The social interpretation is that potters within the same area used different strategies to select and mix materials for their clay recipes. These strategies could relate to the production of different types of vessels, for example, for different functions; or to the organization of different ceramic workshops, with different catchment areas for raw materials. It is also possible that strategies of clay mixing could have changed in time, although if this is the case, this was a very fast change as the period of occupation of Murwab lasted only about a century or a century and a half. As knowledge about the early Islamic pottery of the Gulf expands, this type of analysis will prove more valuable to increase our understanding of this technological dispersion.

This analysis also allows us to start shedding some light on the history of technological pottery production in the Upper and Central Gulf regions. The common pottery distributed in this area in the early Islamic period (present study) and in the late Islamic period (Carvajal López et al. 2019) shows the presence of fine clays too, as well as clays with large numbers of inclusions, with a clear instance of tempering in the case of sand and a strong possibility in the case of shale. This means that the general perspective on what constitutes a good clay recipe for pottery making seems to be quite similar in the two periods of the Upper and Central

Gulf. This is important, because, contrary to what an uninformed observer may think, there is not one single way of achieving a good clay for pottery; there are many and they can change throughout history. The available results suggest that potters in this context seem to rely on clays rich in certain types of inclusions, like fossils and shale, and there is a tendency to use a temper of sand, and perhaps shale too, for their recipes. Thanks to the ethnographic work of William and Fidelity Lancaster (2010; cf. Carvajal López et al. 2019: 61–62), we know that clay mixing certainly happened in the later periods and seems a distinct possibility in earlier periods.

It is possible to look at the wider historical picture of ceramic technology in the Gulf to understand how these results relate to earlier tradition and areas beyond the reach of the Musandam Peninsula. Fine clays and sand tempering traditions have also been argued for Bronze Age pottery retrieved in Failaka Island, made according to Ancient Mesopotamian and Dilmun traditions (Ashkanani 2014; Ownby 2014). However, the tradition of using clay with shale is absent. In Oman, Bronze Age traditions of pottery production also lack clays with shale. The documented production of Omani pottery seems to rely on fine clays, possibly levigated, with a small to no possibility of tempering or clay mixing (cf. Méry 2000, which includes the consideration of Iranian grey wares). Since the tradition of clay with shale has only been documented in later periods, it is possible to suggest that it was developed at a later stage than the Bronze Age. It is also likely that it was developed in a location in the Upper or Central Gulf or on the Musandam Peninsula, rather than in Central Oman. The late Islamic traditions of pottery production documented in Central Oman have been found to lack shale in their recipes too (for Bahla wares cf. Živković et al. 2019; and Fabrics 7 and, arguably, 6 in Carvajal López et al. 2019: 57–58).

Conclusions

This preliminary analysis of the common and unglazed ceramics of Murwab in the eighth and ninth centuries AD allows us to conclude that the wares studied were not produced in Qatar. Most of them (Fabrics 5–12, the Shale Fabric Macro-Group) probably came from southern Iran, though provenance from other places, such as Musandam, is still possible. Siraf must certainly be considered as a potential place of provenance, but the heterogeneity and complexity of the fabrics with shale would indicate that more than one single place or workshop could be involved in the production of these wares. Fabrics 1 and 2 are suggested to have come from southern Mesopotamia. Fabrics 3 and 4 have an uncertain origin, but their composition allows us to point to eastern Arabia as a more likely source. All these provenance suggestions must be considered preliminary until analyses of further assemblages are carried out.

It is also possible to say that the technological landscape of this early Islamic period offered by the ceramics of Murwab is relatively similar to the one that we find in the late Islamic period. There is a common understanding of clay recipes, that is, how pottery is made, which also seems to be characteristic of the region between the Euphrates Delta and the Musandam Peninsula (in contrast to Central Oman). This does not mean that the process of pottery production is centralized or even uniform. The variety observed in the fabrics speaks about a certain dispersion and heterogeneity of technological know-how.

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