VESSELS: INSIDE AND OUTSIDE

PROCEEDINGS OF THE CONFERENCE EMAC '07

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POSSIBILITIES AND LIMITATIONS OF MACROSCOPIC DETERMINATION OF POTTERY FABRICS IN THE FIELD

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Abstract: *Many proposals have been put forward about how to describe pottery fabrics in the field; however, in many instances, later archaeometric analysis carried out to check fabric groups from the field reveals large discrepancies, and the fabric groups determined in the field are not confirmed. When a large number of samples cannot be taken to a laboratory (e.g. to another country) for archaeometric analysis, precise fabric classification and documentation in the field is necessary. Modern digital cameras offer a cheap and quick way of photographing a fresh break. This could be done with thousands of sherds.*
Keywords: *pottery fabrics, macroscopic description, macro photography*

INTRODUCTION

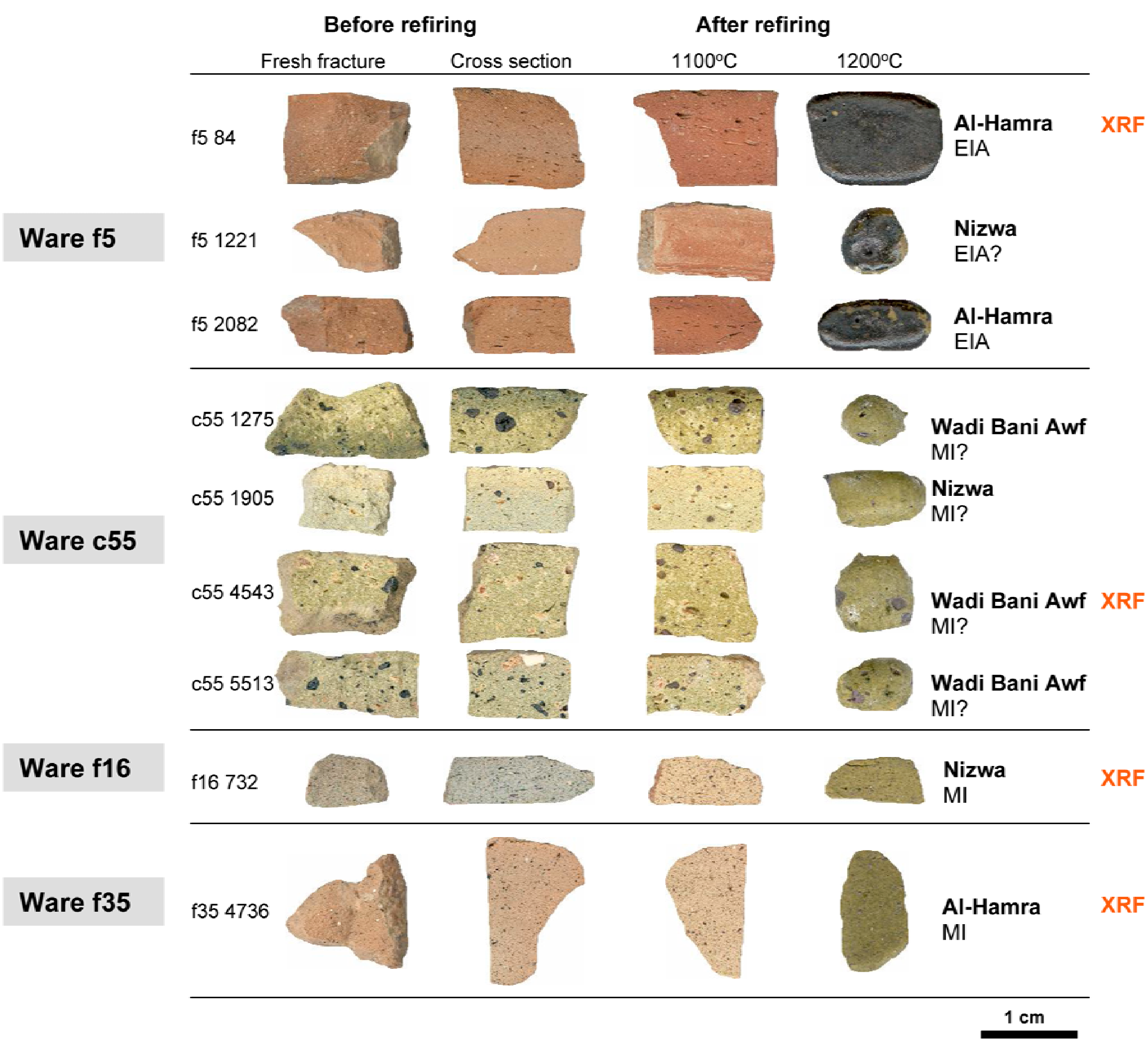
The most commonly encountered artefacts at archaeological sites dating from the Neolithic up to the medieval period are ceramics. In many instances ceramic finds are key chronological indicators, as well as evidence for the existence of trade, technological developments and changes in socioeconomic structures. To have a statistically significant database which can allow hypotheses to be confirmed all, or nearly all, pottery fragments must be classified. In most cases it is impossible (both in view of sherd numbers and administrative limitations) to remove all of the pottery excavated from a site. In consequence ceramic fragments are usually recorded on-site. The shape of each sherd is described (and usually drawn), as are the characteristics of the ceramic body. This is best done working on a fresh fracture.

There are a wide variety of guidelines relating to the macroscopic description of ceramic bodies, and the practical experience of numerous archaeological teams working in various regions on different types of pottery is also diverse. In general, regardless of the criteria used in these descriptions, macroscopic classification of ceramic bodies in the field relies on attributing each sherd to a strictly defined fabric type. In contrast, comprehensive analysis of ceramic finds does not usually begin until work in the field has been completed, when the only material still available for reappraisal is most often an assemblage of representative sherds. There are very few instances when it is possible to re-examine all of the ceramic fragments found at a site. This is true of archaeological as well as archaeometric studies.

Fabric types are often the subject of laboratory analysis conducted in order to provide a precise identification of their chemical, mineralogical and petrographic composition, the conditions in which they were fired and sometimes also their functional properties. It is usually single samples that are submitted for analysis, hence one sample represents one fabric. Very occasionally several samples of each fabric are sent for analysis.

Different fabrics sometimes prove to have the same chemical, mineralogical and petrographic composition, thus must have been made using the same ceramic body. This demonstrates that macroscopically visible differences between individual fabrics stem from technological processes (e.g. firing temperature, firing atmosphere, firing time, or methods used to prepare the ceramic body). Nonetheless, this type of situation does not pose any problems: the process of linking fabrics can be done without re-examining any samples. Problems are presented by the opposite scenario, when, after analysing several samples representing the same fabric, it transpires that each sample has a different chemical, mineralogical and petrographic composition. Experience shows that this situation is relatively commonplace, most frequently occurring at sites where excavation has been ongoing for many years and the classification of ceramic sherds has been carried out by numerous individuals. Presenting an accurate picture of the proportion of sherds representing individual types of ceramic body necessitates the reassessment of all pottery fragments.

Thus, submitting only one sample of each fabric for analysis eliminates the problem of discovering that the samples have been incorrectly classified, but it also means that there can be no confirmation of whether their classification is correct. This situation often leads to the formulation of false theories. An example is provided by the widely held belief that kitchenware vessels were calcite tempered.

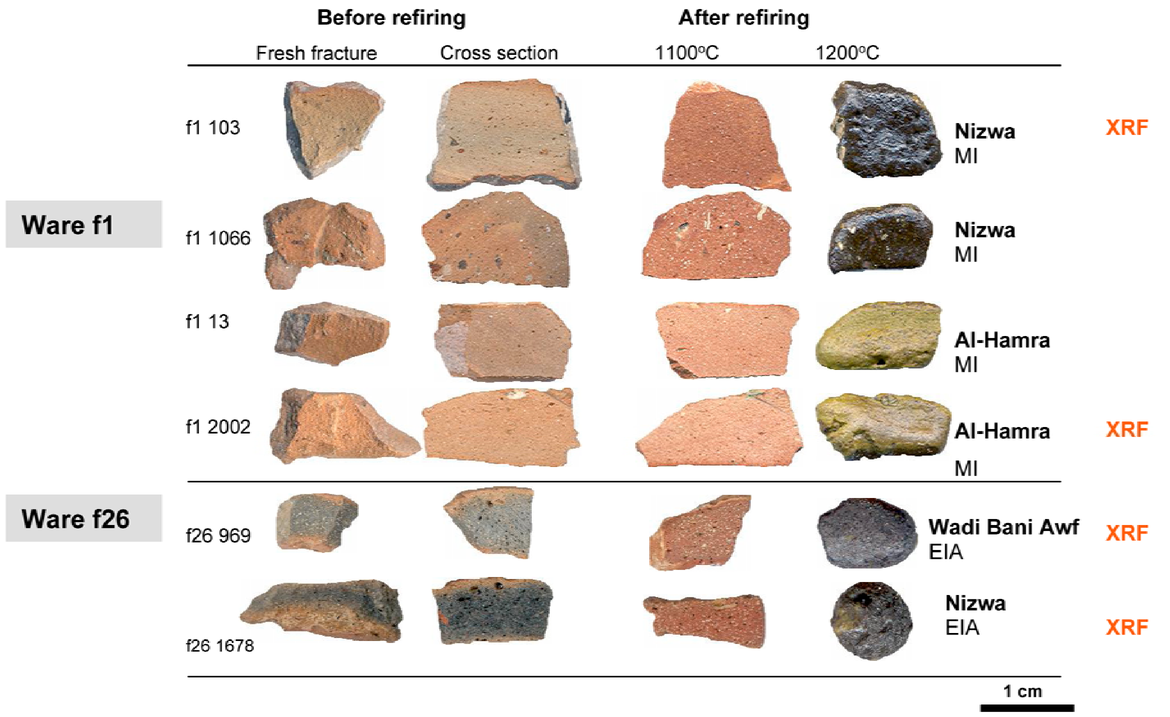


Chemical analysis by WD-XRF

	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	V	Cr	Ni	(Cu)	Zn	Rb	Sr	Y	Zr	(Nb)	Ba	(La	Ce	Pb	Th)	LOI	TOTAL
	% by weight										ppm															%	%
f5 84	61.19	0.72	13.00	7.96	0.048	7.96	5.54	1.18	2.28	0.13	123	523	303	56	69	79	434	20	165	13	343	36	57		14	12	0.96	99.96
c55 4543	57.17	0.68	10.96	5.40	0.047	5.75	16.50	1.73	1.63	0.15	90	921	229	57	48	49	480	16	181	<10	288	19	46	nd	14	0.61	99.56
f16 732	49.96	0.73	14.80	6.50	0.084	6.07	19.04	0.63	2.04	0.15	109	349	134	290	64	82	532	24	158	18	251	40	77	1009	33	2.94	99.26
f35 4736	51.25	0.75	14.92	5.99	0.063	4.95	19.22	0.91	1.83	0.11	101	310	136	71	58	72	503	23	172	17	515	43	60	327	26	6.59	99.45

Fig. 1 Examples of correctly classified fabrics (Ware f5 and Ware c55) and two fabrics (Ware f16 and Ware f35) differing in colour which after refiring and chemical analysis may be combined

Multiple laboratory analyses have revealed that the white grains macroscopically interpreted by archaeologists as calcite are frequently grains of quartz. Examples may be kitchenware vessels from Tell Scheh Hamad (*Daszkiewicz et al. 2006*) and fabrics from Mussawarat as-Sufra (*Daszkiewicz & Schneider 2001b*). The same fabric often actually represents calcite tempered pottery in some instances and quartz tempered pottery in others.



Chemical analysis by WD-XRF

	SiO$_2$	TiO$_2$	Al$_2$O$_3$	Fe$_2$O$_3$	MnO	MgO	CaO	Na$_2$O	K$_2$O	P$_2$O$_5$	V	Cr	Ni	(Cu)	Zn	Rb	Sr	Y	Zr	(Nb)	Ba	(La	Ce	Pb	Th)	LOI	TOTAL
	% by weight										ppm															%	%
f1 103	62.91	0.88	15.45	7.43	0.088	5.46	4.69	1.03	1.98	0.08	120	761	518	55	73	75	343	24	201	15	419	34	64	18	20	3.67	99.02
f1 2002	58.40	0.73	12.32	6.10	0.061	6.97	12.10	1.22	1.96	0.14	113	661	285	62	92	63	352	20	171	13	270	22	36	825	29	7.21	99.12
f26 969	61.77	0.77	17.64	6.54	0.125	3.53	7.03	0.21	2.31	0.08	114	155	79	88	80	90	382	23	160	18	404	47	78	19	19	1.93	99.67
f26 1678	62.70	0.78	12.89	6.84	0.051	8.28	5.56	1.23	1.62	0.06	110	815	372	45	41	55	432	26	199	13	1102	34	43	<10	17	1.50	99.63

Fig. 2 Examples of incorrectly classified fabrics: Ware f11 must be divided into a non-calcareous group and a calcareous group. Ware f26 is represented by two samples clearly differing in chemical composition (Mg, Cr, Ni).

It is easy to imagine the interpretative confusion which can arise if only quartz is noted at one site and only calcite at another. This confusion can be reduced by submitting several samples of each fabric for analysis. If some of these samples prove to have been incorrectly classified the whole ceramic assemblage should be re-examined, which is more often than not impossible. What can be done in this situation? Moreover, what can be done to avoid this type of situation arising?

The best solution would be to conduct laboratory analysis after the first season of excavation. This analysis would not have to be comprehensive; abridged MGR-analysis (MGR = Matrix Group by Refiring, see e.g. *Daszkiewicz & Schneider 2001a*) carried out on as large as possible a number of sherds would suffice. The reference fabric types established on the basis of MGR-analysis results would form the basis for classifying ceramic sherds in future excavation seasons. If it is not feasible to perform laboratory analysis at the onset of fieldwork, then all of the pottery fragments should be recorded in such a way that samples can be reclassified according to fabrics without having to re-examine the original sherds.

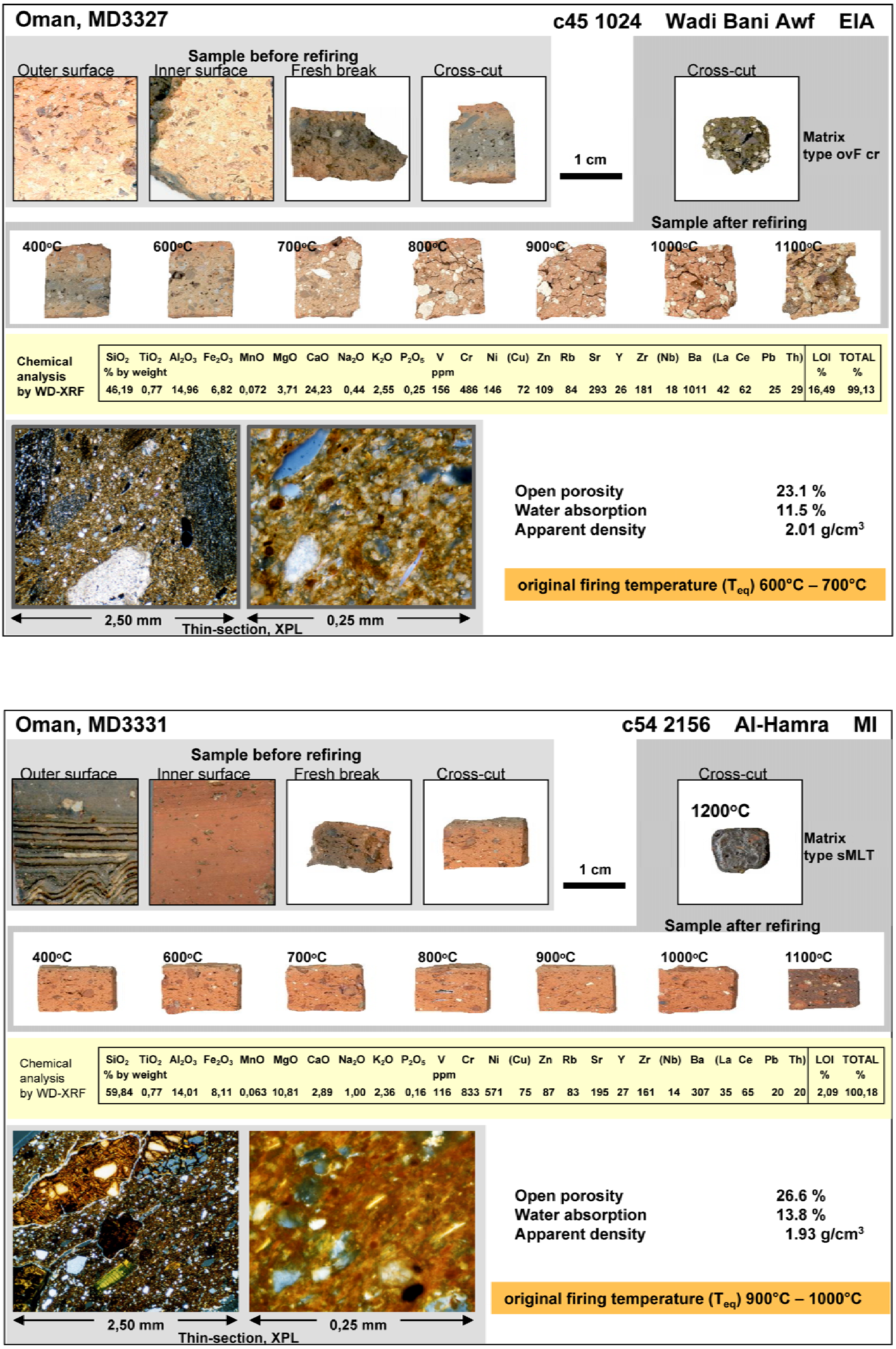
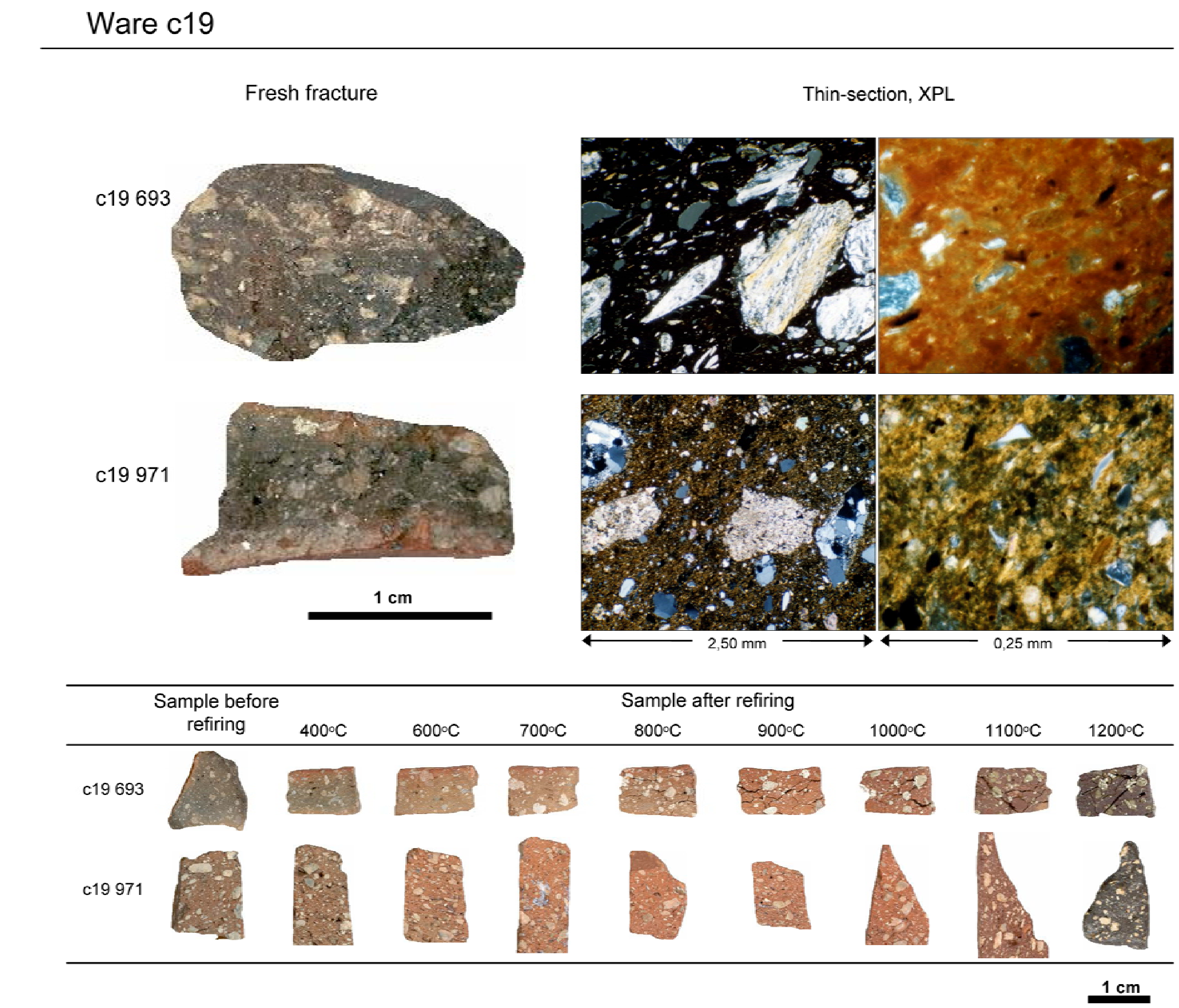


Fig. 3 Examples of the fabric record forms (Ware c45 and Ware c54)



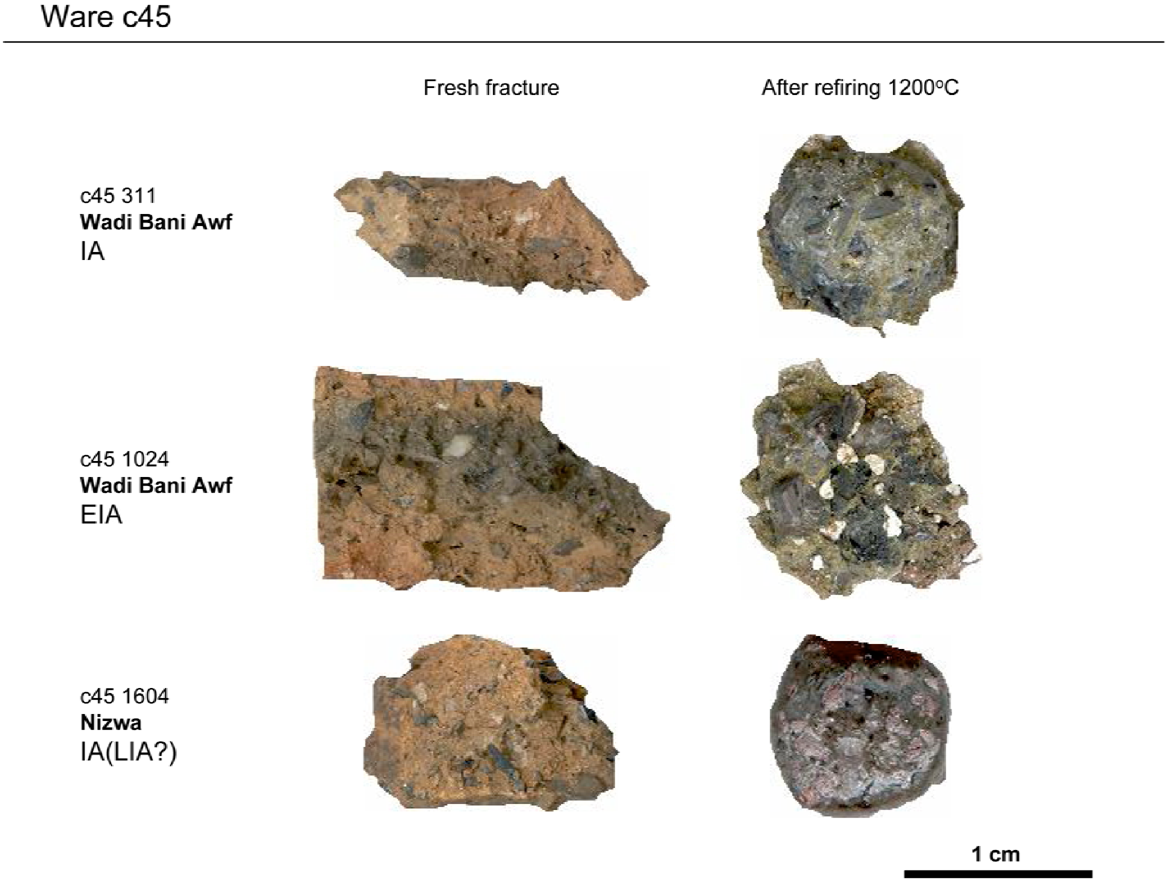
Chemical analysis by WD-XRF

	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	V	Cr	Ni	(Cu)	Zn	Rb	Sr	Y	Zr	(Nb)	Ba	(La	Ce	Pb	Th)	LOI	TOTAL
	% by weight										ppm															%	%
c19 693	59.98	0.57	13.53	6.46	0.037	14.02	3.00	0.25	2.02	0.15	94	1077	668	75	71	84	169	19	111	16	189	19	48	15	22	2.10	99.54
c19 971	48.65	1.10	20.56	9.86	0.105	3.96	13.75	0.24	1.70	0.08	281	742	330	84	114	64	263	37	262	20	591	32	80	26	31	11.15	99.80

Fig. 4 Example (Ware c19) where two sherds, in spite of their significant difference in matrix composition and tempering material, macroscopically were not distinguished

Nowadays it is possible to do this courtesy of digital photography, which provides a fast and cheap method of taking large numbers of photographs, which can be viewed and best compared on a computer screen at any enlargement required.

The theoretical musings of Daszkiewicz, Bobryk and Schneider were put to the test thanks to the co-operation of M. Baranowski, a student at the University of Warsaw's Institute of Archaeology, who took a trial series of photographs showing fresh fractures of various types of pottery (*Baranowski et al. 2007*) and then went on to devise a method which would allow macro photographs of fresh pottery fractures to be taken quickly in the field in standardised conditions (*Baranowski, in preparation*).



Chemical analysis by WD-XRF

	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	V	Cr	Ni	(Cu)	Zn	Rb	Sr	Y	Zr	(Nb)	Ba	(La	Ce	Pb	Th)	LOI	TOTAL
	% by weight										ppm															%	%
c45 311	50.91	0.82	15.63	7.17	0.097	3.95	18.15	0.76	2.37	0.14	127	528	198	50	102	93	275	30	188	16	869	18	77	20	19	14.25	100.52
c45 1024	46.19	0.77	14.96	6.82	0.072	3.71	24.23	0.44	2.55	0.25	156	486	146	72	109	84	293	26	181	18	1011	42	62	25	29	16.49	99.13
c45 1604	65.79	0.82	15.97	7.22	0.067	4.69	2.26	0.77	2.31	0.11	131	381	280	33	86	91	260	28	185	17	362	41	71	33	9	1.74	101.04

Fig. 5 Example (Ware c45) where three macroscopically non-distinguishable sherds were attributed to the same fabric

Due to the kindness of Dr. Jutta Haeser it was possible to test a full classification strategy on materials from a field survey. This test was carried out on 500 ceramic fragments from Oman. Detailed analysis of selected samples (MGR-analysis, XRF, thin-sections) was financed by the German Archaeological Institute in Berlin.

EXPERIMENTAL MATERIAL

In 1998, a project was initiated entitled ‘Transformation Processes in Oasis Settlements in Oman’. Specialists of different disciplines were involved in the project: orientalists, architects and urban planners, agriculturalists and archaeologists.

The project was undertaken with the financial support of the State of Baden-Württemberg, the University of Muscat, the German Archaeological Institute (DAI), and of the German Research Foundation (DFG). Preliminary reports were published e.g. by *Häser (2003)*.

Different methods were used in the study of archaeological sites. A survey was prepared with the help of aerial photographs. The location of the sites was registered with the help of a GPS receiver. Pottery and small finds were collected from the surface in a random survey. In Wadi Bani ‘Awf and in al-Hamra all pottery sherds were collected to get an impression of the different kinds of pottery. Due to the large amount of pottery in Tiwi, Ibra, Nizwa, and Izki, only diagnostic sherds (rims, bases, and decorated sherds) were collected. Not only prehistoric pottery sherds were recorded, but also Islamic material, since this was generally largely neglected in previous research projects.

The main tool for dating the archaeological sites was the pottery, since only in a few cases did the architecture provide any chronological clues. However, the dating of pottery in Oman is very difficult, because very few studies on this subject have been carried out and only small collections have been published which could be used for comparison. Therefore, a new classification of the collected material was created based on the recommendations of the ‘Projektgruppe Keramik im Arbeitskreis Archäometrie’ (*Schneider et al. 1989*) and the ‘Arbeitsgruppe Keramik’ at the Rheinisches Landesmuseum Bonn (*Kunow et al. 1986*). The collected sherds were classified in terms of fabric, shape and dating and statistically processed in a database. This work was done, under the guidance of Dr. Jutta Haeser, by J. Schreiber as part of his thesis (Bronze Age and Iron Age ceramics) and by Anja Dreiser (Islamic ceramics). Fabrics were identified by scrutinizing the fresh fracture of pottery sherds using a 10x magnification lens. All in all, about 16 000 sherds were studied in this way. This approach resulted in the definition of 124 fabrics. In order to cluster the fabrics, to study their composition, and to separate imports from locally manufactured pottery, archaeometric analysis was undertaken. Five hundred samples representing 120 fabrics were chosen for analysis, mostly from Wadi Bani ‘Awf and al-Hamra, some of them from Nizwa and Izki.

RESULTS

During the first stage of analysis all of the ceramic sherds (500 fragments, 120 fabrics) underwent *down-up sampling classification by abridged MGR-analysis* (down-up sampling classification was developed as part of M. Daszkiewicz’s doctoral thesis, see *Daszkiewicz 1998*). Subsequently, comprehensive laboratory analysis was applied to selected representative samples.

Preliminary classification led to the following conclusions:

- samples representing 52 fabrics were classified correctly (two examples, Ware f5 and Ware c55, are shown in **Fig. 1**);

- two fine ware fabrics represent pottery made from the same raw material, the difference in their macroscopic appearance stemming from technological differences, the fact that one of the vessels was glazed also being evinced by chemical analysis, which revealed elevated levels of Cu and Pb in the body of the sherd (Ware f16 and Ware f35 in **Fig. 1**);

- 68 fabrics included isolated examples of incorrectly classified samples, or alternatively each sample was made from a different raw material, as illustrated in **Fig. 2**, which shows that pottery sherds of distinctly different provenance were attributed to a single fabric.

One representative sample was chosen from each of the 52 correctly classified fabrics; a larger number of representative fragments had to be taken from the remaining fabrics. For each of the selected fragments a fabric record form was compiled consisting of MGR-analysis at eight different temperatures (this enables matrix type and equivalent original firing temperature to be determined), chemical analysis (WD-XRF), thin-sections, and ceramic properties (apparent density, open porosity, water absorption). Examples of these fabric record forms are shown in **Fig. 3**.

On completion of this stage of analysis a macro lens was used to photograph the 68 fabrics which included incorrectly classified sherds (photographs were taken with a Canon 350D digital camera equipped with a Canon EF 60mm f/2.8 macro lens). The camera was mounted on a tripod and the shutter released by remote control. **Fig. 4** shows two sherds attributed to the same fabric. These samples were not only made using different clays, but also differ in the mineralogical and petrographic content of their non-plastic components, which is hard to see macroscopically. Close examination of the fresh fracture visible in photographs taken at 20x enlargement reveals differences in sherd density and pore structure. If fresh fractures of all pottery sherds ascribed to this fabric were photographed it would be possible to reclassify them (reverse strategy by macro photography = RSM) without having to study the original samples.

The situation is sometimes even more complicated. **Fig. 5** shows three sherds representing the same fabric: c45. Analysis results revealed that two fragments were made of a calcareous clay (sample 1024 including additional calcite temper) and one fragment was made of an iron-rich non-calcareous clay, hence they should not have been attributed to the same fabric.

Macro photographs of the fresh fractures of these sherds show why they were erroneously classified. These samples are very similar in appearance, seeming virtually identical at first glance. Only once it is known that they differ significantly can any difference be discerned macroscopically. Nevertheless, it is difficult to define this difference in standardised terms, its detection relying more on what some archaeologists refer to as ‘a feel for the fabric’.

CONCLUSIONS

The test results demonstrated that using a digital camera with a macro lens to take photographs in the field of the fresh fractures of all ceramic sherds, in combination with laboratory analyses of selected fragments, minimises the risk of errors occurring in the macroscopic classification of pottery fabrics.

The time required to photograph a fresh fracture is minimal, there are no negatives to develop, and the only prerequisite is that a standardised method should be established for taking the photographs.

Many years’ experience in analysing ancient pottery and the results of the trial detailed in this article lead to the following conclusions:

1. It would be advisable to conduct MGR-analysis for as large a number of samples as possible at the onset of fieldwork in order to establish reference fabric types. In subsequent excavation seasons only fabrics not previously noted would be submitted for analysis.

2. Regardless of whether or not preliminary analysis is carried out, the fresh fracture of each pottery sherd should be photographed, thus allowing reverse strategy by macro photography (RSM) to be employed at a later date.

3. In view of the fact that some fabrics are difficult to identify macroscopically a low-tech method should be applied (abridged MGR-analysis) to the maximum number of samples, thus enabling large quantities of sherds to be classified quickly and cheaply.

5. The best results are achieved by combining down-up sampling classification by MGR-analysis with reverse strategy by macro photography.

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