The pots and potters of Assyria : technology and organization of production, ceramics sequence and vessel function at Late Bronze Age Tell Sabi Abyad, Syria

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APPENDIX D
TECHNOLOGICAL, PETROGRAPHICAL AND CHEMICAL ANALYSES OF LATE BRONZE AGE POTTERY CLAYS AT TELL SABI ABYAD.

This appendix will present the results of the archaeometric analyses of all pottery and clay samples that were analysed for this study. The appendix is organized according to the ware groups that could be distinguished on the basis of the results of the petrographical (thin-section) analysis. In this way, pottery made from similar fabrics is presented together. The results of the analyses are integrated in the discussions and conclusions of the other chapters.

Several kinds of analysis have been performed. The Department of Pottery Technology of Leiden University performed a low-tech analysis of the properties and workability of the unfired clays used for the pottery produced at Sabi Abyad. These included investigations of the colour, plasticity, workability, strength, non-plastic inclusions and shrinkage (cf. Van As 2004). The study was carried out by testing the performance of the clays in different circumstances, by studying both unfired sherds and raw clays using a stereo zoom-microscope, and by firing test bars at different temperatures. The analysis of the shaping methods also performed by the Department at the site in 1996 was presented in Chapter V.

Under the supervision of G. Schneider (FU Berlin), I have carried out a basic analysis of 45 thin-section slides from the Sabi Abyad pottery dating from levels 7-3. The samples were first impregnated with a bonding substance and then abraded to a thickness of 0.025 mm and fixed between glass plates. Under the polarizing microscope under parallel polarized light (ppl) or crossed polarized light (xpl) each mineral has its own optical characteristics. In this way non-plastic mineral (and organic) inclusions can be identified and described. In addition, the matrix itself can be described, although the clay minerals themselves are too small to be seen separately (Rice 1987: 376-382; Schneider and Daszkiewicz 2002; Whitbread 1995: 365-396). The results include descriptions of the colour and homogeneity of the matrix; the amount, size, shape and distribution of non-plastic inclusions; the determination of minerals and rock fragments; and the estimation of firing temperatures. The following terms are used to describe the sizes of non-plastic mineral inclusions (Rice 1987: 38):

Clay	< 2 µm (0.002 mm)
Silt	> 2 µm and < 20 µm (0.02 mm)
Fine sand	> 20 µm and < 200 µm (0.2 mm)
Coarse sand	> 200 µm and < 2000 µm (2 mm)
Gravel	> 2000 µm

To estimate the amount of inclusions, general percentages were estimated with the help of comparison charts for all inclusions together,[232] and rough counts per view were made at an enlargement of 10x:

Very few	less than 1 particle per view (occasionally seen, but not in every view)
Few	1-3 particles per view
Medium amount	4-15 particles per view
Many	15-30 particles per view
Very many	more than 30 particles per view

Furthermore, the following terms are used:

Matrix	The fine clay or silt material in which the coarser particles are embedded (Whitbread 1995: 369-371), grain sizes smaller than 0.02 mm.
"Clay aggregates"	Concentrations of fine-grained clay material without larger inclusions, often of a different colour than the matrix. They are also called "textural concentration features" (Whitbread 1995: 386). These concentrations (aggregates) may be

[232] According to Schneider (2006: 400) these estimates of non-plastic inclusions are always too low, since very small particles are not included.

	naturally present in the clay and can remain in the matrix when the clay is not soaked or mixed very well before shaping.
Organic inclusions	Fine organic fibres. The plant species or kind is not determined. It could be chopped straw or grasses, chaff, or organic fibres derived from animal dung.
Ppl	Parallel polarized light. The polarizer of the microscope lets light in a single plane through the sample.
Xpl	Crossed polarized light, or crossed Nicols. The analyser is used to let light through the sample only in the direction opposite to the direction of the polarizer (see Rice 1987: 377 for a short explanation).

To estimate firing temperatures, the following aspects have been taken into consideration:

Organic inclusions	At low temperatures charred skeletons of organic inclusions frequently remain in the voids.
Decomposition	At firing temperatures above approximately 700 °C primary calcite starts to decompose.
Iron oxides	At temperatures around 800-850 °C iron oxides give a more reddish colour to the matrix in calcareous clays.
Matrix	Calcareous clays become olive-green in colour and isotrope ("glassy") above approximately 900-1000 °C.
Mica	Above approximately 1050 °C mica starts to disappear. At lower temperatures the colourfulness and brightness of mica under crossed Nicols can begin to decrease.

It should be remembered that these are only approximate estimates, since these aspects depend not only on the firing temperature but also on the duration of the firing and the firing atmosphere as well as on the presence of salts in the clay (Schneider 2006: 399; see also Chapter II and V).

These analyses resulted in the formation of several different ware groups. These groups and the correspondence with the ware descriptions made in the field were discussed in Chapter II and Chapter V. In this appendix the ware groups and separate samples will be presented in more detail. With each sample information of both the field descriptions and the thin-section analysis will be given. In this way the field descriptions can be compared with the thin-section results.

G. Schneider furthermore analysed the chemical composition of four samples of unfired pottery, as well as two samples of cooking-ware pottery, using wavelength-dispersive X-ray Fluorescence (WD-XRF). Samples were prepared using 1 gr of pulverized sherd, ignited at 880 °C and melted into glass discs using lithium borate as a flux. These discs were then exposed to X-rays. The intensities of the characteristic secondary X-rays were measured and calculated to concentrations of the oxides of the elements in percentage of weight (for major elements) or in parts per million (ppm, for trace elements). This characteristic composition could then be compared to other samples or to source materials (Duistermaat and Schneider 1998; Schneider and Daszkiewicz 2002). The full data of these analyses is presented with each sample.

Also in Berlin, M. Daszkiewicz tested two Middle Assyrian cooking pots (samples J728 and J730) for water permeability and thermal-shock resistance (Daszkiewicz et al. 2000). Water permeability was tested by applying a constant stream of water to the surface of the sample, and measuring the amount of water that penetrated the sherd. Thermal-shock resistance was measured by establishing the water permeability of the sherd after applying thermal shock at 400 °C. The results of this analysis are presented with each sample.

These archaeometric analyses together yielded many useful insights into the composition of clay and inclusions, the preparation of the fabric, firing temperatures, etc. Moreover, the samples could be grouped in several groups related to the possible origin of the clay. The following origins were suggested:

Sabi Abyad:	This group includes the pottery that was made locally at the site. Clays would have been taken from the immediate surroundings of the site, but not necessarily from one location only.

Balikh Valley: Calcareous clays that could well have come from the region, if not from areas close to Sabi Abyad. However, an origin further away cannot be completely excluded either.

Jezira: Calcareous clays that most probably do not come from the Balikh Valley, because of small basalt inclusions in the natural clay or added as a temper. These clays would be expected in sediments closer to volcanic outcrops, perhaps in the upper Khabur Valley. Most of northern and eastern Syria is covered with calcareous marly clay sediments, so these sherds may come from the region at large and from more than one place.

Non-Jezira Non-calcareous clays that are not found in northern and eastern Syria. Perhaps they are from the Upper Euphrates further north. For one sample the region of origin could be exactly determined in the northwestern coastal area.

LOCAL SABI ABYAD CLAYS

Low-tech technological analysis of local pottery clays (with the cooperation of L. Jacobs and A. van As)

Two samples of unfired Middle Assyrian pottery from the pottery workshops at Tell Sabi Abyad (level 5, M11 33-162).

SN96-12	Body fragments of a type 111 middle-sized bowl, wall thickness 7-12 mm. This sample was also analysed with WD-XRF, see below.
SN96-130	Body fragment of a large bowl, wall thickness 17 mm (see fig. D.1).

Both samples were analysed for technical properties in April 2006 by the Department of Pottery Technology of Leiden University, by L. Jacobs and A. van As. The following report is theirs.

SN96-12 (fig. D.2)
In a raw bone-dry condition the clay is strong, has much cohesive strength and does not crumble easily. The loam shows much resistance when a piece is snapped by hand, which indicates that there is a rather high clay content in the material. The clay is clean; there are no coarse mineral inclusions. Apart from the negative impressions of vegetable fibres, fabric analysis[233] revealed nothing but some very fine quartz grains ≤ 250 μ, in a negligible quantity of less than 2% by weight. This indicates that these sporadic grains are natural to the clay. The rest of the mineral non-plastics belong to the silt fraction. The loam gives a spontaneous reaction with HCl (++), which betrays the presence of finely divided lime. The lime content, however, is not present as grains. The colour of the bone-dry loam is 7.5 YR 6/4 (light brown). When water is added the clay immediately dissolves and becomes plastic again. (PH-value 5 to 6, which is neutral).

Originally the clay was mixed with about 15% of fine organic fibres by volume. These fibres of chopped straw have a maximum size of about 5 mm in length. The fibres themselves have completely gone, even though the clay has not been fired. The only remainder is a dark-brown residue 7.5 YR 4/2 - 4/1 (brown to dark grey), partly visible against the wall of the cavity and partly on the surface of the unbaked sherd.

SN96-130 (figs. D.3, D.4)
In a bone-dry condition this clay, like the other one, is strong. In fact, both clays are quite equal regarding this point. Differences are only marginal, if any. The dry colour is the same as well; 7.5 YR 6/4 (light brown). By adding water to the clay, it immediately dissolves and becomes plastic again (The PH-value is also 5 to 6, neutral).

The amount and size of the organic fibres does not differ much from SN96-12 either. The quantity of fibres is about 15% by volume and the size varies with a maximum length of about 5 mm. It is also interesting to note that the orientation of the fibres is not random, but mostly parallel to the surface and in one direction. This in itself points to the applied shaping technique. With the throwing technique eventual fibres are known to orient themselves parallel to the surface. There are some other similarities between both clay mixtures. In both cases the fibres themselves have disappeared. Only the cavity is visible as negative fibre shapes. In both cases there is some dark brown residue in part of the cavity. This might suggest that the fibres were added as green grasses, with part of the juices still in them. In this way they could have rotted away more quickly and easily than completely pre-dried straw.[234]

The outcome of the observations is that both clay-straw mixtures are quite equal. This is confirmed by the firing colour of both samples at a temperature of 750˚C under oxidizing conditions. The firing colour is 5YR6/6 (reddish yellow) in both cases. Part of the Balikh clay samples (numbers 3, 5 and 6, collected in 1996) correspond with these clays. In these cases the firing colour is practically the same: 7.5YR6/6 (reddish yellow).

[233] Fabric analysis was carried out with a stereo zoom-microscope using 10 to 50X magnification.
[234] On the other hand, we should not forget that the sherds have been deposited for more than 3000 years, and that other than carbonized material no organic material is preserved at Sabi Abyad at all (K. Duistermaat).

Workability of the clay of both samples

By mixing the dry clay with water it was brought in a plastic condition. It was clear that after 3000 years the clay was plastic enough, but that it missed some “bones”. The clay is considered good for coiling and just suited for throwing. When water is added the clay becomes more workable and softer. In the soft condition it allows the piglet’s tail test without showing cracks, or only the beginning of cracks, but without snapping (indicating that the cohesive strength increases: cf. figs. D.5 and D.6). The problem with this soft condition is that the substance now misses the firmness necessary for successfully making pottery. Working these clays in a drier condition is not an option since in that case they start to crack (the cohesive strength decreases, while the resistance increases). Therefore the best solution is to bring the paste to its maximal plasticity. In the case of these loams this is a relatively soft condition, just before the point where they start to get sticky. Next some non-plastic material[235] has to be added. Fibrous organic material is preferable in this case, because it adds firmness and at the same time cohesive strength to the mass. To avoid cracks during the shaping process, cohesive strength is necessary during shaping but also during drying.

To get a good impression of the technical properties, the clay was first tested pure as it was, without the addition of any fibres (fig. D.7). This way the effect of the addition of fibres could become clear by comparison. Linear dry-shrinkage was measured on the original clay first. This was possible because the original organic addition had completely disappeared. Linear dry-shrinkage was 6% for SN96-12 and 7% for SN96-130, which is exactly in correspondence with some of the Balikh clay samples taken in 1996 (see Chapter V). These samples show a linear shrinkage-range from 6 up to 11%. The fact that both loams are in the lowest part of this range may indicate that the particular clays SN96-12 and SN96-130 are not the most plastic loams of the region. What makes them favourable, however, is probably the almost complete lack of larger calcite grains. This is different from the Balikh clay samples, which contain 5 to 15% of small calcite lumps (0.5 to 1.5 mm in diameter) (see Nieuwenhuyse 2006: 65-108).[236] Another advantage of a limited dry-shrinkage is that it helps to avoid cracks during drying and firing.

As a next step the clay was tested after adding fibres. The completely dried sample was moistened again and fine fibres of dried grasses were added (about 15% by volume, to mimic the original situation). Again the sample’s workability was tested and linear shrinkage measured. After 15 volume percents of fine organic fibres had been added to the clay, the mixture was markedly shorter. On modelling it even tended to crack a bit, which at the same time indicates that about 15% by volume is about the maximum desirable quantity of fibrous material. However, the great advantage of the addition was that the mixture had much more firmness, which is necessary for shaping pottery. This exactly must have been the reason that the Assyrian potters added fibrous organic material to these clays. The experiment thus confirmed what was expected theoretically. Moreover, it became clear by the experiment that both loams behaved exactly the same as to workability. Again test bars were made of the mixtures. The quality of the loams mixed with fine chopped grasses had markedly improved after a day of damp storage. This is because the fibres need some time to absorb moisture from the clay, which makes them less stiff. At the moment when the final test bars were made the workability of both mixtures was judged to be good. Dry-shrinkage of the mixtures of loam and 15 volume percents of fine straw is around 6% for both samples SN96-12 and SN96-130. It is interesting to note that the addition of fibres hardly influenced linear shrinkage. Fibres may also have been added to the paste in the form of animal dung. Addition of dung is a very effective way of increasing the cohesion and plasticity of the mixture, qualities that may have been desirable for these clays. A more detailed study of the size, shape and kind of vegetal inclusions in the pottery, and comparison with reference materials of different kinds of dung (sheep/goat, donkey, etc.) and different kinds of chaff, chopped grasses, etc. may solve this question.

[235] Larger portions of clay and straw are best mixed when the clay is in a thick liquid condition.
[236] However, see also the petrographical analysis of Middle Assyrian sherds on the following pages. They often do show calcite grains (K. Duistermaat).

LOCAL SABI ABYAD CLAYS

WD-XRF analyses of the chemical composition of local clays

SN96-12 Several body fragments of type 111 middle-sized bowls, wall thickness 7-12 mm. Sample numbers from the laboratory in Berlin are: V404, V405, V406, and V407. Part of this sample was also tested for technical properties, see above.

1744 Clay collected from the banks of the Balikh River near Tell Hammam et-Turkman, a few kilometres from Sabi Abyad, by G. Schneider in 1983.

4421 Clay from mud bricks from Tell Hammam et-Turkman, collected by G. Schneider in 1983.

Sealings The average composition of 132 unfired Neolithic clay sealings from Sabi Abyad, proved to be of local provenance (data taken from Duistermaat and Schneider 1998).

Walls The average composition of unfired Neolithic pisé walls at Sabi Abyad (data taken from Duistermaat and Schneider 1998).

	Elements																					
Sample no.	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	(S)	(Cl)	V	Cr	Ni	Zn	Rb	Sr	Y	Zr	Ba	(Ce)	GV
V404	48.87	0.853	13.18	6.66	0.095	4.85	21.39	0.89	2.92	0.28	0.17	0.17	128	250	105	95	66	455	26	170	375	75	17.66
V405	48.83	0.850	13.08	6.66	0.105	4.85	21.47	0.94	2.89	0.33	0.13	0.15	135	255	107	98	70	428	25	171	389	70	17.81
V406	49.19	0.845	12.96	6.64	0.090	4.77	21.42	0.86	2.90	0.32	0.20	0.17	129	250	106	95	66	526	26	172	513	47	17.66
V407	49.17	0.854	13.15	6.70	0.089	4.75	21.24	0.87	2.90	0.28	0.14	0.16	137	249	105	92	69	406	26	173	349	55	17.67
average unfired pottery	49.02	0.851	13.09	6.66	0.095	4.80	21.38	0.89	2.90	0.30	0.16	0.16	132	251	106	95	68	454	26	172	407	62	
1744	47.66	0.863	15.34	7.41	0.113	5.13	21.06	0.31	1.87	0.23	0.12	0.02	129	206	167	93	84	552	28	159	324	65	0.00
4421	47.89	0.834	14.58	7.00	0.111	5.18	19.32	1.17	3.52	0.40	0.58	0.58	114	188	152	89	75	619	22	151	316	54	0.00
average sealings	49.28	0.867	13.35	6.70	0.116	4.75	20.61	1.04	2.87	0.43	0.65	0.13	127	286	132	106	70	415	27	182	345	59	
average pisé walls	50.03	0.841	14.97	7.38	0.122	4.85	16.89	0.98	3.37	0.57	1.16	0.13	123	219	152	118	74	407	28	164	315	68	

Table D.1: WD-XRF analyses of the chemical composition of local clays. Wavelength dispersive X-ray fluorescence analysis (WD-XRF) of ignited samples, major elements are normalized to a constant sum of 100% not including S and Cl. Sample weight = 1 gr. Major elements in % oxide by weight, trace elements in parts per million (ppm). Samples analysed by dr. G. Schneider, Freie Universität Berlin.

The WD-XRF-analyses show that the chemical composition of the unfired pottery is very similar to the local Balikh clays (modern) and other local clay samples (Neolithic) from Sabi Abyad. A multivariate cluster analysis resulting in a dendrogram (not illustrated) also confirmed the similarity of unfired pottery and other Sabi Abyad clay samples. All clays contain a rather high amount of CaO around 21%. We see that the salt content (Na_2O) of the unfired pottery is relatively low, although evidence for the presence of salts in the pottery was found in several thin-sections (see below, sample nos. 03, 14, 18, 26, 24). The low salt content in the unfired pottery samples could perhaps be due to leaching during deposition. The samples from sealings and pisé walls from the same site show similar Na_2O levels. The clay from the riverside contains even less salt, perhaps suggesting that slightly brackish water instead of sweet water was used for making pottery, sealings and bricks. However, the data is ambiguous. See also the discussion about the possible addition of salt in Chapter V. The slightly lower amount of K_2O in the unfired ceramics and the sealings, as opposed to the samples from mud-brick walls, could be related to levigation processes possibly employed to obtain finer clays for sealings and pottery (Schneider 2006: 395).

LOCAL SABI ABYAD CLAYS

Thin-sections – Group A: Local calcareous clays with fine inclusions

Group A is characterized by calcareous clays with fine sand inclusions, with or without organic inclusions. Several sherds in Group A (samples 02, 05, 44 in group A1, samples 16, 22, 24, 47 in group A2; mostly from level 7 or 6) contain fragments of shells or microfossils, perhaps indicating a slightly different clay bed for these sherds.[237]

Group A includes the most common Middle Assyrian shapes. The pottery in group A was most probably made from a clay derived from a local clay source in the immediate surroundings of Sabi Abyad, and is therefore comparable to the local clays discussed on the previous pages. The group is subdivided into several subgroups according to the composition. Differences are either due to intentional temper additions of the potter (organic inclusions only) or to a slightly different location of clay collection, although all samples from group A are considered to be local to Sabi Abyad or the immediate surroundings.

A1 Local clay including a large amount of rounded cryptocrystalline calcite inclusions or calcite aggregates, and many "clay aggregates". This group includes mainly samples from level 7, and it is possible that the clay for the pottery from level 7 was taken from a slightly different spot in the area or a different clay deposit. Or, perhaps, the pottery was produced at a site not far from Sabi Abyad instead of at the site itself (there are no indications for pottery production from the excavations of level 7).

- A1a with organic inclusions added by the potter
- A1b without organic inclusions (fine wares)
- A1c with (intentional?) fine sand inclusions, no organic inclusions. Possibly not local? See the description of sample 12 below.

A2 Local clay with calcite inclusions. Inclusions are generally fewer or finer than in group A1 and better mixed, not containing any "clay aggregates". The clays either come from a slightly different location than group A1 or have been better soaked by the potter. This group includes the common Middle Assyrian shapes and may be considered to be the clay obtained close to Sabi Abyad. The presence of a kiln waster (sample 31) in this group is extra evidence for the local provenance of these sherds. This group would compare best to the samples of local potters' clay described above (SN96-12, SN96-130, low-tech and WD-XRF analysis).

- A2a with organic inclusions added by the potter
- A2b without organic inclusions (fine wares)
- A2c with fine sand inclusions and many calcite inclusions, with organic inclusions added by the potter. Possibly not local from the site? See the description of sample 08 below.

[237] It was noted that the pottery from Middle Assyrian Tell Sheikh Hamad very rarely contained these calcite microfossils (Schneider 2006: 403).

LOCAL SABI ABYAD CLAYS
Thin-sections – Group A1a

Sample no. **02**
Field no. N9 17-63:5
Level 7
Shape type 132 bowl rim
Illustration Fig. D.8

Field description:
Ware I (organic inclusions and calcite and sand)
Fired at a medium temperature in an incompletely oxidizing atmosphere.

Thin-section description:

Matrix
Calcareous clay containing iron. A lot of fine-grained calcite in silt fraction is present in the matrix. Brownish, anisotrope matrix. At the core of the sherd the colour is darker brown due to the deposition of carbon of unburnt organic inclusions (in the upper left of the thin-section illustrated in fig. D.8). At the surface of the sherd the colour is lighter brown. Several "clay aggregates" are present in coarse-sand fraction (up to 2 mm; in the lower right of the thin-section in fig. D.8).

Organic inclusions
Approximately 15% or fewer inclusions of fine organic fibres, rather evenly distributed through the matrix. Mostly triangular shapes (possibly the section of more longitudinal particles) of 0.625 – 0.75 mm long. Also some long and thin parts, max. 1.875 mm long but many are shorter, and some long and slightly bent shapes up to 1 mm long and 0.15 mm thick. In many voids, especially at the core of the sherd, there are still carbonized skeletons of the fibres (visible as a black skeleton in a grey void, at the centre top of the thin-section in fig. D.8).

Mineral inclusions
Generally small non-plastic inclusions, evenly distributed throughout the matrix. Approximately 40-50%, including organic inclusions. Mineral inclusions were most probably present in the natural clay, no mineral inclusions were added by the potter.

Many to very many smaller cryptocrystalline and crystalline, rounded or sometimes more angular primary calcite grains spread evenly through the matrix, most probably part of the natural clay. Up to 0.35 mm in size but most are smaller (white and beige rounded dots in the thin-section in fig. D.8). Also some calcite microfossils, up to 0.4 mm long, rectangular and curved in shape. Some calcite grains seem to be of biogene origin. The decomposition of calcite has barely started.

Iron oxides are mixed through the whole matrix in fine-sand or silt fraction. A few larger quartz grains in the coarse-sand fraction, and many much smaller quartz grains (fine-sand fraction), both have angular shapes. A few rounded or oval grains of chert, somewhat unevenly distributed, in coarse-sand fraction but mostly smaller. A few rock fragments in fine-sand fraction. A few mica (muscovite?) grains in fine-sand fraction, bright blue-pink under xpl. Very few small grains of feldspar (plagioclase, fine-sand fraction); very few grains of epidote, pyroxene, and hornblende in silt fraction.

Estimate of firing temperature
Low. Matrix is still anisotrope, the decomposition of calcite has not started yet. Fibres and carbon from organic inclusions have not fully burnt away.

LOCAL SABI ABYAD CLAYS
Thin-sections – Group A1a

Sample no. **05**
Field no. N9 17-900:5
Level 7
Shape type 315 jar rim
Illustration fig. D.9

Field description:
Ware I (organic inclusions and calcite and sand)
Fired at medium temperatures in an incompletely oxidizing atmosphere

Thin-section description:

Matrix
Calcareous clay containing iron. A lot of fine-grained calcite in silt fraction and smaller is present in the matrix. Brownish, mostly anisotrope matrix with red-brown clouding. Several dark red-brown “clay aggregates” in coarse-sand and gravel fraction. Sometimes these have cracked or shrunk, leaving a void around the particle. This is visible at the right side of the thin section illustrated in fig. D.9.

Organic inclusions
About 10% or fewer fine fibres, not very evenly distributed through the matrix. Mostly long and thin particles, some thicker longitudinal shapes, up to 1.5 mm long. Very few triangular-shaped inclusions, up to 0.5 mm long. Hardly any charred skeletons remain in the voids.

Mineral inclusions
Generally small non-plastic inclusions, evenly distributed throughout the matrix. Mineral inclusions were most probably present in the natural clay, no mineral inclusions were added by the potter.

Very many crystalline or cryptocrystalline, rounded, oval or irregular-shaped calcite grains spread evenly through the matrix, most probably part of the natural clay. Up to 0.5 mm in size, but most are much smaller, in silt and fine-sand fraction (up to 0.2 mm; rounded beige particles in the thin-section on fig. D.9). At the core of the sherd primary calcite is still preserved, but towards the surface of the sherd calcite has started to decompose. At the very surface the grains have turned grey in colour under xpl. A few calcite microfossils, up to 0.4 mm long, with a curved shape.

Iron oxides mixed through the whole matrix in fine-sand or silt fraction. A few angular quartz grains in coarse-sand fraction (up to 0.5 mm), many smaller quartz grains of fine-sand fraction (up to 0.1 mm) (shiny bright white particles in the thin-section on fig. D.9). A few mica grains (muscovite?) in fine-sand fraction (up to 0.1 mm). A few and small hornblende grains in fine-sand fraction (up to 0.06 mm). Very few rock fragments in fine-sand fraction, very few chert grains in fine-sand fraction (up to 0.1 mm). Very few epidote and pyroxene particles, and very few feldspar (plagioclase) grains, all in fine-sand fraction (up to 0.07 and 0.1 mm respectively).

Estimate of firing temperature
Low to medium. No charred organic remains are left, and calcite has decomposed at the surface of the sherd. The matrix is still largely anisotrope.

LOCAL SABI ABYAD CLAYS
Thin-sections – Group A1a

Sample no.	**32**
Field no.	K10 61-132:59
Level	7
Shape	type 117 bowl rim
Illustration	fig. D.10; IV.1.n

Field description:
Ware I (organic inclusions and calcite and sand)
Fired at a medium temperature in an oxidizing atmosphere.

Thin-section description:

Matrix
Calcareous clay containing iron. Fine-grained calcite in silt fraction and smaller, evenly mixed through the matrix. Reddish green-brown homogeneous matrix, largely anisotrope.

Organic inclusions
About 10% inclusions of fine organic fibres. Some longitudinal thick shapes up to 3.25 mm, longitudinal thick curved shapes up to 1.25 mm long, and some triangular-shaped particles up to 0.75 mm long. Hardly any charred skeletons of organic remains are left in the voids.

Mineral inclusions
Generally small non-plastic inclusions, evenly distributed throughout the matrix. About 40-50% including organic inclusions. Mineral inclusions were most probably present in the natural clay, no mineral inclusions were added by the potter.

The fabric is dominated by very many (up to 100 per view at 10x!) rounded and oval particles of cryptocrystalline calcite, in coarse-sand fraction (up to 0.5 mm) and smaller, spread evenly through the matrix and most probably part of the natural clay. All calcite has decomposed, no primary calcite is preserved. Some secondary deposition of calcite has started at the edge of voids.

Iron oxides are mixed through the whole matrix in fine sand and silt fraction, some larger particles up to 0.35 mm (visible in the thin-section in fig. D.10 as orange translucent and dark non-translucent oval particles). A few larger quartz grains in coarse-sand fraction (up to 0.5 mm) but very many smaller angular quartz grains in fine-sand fraction. A medium amount of mica particles in fine-sand fraction (up to 0.06 mm). A few chert particles in fine and coarse-sand fractions (up to 0.4 mm but mostly smaller). A few feldspar grains (plagioclase) in fine-sand fraction (up to 0.2 mm). A few rock particles in fine-sand fraction. A few hornblende grains in fine-sand fraction. Very few epidote and pyroxene grains in fine-sand fraction.

Estimate of firing temperatures
Medium. Matrix is still largely anisotrope, but calcite has completely decomposed.

LOCAL SABI ABYAD CLAYS
Thin-sections – Group A1a

Sample no. **42**
Field no. K10 61-122:38
Level 7
Shape type 315 jar rim
Illustration fig. D.11; IV.8.i

Field description:
Ware I (organic inclusions and calcite and sand), very many calcite inclusions.
Fired at a medium temperature in an oxidizing atmosphere.

Thin-section description:

Matrix
Calcareous clay containing iron. Fine-grained calcite in silt fraction mixed evenly through the whole matrix. Brown, slightly olive-grey green matrix, starting to become isotrope. Not very homogeneously mixed. Towards the outer surface of the sherd the matrix is greener than at the core of the sherd.

Organic inclusions
Very few, fewer than 5% inclusions of fine organic fibres. Mostly longitudinal thin and straight or slightly curved particles, up to 2 mm long, a few triangular-shaped particles up to 0.5 mm long.

Mineral inclusions
Generally small non-plastic inclusions, evenly mixed in the matrix. About 30% including voids of organic inclusions. Mineral inclusions were most probably present in the natural clay, not added by the potter.

The fabric is dominated by many rounded or oval cryptocrystalline grains of calcite. Some very large parts in gravel fraction (2 mm), but many are much smaller in coarse and fine-sand fractions. All calcite has decomposed. Some redeposition of secondary calcite has started at the edge of voids, mainly at the surface of the sherd.

Iron oxides are mixed through the matrix in silt and fine-sand fractions. Also some spiral iron-oxide aggregates. Many angular quartz particles in fine-sand fraction (up to 0.2 mm). Medium amount of mica grains in fine-sand fraction. A few angular feldspar (plagioclase) grains in fine-sand fraction (up to 0.1 mm). A few angular chert fragments in fine to coarse-sand fraction (up to 0.3 mm), and few radiolarite chert fragments in fine-sand fraction. A few hornblende and pyroxene grains in fine-sand fraction. Very few rock fragments in fine to coarse-sand fraction (up to 0.25 mm).

Estimate of firing temperatures
Medium to high. Matrix is starting to become isotrope, calcite has completely decomposed.

LOCAL SABI ABYAD CLAYS
Thin-sections – Group A1b (fine wares)

Sample no.	**44**
Field no.	K10 61-121:P93-110
Level	7
Shape	type 122 bowl
Illustration	fig. D.12; IV.2.c

Field description:
Ware C (fine sand inclusions)
Fired at a medium temperature in an oxidizing atmosphere. Different (but not grey) core colour.

Thin-section description:

Matrix
Calcareous clay containing iron. Orange brown, anisotrope matrix. The matrix is not very homogeneous: there are irregular bands of darker brownish and darker-red clay, as well as some oval “clay aggregates”. Very small irregularly-shaped voids, most probably from air bubbles in the clay.

Mineral inclusions
Small to slightly larger non-plastic inclusions, not very homogeneously mixed in the matrix. Approximately 15%. Mineral inclusions were most probably present in the natural clay, not added by the potter.

The mixture is dominated by many crystalline and cryptocrystalline grains of calcite, rounded and oval or irregularly-shaped; some crystalline grains have retained the original crystal rhomboid shape. Some are quite large, up to 0.8 mm (coarse-sand fraction), most are smaller in the fine-sand and coarse-sand fractions. Some grains include very small iron-oxide inclusions. Several microfossils or calcite grains of biogene origin, up to 0.4 mm. One is visible at the top centre of the thin-section in fig. D.12. All calcite is still primary, decomposition has not started yet.

Many angular quartz particles in coarse-sand fraction (up to 0.4 mm) and smaller, also including microcrystalline grains. A few mica particles, sometimes very large (up to 0.25 mm) but mostly smaller. A few feldspar grains in fine-sand fraction. A few angular and rounded chert grains in coarse-sand fraction (up to 0.4 mm). A few rock fragments in coarse-sand fraction. Very few epidote and pyroxene particles in fine-sand fraction (up to 0.06 mm), very few hornblende particles in fine-sand fraction (up to 0.1 mm).

Estimate of firing temperatures
Low. Matrix is not isotrope, calcite is still present in primary form.

LOCAL SABI ABYAD CLAYS
Thin-sections – Group A1b (fine wares)

Sample no.	**45**
Field no.	K9 48-113:16
Level	5 (but intrusive, probably from level 7)
Shape	body sherd of a goblet with "Nuzi"-style decoration
Illustration	fig. D.13, D.14; IV.98.c

Field description:
Ware B (with calcite and fine sand)
Fired at a medium temperature in an oxidizing atmosphere.

Thin-section description:

Matrix
Calcareous clay containing iron. Deep dark olive-green matrix with dark brown-red stains from iron oxides. The matrix is largely isotrope. The matrix is not very homogeneous. The outer 0.12 mm or so at the surface of the sherd (towards the upper left of the thin-section in fig. D.13) is more deeply greenish and seems to contain fewer iron oxides, creating a lighter cream colour in the sherd when viewed macroscopically. A few small circular or rounded voids are present, most probably from air bubbles or from decomposed calcite.

Mineral inclusions
Generally very small non-plastic inclusions, not very evenly mixed in the matrix. Approximately 20%. Mineral inclusions were most probably present in the natural clay, not added by the potter.

Very many rounded and oval cryptocrystalline grains of calcite in coarse-sand fraction (up to 0.4 mm), although most are much smaller. All calcite has decomposed. Some redeposition of secondary calcite has started at the edges of voids left by decomposed calcite grains. Many angular quartz grains in fine-sand fraction. Medium amount of mica (muscovite, biotite?) in fine-sand fraction (up to 0.08 mm). A few feldspar (plagioclase) grains in fine-sand fraction. A few angular chert grains in fine-sand fraction. A few hornblende grains in fine-sand fraction. Very few rock fragments in fine-sand fraction. Very few pyroxene grains in silt fraction.

Estimate of firing temperatures
Rather high. Matrix is largely isotrope and started to turn olive-green, calcite has completely decomposed.

Remarks
The dark-brown painted bands of the "Nuzi"-style decoration are visible in the thin section as a thin (0.05 mm) layer of iron-rich clay at the surface, well bonded with the matrix (visible in close-up at the top of the thin-section in fig. D.14). Due to the high firing temperature, the iron-rich clay paint has melted into the matrix. The white motives are not visible at all.

LOCAL SABI ABYAD CLAYS ?
Thin-sections – Group A1c

Sample no.	**12**
Field no.	N9 6-52:1
Level	5?
Shape	body sherd of a type 911 "pilgrim bottle"
Illustration	fig. D.15

Field description:
Ware A (calcite inclusions), many calcite inclusions
Fired at a medium temperature in an oxidizing atmosphere.

Thin-section description:

Matrix
Very calcareous, iron-rich clay. Fine-grained calcite in silt fraction spread evenly through the matrix. Dark deep olive-green-brown matrix, starting to become isotrope. Several small (0.3 mm) "clay aggregates" with few inclusions are mixed unevenly in the matrix (visible at the top of the thin-section in fig. D.15). Very few small irregular voids up to 0.4 mm are present, perhaps air bubbles or voids left after the decomposition of calcite.

Mineral inclusions
Mostly very fine and many non-plastic inclusions, up to 40%, spread rather evenly in the matrix. Most probably not added intentionally by the potter.

Many to very many rounded and oval cryptocrystalline grains of calcite in coarse-sand fraction (up to 0.3 mm) and smaller. All calcite has decomposed. Redepostion of secondary calcite has started at the edges of some voids, but not everywhere.

Iron oxides are mixed through the matrix in silt or fine-sand fraction. Many angular quartz grains in coarse-sand fraction (up to 0.4 mm) and smaller. A medium amount of pyroxene in fine-sand fraction (up to 0.05 mm). A few rock fragments in fine-sand fraction. A few mica particles in fine-sand fraction. A few hornblende particles in fine-sand fraction (up to 0.1 mm). A few feldspar (plagioclase) grains in fine-sand fraction (up to 0.05 mm), few epidote grains in fine-sand fraction (up to 0.2 mm). In general it seems that this fabric contains more colourful and brighter mineral grains than the other fabrics in the same group.

Estimate of firing temperatures
Medium – high. Matrix is starting to become isotrope, all calcite has decomposed.

Remarks
This fabric is a bit different from the rest of the fabrics in Group A1, because it seems to contain slightly more mixed fine sand inclusions than the other sherds in the group. However, there is no immediate reason to suggest a non-local origin for this sample.

LOCAL SABI ABYAD CLAYS
Thin-sections – Group A2a

Sample no.	**01**
Field no.	H7 5-8:1
Level	4
Shape	type 311 small jar rim
Illustration	fig. D.16

Field description:
Ware H (organic inclusions and calcite), many calcite inclusions
Fired at a medium temperature in an incompletely oxidizing atmosphere. Cream surface colour and orange core.

Thin-section description:

Matrix
Calcareous clay containing iron. Fine-grained calcite in silt fraction mixed through the matrix. Towards the surface of the sherd, this secondary calcite started to form "clouds". Olive-grey-brown matrix, towards the surface becoming darker green-brown and more isotrope than at the core (the surface is towards the top of the thin-section in fig. D.16).

Organic inclusions
Around 10% or fewer, fine organic fibres, rather evenly distributed through the matrix. Triangular shapes between 0.375 and 0.8 mm long, longitudinal thin and straight or slightly curved fibres up to 1.25 mm long, spherical shapes up to 1.125 mm in diameter and more irregularly-shaped inclusions. A few carbonized "skeletons" of fibres are left in the voids.

Mineral inclusions
Generally small non-plastic inclusions, evenly distributed through the matrix. Approximately 30% including voids left by organic inclusions. Mineral inclusions were most probably present in the natural clay and not added intentionally.

A few larger cryptocrystalline calcite inclusions retained their original crystal shape (for example in the upper right part of the thin-section in fig. D.16, the rhomboid bright white shape), in coarse-sand fraction (up to 0.75 mm), but many smaller rounded and oval calcite grains in fine-sand fraction. Inside one grain a small oolite (0.175 mm) has built around a quartz particle. All calcite has decomposed, and some has started to disappear at the edges of the larger particles. Redepostion of secondary calcite has started at the edges of voids.

Iron oxides are mixed through the whole matrix in fine-sand and silt fraction. Also some cloudy or rounded iron-oxide aggregates. Very many angular quartz inclusions in fine-sand fraction (up to 0.075 mm). A medium amount of mica (muscovite?) in fine-sand fraction (up to 0.07 mm). A few hornblende and epidote grains in fine-sand fraction (up to 0.03 mm). Very few feldspar grains in fine-sand fraction (up to 0.1 mm).

Estimate of firing temperatures
Medium to high. Matrix is starting to become more isotrope at the surface. Calcite has completely decomposed and partly disappeared.

Remarks
Gypsum minerals are building at the edges of voids left by organic inclusions and decomposed calcite, and adhering to the sherd surface. This is probably related to the deposition in the soil, or to contact with gypsum for the reparation of cracks by the potter (see Chapter V).

LOCAL SABI ABYAD CLAYS
Thin-sections – Group A2a

Sample no.	**03**
Field no.	H7 5-9:3
Level	4
Shape	type 111 carinated bowl rim.
Illustration	fig. D.17

Field description:
Ware I (organic inclusions and calcite and sand).
Fired at a medium temperature in an oxidizing atmosphere (core colour orange, surface colour red)

Thin-section description:

Matrix
Calcareous clay containing iron. Fine-grained calcite in silt fraction is mixed through the whole matrix, and concentrated in a thin zone just below the surface of the sherd. Dark brown largely anisotrope matrix at the core of the sherd (at the thickest point), becoming more reddish-brown towards the surface. At the surface of the sherd, a thin zone (0.2 mm thick) is darker olive-green and slightly more isotrope. Perhaps this is due to a "salt effect", where salts present in the wet clay migrated to the surface of the sherd during drying and acted as a flux during firing (visible at the top of the thin-section in fig. D.17).

Organic inclusions
Approximately 10% or fewer fine organic fibres, mostly thicker curved shapes up to 1.5 mm long and triangular shapes up to 0.75 mm long. Not very evenly mixed in the matrix. Hardly any charred skeletons of fibres left in the voids.

Mineral inclusions
Generally small and very homogeneously mixed non-plastic inclusions, approximately 40% including the voids left by organic inclusions. Mineral inclusions were most probably present in the natural clay, not intentionally added by the potter.

A few larger cryptocrystalline calcite grains retained their original crystal shape (up to 0.75 mm), but very many smaller oval and rounded calcite grains in fine-sand fraction (up to 0.25 mm). All calcite has decomposed and is yellow or grey in colour under xpl. Only at the very core of the sherd there are some primary grains left.

Iron oxides in fine-sand and silt fraction mixed through the whole matrix. Many angular quartz grains in fine-sand fraction (up to 0.25 mm). Medium amount of mica (muscovite?) grains in fine-sand fraction. A few rock fragments in fine-sand fraction. Very few feldspar grains (plagioclase) in fine-sand fraction, very few chert grains in fine-sand fraction, very few epidote, hornblende and pyroxene particles in fine-sand fraction.

Estimate of firing temperatures
Medium. Matrix is largely anisotrope, primary calcite is still preserved at the core of the sherd. At the surface of the sherd the temperature may have been a bit higher, or the fabric sintered earlier due to a "salt effect."

Remarks
Gypsum minerals are adhering to the sherd surface. This is probably related to the deposition in the soil, or to contact with gypsum for reparation of cracks by the potter (see Chapter V).

LOCAL SABI ABYAD CLAYS
Thin-sections – Group A2a

Sample no.	**04**
Field no.	I7 3-24:4
Level	4
Shape	type 313 small jar rim.
Illustration	fig. D.18

Field description:
Ware I (organic inclusions and calcite and sand).
Fired at a high temperature in an oxidizing atmosphere.

Thin-section description:

Matrix
Calcareous clay containing iron. Fine-grained secondary calcite in silt fraction spread through the matrix and forming cloudy concentrations, partly molten into the matrix. Calcite clouding concentrates at the outside surface of the sherd and around voids. At the inside surface of the sherd, calcite grains concentrate in a very thin zone just below the surface, while the surface itself is more isotrope and contains fewer calcite grains (not shown in picture). Dark olive-grey-green matrix that is largely becoming isotrope.

Organic inclusions
A few, maximally 5%, fine organic fibres. Some longitudinal thin or thicker fibres up to 2.5 mm long, and some triangular particles up to 0.75 mm long, evenly distributed through the matrix. Hardly any charred remains of fibres are left in the voids.

Mineral inclusions
Fine non-plastic inclusions, evenly distributed through the matrix and most probably already partly molten into it. Approximately 15% including voids left by organic inclusions. Mineral inclusions present in the natural clay, not added by the potter.

Very few rounded calcite grains in coarse-sand fraction (up to 0.5 mm) are still present in the matrix. Most grains were much smaller but have completely decomposed and disappeared or fused with the matrix. No primary calcite is present. Redepostion of secondary calcite at the edges of voids is rare.

Iron oxides in silt and fine-sand fraction mixed through the matrix. No concentration of iron is visible around the voids (sometimes seen in highly fired calcareous clays, cf. sample nos. 21 and 09 below). Many angular quartz grains in fine-sand fraction (most up to 0.04 mm and some up to 0.1 mm). Very few rock fragments and chert particles in fine-sand fraction. Very few pyroxene and hornblende grains in fine-sand fraction.

Estimate of firing temperatures
High. Matrix is largely isotrope and calcite has completely decomposed or disappeared. Mica and other finer inclusions have lost their brilliance or have fused with the matrix.

LOCAL SABI ABYAD CLAYS
Thin-sections – Group A2a

Sample no.	**11**
Field no.	H7 4-14:10
Level	4
Shape	type 221 pot rim
Illustration	fig. D.19

Field description:
Ware H (organic inclusions and calcite).
Fired at a medium temperature in an oxidizing atmosphere.

Thin-section description:

Matrix
Calcareous clay containing iron. Fine-grained secondary calcite present in large amounts in silt fraction and forming clouds in the matrix, especially towards the inner surface of the sherd (the inner surface of the sherd is on the left of the thin-section in fig. D.19). The core and outer surface of the sherd show less clouding but instead the fine calcite is more evenly mixed here. The matrix is dark grey-olive-green and largely isotrope. At the surface of the sherd the matrix is darker and more isotrope.

Organic inclusions
Approximately 10% of fine organic fibres. Longitudinal straight and curved shapes up to 1.25 mm long, as well as triangular shapes up to 0.75 mm long or smaller, rather evenly distributed through the matrix. One heart-shaped void left by an organic inclusion. No charred remains of organic inclusions are left in the voids.

Mineral inclusions
Generally fine inclusions, dominated by fine-grained calcite in silt fraction forming clouds (see above). Approximately 20% including voids of organic inclusions, but difficult to estimate because of clouding.

Only a few grains of calcite are still preserved, cryptocrystalline and decomposed, in coarse-sand fraction (up to 0.625 mm). Many grains have disappeared leaving a small void. Redepostion of secondary calcite has started at the edges of some voids, but not everywhere.

Iron oxides in fine-sand and silt fractions mixed evenly with the matrix. A few larger angular quartz grains in coarse-sand fraction up to 0.5 mm, but very many smaller particles in fine-sand fraction. A few angular and radiolarite chert particles in fine-sand fraction (up to 0.2 mm). A few rock fragments in fine-sand fraction. A few feldspar (plagioclase) grains in fine-sand fraction. A few mica grains in fine-sand fraction, colours are starting to become dull and do not include blue and pink anymore under xpl. A few hornblende particles in fine-sand fraction.

Estimate of firing temperatures
High. Matrix is largely isotrope, calcite grains have decomposed or disappeared. Mica has lost its brilliance and is probably already fusing with the matrix.

LOCAL SABI ABYAD CLAYS
Thin-sections – Group A2a

Sample no. **13**
Field no. H8 13-141:1
Level 5
Shape type 212 large storage-pot rim
Illustration fig. D.20

Field description:
Ware I (organic inclusions and calcite and sand). Many fine calcite inclusions. Handmade.
Fired at a medium temperature in an oxidizing atmosphere.

Thin-section description:

Matrix
Calcareous clay containing iron. Fine-grained secondary calcite in silt fraction mixed evenly with the matrix, forming cloudy concentrations towards the surface of the sherd. Grey-olive-green brown homogeneous matrix, starting to become isotrope. Towards the surface of the sherd, the matrix becomes darker green and more isotrope.

Organic inclusions
A large amount, approximately 20%, of fine organic fibres. These fibres were noted to be less clearly oriented in a preferred orientation than in the other sherds. On the contrary, they seem to be rather randomly mixed with the matrix. This is probably related to the slab-building method of shaping (see Chapter V). Longitudinal thin straight and thicker bent fibres, up to 2.5 mm long, and some triangular fibres up to 0.75 mm long. Hardly any charred remains preserved in the voids.

Mineral inclusions
Generally small mineral inclusions, evenly mixed with the matrix. Approximately 40% or less, including voids left by organic inclusions. Mineral inclusions were most probably present in the natural clay, not added by the potter.

Very many rounded and oval cryptocrystalline calcite grains, in coarse and fine-sand fraction (up to 0.375 mm but mostly smaller). All calcite has decomposed and many grains have left voids. Redepostion of secondary calcite is present at the edges of many voids.

Iron oxides in fine-sand and silt fraction mixed evenly through the matrix. Very many angular particles of quartz, occasionally in coarse-sand fraction (up to 0.6 mm) but mostly in fine-sand fraction (up to 0.1 mm). A few mica grains in fine-sand fraction. A few hornblende and pyroxene (?) grains in fine-sand fraction. A few rock fragments in fine-sand fraction.

Estimate of firing temperatures
Medium to high. Matrix is becoming largely isotrope, calcite has completely decomposed.

Remarks
Orientation of organic inclusions seems to be related to the shaping method.

LOCAL SABI ABYAD CLAYS
Thin-sections – Group A2a

Sample no.	**14**
Field no.	H7 3-7:7
Level	4
Shape	type 111 carinated bowl rim
Illustration	fig. D.21

Field description:
Ware H (organic inclusions and calcite).
Fired at a medium temperature in an oxidizing atmosphere.

Thin-section description:

Matrix
Calcareous clay containing iron. Fine-grained calcite in silt fraction mixed evenly in the matrix, but not that much. Dark red-brown anisotrope matrix. At the surface of the sherd, a zone of 0.35 mm is a deeper dark-green and more isotrope. This is visible in the sherd as a cream outer-surface colour as opposed to the red inner colour (visible towards the upper left of the thin-section in fig. D.21). This effect is most probably due to the migration of salts during the drying of the pottery. Salt then acted as a flux at the surface of the sherd, sintering the clay more easily than at the core.

Organic inclusions
Approximately 15% or fewer, fine organic fibres. Most of them have a triangular shape (these could be the sections of more longitudinal shapes, oriented parallel to the sherd surface due to the wheel throwing), up to 1 mm long. Longitudinal fibres are few and concentrated at the core of the sherd, and up to 1.5 mm long. Hardly any charred skeletons of organic inclusions remain in the voids.

Mineral inclusions
Generally fine mineral inclusions, mixed evenly through the matrix. Approximately 20% including voids left by organic inclusions. Mineral inclusions were most probably present in the natural clay, not added by the potter.

Many rounded or oval cryptocrystalline calcite grains in coarse and fine-sand fraction (up to 0.5 mm but many are smaller), some retaining a bit of their original crystal shape. All calcite has decomposed. There is hardly any redepostion of secondary calcite at the edges of voids.

Iron oxides in fine-sand and silt fraction are evenly spread in the matrix. Many angular quartz grains in coarse and fine-sand fraction, up to 0.4 mm. A medium amount of mica (muscovite, biotite?) in fine-sand fraction. A few angular chert particles in coarse and fine-sand fraction (up to 0.35 mm) and radiolarite chert particles in fine-sand fraction (up to 0.1 mm in diameter). A few feldspar (plagioclase) particles in fine-sand fraction. A few rock fragments in coarse and fine-sand fraction (up to 0.3 mm). A few hornblende grains in fine-sand fraction. Very few epidote (?) grains in fine-sand fraction, up to 0.1 mm.

Estimate of firing temperatures
Medium. Matrix is still largely anisotrope, but all calcite has decomposed. Mica is still present in rather large amounts.

Remarks
Gypsum minerals are building at the edges of voids left by organic inclusions and decomposed calcite. This is probably related to the deposition in the soil, or to contact with gypsum for the reparation of cracks by the potter (see Chapter V).

LOCAL SABI ABYAD CLAYS
Thin-sections – Group A2a

Sample no.	**16**
Field no.	M13 2-30: P93-184
Level	6
Shape	type 113 bowl, burnished and decorated with white-filled impressions
Illustration	fig. D.22; IV.17.b

Field description:
Ware J (organic inclusions and fine sand)
Fired at a medium temperature in a reducing atmosphere.

Thin-section description:

<u>Matrix</u>
Calcareous clay containing iron. A lot of fine-grained calcite in silt fraction mixed evenly through the matrix. Brownish, anisotrope matrix.

<u>Organic inclusions</u>
A few, approximately 10% or fewer, fine organic fibres. Longitudinal shapes up to 0.625 mm long and smaller, as well as triangular shapes up to 0.75 mm long (as visible at the top of the thin-section on fig. D.22). Hardly any charred skeletons of charred fibres remain in the voids. Around voids at the core carbon has deposited, but not so much around voids near the surface of the sherd.

<u>Mineral inclusions</u>
Generally fine non-plastic inclusions, evenly distributed through the matrix. Approximately 30% or less, including the voids left by organic inclusions. Mineral inclusions were most probably present in the natural clay, not added by the potter.

The fabric is dominated by the fine-grained calcite mixed through the matrix. Calcite is also present as very many crystalline or micro-crystalline angular, geometrically-shaped or more rounded particles, in coarse and fine-sand fraction up to 0.5 mm. Also a few curved calcite microfossils. All calcite is still primary, decomposition has not yet started.

Iron oxides in fine-sand and silt fractions are mixed through the matrix. They are less apparent because there is so much fine-grained calcite present. Many angular particles of quartz, in fine-sand and sometimes coarse-sand fraction (up to 0.25 mm). A medium amount of mica (muscovite?) in fine-sand fraction up to 0.12 mm long (lengthy thin bright blue/violet particles, for example near the centre of the thin-section in fig. D.22). A few feldspar (plagioclase) grains in fine-sand fraction. A few angular or irregular chert particles in coarse and fine-sand fraction up to 0.3 mm. A few rock fragments in coarse and fine-sand fraction (up to 0.3 mm). A few epidote and hornblende particles in fine-sand fraction (up to 0.05 mm).

<u>Estimate of firing temperatures</u>
Low. Matrix is still anisotrope, and decomposing of calcite has not yet started. Mica is still abundant and colourful under xpl. The dark brown colour of the sherd could thus have been created by a low firing temperature and an incompletely oxidizing atmosphere, and not necessarily by a reducing firing atmosphere. Moreover, a reducing atmosphere would probably have quickened the decomposition of calcite (Rice 1987: 98).

<u>Remarks</u>
The incisions made for the decoration show no traces of a white inlay in the thin-section.

LOCAL SABI ABYAD CLAYS
Thin-sections – Group A2a

Sample no. **17**
Field no. I7 3-19: 4
Level 4
Shape type 112 carinated bowl rim.
Illustration fig. D.23

Field description:
Ware H (organic inclusions and calcite).
Fired at a high temperature and in an oxidizing atmosphere.

Thin-section description:

Matrix
Calcareous clay containing iron. Fine-grained secondary calcite mixed through the matrix and forming cloudy stains at the core of the sherd. Dark olive-grey-green matrix, largely isotrope. Towards the surface of the sherd the matrix is darker green and does not contain as much cloudy calcite (visible towards the bottom right of the thin-section in fig. D.23).

Organic inclusions
Approximately 10% fine organic fibres. Mostly triangular and oval shapes up to 0.75 mm long, perhaps because the fibres are oriented along with the surface of the sherd due to the wheel-throwing technique, and we are looking at the sections. Hardly any charred skeletons of fibres remaining in the voids.

Mineral inclusions
Generally small non-plastic inclusions, mixed evenly in the matrix. Approximately 20% including voids left by organic inclusions. Mineral inclusions were most probably present in the natural clay, not added by the potter.

Fabric is dominated by the fine-grained secondary calcite clouding. A few larger cryptocrystalline calcite grains are preserved, in fine-sand fraction. All calcite has decomposed, some leaving voids.

Iron oxides in fine sand and silt fraction mixed with the matrix. Many angular quartz particles in fine-sand fraction. A few angular and rounded chert grains in fine and coarse-sand fraction (up to 0.25 mm). A few mica particles in fine-sand fraction, losing its brilliance (blue colours disappeared under xpl). A few rock fragments in coarse and fine-sand fraction, up to 0.3 mm. A few hornblende grains in fine-sand fraction. A few small pyroxene particles in silt fraction. Very few epidote (?) and feldspar (plagioclase) particles in fine-sand fraction.

Estimate of firing temperatures
High. Matrix is largely isotrope, calcite has decomposed. Secondary calcite is present in clouds. Mica has lost its brilliance.

Remarks
Orientation of organic inclusions seems to be related to the shaping method.

LOCAL SABI ABYAD CLAYS
Thin-sections – Group A2a

Sample no. **18**
Field no. I7 10-28:2
Level 4
Shape type 111 carinated bowl rim.
Illustration fig. D.24

Field description:
Ware I (organic inclusions and calcite and sand).
Fired at a medium temperature in an incompletely oxidizing atmosphere.

Thin-section description:

Matrix
Calcareous clay containing iron. Fine-grained calcite in silt fraction mixed evenly through the matrix. Dark brown to grey-green-brown largely anisotrope matrix. Towards the surface of the sherd, especially on the inside of the sherd, the fine-grained calcite forms a thin band below a slightly more isotrope surface. This has created a lighter surface colour and is probably due to the effects of the migration of salts to the surface during drying (visible at the top of the thin-section in fig. D.24).

Organic inclusions
Approximately 20% fine organic fibres, more than usual. Both triangular, 0.875 mm long, as well as longitudinal thin straight or thick curved fibres up to 1.5 mm long. One very large piece of 2.75 mm. Also some more irregularly-shaped voids, perhaps also from air bubbles. No charred skeletons of organic fibres have remained in the voids. Around the voids at the core of the sherd carbon has deposited.

Mineral inclusions
Generally small non-plastic inclusions, mixed evenly with the matrix. Mineral inclusions were most probably present in the natural clay, not added by the potter.

Very many calcite particles, both in crystalline and in micro-crystalline form, angular as well as more rounded, in coarse and fine-sand fractions up to 0.6 mm but mostly smaller. At the core primary calcite is preserved, at the surface the calcite has started to decompose.

Iron oxides in fine-sand and silt fraction mixed with the matrix. Many angular quartz inclusions in fine-sand fraction. A medium amount of mica (muscovite? Biotite?) in fine-sand fraction up to 0.15 mm long, bright blue colours under xpl are still preserved. A few rounded chert grains in fine-sand fraction. A few rock fragments in fine-sand fraction. A rare serpentinite (?) inclusion of 0.3 mm in size. A few feldspar (plagioclase) grains in fine-sand fraction. A few hornblende and epidote grains in fine-sand fraction up to 0.05 mm.

Estimate of firing temperatures
Low to medium. The matrix is still largely anisotrope, and calcite has started to decompose only at the surface.

Remarks
Gypsum minerals are building at the edges of voids left by organic inclusions. This is probably related to the deposition in the soil, or to contact with gypsum for the reparation of cracks by the potter (see Chapter V).

LOCAL SABI ABYAD CLAYS
Thin-sections – Group A2a

Sample no.	**21**
Field no.	I7 10-23:3
Level	4
Shape	type 322 large jar rim.
Illustration	fig. D.25

Field description:
Ware H (organic inclusions and calcite).
Fired at a high temperature, in an oxidizing atmosphere.

Thin-section description:

Matrix
Calcareous clay containing iron. Fine-grained calcite in silt fraction has mostly molten into the matrix and is less well visible. Matrix is olive-grey-green, largely isotrope. At the inside surface of the sherd the matrix is a little more reddish.

Organic inclusions
Approximately 10% fine organic fibres. Mostly thick and curved longitudinal shapes up to 1.25 mm long and triangular shapes of 0.75 mm long. A few thin longitudinal shapes. This is perhaps because fibres show a preferred orientation along the surface of the sherd due to the wheel throwing. Some more irregular voids are present as well. No charred skeletons of organic fibres left in the voids.

Mineral inclusions
Generally small non-plastic inclusions, mixed evenly with the matrix. Approximately 20% including voids left by organic inclusions. Mineral inclusions were most probably present in the natural clay, not added by the potter.

Some larger particles of calcite up to 1 mm long, but many rounded or oval calcite grains in coarse and fine-sand fraction (up to 0.3 mm). All calcite has decomposed, leaving many voids. Only at the inside surface of the sherd, some redepostion of secondary calcite has taken place at the edges of voids.

Iron oxides in fine-sand and silt fraction are mixed through the matrix. Iron oxides also seem to concentrate in cloudy stains around voids, creating the illusion of reddish particles in the fresh fracture of the sherd (as visible at the top of the thin-section in fig. D.25). Many angular quartz particles in fine-sand fraction. A few mica grains in fine-sand fraction, golden-brown colours under xpl dominate. A few chert grains in fine-sand fraction, up to 0.1 mm. A few rock fragments in fine-sand fraction up to 0.25 mm. A few feldspar (plagioclase) grains in fine-sand fraction, up to 0.04 mm. A few hornblende and pyroxene grains in fine-sand fraction up to 0.04 mm. Very few epidote particles in fine-sand fraction.

Estimate of firing temperatures
High. Matrix is isotrope, all calcite has decomposed, and finer-grained calcite has started to melt into the matrix. Mica is losing its brilliance under xpl. Iron oxides cloud around the edges of voids.

Remarks
Orientation of organic inclusions seems to be related to the shaping method.

LOCAL SABI ABYAD CLAYS
Thin-sections – Group A2a

Sample no.	**22**
Field no.	I7 3-24:3
Level	4
Shape	type 111 carinated bowl.
Illustration	fig. D.26

Field description:
Ware I (organic inclusions and calcite and sand).
Fired at a medium temperature in an oxidizing atmosphere.

Thin-section description:

Matrix
Calcareous clay containing iron. A lot of fine-grained calcite in silt fraction is mixed evenly through the whole matrix. Beige-brown anisotrope, homogeneous matrix.

Organic inclusions
Approximately 15% or fewer, fine organic fibres. Mostly thick curved longitudinal shapes up to 1.25 mm long, and triangular-shaped inclusions up to 0.75 mm long. This is perhaps because fibres show a preferred orientation along the surface of the sherd due to the wheel throwing. Few thin longitudinal ones and few irregular voids, among which two heart-shaped voids. No charred skeletons of organic inclusions left in the voids.

Mineral inclusions
Generally small non-plastic inclusions, mixed evenly with the matrix. Approximately 25% including voids left by organic inclusions. Mineral inclusions were most probably present in the natural clay, not added by the potter.

Many crystalline and micro-crystalline primary calcite grains in rounded as well as more angular shapes, in coarse and fine-sand fractions up to 0.3 mm. Also some curved microfossils or shell fragments, up to 0.2 mm. Most calcite is primary, only at the very edge of the sherd some decomposition occurs. No redepostion of secondary calcite.

Iron oxides in fine-sand and silt fraction are mixed through the matrix. A medium amount of angular quartz particles in fine-sand fractions up to 0.25 mm. A medium amount of mica in fine-sand fraction up to 0.1 mm long, bright blue-pink colours under xpl still present. A few feldspar (plagioclase) grains in fine-sand fraction up to 0.15 mm. A few rounded or oval chert particles in fine-sand fraction. A few rock fragments of fine-sand fraction. A few hornblende grains in fine-sand fraction up to 0.15 mm. A few epidote grains in fine-sand fraction up to 0.06 mm. A possible grain of chlorite (?), 0.04 mm.

Estimate of firing temperatures
Low. Matrix is still anisotrope, calcite has only just started to decompose at the surface of the sherd.

Remarks
Orientation of organic inclusions seems to be related to the shaping method.
Gypsum minerals are building in voids at the surface of the sherd. This is probably related to the deposition in the soil, or to contact with gypsum for the reparation of cracks by the potter (see Chapter V).

LOCAL SABI ABYAD CLAYS
Thin-sections – Group A2a

Sample no. **26**
Field no. K9 47-169:2
Level 4
Shape type 111 carinated bowl.
Illustration fig. D.27; IV.99.ae

Field description:
Ware I (organic inclusions and calcite and sand), some larger calcite inclusions up to 1 mm.
Fired at a medium temperature in an oxidizing atmosphere.

Thin-section description:

Matrix
Calcareous clay containing iron. Fine-grained secondary calcite in silt fraction mixed through the matrix, and forming clouds around voids left by decomposed calcite. Below the surface of the sherd, secondary calcite has built a 0.25 mm thin band (visible at the top right corner of the thin-section in fig. D.27). The matrix is dark olive-brown, largely isotrope. At the surface of the sherd, the matrix is greener and more isotrope, and less secondary calcite is present here. This is probably due to the effects of the migration of salts to the surface during drying.

Organic inclusions
Approximately 10% or fewer, fine organic fibres. Mostly thick curved longitudinal ones of up to 1 mm long, and triangular shapes up to 0.75 mm long (two triangular shapes visible at the bottom of the thin-section in fig. D.27). This is perhaps because fibres show a preferred orientation along the surface of the sherd due to the wheel throwing. Few thin longitudinal fibres. Hardly any charred skeletons of fibres left in the voids.

Mineral inclusions
Generally small non-plastic inclusions, mixed evenly with the matrix. Approximately 20% including voids left by organic inclusions. Mineral inclusions were most probably present in the natural clay, not added by the potter.

A few cryptocrystalline calcite grains are still preserved in fine-sand fraction. Most calcite grains of fine and coarse-sand fraction up to 0.6 mm have disappeared, all calcite has decomposed. Sometimes voids retain the original rhomboid crystal shape. Redepostion of secondary calcite at the edges of voids has only started near the surface of the sherd.

Iron oxides in fine-sand and silt fraction are mixed through the matrix. Very many quartz grains of fine-sand fraction up to 0.25 mm but mostly smaller, around 0.06 mm. A medium amount of mica in fine-sand fraction (up to 0.06 mm), but colours are not so brilliant anymore under xpl. A few rock fragments in fine-sand fraction. A few rounded chert particles in fine-sand fraction. A few feldspar (plagioclase) grains in fine-sand fraction (up to 0.05 mm). A few pyroxene grains in fine-sand fraction (up to 0.04 mm). A few hornblende grains in fine-sand fraction (up to 0.05 mm).

Estimate of firing temperatures
Medium-high. A largely isotrope matrix and the complete decomposition of calcite point to higher temperatures. Micas are still abundant but the colours are less brilliant.

Remarks
Orientation of organic inclusions seems to be related to the shaping method.
Gypsum minerals are building in voids at the surface of the sherd. This is probably related to the deposition in the soil, or to contact with gypsum for the reparation of cracks by the potter (see Chapter V).

LOCAL SABI ABYAD CLAYS
Thin-sections – Group A2a

Sample no.	**29**
Field no.	K9 47-66:3
Level	4
Shape	type 113(?) bowl rim.
Illustration	fig. D.28; IV.100.v

Field description:
Ware I (organic inclusions and calcite and sand).
Fired at medium temperatures, in an incompletely oxidizing atmosphere.

Thin-section description:

Matrix
Calcareous clay containing iron. Fine-grained calcite in silt fraction is evenly mixed through the matrix. Around voids at the surface of the sherd secondary fine grains of calcite start to cloud, as well as in a 0.1 mm thin zone at the surface of the sherd. Dark olive-green-brown, not very isotrope, homogeneous matrix. At the surface of the sherd the matrix has become a bit greener and more isotrope, possibly due to the effects of salts migrating to the surface of the sherd, but the effect is minor.

Organic inclusions
Approximately 20% or fewer, fine organic fibres. Mostly longitudinal curved thicker fibres up to 1 mm long, and triangular particles up to 0.75 mm long. Fewer thin longitudinal fibres up to 1 mm long. Hardly any charred skeletons of organic inclusions left in the voids.

Mineral inclusions
Generally small non-plastic inclusions, mixed evenly with the matrix. Approximately 40% including voids left by organic inclusions? Mineral inclusions were most probably present in the natural clay, not added by the potter.

Very many cryptocrystalline calcite grains in fine and coarse-sand fractions, up to 0.5 mm. Oval or slightly angular in shape. One very big inclusion of 3.75 mm at the surface of the sherd. All calcite has decomposed, and particles appear yellow or greyish blue in xpl. Redepostion of secondary calcite has started in clouds around voids, at the edges inside many voids and in a zone at the surface of the sherd.

Iron oxides in fine-sand and silt fraction are mixed through the matrix. Many angular quartz grains in fine-sand fraction. A medium amount of mica in fine-sand fraction, but largely losing its brilliance under xpl. A few rock fragments in fine-sand fraction. A few feldspar (plagioclase) grains in fine-sand fraction, up to 0.1 mm. A few rounded and angular chert grains in fine-sand fraction. A few hornblende, epidote and pyroxene grains in fine-sand fraction, up to 0.04 mm.

Estimate of firing temperatures
Medium. Matrix is not very isotrope, but calcite has completely decomposed. Mica is still abundant but has lost its brilliant colours under xpl, indicating that temperatures tend towards high.

LOCAL SABI ABYAD CLAYS
Thin-sections – Group A2a

Sample no.	**31**
Field no.	L12 29-120: P93-311
Level	5?
Shape	type 611 pot stand, total kiln waster
Illustration	fig. D.29

Field description:
Ware I (organic inclusions and calcite and sand).
Fired at very high temperatures (over fired), totally warped crumbly fabric, fired in an oxidizing atmosphere.

Thin-section description:

Matrix
Calcareous clay containing iron. Fine-grained secondary calcite in silt fraction still preserved in the matrix, evenly mixed. Very dark grey-green, isotrope and glassy matrix.

Organic inclusions
Approximately 10% fine organic fibres. Long thin ones up to 2 mm long, some triangular ones up to 0.75 mm, and several more irregularly-shaped voids left by organic inclusions. No charred skeletons of organic fibres left in the voids.

Mineral inclusions
Originally probably mostly small non-plastic inclusions, mixed evenly with the matrix. Mineral inclusions were most probably present in the natural clay, not added by the potter. Not many mineral inclusions left.

Larger calcite particles have decomposed and disappeared, leaving small voids. Secondary calcite has built along the edges of voids. Iron oxides are mostly molten into the matrix, some dark non-translucent particles in fine-sand fraction are still preserved. A medium amount of angular quartz particles in fine-sand fraction up to 0.2 mm. A few feldspar and rock fragments in fine-sand fraction. A few or very few epidote and hornblende grains in very fine-sand fraction up to 0.05 mm. A few and very small mica fragments.

Estimate of firing temperatures
Very high, too high. The matrix is completely glassy and isotrope, calcite has disappeared and also mica has started to disappear.

LOCAL SABI ABYAD CLAYS
Thin-sections – Group A2a

Sample no.	**47**
Field no.	K10 61-132:19
Level	7
Shape	type 315 jar rim.
Illustration	fig. D.30; IV.8.d

Field description:
Ware I (organic inclusions and calcite and sand).
Fired at a medium temperature, in a mostly reducing atmosphere. Fracture is almost completely grey, only the surface is lighter.

Thin-section description:

Matrix
Calcareous clay containing iron. Fine-grained calcite in silt fraction mixed evenly through the whole matrix. Olive-green-brown, largely anisotrope matrix. At the surface of the sherd a thin layer of 0.1 mm thick is more isotrope and a bit greener, and seems to contain more fine-grained calcite particles. The rest of the matrix is very dark due to carbon deposition around the voids left by organic inclusions.

Organic inclusions
Approximately 20% or fewer, fine organic fibres. Rather a lot of organic inclusions compared to the other sherds. The thin-section was cut obliquely to the plane of the rim, thus revealing more longitudinal and longer inclusions than in perpendicular thin-sections. Very long thin straight fibres up to 5 mm long, triangular-shaped inclusions up to 0.75 mm long, shorter and very thin fibres up to 1.25 mm long and thicker curved ones up to 1.25 mm long. Some charred skeletons of organic inclusions are preserved in the voids: not all carbon has burnt away. The lighter surface colour of the sherd is due mainly to the burning away of the carbon deposits around the voids, and not to a salt effect as is sometimes the case with other sherds.

Mineral inclusions
Some larger but generally small non-plastic inclusions, mixed evenly with the matrix. Approximately 35% including voids left by organic inclusions. Mineral inclusions were most probably present in the natural clay, not added by the potter.

Many oval and rounded particles of cryptocrystalline calcite, in coarse and fine-sand fractions up to 0.6 mm. Some are cryptocrystalline aggregates including tiny particles of quartz and other minerals. Most are primary, but decomposition of calcite has started at the surface of the sherd. A few rounded and more angular crystalline primary calcite in fine-sand fraction, as well as a few curved parts of shells or calcite of biogene origin (microfossils), up to 0.4 mm long.

Iron oxides in silt and fine-sand fraction are mixed evenly through the matrix. Many angular quartz inclusions of coarse and fine-sand fraction up to 0.3 mm, also in more microcrystalline form. A few to medium amount of rock fragments, different kinds, in fine and coarse-sand fraction up to 0.35 mm. A few chert particles in fine-sand fraction up to 0.25 mm. A few feldspar (plagioclase) grains in silt to fine-sand fraction up to 0.03 mm. A few epidote and pyroxene grains in fine-sand fraction, rather large compared with other sherds, up to 0.18 mm. A few mica grains in fine-sand fraction up to 0.07 mm. A few hornblende grains in fine-sand fraction.

Estimate of firing temperatures
Low to medium. Matrix largely isotrope, decomposition of calcite has started on the surface. The sherd was probably fired in a mostly reducing atmosphere, with a short oxidizing period at the end colouring the surface light reddish.

LOCAL SABI ABYAD CLAYS
Thin-sections – Group A2b (fine wares)

Sample no.	**09**
Field no.	I7 10-30:9
Level	4
Shape	type 712 goblet base
Illustration	fig. D.31

Field description:
Ware A (fine calcite inclusions).
Fired at a high temperature in an oxidizing atmosphere.

Thin-section description:

Matrix
Calcareous clay containing iron. Fine-grained secondarily-built calcite is spread through the matrix in cloudy concentrations. Matrix is dark grey-olive-green and isotrope, glassy. Small voids have been caused by the disappearance of calcite and are rounded or irregular in shape, up to 0.75 for the longitudinal ones.

Mineral inclusions
Generally fine mineral inclusions, approximately 20%. Apart from quartz and calcite inclusions, other mineral inclusions are very small. Mineral inclusions were certainly part of the natural clay, not added by the potter.

All calcite has decomposed. Calcite is only visible as secondarily redeposited calcite in cloudy concentrations in the matrix and around voids of former calcite inclusions (in fine-sand fraction up to 0.25 mm). Just below the outer surface of the sherd calcite is concentrated more strongly in a milky-way type zone of around 0.125 mm thick (running through the middle of the thin section in fig. D.31, the surface of the sherd is at the bottom of the thin section).

Iron oxides are present in silt and fine-sand fraction. Iron oxides are also concentrated together with the secondary calcite around voids, creating orange “rims” around the voids (on the right of the thin section in fig. D.31). Very many very fine quartz grains, mostly in fine-sand fraction up to 0.075 mm and smaller, but also some grains up to 0.25 mm. A few small mica fragments in fine-sand fraction, they have lost their bright blue-pink colours completely under xpl. A few rock fragments in fine-sand fraction. Very few small chert particles in fine-sand fraction up to 0.07 mm.

Estimate of firing temperatures
High. Matrix is isotrope and calcite has decomposed completely, redeposited around voids and in cloudy concentrations. Iron oxides concentrate around voids as well. Mica has lost its brilliance under xpl.

LOCAL SABI ABYAD CLAYS
Thin-sections – Group A2b (fine wares)

Sample no.	**10**
Field no.	I7 10-31:10
Level	4
Shape	type 421 s-shaped goblet rim
Illustration	fig. D.32

Field description:
Ware A (fine calcite inclusions)
Fired at a medium temperature in an oxidizing atmosphere.

Thin-section description:

Matrix
Calcareous clay containing iron. Fine-grained calcite in silt fraction mixed evenly through the sherd. Matrix is largely anisotrope, greenish-red-brown in colour. Towards the surface of the sherd, the colour becomes slightly more reddish (the surfaces of the sherd are in the left upper and right lower corner of the thin-section in fig. D.32). Some small voids are present, perhaps air bubbles or burnt-out occasional organic inclusions.

Mineral inclusions
Very fine non-plastic inclusions, evenly distributed through the matrix. Approximately 15%. Certainly part of the natural clay, not added by the potter.

Many cryptocrystalline calcite inclusions, some up to 0.6 mm but most are smaller in fine-sand fraction up to 0.2 mm. Some have retained their original crystal rhombohedric shape, but all are decomposed. Decomposition is stronger towards the surface of the sherd.

Iron oxides in silt and fine-sand fractions are evenly mixed through the matrix. Very many angular quartz particles in fine and coarse-sand fractions up to 0.3 mm. A few feldspar (plagioclase) grains in fine-sand fraction up to 0.06 mm. A few rock fragments in fine and coarse-sand fractions up to 0.3 mm. A few radiolarite and angular chert fragments in fine-sand fraction. A few mica (muscovite?) grains in fine-sand fraction, yellow-pink under xpl. A few epidote and hornblende grains, rather small up to 0.05 mm.

Estimate of firing temperatures
Medium. Matrix is largely anisotrope, but calcite has decomposed.

LOCAL SABI ABYAD CLAYS
Thin-sections – Group A2b (fine wares)

Sample no.	**15**
Field no.	I7 10-35:1
Level	mixed 4/5
Shape	type 421 s-shaped goblet rim.
Illustration	fig. D.33

Field description:
Ware B (fine calcite and sand).
Fired at a medium temperature in an oxidizing atmosphere.

Thin-section description:

Matrix
Calcareous clay containing iron. Fine-grained secondary calcite is spread in cloudy concentrations in the matrix. Dark olive-grey-green matrix, isotrope. Occasionally small voids left by decomposed calcite inclusions or occasional small organic inclusions. Longitudinal irregular voids tend to be oriented parallel to the surface of the sherd.

Mineral inclusions
Generally fine non-plastic inclusions but including some larger particles, evenly distributed through the matrix. Approximately 30%. Certainly part of the natural clay, not added by the potter.

Very many cryptocrystalline, rounded or oval calcite grains were present in the matrix, in fine and coarse-sand fractions occasionally up to 0.8 mm. All have decomposed. Fine-grained secondary calcite has redeposited in cloudy concentrations under the surface of the sherd in two zones of approximately 0.3 mm, while redepostion is less apparent at the very surface and at the core (visible at the upper right and lower left corners of the thin-section in fig. D.33). Redepostion also took place in and around the voids of former inclusions, together with an enrichment of iron oxides creating an orange edge around the void.

Iron oxides in silt and fine-sand fraction are still visible mixed with the matrix. Also in a few oval aggregates. Very many angular quartz particles in fine-sand fraction up to 0.15 mm. A medium amount of hornblende, small (up to 0.04 mm) but relatively much in comparison to other sherds. A few chert particles in fine-sand fraction. A few mica grains in fine-sand fraction, golden yellow under xpl. A few rock fragments in fine-sand fraction. Very few feldspar (plagioclase) particles in fine-sand fraction up to 0.04 mm.

Estimate of firing temperatures
High. Matrix is isotrope, calcite is only present in secondary form, and mica has lost its brilliance under xpl.

Remarks
A relatively large amount of calcite, quartz and hornblende inclusions may suggest a slightly different origin for this sample?

LOCAL SABI ABYAD CLAYS
Thin-sections – Group A2b (fine wares)

Sample no. **24**
Field no. L12 21-73:26
Level 5
Shape type 711 goblet nipple base
Illustration D.34

Field description:
Ware B (fine calcite and sand)
Fired at a medium temperature in an incompletely oxidizing atmosphere.

Thin-section description:

Matrix
Calcareous clay containing iron. Fine-grained calcite in silt fraction is mixed through the whole sherd. Matrix is largely anisotrope. At the core the matrix is greenish brown, becoming more reddish brown towards the surface of the sherd. On the inside surface of the sherd there is a small band of secondary calcite clouding about 0.25 mm wide, after which the matrix is dark brown and more isotrope (the inside surface of the sherd is visible in the top part of the thin-section in fig. D.34). Perhaps this is due to the effect of salt in the clay, or to variations in firing temperatures and atmospheres. This zoning is also clearly visible macroscopically in the sherd and led to the description of the incompletely oxidizing atmosphere. Some irregularly-shaped voids with fringed edges are possibly due to air bubbles in the clay.

Mineral inclusions
Generally fine non-plastic inclusions but including some larger particles, evenly distributed through the matrix. Approximately 30%. Certainly part of the natural clay, not added by the potter.

Very many cryptocrystalline and crystalline particles of calcite, rounded in shape and in fine and coarse-sand fractions up to 0.4 mm. Also some curved fragments of shell or microfossils, around 0.15 mm. Towards the surface of the sherd calcite has started to decompose.

Iron oxides in silt and fine-sand fraction are mixed evenly with the matrix. Many angular quartz particles in fine and coarse-sand fractions up to 0.3 mm. A medium amount of mica (muscovite?) in fine-sand fraction up to 0.05 mm, partly retaining the bright blue-pink colours under xpl. A few rounded or oval chert particles in fine-sand fraction. A few rock fragments in fine-sand fraction. A few feldspar (plagioclase) particles in fine-sand fraction up to 0.06 mm. A few hornblende grains in very small fine-sand fraction up to 0.03 mm. Very few epidote and pyroxene grains in fine-sand fraction up to 0.15 mm.

Estimate of firing temperatures
Low to medium. Matrix is largely anisotrope, calcite has begun to decompose only at the surface.

LOCAL SABI ABYAD CLAYS
Thin-sections – Group A2b (fine wares)

Sample no.	**25**
Field no.	L12 21-73:23
Level	5
Shape	type 711 goblet nipple base.
Illustration	fig. D.35

Field description:
Ware A (fine calcite)
Fired at a medium temperature in an oxidizing atmosphere.

Thin-section description:

Matrix
Calcareous clay containing iron. Not too much fine-grained calcite in silt fraction spread in the matrix. Dark reddish-brown, mostly anisotrope matrix. Rather compact fabric with only a few voids smaller than 0.25 mm.

Mineral inclusions
Generally fine non-plastic inclusions, evenly distributed through the matrix. Approximately 20%. Certainly part of the natural clay, not added by the potter.

Very many rounded or oval but also some angular calcite particles, mostly cryptocrystalline but also a few crystalline ones. Most are primary but decomposition has started in many places.

Iron oxides in silt and fine-sand fraction are mixed through the matrix, sometimes forming cloudy concentrations. Very many small angular quartz particles, some up to 0.25 mm but most are smaller, up to 0.1 mm. A few feldspar inclusions in fine-sand fraction up to 0.05 mm. A few angular and rounded chert particles in fine-sand fraction up to 0.1 mm. A few rock fragments in fine-sand fraction. A few hornblende grains in fine-sand fraction up to 0.15 mm. A few mica grains in fine-sand fraction. A few epidote and pyroxene particles in fine-sand fraction up to 0.05 mm.

Estimate of firing temperatures
Low to medium. Matrix is largely anisotrope, decomposition of calcite has started but is not complete.

LOCAL SABI ABYAD CLAYS
Thin-sections – Group A2b (fine wares)

Sample no. **40**
Field no. K10 61-131:1
Level 7
Shape small type 314 jar rim with "Nuzi"-style decoration
Illustration fig. D.36; IV.8.b

Field description:
Ware A (fine calcite inclusions)
Fired at medium temperatures in an oxidizing atmosphere.

Thin-section description:

Matrix
Calcareous clay containing iron. Fine-grained calcite grains in silt fraction mixed through the matrix, more at the core and less towards the surface of the sherd. Just below the inner surface of the sherd, a thin zone (0.2 mm) of clouding secondary calcite grains has started to form. Dark olive-green, not very isotrope, homogeneous matrix. At the inner surface of the sherd the matrix is greener and more isotrope (the surfaces of the sherd are towards the the lower right and upper left corners of the thin-section in fig. D.36). Some voids from air bubbles and small rounded voids from decomposed calcite inclusions.

Mineral inclusions
Generally fine non-plastic inclusions apart from some larger calcite grains, evenly distributed through the matrix. Approximately 15%. Certainly part of the natural clay, not added by the potter.

A medium amount of oval or rounded, cryptocrystalline calcite particles in fine to coarse-sand fraction up to 0.5 mm but mostly smaller. All have decomposed, some have disappeared and left voids. Redepostion of secondary calcite is present at the edges of voids.

Iron oxides in silt and fine-sand fractions are spread through the whole matrix. Many angular quartz particles in fine-sand fraction up to 0.25 mm. Medium amount of mica in fine-sand fraction up to 0.05 mm, it has largely lost its blue-pink colours under xpl. A few radiolarite and angular chert particles, rather small up to respectively 0.08 and 0.03 mm. A few rock fragments in fine-sand fraction. A few feldspar (plagioclase) particles in fine-sand fraction up to 0.04 mm. A few hornblende grains in fine-sand fraction up to 0.04 mm.

Estimate of firing temperatures
Rather high. Matrix is not completely isotrope, but all calcite has decomposed and mica seems to have lost its brilliant colours.

Remarks
The reddish painted bands in "Nuzi"-style are visible in the thin-section only as a thin zone of more iron-rich, dark reddish-brown matrix at the surface of the sherd. The paint has fused with the matrix and no longer forms a separate layer.

Possibly there is some deposition of gypsum crystals in the voids, most probably related to post-depositional processes.

LOCAL SABI ABYAD CLAYS
Thin-sections – Group A2b (fine wares)

Sample no.	**43**
Field no.	K10 47-110:1
Level	7
Shape	type 721 goblet pedestal base with "Nuzi"-style decoration
Illustration	fig. D.37; IV.10.e

Field description:
Ware A (fine calcite inclusions)
Fired at a high (too high) temperature in an oxidizing atmosphere.

Thin-section description:

Matrix
Calcareous clay containing iron. Fine-grained calcite in silt fraction has mostly disappeared or fused with the matrix. A few cloudy concentrations are still visible. Matrix is deep grey-olive-green, isotrope and glassy and homogeneous. Small voids have been left by decomposed calcite. The fabric seems to be very compact.

Mineral inclusions
Generally fine non-plastic inclusions apart from some larger calcite grains, evenly distributed through the matrix. Approximately 10%. Certainly part of the natural clay, not added by the potter.

A medium amount of rounded and oval particles of calcite was present, in fine and occasionally coarse-sand fraction up to 0.5 mm, but they have mostly disappeared. All calcite has decomposed. Redepostion of secondary calcite is present around voids, also containing iron oxides building an orange edge around the void (visible at the top of the thin-section in fig. D.37). Redepostion of secondary calcite is also present inside some voids.

Iron oxide in silt fraction still mixed in the matrix, and concentrated in rings around voids left by former calcite grains. Many small angular quartz particles in fine-sand fraction. A few feldspar (plagioclase) particles in fine-sand fraction. A few radiolarite and angular chert grains in fine-sand fraction. A few mica particles in fine-sand fraction, but they have lost their brilliant blue-pink colours completely under xpl. Very few and very small hornblende and pyroxene grains in silt fraction up to 0.03 mm.

Estimate of firing temperatures
High. Matrix is glassy, all calcite has decomposed or disappeared, mica has lost its brilliance under xpl.

Remarks
The "Nuzi"-style paint is not visible at all in the thin-section, all traces of it have fused completely with the matrix.

LOCAL SABI ABYAD CLAYS ?
Thin-sections – Group A2c

Sample no.	**08** (possibly not from Sabi Abyad itself)
Field no.	L8 40-114: P97-147
Level	5
Shape	type 151 deep bowl with spout and handle. Surface completely flaking off.
Illustration	fig. D.38; IV.61.b

Field description:
Ware I (organic inclusions and calcite and sand)
Fired at a medium temperature in an oxidizing atmosphere.

Thin-section description:
Matrix
Calcareous clay containing iron. Many fine-grained calcite particles in silt fraction are mixed with the matrix. Dark olive-brown homogeneous anisotrope matrix. Some carbon deposition colours the matrix darker around the voids left by organic inclusions.

Organic inclusions
Approximately 10%, fine organic fibres. The thin-section was cut from a body sherd. The section was cut parallel to the plane of the rim. This is clearly visible in the preferred lengthwise orientation of the organic inclusions, parallel to the surface of the sherd. This is related to the wheel-throwing method of shaping. Mostly longitudinal, rather thin fibres, up to 1.75 mm long. No triangular-shaped voids were found. Hardly any charred skeletons of fibres have remained in the voids.

Mineral inclusions
Generally fine non-plastic inclusions, evenly distributed through the matrix. Approximately 40% including voids left by organic inclusions. Mineral inclusions present in the natural clay, not added by the potter.

Very many rounded as well as more angular, cryptocrystalline as well as crystalline primary calcite inclusions, in fine-sand and coarse-sand fractions up to 0.5 mm. It seems there are rather more calcite inclusions than normal for the sherds in this group. Decomposition of calcite has started at the surface of the sherd. Redepostion of secondary calcite (or another material?) has filled most of the voids left by organic inclusions (visible in the thin-section on fig. D.38 as bright white concretions), and is certainly due to post-depositional processes or to the use of the vessel.

Iron oxides in silt and fine-sand fraction are many and spread evenly in the matrix. Many mica inclusions, much more than in other sherds, showing a preferred orientation parallel with the sherd surface like the organic inclusions. A medium amount of angular quartz grains in fine-sand and coarse-sand fraction, up to 0.4 mm. A few to medium amount of rock fragments in fine and coarse-sand fractions up to 0.35 mm. A few chert fragments in fine-sand fraction. Very few feldspar (plagioclase) grains in fine-sand fraction. A few hornblende and epidote particles, in fine-sand fraction.

Estimate of firing temperatures
Low to medium. Matrix is anisotrope, and decomposition of calcite has only started at the surface of the sherd. This is perhaps also the reason for the flaking of the sherd surface?

Remarks
Preferred orientation of organic fibres is related to the shaping method.
Deposition of secondary calcite (or other minerals) in the voids is due to vessel use or post-depositional processes.

The relatively large amount of calcite inclusions, rock fragments and mica particles, as well as the relatively small amount of quartz inclusions might point to a slightly different location for the raw materials for this vessel. Perhaps it was not made at Sabi Abyad itself?

LOCAL BALIKH VALLEY CLAYS
Thin-sections – Group D: Local calcareous clays with coarse inclusions (cooking wares)

Group D consists of calcareous, iron containing clays with fine sand-inclusions but without volcanic rock inclusions, and could very well be local to the Balikh Valley. In contrast to Group A, the fabrics in Group D contain coarse mineral inclusions that were added on purpose by the potter. Group D contains only vessels of the "cooking-pot" type from level 7.

Group D is subdivided into two subgroups according to the different kinds of coarse temper added by the potter:

D1 With coarse calcite temper

- D1a without chaff inclusions
- D1b with chaff inclusions

D2 With crushed shell temper

LOCAL BALIKH VALLEY CLAYS
Thin-sections – Group D1a

Sample no. **35**
Field no. K10 61-132:28
Level 7
Shape type 212 cooking-pot rim.
Illustration fig. D.39; IV.5.e

Field description:
Ware E (coarse calcite). Coarse angular white and grey particles, cooking ware.
Fired at a low temperature in an oxidizing atmosphere.

Thin-section description:

Matrix
Calcareous clay containing iron. Very many fine-grained calcite particles in silt fraction mixed evenly with the matrix. Beige-brown anisotrope matrix. Some irregularly-shaped voids from air bubbles. Very rarely an organic inclusion, up to 1 mm long.

Mineral inclusions
Smaller inclusions evenly mixed with the matrix and most probably part of the natural clay. Large angular calcite inclusions were added by the potter as a temper. Approximately 30%.

Calcite is by far the predominant non-plastic inclusion. Many larger and smaller very angular or crystal-shaped grains of primary calcite, both crystalline and more micro-crystalline, in very coarse-sand fraction up to 1.75 mm and smaller (visible as angular pastel-coloured particles in the thin-section on fig. D.39). Also some curved calcite microfossil grains. All calcite is primary.

Finer non-plastic inclusions belong to the natural clay body. Iron oxides mixed through the matrix in silt and fine-sand fraction. A medium amount of quartz grains in fine-sand fraction (up to 0.1 mm). A few irregular and rounded, also radiolarite, chert grains in fine-sand fraction (up to 0.15 mm). A few feldspar grains (plagioclase) in fine-sand fraction (up to 0.06 mm), few mica particles in fine-sand fraction (up to 0.05 mm), very few epidote grains in small fine-sand fraction (up to 0.03 mm).

Estimate of firing temperatures
Low. Calcite is completely primary, matrix is anisotrope.

Remarks
It is remarkable that the fabric does not show any severe cracking, like most of the other cooking-ware samples (cf. samples 33 and 46). Perhaps this vessel broke before it had been used very often, so that no cracks from thermal shock could form?

LOCAL BALIKH VALLEY CLAYS
Thin-sections – Group D1b

Sample no.	**46**
Field no.	K10 61-132:34
Level	7
Shape	type 212 cooking-pot rim
Illustration	fig. D.40, D41; IV.5.l

Field description:
Ware D (coarse sand)
Fired at a low temperature in an oxidizing atmosphere.

Thin-section description:

Matrix
Calcareous clay containing iron. Perhaps slightly less calcareous than sample 35 in Group D1. Fine-grained calcite in silt fraction is mixed evenly through the matrix. Brown, anisotrope matrix. A lot of fine cracks have formed between the inclusions, probably due to use (thermal shock) (visible in purple in the thin-section on fig. D.41).

Organic inclusions
Very few organic inclusions, around 5% at the most, perhaps not added on purpose? Some irregular longitudinal shapes, as well as triangular shapes approximately 0.75 – 1 mm long. Carbon has deposited around the voids left by the organic inclusions.

Mineral inclusions
Many inclusions, approximately 40%, in different sizes. Smaller inclusions most probably present in the natural clay, larger angular calcite particles were added as a temper by the potter.

The fabric is dominated by calcite inclusions. A medium amount of large, angular irregular or cubical/triangular crystalline and microcrystalline calcite grains in coarse-sand fraction, up to 1.5 mm. A medium amount of smaller or larger oval and rounded cryptocrystalline primary calcite grains in coarse-sand fraction (up to 0.625 mm). A few microfossils or calcite grains of biogene origin, curved and straight particles up to 0.25 mm. All calcite is primary, except for the calcite at the outer surface of the sherd where decomposition has started, to a depth of approximately 0.9 mm (decomposition of calcite is visible at the top of the thin-section in fig. D.40, where calcite has turned grey or beige. The upper edge of the large calcite grain in the middle left has also started to decompose).

Other inclusions are fine and probably part of the natural clay. Iron oxides in fine-sand fraction mixed through the matrix. A medium amount of angular quartz grains in fine-sand fraction (up to 0.06 mm). A few mica grains in fine-sand fraction (up to 0.08 mm). A few hornblende and feldspar grains (plagioclase) in fine-sand fraction (up to 0.05 mm). Very few rounded chert grains in fine to coarse-sand fraction up to 0.2 mm, and very few pyroxene particles in fine-sand fraction.

Estimate of firing temperatures
Low. Matrix is anisotrope and calcite is still preserved in primary form. The decomposition of calcite at the outer surface of the sherd may have occurred in the kiln during firing, or during cooking on the fire.

Remarks
This vessel is probably not made of the same natural clay bed as sample 35, although both may very well come from the Balikh region.

LOCAL BALIKH VALLEY CLAYS
Thin-sections – Group D2

Sample no.	**34**
Field no.	K10 61-132:35
Level	7
Shape	type 2211 cooking-pot rim.
Illustration	fig. D.42; IV.7.h

Field description:
Ware F (grog inclusions), grey particles, perhaps grog?
Fired at a medium temperature in a reducing atmosphere.

Thin-section description:

Matrix
Calcareous clay. Dark-brown matrix, anisotrope but difficult to see because of the enormous amount of inclusions. Small voids are cracks in the fabric or small air bubbles.

Mineral inclusions
The fabric is completely dominated by two kinds of calcite inclusions. One kind: rounded irregular or oval particles of beige cryptocrystalline calcite aggregate in fine and coarse-sand fraction and in gravel fraction up to 2.5 mm, including small voids, brown anisotrope inclusions and very tiny shell fragments (microfossils) up to 0.25 mm (visible mainly in the lower left corner of the thin-section on fig. D.42). The other kind: longitudinal straight particles of finely layered calcite in fine-sand and coarse-sand fraction up to 1.75 mm and up to 0.4 mm thick. Some of these particles have been cut "horizontally", showing a finer micro-crystalline structure. These are probably fragments of crushed shells (visible mainly in the right half of the thin-section on fig. D.42). Either both or possibly only the shell have been added on purpose by the potter. All calcite is still primary.

Other finer inclusions present in the natural clay are hardly visible because of the large amounts of calcite. They include few angular particles of quartz in fine-sand fraction, few iron oxide grains in silt fraction, very few hornblende grains in silt fraction.

Estimate of firing temperatures
Low. All calcite is still primary.

Remarks
Although this clay is calcareous, it is difficult to establish whether it resembles the Sabi Abyad clays. It could be from the Balikh region, but also from elsewhere.

The determination of the inclusions as "grog" in the field is definitely wrong.

CLAYS FROM THE JEZIRA REGION, BUT PROBABLY NOT FROM THE BALIKH
Thin-sections – Group B: calcareous clays with fine inclusions, including a few volcanic rock fragments

Group B is a heterogeneous group of sherds. The fabrics of this group are in general similar to those in Group A, but the main difference is that the fabrics in Group B contain a few small fragments of volcanic rock (basalt). Since the Balikh River does not flow through regions containing volcanic rock outcrops (see the geological map of Syria, fig. V.1), it is not likely that these sherds originate from the Balikh Valley or from Sabi Abyad. However, the similarity of the fabrics with Group A suggests that these sherds do derive from the greater Jezira or north-eastern Syrian region.[238] It has to be noted that these small basalt inclusions were not visible in the fresh fracture under 10x magnification in the field, and that these sherds were therefore not recognizable in the field as imports.

Group B has been divided into several subgroups according to the composition of the sherds. Each subgroup contains only one or two samples. This is in line with the idea that the origin of these sherds is not local: they may have come from more than one place in the Jezira.

It is remarkable that all sherds in Group B are from level 7 (in which no evidence for pottery production at the site was found), except for the glazed bowl in Group B1, which is from level 5 but very uncommon in the Middle Assyrian corpus.

B1 Calcareous clay with volcanic rock inclusions and many fine chert, quartz and feldspar inclusions, with added organic inclusions.

B2 Calcareous clay with volcanic rock inclusions and a large amount of rounded calcite inclusions and "clay aggregates" (like Group A1), with added organic inclusions.

B3 B3a: Calcareous clay with volcanic rock inclusions and fine-sand inclusions (including garnet?), and added organic inclusions.

B3b: Calcareous clay with volcanic rock inclusions and fine-sand inclusions, no organic inclusions.

[238] At Tell Sheikh Hamad on the lower Khabur, many sherds show a few basalt inclusions. The sherds from Tell Bderi, Rad Shaqrah and Tell Arbid in the Hassake region closer to a basalt outcrop in the landscape, contain basalt inclusions also as an intentionally added temper (Schneider 2006: 401; Daszkiewicz et al. 2006: 423).

CLAYS FROM THE JEZIRA REGION, PROBABLY NOT FROM THE BALIKH
Thin-sections – Group B1

Sample no. **23**
Field no. K8 162-380: P99-96
Level 5
Shape ring base from a large bowl glazed on both sides with a greenish glaze.
Illustration fig. D.43; IV.51.r

Field description:
Ware I (organic inclusions and calcite and sand).
Fired at a medium temperature in an oxidizing atmosphere.

Thin-section description:

Matrix
Calcareous clay containing iron. The fine-grained calcite in silt fraction has largely fused with the matrix. Matrix is grey-olive-green, isotrope and homogeneous.

Organic inclusions
Approximately 10% of fine organic inclusions. Mostly they are long thin particles up to 1.25 mm. No charred skeletons of organic inclusions are left in the voids.

Mineral inclusions
Generally very fine inclusions, approximately 30%, evenly distributed through the matrix. Mineral inclusions were present in the natural clay, not added by the potter.

A medium amount of cryptocrystalline calcite particles is still preserved, rounded and in fine to coarse-sand fraction up to 0.3 mm. All calcite has decomposed. Redepostion of secondary calcite has taken place at the edges of some voids, but not in all cases.

Iron oxides in silt and fine-sand fraction are present in the matrix, but seem to be fewer than usual with the other samples. Many angular quartz particles in fine-sand fraction up to 0.25 mm. A medium amount of feldspar (plagioclase) particles in fine-sand fraction up to 0.15 mm. A medium amount of chert particles in fine-sand fraction up to 0.25 mm. A few rock fragments in fine-sand fraction. A few volcanic stone inclusions (basalt) in fine and coarse-sand fraction up to 0.6 mm. A few hornblende, epidote, and mica particles in fine-sand fraction up to 0.1 mm.

Estimate of firing temperatures
High. Matrix is isotrope, calcite has decomposed and partly disappeared. Glaze has fused with the matrix.

Remarks
On both surfaces of the sherd a layer of glaze between 0.5 and 1 mm thick is present. It is an isotrope, glassy and colourless layer, with many cracks and radial lines. This alkali glaze has bonded with the upper surface of the sherd, indicating that the glaze was applied before the first firing of the vessel. The surface between glaze and sherd shows thin spikelets of wollastonite in all directions. The glaze has very few tiny non-translucent inclusions and numerous air bubbles up to 0.25 mm (the glaze is visible at the top of the thin-section in fig. D.43). This is a glaze of a rather poor quality. The greenish colour is either due to the minerals originally present in the alkali mixture (iron content), or to the translucency of the glaze showing the underlying greenish colour of the sherd. In this respect it is interesting that when the sherd dried after excavation the greenish colour largely seemed to have disappeared.

This fabric is different from the fabrics in group A, mainly because of its relatively high amounts of quartz, feldspar and chert particles (as well as the basalt inclusions).

CLAYS FROM THE JEZIRA REGION, PROBABLY NOT FROM THE BALIKH
Thin-sections – Group B2

Sample no.	**39**
Field no.	K10 61-121:P93-111
Level	7
Shape	type 123 bowl
Illustration	fig. D.44; IV.3.d

Field description:
Ware I (organic inclusions and calcite and sand). Very many calcite inclusions.
Fired at a medium temperature in an incompletely oxidizing atmosphere.

Thin-section description:

Matrix
Calcareous, iron-rich clay. Fine-grained calcite in silt fraction mixed in the matrix. Dark-reddish olive-green brown matrix, starting to become isotrope. Many very fine cracks have formed between inclusions. Several "clay aggregates" of dark red-brown clay with finer inclusions and fewer calcite particles are present in coarse-sand fraction, spread unevenly in the matrix (visible at the upper left side of the thin-section in fig. D.44).

Organic inclusions
Approximately 10% or fewer fine organic fibres, rather evenly distributed through the matrix. Both thick longitudinal curved shapes up to 0.75 mm long and triangular shapes up to 0.75 mm long are present, as well as some more irregular-shaped fragments. No charred skeletons of fibres have been preserved.

Mineral inclusions
Generally small non-plastic inclusions completely dominated by calcite grains, evenly distributed throughout the matrix. Approximately 50% or more, including organic inclusions. Mineral inclusions were most probably present in the natural clay, no mineral inclusions added by the potter.

The fabric is dominated by very many rounded or oval, fine-grained particles of calcite, some in coarse-sand fraction (up to 1.2 mm) but most in fine-sand fraction (up to 0.3 mm and smaller). Evenly mixed in the matrix. All calcite has decomposed. Redepostion of secondarily formed calcite has started at the edges of calcite grains, but not at the edges of voids.

Iron oxides are mixed through the whole matrix in silt and fine-sand fractions. Many angular quartz grains in fine-sand fraction (up to 0.25 mm but mostly much smaller). Medium amount of mica in fine-sand fraction (up to 0.1 mm). A few feldspar grains (plagioclase) in fine-sand fraction (up to 0.08 mm). A few oval or rounded chert fragments in coarse-sand fraction (up to 0.3 mm). A few hornblende in fine-sand fraction. Very few rock fragments in coarse-sand fraction (up to 0.4 mm). Very few volcanic rock (basalt) fragments in fine-sand fraction up to 0.15 mm. Very few pyroxene particles in fine-sand fraction (up to 0.04 mm).

Estimate of firing temperatures
Medium, approximately 850 °C? Matrix starting to become isotrope, calcite has completely decomposed.

Remarks
This fabric is very similar to the fabrics in group A1a, except for the fact that this sample includes some fragments of volcanic rock.

CLAYS FROM THE JEZIRA REGION, PROBABLY NOT FROM THE BALIKH
Thin-sections – Group B2

Sample no. **41**
Field no. K10 61-122:4
Level 7
Shape type 111 carinated bowl rim
Illustration fig. D.45; IV.1.e

Field description:
Ware I (organic inclusions and calcite and sand)
Fired at a medium temperature in an incompletely oxidizing atmosphere.

Thin-section description:

Matrix
Calcareous clay containing iron. Fine-grained calcite in silt fraction mixed evenly through the matrix. Matrix is dark olive-green red-brown, starting to become isotrope. Some “clay aggregates” have fewer fine-grained calcite inclusions and more iron oxides, as in the fabrics of Group A1.

Organic inclusions
Approximately 15%, fine organic inclusions. Mostly triangular-shaped, up to 1 mm and smaller, longitudinal rather thick particles up to 1.25 mm long and some very thin long ones up to 2 mm.

Mineral inclusions
Non-plastic inclusions generally evenly distributed through the matrix, except for the “clay aggregates”. Approximately 40%, present in the natural clay, not added by the potter.

Very many rounded and oval cryptocrystalline particles of calcite in fine and coarse-sand fraction up to 0.5 mm. A few micro-crystalline grains are preserved. Most calcite is decomposed, but some primary calcite is still preserved. Redepostion of secondary calcite around the voids and in the voids is present at the surface of the sherd.

Iron oxides in silt and fine-sand fraction (up to 0.25 mm) are mixed through the matrix. Very many angular quartz particles in fine and coarse-sand fraction up to 0.3 mm but mostly much smaller. A medium amount of mica in fine-sand fraction up to 0.07 mm, blue-pink colours under xpl are preserved. A few angular chert fragments in fine-sand fraction up to 0.2 mm. A few rock fragments of different kinds, mostly rounded, in fine and coarse-sand fraction up to 0.7 mm (exceptional). A few volcanic rock (basalt) fragments in coarse-sand fraction up to 0.5 mm (visible in the upper right corner of the thin-section in fig. D.45). A few feldspar particles in fine-sand fraction. A few epidote, hornblende, pyroxene particles in fine-sand fraction up to 0.1 mm.

Estimate of firing temperatures
Low to medium. Matrix is starting to become isotrope, but not all calcite has decomposed yet.

CLAYS FROM THE JEZIRA REGION ?, PROBABLY NOT FROM THE BALIKH
Thin-sections – Group B3a

Sample no. **38**
Field no. K10 61-132:1
Level 7
Shape body sherd of a red-slipped jar with vertical burnish.
Illustration fig. D.46, D.47; IV.9.m

Field description:
Ware I (organic inclusions and calcite and sand)
Fired at a medium temperature in an oxidizing atmosphere.

Thin-section description:
Matrix
Calcareous clay containing iron. Fine-grained calcite in silt fraction mixed evenly through the whole matrix. Beige-brown matrix, homogeneous and anisotrope. Towards the surface of the sherd the matrix becomes more reddish, while at the core it is more greenish-beige.

Organic inclusions
Approximately 10% fine organic fibres. The thin-section was cut parallel to the horizontal plane of the rim (since it was cut from a body sherd), so that all organic inclusions show a preferred orientation parallel to the surface of the sherd. Only longitudinal, thin fibres are visible, triangles are not visible (suggesting that these triangles are really the sections of the longitudinal ones). Up to 3.75 mm long.

Mineral inclusions
Generally fine non-plastic inclusions, around 20% including voids left by organic fibres, homogeneously mixed with the matrix. Mineral inclusions are present in the natural clay and have not been added by the potter.

A medium amount of rounded, more or less cryptocrystalline and some crystalline calcite particles in fine and coarse-sand fraction up to 0.4 mm. Most calcite is primary, only the smaller particles have started to decompose. Redepostion of secondary calcite (from post-depositional circumstances?) has started at the edges of voids. Calcite particles are not very dominant in this fabric.

Iron oxides in silt and fine-sand fraction are mixed evenly through the matrix. Many angular quartz particles in fine and coarse-sand fraction up to 0.3 mm. A medium amount of mica particles in fine-sand fraction up to 0.15 mm, preserving their blue-pink and green colours under xpl. A few angular as well as rounded chert particles, in fine and coarse-sand fraction up to 0.3 mm. A few volcanic rock (basalt) fragments in fine and coarse-sand fraction up to 0.3 mm. A few feldspar (plagioclase) particles in fine-sand fraction (in the upper left corner of the thin-section on fig. D.46, right next to the small basalt particle). A few sedimentary and other rock fragments in fine-sand fraction up to 0.25 mm. A few epidote and pyroxene particles in fine-sand fraction. A single particle of garnet (?), 0.15 mm. Compared to other samples in Group A, this sample contains relatively many colourful mixed fine-sand particles.

Estimate of firing temperatures
Low. Matrix is still anisotrope, calcite has only just started to decompose.

Remarks
Preferred orientation of organic fibres is probably due to wheel throwing. The red slip is a very thin (up to 0.03 mm) layer of dark red, iron-rich fine-grained clay, smoothed or very lightly burnished (visible in the close-up thin-section on fig. D.47). The layer has bonded with the clay of the matrix (this depends on the humidity of the sherd and the fluidity of the slip at the time of application). The slip contains very small quartz, mica and calcite inclusions. The slip covers all irregularities in the surface of the sherd. The iron-rich materials for this slip were most probably not found in the area of Sabi Abyad or the Jezira (Schneider 2006: 402) and so at least the materials for the slip are not local.

CLAYS FROM THE JEZIRA REGION, PROBABLY NOT FROM THE BALIKH
Thin-sections – Group B3b

Sample no.	**48**
Field no.	K10 61-121: P93-109
Level	7
Shape	type 111 carinated bowl, burnished well on the in and outside
Illustration	fig. D.48; IV.1.c

Field description:
Ware B (fine calcite and sand)
Fired at a medium temperature in an oxidizing atmosphere (core colour different from surface colour)

Thin-section description:

Matrix
Calcareous clay containing iron. Fine-grained calcite in silt fraction in medium amount spread evenly through the matrix. Matrix is olive-brown, towards the surface of the sherd becoming more orange-lighter brown (the surface of the sherd is at the lower right corner of the thin-section in fig. D.48). Matrix is homogeneous, not very isotrope. Some small voids are caused by air bubbles, otherwise the fabric is rather compact.

Mineral inclusions
Both very fine and slightly larger non-plastic inclusions, around 20%, creating a slightly more "colourful" impression under the microscope than the samples in Group A. Inclusions other than calcite are generally a bit larger than those in the fine-ware groups A1b and A2b.

Many oval and rounded crystalline or cryptocrystalline particles, in fine and coarse-sand fraction up to 0.35 mm. Decomposition of calcite has started with the finer particles, but primary particles are still preserved as well. Occasional straight pieces of shell or microfossils, up to 0.15 mm.

Iron oxides in silt and fine-sand fraction are evenly mixed through the matrix. Most aggregates and grains are of the non-translucent type. Many angular quartz particles in fine-sand fraction up to 0.25 mm. A medium amount of mica in fine-sand fraction, bright blue-pink colours under xpl are still visible. A few feldspar particles in fine-sand fraction. A few radiolarite and more irregular chert particles in fine-sand fraction up to 0.15 mm. A few rock fragments of different kinds, in fine and coarse-sand fraction up to 0.7 mm (for example in the upper left corner of the thin-section in fig. D.48). A few hornblende, epidote and pyroxene particles in fine-sand fraction.

Estimate of firing temperatures
Low to medium. Matrix is still largely anisotrope, while calcite has not completely decomposed yet.

CLAYS FROM THE JEZIRA REGION, BUT PROBABLY NOT FROM THE BALIKH
Thin-sections – Group C: calcareous clays with coarse inclusions, including volcanic rock fragments

The coarse wares in Group C form a rather diverse group as well, like those in group D. The fabrics of this group are calcareous clays, somewhat similar to those in Group A or D. However, the fabrics in Group C have coarse mineral inclusions, including fragments of volcanic rock (basalt). Since the Balikh River does not flow through regions containing volcanic rock outcrops (see the geological map of Syria, fig. V.1), it is not likely that these sherds originate from the Balikh Valley or from Sabi Abyad. However, it is possible that these sherds do come from the greater Jezira or northeastern Syrian region.[239] The basalt inclusions in the fabrics of Group C are generally large enough to be recognized under 10x magnification in the field. However, during the description of the Sabi Abyad material they were not recognized or described as such.

Group C has been divided into several subgroups according to the composition of the sherds. Even within the larger groups, every single sherd is different from the others. The only aspect they all have in common is the calcareous fabric and the presence of basalt inclusions indicating a non-Balikh origin. The variety of fabrics supports the non-local origin. Any suggestions as to the origin will be discussed with each sample. The following fabrics can be distinguished:

C1 Calcareous clay with basalt fragments and with coarse calcite inclusions (cooking wares)

- C1a with coarse crushed crystalline calcite and calcite of biogene origin, a few small basalt fragments[240]
- C1b with coarse crushed crystalline calcite, and coarse basalt inclusions

C2 Calcareous clay with coarse sand inclusions (including basalt)

- C2a with dominant volcanic stone and radiolarite chert inclusions, no cooking ware
- C2b with coarse sand and coarse calcite of biogene origin, cooking ware

C3 Calcareous clay with medium-coarse sand inclusions (including basalt)

[239] The cooking-ware pots from Tell Bderi, for example, contain basalt inclusions (Schneider 2006: 401).
[240] Schneider (2006: 404 footnote 29) remarks that small basalt fragments in pots with large crushed-calcite inclusions may have originated due to the use of a basalt mortar to crush the calcite. In that case, this pot may have come from the Balikh Valley region.

CLAYS FROM THE JEZIRA REGION, PROBABLY NOT FROM THE BALIKH
Thin-sections – Group C1a

Sample no.	**33**
Field no.	K10 61-132:7
Level	7
Shape	type 211 cooking-pot rim
Illustration	fig. D.49; IV.5.a

Field description:
Ware E (with coarse calcite inclusions)
Fired at a low temperature in an oxidizing atmosphere.

Thin-section description:

<u>Matrix</u>
Calcareous clay containing iron. Fine-grained calcite in silt fraction evenly mixed through the matrix. Matrix is light brown, anisotrope and homogeneous. Occasional voids are present from small organic particles, probably accidentally present in the clay. Many voids from small cracks in the matrix, running against the inclusions and probably caused by thermal shock.

<u>Mineral inclusions</u>
Both finer as well as large non-plastic inclusions, approximately 40%. The smaller inclusions are part of the natural clay, but the larger inclusions have most probably been added by the potter as a temper.

A medium amount of crystalline angular or rhombohedric calcite particles, in primary form, in fine-sand fractions up to 0.25 mm. Many other calcite inclusions, e.g. irregular but mostly angular grains of biogene origin in different shapes including curved shell-like fragments and larger rectangular or other shapes, in coarse-sand fraction up to 1.75 mm (visible at the top edge of the thin-section in fig. D.49). Angular or more irregular cryptocrystalline calcite aggregates in coarse-sand fraction up to 1.625 mm. These inclusions were most probably added by the potter. All calcite is still primary; decomposition has not taken place yet.

Iron oxides in silt and fine-sand fraction evenly mixed with the matrix. A medium amount of angular quartz particles in fine and coarse-sand fraction up to 0.3 mm. A few rounded volcanic rock fragments (basalt) in coarse-sand fraction up to 0.4 mm (at the top right of the thin-section in fig. D.49). A few chert particles in fine and coarse-sand fraction up to 0.4 mm, larger than usual. A few pyroxene grains in fine-sand fraction up to 0.17 mm, larger than usual. A few hornblende particles in fine-sand fraction up to 0.2 mm. A few epidote grains in fine-sand fraction. A few mica particles in fine-sand fraction up to 0.05 mm, blue-pink colours under xpl are still preserved. A few feldspar particles in fine-sand fraction up to 0.15 mm. A single olivine particle (?) in fine-sand fraction (0.18 mm).

<u>Estimate of firing temperatures</u>
Low. Matrix is still anisotrope, calcite has not yet decomposed.

<u>Remarks</u>
Apart from the coarse inclusions added by the potter, the non-plastic inclusions in the natural clay also seem to be slightly coarser than is usual for the other samples.

CLAYS FROM THE JEZIRA REGION, PROBABLY NOT FROM THE BALIKH
Thin-sections – Group C1b

Sample no.	**36**
Field no.	K10 61-132:24
Level	7
Shape	type 212 cooking-pot rim
Illustration	fig. D.50, D.51; IV.5.i

Field description:
Ware E (coarse calcite), angular white and grey coarse particles, cooking ware.
Fired at a low temperature in an oxidizing atmosphere.

Thin-section description:

Matrix
Calcareous clay containing iron. Fine-grained calcite in silt fraction mixed evenly through the matrix. Dark brown-grey, anisotrope matrix, homogeneously mixed. Many tiny cracks run between the larger inclusions, probably due to thermal shock (visible in purple in the thin-section in fig. D.51). Hardly any other voids.

Mineral inclusions
Both small and larger inclusions, evenly mixed through the matrix, around 40%. The smaller non-plastic inclusions are most probably part of the natural clay, while the larger inclusions were certainly added by the potter as a temper.

Dominant inclusions are calcite, basalt and feldspar fragments. Many primary crystalline and more micro-crystalline angular as well as more rounded particles of calcite in original rhombohedric or more irregular shape, in coarse-sand fraction up to 1.75 mm. Also a few rounded cryptocrystalline particles of calcite in fine and coarse-sand fraction up to 0.5 mm, possibly partly present in the natural clay. A few small fragments of shell or microfossils, up to 0.3 mm long. All calcite is primary, decomposition of calcite has not taken place yet.

Rather many iron oxides in fine-sand fraction and silt fraction mixed with the matrix. A few to a medium amount of oval or irregular volcanic rock (basalt) inclusions in different kinds in coarse-sand fraction, up to 1.25 mm (filling the upper left corner of the thin-section in fig. D.50). A medium amount of feldspar (plagioclase) particles in fine-sand fraction up to 0.2 mm. A few epidote particles in fine-sand fraction up to 0.15 mm, few mica grains in fine-sand fraction up to 0.03 mm. A few pyroxene and olivine (?) grains in fine-sand fraction up to 0.2 mm. A few angular quartz particles in fine-sand fraction up to 0.1 mm. A few rounded chert particles in fine-sand fraction up to 0.2 mm.

Estimate of firing temperatures
Low. Matrix is anisotrope, and all calcite is still primary.

CLAYS FROM THE JEZIRA REGION, PROBABLY NOT FROM THE BALIKH
Thin-sections – Group C2a

Sample no.	**07**
Field no.	K8 102-239: P97-296
Level	5
Shape	type 911 "pilgrim" flask, with burnished outer surface
Illustration	fig. D.52, D.53; IV.94.d

Field description:
Ware C (fine sand inclusions).
Fired at a low temperature, in an oxidizing atmosphere.

Thin-section description:

Matrix
Calcareous clay containing iron. A lot of fine-grained calcite grains in silt fraction mixed with the matrix. Matrix is light buff-brown and anisotrope. Some smaller "clay aggregates" up to 0.5 mm are present. Hardly any voids are present: a very compact fabric.

Mineral inclusions
Both small and large inclusions are present, very colourful, rather evenly distributed in the matrix, approximately 30%. The predominant inclusion seems to be basalt. Smaller inclusions were probably present in the natural clay. The larger inclusions have possibly been added by the potter.

A medium amount of crystalline as well as cryptocrystalline rounded or angular calcite particles in fine and coarse-sand fraction up to 0.75 mm. All calcite is primary.

A medium amount of iron oxides in fine-sand and silt fraction mixed with the matrix. A medium amount of volcanic rock (basalt) fragments of different kinds in coarse-sand fraction up to 1 mm (e.g. at the top left of the thin-section in fig. D.52). Also some grains of weathered metamorphic rock in coarse-sand fraction up to 1.375 mm. A few larger angular chert particles in coarse-sand fraction up to 0.875 mm, as well as few radiolarite chert fragments in coarse-sand fraction up to 0.625 mm (visible near the lower left corner of the thin-section in fig. D.52). A few angular quartz particles in fine to coarse-sand fraction up to 0.5 mm. A few feldspar particles in fine-sand fraction.

Estimate of firing temperatures
Low. Matrix is anisotrope and calcite is still present in primary form.

Remarks
The burnishing of the outer surface has flattened the inclusions (visible on the top of the thin-section picture in fig. D.52). However, the burnishing did not cause a preferred orientation of inclusions. The inner surface is completely untreated (due to the "thrown-closed" shaping technique, see Chapter V), in the thin-section recognizable by a rough and irregular surface (fig. D.53).

CLAYS FROM THE JEZIRA REGION, PROBABLY NOT FROM THE BALIKH
Thin-sections – Group C2b

Sample no. **J730**
Field no. I11 27-61:6
Level 5
Shape type 212 cooking pot
Illustration fig. D.54; IV.62.i

Field description:
Ware D (coarse sand inclusions)
Fired at a low temperature, in an oxidizing atmosphere.

Thin-section description:

Matrix
Calcareous clay containing iron. Fine-grained calcite in silt fraction mixed evenly through the whole matrix. Light and darker beige-brown matrix, homogeneous, anisotrope. Rather large cracks are visible between the inclusions, probably due to repeated thermal shock (see also below; visible in the thin-section in fig. D.54).

Mineral inclusions
Both small and large inclusions are present, approximately 20%. It is remarkable that inclusions of medium size between 0.125 and 0.6 mm are largely absent. This indicates that the smaller inclusions were part of the natural clay, while the larger ones had been added by the potter. The inclusions are of a very mixed nature, in fact almost every larger grain in the thin-section slide is of a different kind.

Calcite inclusions are not dominant in this fabric. A few large rounded particles of calcite grains of biogene origin in coarse-sand and gravel fraction up to 2.5 mm. A few cryptocrystalline calcite particles in coarse-sand fraction up to 0.75 mm. A few smaller crystalline calcite particles in fine-sand fraction up to 0.1 mm. All calcite is still present in primary form.

Iron oxides in fine-sand and silt fraction mixed evenly through the matrix. A medium amount of mica in fine-sand fraction up to 0.2 mm, bright colours under xpl preserved. A few radiolarite chert grains in coarse-sand fraction up to 2 mm (at the right edge of the thin-section in fig. D.54). Also few angular pieces of chert in coarse-sand fraction up to 0.75 mm. A few volcanic rock (basalt) inclusions of different kinds in coarse-sand fraction up to 2.25 mm. A few crystalline or more micro-crystalline quartz fragments in coarse-sand fraction up to 1.5 mm, and also few angular quartz particles in fine-sand fraction up to 0.125 mm mixed evenly in the matrix. A few rock fragments of different kinds and colours in coarse-sand and gravel fraction up to 2.5 mm. A few silt-stone fragments in coarse-sand fraction up to 0.75 mm. A few pyroxene and epidote grains in fine-sand fraction up to 0.15 mm. Very few feldspar inclusions in fine-sand fraction up to 0.125 mm. Very few serpentinite (?) and hornblende particles in fine-sand fraction up to 0.08 mm.

Estimate of firing temperatures
Low. Matrix is anisotrope, calcite is still primary.

Remarks
The chemical composition of sample J730 was established with WD-XRF analysis. The data are presented in the table below, including the data for the unfired pottery from Sabi Abyad and the Balikh clay sample for comparison. Not only these data but also the dendrogram resulting from a multivariate cluster analysis (not illustrated) show that sample J730 is largely similar to the local clays. Small differences in composition, mainly in the elements SiO_2, CaO, Na_2O, and S, place the sample at the end of the dendrogram but within the group of local clays and next to the Balikh River clay sample. Sample J730 contains notably less calcium. Since it does contain coarser calcite inclusions, this may point to a slightly less calcareous clay, but it may also be caused by the relatively larger amount of sand inclusions. However, there is no reason to suggest that sample J730 could not have come from the larger Jezira region. The inclusion of volcanic rock fragments in

the fabric indicates that it probably does not come from the Balikh Valley itself. The similarity in chemical composition between J730 and the local samples also in the trace elements (Daszkiewicz et al. 2006: 423) illustrates the similarity of the clay compositions in the larger Jezira region as well.

	Elements																						
Sample no.	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	(S)	(Cl)	V	Cr	Ni	Zn	Rb	Sr	Y	Zr	Ba	(Ce)	GV
average unfired pottery	49.02	0.851	13.09	6.66	0.095	4.80	21.38	0.89	2.90	0.30	0.16	0.16	132	251	106	95	68	454	26	172	407	62	
1744 Balikh clay	47.66	0.863	15.34	7.41	0.113	5.13	21.06	0.31	1.87	0.23	0.12	0.02	129	206	167	93	84	552	28	159	324	65	0.00
J730	54.89	0.682	12.08	6.75	0.131	4.87	16.57	1.52	2.24	0.27	0.06	0.02	134	247	161	96	41	473	24	129	269	29	12.07

Table D.2: Comparison of the chemical composition of sample J730 with a selection of Sabi Abyad clays. The data format is the same as in Table D.1.

Sample J730 was also included in a study of Prehistoric and Bronze Age cooking-ware sherds (Daszkiewicz et al. 2000). It was tested for water permeability and thermal-shock resistance. The study shows that the fabric of J730 was so permeable that water droplets were already appearing at the surface after only 6 minutes of exposure to water from the inside, which suggests that the vessel could only have been used for storage of dry products and not for cooking liquids. This result, which is rather at odds with the suggestion that pots of this material and shape were used for cooking, is probably linked to the fact that we are dealing with discarded material. Possibly the vessel had suffered so much thermal shock during its use-life that the fabric had become unstable, indeed making it unsuitable for cooking and ready to be discarded.

CLAYS FROM THE JEZIRA REGION, PROBABLY NOT FROM THE BALIKH
Thin-sections – Group C3

Sample no. **37**
Field no. K10 61-132:4
Level 7
Shape type 315 jar rim.
Illustration fig. D.55; IV.8.g

Field description:
Ware B (calcite and fine sand)
Fired at a medium temperature in an oxidizing atmosphere.

Thin-section description:

Matrix
Calcareous clay containing iron. Not too much fine-grained calcite in silt fraction mixed with the matrix. Dark olive-brown homogeneous matrix, largely anisotrope. A relatively compact fabric with only a few voids from air bubbles up to 0.3 mm.

Mineral inclusions
Smaller, but predominantly middle-sized non-plastic inclusions, approximately 30%, mostly rounded or slightly angular. There are no dominant minerals. It seems that the potter added a naturally sorted sand of a very mixed nature (transported over a large distance by a river).

Many oval or more angular fine and larger cryptocrystalline calcite inclusions in fine and coarse-sand fraction up to 0.5 mm. Decomposition of calcite has started in some particles.

Iron oxides in fine-sand and silt fractions mixed with the matrix. Also some larger inclusions up to 0.5 mm. A few to medium amount of chert in different forms (fine-grained, radiolarite, fine-grained with yellow or reddish mineral inclusions), rounded as well as angular, in coarse-sand fraction up to 0.7 mm (at centre top edge of thin-section in fig. D.55). Medium amount of feldspar (plagioclase) particles in fine and coarse-sand fraction up to 0.4 mm (in bottom centre of thin-section in fig. D.55). Medium amount of quartz particles in fine and coarse-sand fraction up to 0.5 mm. A few volcanic rock (basalt) inclusions of different kinds and colours, in coarse-sand fraction up to 0.3 mm (at upper left corner of thin-section in fig. D.55). A few hornblende and pyroxene in fine-sand fraction up to 0.15 mm. A few olivine (?) particles in fine-sand fraction up to 0.2 mm. A few sedimentary and other rock fragments in different kinds and colours, in fine and coarse-sand fraction up to 0.3 mm. A few serpentinite grains in coarse-sand fraction up to 0.8 mm. A few silt-stone particles in fine-sand fraction. A few mica particles in fine-sand fraction up to 0.18 mm, blue-pink bright colours under xpl.

Estimate of firing temperatures
Low to medium, approximately 700-800 °C. Matrix largely anisotrope, calcite has started to decompose.

Remarks
Possibly from the Euphrates River area.

CLAYS NOT FROM THE JEZIRA REGION

Thin-sections – Group E: less calcareous clays with coarse inclusions

There are only two samples that definitely do not come from the larger northeastern Syrian or Jezira region. They are made from clays that contain relatively little calcite. These non-calcareous clays are not found in the Jezira region, where all sediments are highly calcareous (Schneider 2006: 391).

The two samples in group E are very different from each other and most probably have a very different origin. They are combined in this group because they are both made of less-calcareous clays.

E1 with volcanic rock (basalt) inclusions and medium coarse sand inclusions

E2 with steatite (talc) temper

Sample J728 in group E2, with steatite inclusions, almost definitely comes from the region around Ugarit / Ras al-Bassit on the Syrian coast. See below for a more detailed discussion of this sample. For sample 06 in group E1 the origin is less clear.

CLAYS NOT FROM THE JEZIRA REGION
Thin-sections – Group E1

Sample no.	**06**
Field no.	K9 70-264: P93-294
Level	5
Shape	type 911 “pilgrim” flask, outside burnished
Illustration	fig. D.56; IV.94.h

Field description:
Ware B (calcite and fine sand), rather coarse inclusions.
Fired at a medium temperature in an oxidizing atmosphere.

Thin-section description:

Matrix
Not very calcareous (but still containing some fine-grained calcite), iron-rich clay. Dark grey-green reddish, largely anisotrope matrix, finer inclusions mixed rather evenly. In the thin-section, one larger “clay aggregate” is visible, 3 mm, in the lower right corner (fig. D.56). Matrix becomes a little more greenish and isotrope towards the surface of the sherd.

Mineral inclusions
Mostly rather large non-plastic inclusions, approximately 30%, a (naturally?) sorted mixed sand most probably added by the potter.

No visible calcite particles. Iron oxides in fine-sand and silt fraction are evenly mixed in the matrix. Medium amount of angular and irregular quartz grains in fine and coarse-sand fraction, up to 0.625 mm. A few angular and rounded fine-grained and radiolarite chert particles in coarse-sand fraction up to 0.625 mm. A few angular and more rounded volcanic rock (basalt) particles of different kinds and colours, in coarse-sand fraction up to 0.5 mm. A few metamorphic rock fragments in fine-sand fraction. Very few feldspar (plagioclase) particles in fine-sand fraction up to 0.25 mm. Very few pyroxene, serpentinite, hornblende and mica grains in fine-sand fractions.

Estimate of firing temperatures
Low to medium? Matrix is still largely anisotrope.

Remarks
Perhaps from the upper Euphrates region?

CLAYS FROM THE UGARIT REGION
Thin-sections – Group E2

Sample no.	***J728***
Field no.	K9 72-167: P93-308
Level	5
Shape	type 211 large cooking pot, burnished both inside and outside.
Illustration	Fig. D.57; IV.62.a

Field description:
Ware D (coarse sand), angular dark-grey inclusions, sand?
Fired at a medium temperature in an oxidizing atmosphere.

Thin-section description:

Matrix
Non-calcareous, iron-rich clay. Dark-brown matrix, turning more grey-brown towards one surface of the sherd. Matrix is difficult to see because of the enormous amount of inclusions. Some small voids and many small cracks are visible, probably due to thermal shock. The large amount of inclusions suggests that the original clay was rather plastic.

Mineral inclusions
The fabric is completely dominated by steatite (talc) inclusions (as identified in the chemical analysis (see below) and confirmed in the thin-section). Steatite inclusions are irregular, sometimes angular, finely laminated particles, in all different sizes up to gravel fraction (up to 4 mm) (in the thin-section in fig. D.57 they have very light pastel colours). They are slightly aligned with the surface of the sherd, but not much. Some include tiny black non-translucent particles.

Other non-plastic inclusions are few. The most apparent are some medium to very large (up to 3 mm) particles of a metamorphic rock (shale?), dark brown in colour under xpl, sometimes including small grains of quartz and feldspar. These particles are often cracked. Other non-plastic inclusions: a medium amount of very small quartz particles in fine-sand fraction (up to 0.04 mm). A medium amount of small iron ore (chromite) particles in fine-sand fraction (e.g. the black particles in the the lower centre of the thin-section on fig. D.57). A medium amount of different rock fragments in coarse-sand fraction (up to 0.8 mm). A few volcanic rock inclusions in coarse-sand fraction (0.4 mm). Very few chert particles and mica grains in fine-sand fraction up to 0.05 mm. Very few feldspar (plagioclase) particles in fine-sand fraction up to 0.1 mm.

Estimate of firing temperatures
Low?

Remarks
The closest source of steatite is in the area around Ugarit and Ras el-Bassit in northern coastal Syria, as well as around Mersin and the Antakya region in Turkey and on Cyprus, where Mesozoic Ophiolite rocks (metamorphic rocks and deep-sea sediments) are exposed. Indeed, the shape of our cooking pot resembles cooking pots from coastal Late Bronze Age sites made from “Handmade Burnished Ware”, and also tempered with steatite (L. du Pied personal communication, 8-5-2006). In general, this type of fabric resembles the prehistoric Dark Faced Burnished Ware that originated in the same region (Daszkiewicz et al. 2000).

The chemical composition of sample J728 was established with WD-XRF analysis. The data are presented in the table below, including the data for the unfired pottery from Sabi Abyad and the Balikh clay sample for comparison. The difference with the local Balikh clays is very clear. Sample J728 contains a very large amount of MgO (due to the steatite inclusions) and hardly any CaO (because of the non-calcareous clay). The clay is also very different from the Balikh ones in almost all other elements, including trace elements.

	Elements																								
Sample no.	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	(S)	(Cl)	V	Cr	Ni	Zn	Rb	Sr	Y	Zr	Ba	(Ce)	GV
average unfired pottery	49.02	0.851	13.09	6.66	0.095	4.80	21.38	0.89	2.90	0.30	0.16	0.16	132	251	106	95	68	454	26	172	407	62	
1744 Balikh clay	47.66	0.863	15.34	7.41	0.113	5.13	21.06	0.31	1.87	0.23	0.12	0.02	129	206	167	93	84	552	28	159	324	65	0.00
J728	61.74	0.405	5.30	7.96	0.100	22.33	0.96	0.40	0.74	0.07	-0.02	-0.01	82	1564	1503	56	20	68	12	76	84	38	4.59

Table D.3: Comparison of the chemical composition of sample J728 with a selection of Sabi Abyad clays. The data format is the same as in Table D.1.

Sample J728 was also included in a study of Prehistoric and Bronze Age cooking-ware sherds (Daszkiewicz et al. 2000). It was tested for water permeability and thermal-shock resistance. The study showed that this pot was excellently suited for cooking. It was impermeable (also due to the burnished inner and outer surfaces) and very resistant to thermal shock. It is very likely that the pot had been imported to the site of Sabi Abyad for its excellent properties as a cooking vessel.

sample no.	group	level	figure no.	square	locus	lot	no.	rim type	base type
01	A2a	4	D.16	H7	5	008	1	311	-
02	A1a	7	D.8	N9	17	063	5	132	-
03	A2a	4	D.17	H7	5	009	3	111	-
04	A2a	4	D.18	I7	3	024	4	313	-
05	A1a	7	D.9	N9	17	900	5	315	-
06	E1	5	D.56; IV.94.h	K9	70	264	P93-294	911	751
07	C2a	5	D.52, 53; IV.94.d	K8	102	239	P97-296	911	751
08	A2c	5	D.38; IV.61.b	L8	40	114	P97-147	151	741
09	A2b	4	D.31	I7	10	030	9	-	712
10	A2b	4	D.32	I7	10	031	10	421	-
11	A2a	4	D.19	H7	4	014	10	221	-
12	A1c	-	D.15	N9	6	052	1	-	-
13	A2a	5	D.20	H8	13	141	1	212	-
14	A2a	4	D.21	H7	3	007	7	111	-
15	A2b	4/5	D.33	I7	10	035	1	421	712
16	A2a	6	D.22; IV.17.b	M13	2	030	P93-184	113	741
17	A2a	4	D.23	I7	3	019	4	112	-
18	A2a	4	D.24	I7	10	028	2	111	-
21	A2a	4	D.25	I7	10	023	3	322	-
22	A2a	4	D.26	I7	3	024	3	111	731
23	B1	5	D.43; IV.51.r	K8	162	380	P99-96	-	741
24	A2b	5	D.34	L12	21	073	26	-	711
25	A2b	5	D.35	L12	21	073	23	-	711
26	A2a	4	D.27; IV.99.ae	K9	47	169	2	111	-
29	A2a	4	D.28; IV.100.v	K9	47	066	3	113?	-
31	A2a	5?	D.29	L12	29	120	P93-311	611	611
32	A1a	7	D.10; IV.1.n	K10	61	132	59	117	-
33	C1a	7	D.49; IV.5.a	K10	61	132	7	211	-
34	D2	7	D.42; IV.7.h	K10	61	132	35	2211	-
35	D1a	7	D.39; IV.5.e	K10	61	132	28	212	-
36	C1b	7	D.50, 51; IV.5.i	K10	61	132	24	212	-
37	C3	7	D.55; IV.8.g	K10	61	132	4	315	-
38	B3a	7	D.46, 47; IV.9.m	K10	61	132	1	-	-
39	B2	7	D.44; IV.3.d	K10	61	121	P93-111	123	731
40	A2b	7	D.36; IV.8.b	K10	61	131	1	314	-
41	B2	7	D.45; IV.1.e	K10	61	122	4	111	-
42	A1a	7	D.11; IV.8.i	K10	61	122	38	315	-
43	A2b	7	D.37; IV.10.e	K10	47	110	1	-	721
44	A1b	7	D.12; IV.2.c	K10	61	121	P93-110	122	731
45	A1b	5	D.13, 14; IV.98.c	K9	48	113	16	-	-
46	D1b	7	D.40, 41; IV.5.l	K10	61	132	34	212	-
47	A2a	7	D.30; IV.8.d	K10	61	132	19	315	-
48	B3b	7	D.48; IV.1.c	K10	61	121	P93-109	111	741
J728	E2	5	D.57; IV.62.a	K9	72	167	P93-308	211	751
J730	C2b	5	D.54; IV.62.i	I11	27	061	6	212	-

Table D.4: List of thin-section sample numbers.