Chapter II: Field and Research Methods

CHAPTER II: FIELD AND RESEARCH METHODS

“Dad, aren’t they supposed to be broken?”
Jake (4), watching his archaeologist father excavate a completely preserved jar, Tell Brak 1995.

The present study is based on ceramic data collected and recorded in the field (at the project’s excavation house in the village of Hammam et-Turkman) during the excavation seasons. The choice of data to be recorded and the methods used to collect and process the data can influence the interpretation and the results. Therefore, it is important to specify which methods and procedures have been followed during all stages. They will be presented in this chapter. Also the technical terms used in this study will be defined here: in the text they appear in italics followed by a definition. Finally, a short description will be presented of archaeometrical analyses performed on the Sabi Abyad material and of the statistical tests and measures used to evaluate the data.

II.1 Excavation and sample selection

Excavation procedures

The excavations at Sabi Abyad take place within 9 x 9 m squares designated with capital letters from west to east and with numbers from north to south, with 1 m wide section baulks in between (cf. figs. III.2-6). Each square is administrated by a ‘supervisor’, an experienced student of archaeology. The supervisor directs the work of 5-6 workmen on average, makes decisions on where and how to dig, and administrates all procedures and finds. To secure comparable results and an overall standard of work, each supervisor has to work within the same excavation system and use the same administration procedures and recording forms.

The actual excavating is done by breaking the soil with small or larger picks or with trowels, and removing the loose earth. While removing the earth, all sherds, bone and flint pieces as well as any other finds are collected by hand. Then the surface is levelled and cleaned, and the square can be divided into different loci. In each square, the material is collected within these loci, which can be defined as spatial, confined units (e.g. a room, pit, soil layer, oven, etc.). Within each locus material is collected in lots. A lot is a collection unit within a locus. Each lot has a unique number within each square. The lot numbers are changed every day, as well as whenever the need of separating material arises, and after every 10-20 cm of digging, so that material can be kept apart if necessary. In the Sabi Abyad registration each object or collection unit is identified by the sequence “square – locus number – lot number” (for example: K8 24-134, see Appendix A). Locus and lot numbers are continuous: subsequent excavation seasons will start from where the numbers ended the previous season, and within squares numbers are never repeated.

All small finds (all artefacts other than flint implements, including complete ceramics or ceramics with a reconstructable profile, but not loose sherds) are given three coordinates: place in the square and absolute height. Flint, bones and loose sherds are collected within the lot without point location. All finds are picked out and collected by hand; sieving of deposits only takes place in special find circumstances. It is felt that sieving all deposits would take a lot of time and effort, while the information recovered in relation to the project’s research questions does not justify this effort. For this pottery study I do not feel that sieving the deposits would have yielded substantially more or better information, as sherds are easily picked out and are of a size big enough to be recovered manually. In the worst case not sieving the deposits might have led to a minor under-representation of the very small shapes and fine wares. Each small find receives a unique “masterfile number”. For ceramic objects, the masterfile numbers are composed of the capital P (for pottery) followed by the excavation year, followed by a sequence number (for example: P96-37).

The course of the excavation is recorded in a daily written report of the work and a daily drawing of the whole square on scale 1:50. In addition, a series of forms is used to facilitate and
standardize the recording of deposits, features, finds, burials, etc. After excavation, the finds are 
processed in the excavation house in the nearby village.

I believe that the excavation techniques used at Sabi Abyad provide good circumstances for 
questions on ceramic typology and ceramic sequence. I also think that data on ceramic technology and 
function will not have been influenced much by the excavation techniques. No systematic sampling of 
vessel contents has been done, but then the earth inside complete vessels was only rarely 
(macroscopically) any different from the surrounding fill. For vessels that clearly contained charred 
seeds, charcoal or other material, a (botanical) sample was taken to be analysed by the 
archaeobotanical laboratory in Groningen or other laboratories (see Chapter VI). The used excavation 
system accounts for the exact position of complete vessels in the square. For many floor contexts 
detailed drawings are available, indicating the position of complete vessels and fragments, while the 
general position and elevation of loose sherds can be reconstructed with the lot numbers.

The various stratigraphical units are grouped within each square in a sequence of strata. Then the 
strata and strata groups are linked between squares, yielding overall levels and sublevels. A level 
delineates a coherent building phase. Strata and levels are numbered in order of excavation (top- 
down). Besides, for each locus and lot the nature of the unit (e.g. undisturbed or mixed), the kind of 
unit (e.g. room fill, pit fill, deposit on floor, burial, etc.) and the strata and level are indicated in the 
stratigraphical databases (Sabi Abyad files). This information is used as the basis for processing all the 
other finds, including the pottery. The stratigraphy of the complete Late Bronze Age settlement is 
currently being analysed by M. Brüning and P.M.M.G. Akkermans. Detailed but preliminary 
stratigraphical databases and descriptions of many contexts, providing information on the sequence 
and the nature of deposits, were kindly put at the disposal of the author for the preparation of the 
current study. Additionally, I have processed several contexts in a less detailed manner since the 
stratigraphical databases were not all available yet. Chapter III will provide a summary overview of 
stratigraphy and architecture for the purposes of this study. However, a final publication is being 
prepared at the moment (Akkermans in prep.) and only that publication should be used for future 
reference on the topic of stratigraphy and architecture in Late Bronze Age Sabi Abyad.

Selection of the sample

I collected most data on the ceramics presented in this thesis during six two-month’s fieldwork 
seasons in the autumns of 1994 to 1999. Several students of archaeology have assisted me. Selection 
of lots and objects took place according to the procedures described below (“collection in the field”, 
paragraph II.2), and we tried to process all pottery from good contexts excavated in these and earlier 
seasons. However, due to the enormous quantities of pottery coming from the field, this was not 
entirely possible. Initially the intended topic for this thesis was the function and use of ceramics at the 
site, and the spatial distribution of ceramics over the different functional contexts in the dunnu. The 
focus of data collection was therefore less on the collection of material from the whole stratigraphical 
sequence, and more on the spatial distribution and in situ contexts of one level. However, there were 
two reasons to change the focus of the thesis to the present work. First of all it became clear that the 
detailed stratigraphy and architecture reports, as well as the reports on other find groups, would not be 
available in time to conduct a spatial study. Secondly, the discovery of pottery production locations 
and several kilns attracted my attention and greatly increased the value of a study into the 
organization of pottery production. An important consequence of this change in focus is that the 
recording of the ceramics in the field has not always been tailored to the research questions put in this 
thesis.

Part of the ceramics presented here were excavated in 1991 and 1992 and studied by J. Limpens 
(1994). From 1994 to 1999, I was responsible for the ceramic fieldwork. The excavations at Sabi 
Abyad have continued until today. For the field seasons after 1999, processing and recording of the 
pottery was the responsibility of a team of archaeology students not including myself, and headed by 
D. Isendoorn (2001, 2002) and E. Koek (2003, 2004). Although these data were all available as well,
for reasons of feasibility and time I had to limit myself largely to the data collected until 1999, except for certain special contexts like the material from the level 6 pottery workshops (see chapter V, described in 2003 and 2004 by the team under the direction of E. Koek) or contexts important for chronological questions (see chapter IV). In Appendix A all material presented and processed for the current publication is listed. Moreover, the architectural plans (figs. III.2-6) indicate, for each level, from which contexts the pottery has been included in this study. In hindsight, and as is natural when processing material from an ongoing excavation project, the selection of the sample has for a large part been determined by factors of feasibility and the nature of the contexts as interpreted during the course of excavation. Also, the year of excavation rather than the nature of the finds of a particular context or level sometimes determined whether the material was included in the present study (some contexts are not included although they may have been useful, simply because the author was not involved in fieldwork anymore). It is felt, however, that the total sample size of 19,562 sherds and complete vessels is more than large enough to allow for meaningful conclusions.

II.2 Description of the pottery and typology

The system used to collect and describe the Late Bronze Age pottery from Sabi Abyad was initially based on the system used at nearby Tell Hammam et-Turkman (Meijer et al. 1988:14-18). During the excavations and processing of finds at Sabi Abyad, this system was expanded, refined and adapted to the Middle Assyrian ceramics and to our questions. Some of these adaptations had already been made by J. Limpens in her M.A. thesis on the Late Bronze Age pottery from the excavation seasons 1991 and 1992 (Limpens 1994). Originally this system was not directed towards any specific research question other than chronology and general publication of the pottery. Research questions concerning techniques and function as in this study were formulated during the work on the pottery. Occasionally this led to an adaptation of the way certain attributes were described (like firing circumstances) and to the addition of attributes like percentage of total vessel circumference (see below). In general, however, in order to guarantee the comparability of the data from different field seasons and from different field staff, the description and attributes were kept the same.

Collection in the field and subsequent treatment

When vessels were recognizable in the field as being complete or reconstructable (either by actually fitting the sherds or by reconstructing the shape on paper, i.e. when rim and base were at least partially present), their exact position in the field was noted. Other sherds were collected per lot. In the excavation house the sherds and vessels were all washed in water from a nearby irrigation pump, dried and numbered. Prehistoric (Late Halaf) sherds, included in the Late Bronze Age mud bricks and therefore present in small numbers and sizes in contexts rich in mud-brick debris, were counted and put aside (see Nieuwenhuys 1996, 1997). Subsequently the sherds were sorted per lot in diagnostic and non-diagnostic fragments. Diagnostic sherds are rims, bases, handles, spouts and body sherds with decorations or other special attributes like holes. All body sherds without any features were called non-diagnostic. Then both categories of sherds were counted. It is important to realize that these represent counts “before fitting”. Any estimation of original amounts of vessels based on the sherd counts will therefore almost certainly be too high (Rice 1987: 291). All sherds from all loci were counted systematically, whereas selections of material were made for the description (see below).

The pottery from selected loci (mainly floor contexts) was refitted as far as possible, per locus or group of loci. The non-diagnostics that could not be refitted were then discarded. The time spent in

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7 The different wares were not counted at this stage. Inclusions are clearly visible only in a fresh fracture. It would have been too time-consuming to note inclusions for all the sherds including non-diagnostics. Instead I decided to record inclusions only for diagnostic sherds. More importantly, I felt that the described sample is statistically large enough to include all wares in a representative manner.

8 Only for those loci that yielded well-preserved floor contexts, containing complete or reconstructable vessels. Often the
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refitting sherds from a context varied between one and three weeks depending on the size of the loci and the amount of sherds and complete vessels, while refitting was done by one to three persons. The material was always sorted in fragments belonging to the same vessel. In most cases I felt that the material was refitted sufficiently. Sometimes it was necessary to limit refitting due to time constraints. Sometimes the refitting of sherds provided useful information concerning stratigraphical problems. For example, it could be proven that two rooms in square M9 originally were one but that a wall foundation trench had been cut through the room fill at a later stage. And in square L8 it became clear that a collapsed wall actually sealed the fill on the floor from the upper fill of the room. In general, refitting gave an impression of the degree of disturbance of the context or the fragmentation of the original material (Rosen 1986: 63): did the context originally contain many complete vessels, or mainly broken ones, and what is the relative amount of sherds not belonging to any vessel in the deposit? Fragments that clearly belonged to the same vessel but could not be refitted were kept together and described as one fragment or vessel. Therefore, the number of described diagnostics gives a more accurate basis for estimating original amounts of vessels than “before fitting” sherd counts.

Most work on the pottery was carried out in the open in the courtyard of the excavation house, in daylight but under a reed-matting shade roof (figs. II.1-5). Work that did not require daylight conditions was also often carried out inside the excavation house with electrical light (bulbs, gas lamps or neon), and sometimes outside in the evenings with the help of electrical light. This work included drawing and refitting.

Description and typology

Each diagnostic sherd was described according to a number of attributes (see below), and all information was entered on a standardized code-sheet (fig. II.6) and entered into computerized data files using the computer program Visual Dbase 5.5. A total amount of 19,562 diagnostic sherds was described. About 25% of the described sherds and most complete vessels were drawn and some were photographed. The drawings include most complete shapes, all rare shapes, all sherds with remarkable features or with decoration, good examples for shape types and a sample of the remaining sherds from each lot. In this way, a large collection of drawings is available for every studied locus.

The description of the pottery presented in this study was done by several persons. Most pottery excavated in 1991 (from the central tower in squares K-L 10-11, see Chapter III) and most of the complete vessels excavated in 1992 (also from the central tower) were recorded by J. Limpens. A small amount of material from 1991, all remaining pottery from 1992, all material excavated in 1993 and a selection of the pottery excavated in 1996, 1997 and 1998 was recorded by myself (in 1994 and 1995 no excavations took place). The material from 2003 and 2004 used in this study was processed by E. Koek and his assistants. Within the various collections it can be assumed that recording was more or less consistent, although of course subjective. The differences in description between the persons processing the pottery were never studied, but since all used the same description system and were trained by their predecessors, differences should not be too big. The main differences in description between myself and E. Koek have been noticed in the description of fine sand inclusions, and groupings of the “ware” categories have been made accordingly when necessary (see below). Unavoidably, my own descriptions probably changed somewhat over time, due to more experience with the material, more background knowledge or other factors. All (computer) files containing descriptions and drawings of the material presented here are kept at the National Museum of Antiquities at Leiden.

size, kind, fragmentation, amount of erosion, etc. of the sherds already indicated whether refitting would yield any complete shapes or not. Sherds from clear garbage contexts or contexts that only contained small eroded sherds (like most open areas) were therefore not refitted. In these cases the sherds were counted, after which the non-diagnostics were discarded.

9 On average diagnostics comprise about 24% of the total amount of counted sherds.
The attributes used to describe the pottery are: *inclusions, texture, manufacture, shape, surface treatment, colours, firing, decoration, special features and measurements*. The attributes *level* and *provenance* were added afterwards according to the stratigraphical information contained in locus and lot numbers. For each sherd there is space for remarks on the recording forms. The following will include both the definitions of the used terms and a general overview of the different appearances each attribute has in the Late Bronze Age material at Sabi Abyad. In the next chapters, describing specific groups of pottery, I shall refer to the descriptions of the attributes as presented here.

The description of the pottery with the help of the above-mentioned attributes results in the formation of a descriptive classification. Each of the attributes can in their turn be divided into two or more states of the attribute. All of the attributes are recorded independently of each other. Any connection between attributes must be established during the analysis. Moreover, different questions require the study of different combinations of attributes (Pfälzner 1995: 10). Additionally, a description according to independent attributes allows a better comparison between the ceramics of Sabi Abyad and other sites, especially the Middle Assyrian ceramics from Tell Sheikh Hamad that are presented in roughly the same way (Pfälzner 1995). The pottery classification resulting from this description is of course a formal, modern classification and has no defined relation to vessel function or to the Assyrian names or classifications of vessels (cf. Chapter VI).

Many pottery studies use a typology in which each ceramic type is defined by a characteristic combination of two or more attributes, like decoration, surface treatment, used clays, size, geometric shape, etc. The resulting types are often called “wares” (Rice 1987: 215ff). For Late Bronze Age Syria this resulted in the use of terms like Khabur Ware, Nuzi Ware, etc. (cf. Hrouda 1989, 2001; Parayre 1986; Stein 1984; see also Duistermaat, in prep. a). In the case of Sabi Abyad a ware typology in this sense was not used while describing the sherds in the field, for several reasons. First of all, not all attributes are always visible on all sherds (like decoration, shape, etc.). Secondly, attributes like decoration or special surface treatment like burnishing do not occur very often and are not always connected with shape or inclusions. They can therefore easily, and preferably, be described separately. Thirdly, treating each attribute independently provides the possibility of comparing the Sabi Abyad material with other collections, thereby lessening the trouble of comparing ware types that have similar names but were defined according to different standards. Lastly, and most importantly, the characteristic combination of attributes that defines a type should be constructed after the evaluation of the individual attributes, and the interrelation of attributes should be demonstrated. Only when it can be proven that a group of pots shows the same combination of, for example, inclusions, decoration and shape, one can decide to call this group a “type” or “ware”. The notion of “ware” in the classical sense was therefore not used during the description of the ceramics (for the definition of “ware” in this study, see below).

**Inclusions**

Because in the field all sherds were analysed macroscopically only (but with 10x magnification), no distinction was made between non-plastics added by the potter and those naturally present in the clay. It was therefore decided to speak about *inclusions*, avoiding the word temper (Rye 1981: 31-32, Rice 1987: 411). Inclusions here are the non-plastics visible in a fresh fracture under magnification (10x), or the voids left by them (in the case of organic inclusions). See the illustrations in Appendix D for an impression of the fresh fractures.

The majority of the pottery from Sabi Abyad was most probably made of a clean clay, either without any additional temper material (but naturally containing fine grains of calcite and some fine sand) or with added organic inclusions (dung or chaff) and possibly salt (see also Chapter V and Appendix D). Few vessels show other inclusions, which were probably added in connection with the intended use of the vessel (e.g. as a cooking pot).

For describing the inclusions in the clay, the following general terms have been used. It must be stressed that this classification was set up before microscopical fabric analysis had been carried out. Therefore these terms were used only as generic names and not as chemical identifications (a more
detailed description of the fabric and inclusions was made for those sherds analysed by thin-section analysis; see Chapter V and Appendix D). In describing the inclusions on the recording forms, only the main type of inclusion or combination of inclusions was written down. Remarkable secondary inclusions have been described in the ‘remarks’ on the forms, but this rarely occurred. In general, macroscopic descriptions of inclusions are very limited in value. With macroscopic analysis only one cannot expect to draw conclusions on, for example, different sources of clay (Schneider 2006). To solve such questions one needs thin-section analyses or chemical analyses. This being the case, I decided not to burden the typology with overly detailed descriptions of inclusions that are hard or impossible to identify macroscopically anyway, but instead to stick to some larger categories only.

**Macroscopic determination of inclusions**

*Organic inclusions*: these are small plant parts. Generally, they have burnt away and have left a void in the matrix. This void is longitudinal in shape or, occasionally, grain-shaped. Sometimes a whitish “skeleton” of the fibres is left in the void. Organic inclusions with even particle sizes are an added temper, as they do not occur naturally in the clay (Rice 1987: 409). L. Jacobs suggested (Appendix D) that because the organic inclusions in the clay of the LBA pottery from Sabi Abyad are often small and even in size, they may have come from animal dung mixed with the clay to enhance workability. *Calcite*: very small to larger dull, white inclusions, with a rounded shape and no sharp fractures. As all clays in the Balikh region have a high calcareous content, it is no surprise that a lot of sherds contain visible, although small, particles of calcite. Especially the small calcite inclusions most probably occur naturally in the clay. *Coarse calcite*: Larger, white, angular or crystalline particles with sharp fractures. Most probably these particles were added on purpose to influence the properties of the vessel. Calcite inclusions may lessen the thermal stress in cooking vessels, for example. *Fine sand*: small rounded mineral inclusions of even sizes and with various, sometimes shiny or glittery, colours (reddish, brown, buff, black), mixed evenly in the matrix. Like calcite, fine sand was probably in most cases already naturally present in the clay. *Coarse sand*: as above but with larger particle sizes, sometimes with angular, sharp fractures but mostly rounded, and shiny or translucent in colour. *“Grog”*: larger and angular parts of clay or pottery (crushed sherds), mostly in a different colour or texture than the surrounding matrix. These inclusions are always added by the potter (Rice 1987: 409). Colours are mostly greyish, brown or reddish. The inclusions defined macroscopically as grog appeared in the thin-section analysis to be crushed shell (see below, ware F). With the benefit of hindsight it can therefore be stated that grog was most probably not used in the pottery at Sabi Abyad.

**Ware**

In this study, a *ware* is defined by the combination of the most important inclusions in the clay. In other pottery descriptions attributes like shaping, surface treatment, decoration and firing are often included in ware definitions (cf. above; Rice 1987: 287). Here, however, they are regarded as aspects that have to be studied independently, and therefore recorded independently. The following *wares* have been noted macroscopically (before thin-section analysis) in the pottery from Tell Sabi Abyad:

<table>
<thead>
<tr>
<th>A</th>
<th>calcite = X</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>calcite and sand = X</td>
</tr>
<tr>
<td>C</td>
<td>fine sand = X</td>
</tr>
<tr>
<td>D</td>
<td>coarse sand</td>
</tr>
<tr>
<td>E</td>
<td>coarse calcite</td>
</tr>
<tr>
<td>F</td>
<td>shell (originally “grog”)</td>
</tr>
<tr>
<td>G</td>
<td>organic inclusions only = Y</td>
</tr>
<tr>
<td>H</td>
<td>organic inclusions and calcite = Y</td>
</tr>
<tr>
<td>I</td>
<td>organic inclusions and calcite and sand = Y</td>
</tr>
<tr>
<td>J</td>
<td>organic inclusions and fine sand = Y</td>
</tr>
<tr>
<td>K</td>
<td>organic inclusions and coarse sand</td>
</tr>
<tr>
<td>L</td>
<td>organic inclusions and coarse calcite</td>
</tr>
<tr>
<td>M</td>
<td>organic inclusions and “grog”</td>
</tr>
<tr>
<td>N</td>
<td>no visible inclusions = X</td>
</tr>
</tbody>
</table>
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Thin-section analyses

Thin-section analyses (Appendix D, see also table V.2) showed that the distinction between finer calcite and sand inclusions has no basis in the petrography of the sherds. Basically, apart from the coarse wares, the presence or absence of organic inclusions was the only significant difference between clay mixtures. Therefore, wares A, B and C occur together within one petrographically homogeneous ware group. Similarly, wares H, I and J are interchangeable from a petrographical perspective. On a finer scale, differences between fabrics and small inclusions other than quartz or calcite were distinguishable in the thin-sections, but they did not correlate with the macroscopic ware groups. The finer distinctions between different petrographical groups were determinable with the microscope only. In the following study wares A, B, C and N are therefore not only presented separately as described in the field, but often also grouped in ware group X (which is a more realistic group), while wares H, I, J and G are grouped in ware group Y. Similarly, the distinction between ware groups D and E, although valuable in principle, often appeared to be wrong because calcite and sand were not properly identified in the field. The only cooking pot imported from far away was not recognized as having a different temper (although the shape was recognized as strange; sample J728 in Appendix D). One sherd of Ware F, originally tentatively described as “grog”, was identified in the thin-section as tempered with crushed shell (Appendix D, sample 34). Therefore, on the basis of the petrographical analysis, it can be stated that the minor differences between the descriptions of the various people participating in the Sabi Abyad pottery descriptions (most apparent in the identification of fine sand inclusions) are of no consequence for this analysis. The petrographically sound groupings in groups X and Y eliminate the most important differences between my descriptions and those of others. The identification of inclusions that are meaningful from a petrographical point of view, like basalt inclusions and the distinction between these and iron-rich clay aggregates, and the distinction between sand and calcite grains, appears to require a lot of experience and mineralogical knowledge that is generally not available in the team. For future work I would recommend the proper training of team members in these aspects so as to make them familiar with the fabrics and inclusions they will be likely to encounter. Moreover, a microscope and a small amount of hydrochloric acid for the determination of calcite inclusions would be valuable additions to the field equipment.

Texture

Three general groups of texture have been used: fine, medium, and coarse. A sherd with a fine texture has an even fracture surface and a compact fabric with little or no macroscopically visible inclusions or very small inclusions only. Walls are generally thin. Most Late Bronze Age ceramics from Sabi Abyad have a medium texture. This fabric shows an even fracture surface and macroscopically visible inclusions. Sherds with a coarse texture have an uneven or rough fracture surface and large, clearly visible inclusions. They include sherds from cooking pots and large trays. As a general guideline, the inclusions in the fine-textured sherds are visible only with a magnifying glass. Sherds with a coarse texture have inclusions that are generally larger than 1-2 mm.

The quantity of inclusions was not measured. Only when a sherd contained remarkably few or many of any type of inclusions, this was recorded in the remarks.

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10 The same was true for the differences between calcite and sand inclusions in the wares described at Tell Sheikh Hamad (Schneider 2006: 393, 401, 402, 403, and 404).

11 Because the thin-section analyses were carried out at the end of this study, the use of ware groups A, B, C, N and H, I, J, G is generally maintained in the following chapters.
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Manufacturing techniques

The shape and surface of the pottery give indications about the techniques of shaping the vessel. For all the described shaping methods, traces were found on the sherds or complete vessels. For all sherds it was recorded whether they were *hand-made* or *wheel-thrown*. Any marks pointing to specific manufacturing techniques were described in the remarks. A reconstruction of manufacturing techniques is presented in Chapter V. This reconstruction was made by carefully studying traces of manufacture on the sherds, with the assistance of the specialists from the Department of Pottery Technology at the Faculty of Archaeology of Leiden University. Where useful, information on traditional pottery techniques in ethno-archaeological and ethnographical studies is cited to clarify a specific technique. On the basis of this information, a large part of the diagnostics were classified in five technology groups.

Shape

The shape classification is based on four levels of description. On the first level the shape of the fragment is described: complete vessel, rim fragment, base fragment, body fragment, spout or handle. On the second level the general vessel shape is described: bowls, pots, jars, goblets, sieves, pot stands, bases, bottles, miniatures, trays, miscellaneous. These shape names are distinguished from each other by simple criteria (see Appendix B, with each vessel name). The shape names are not intended to designate vessel function. However, because words like “bowl” and “pot stand” are so widely used in archaeology, it is felt that using completely neutral names like geometric shapes or even numbers would only make the text less comprehensible. The third level then describes the general wall shape and direction: restricted shape, unrestricted shape, convex wall, carinated wall, straight wall, etc. The shape of the base is also described within the third level. The fourth level describes the rim shape (see table II.1). The second, third and fourth levels together form the shape-type number. This rather simple system was preferred because it was felt that the more criteria there are for classifying a vessel shape, the more difficult it becomes to work with the system in the field, the more different classes will come into existence and the more exceptions there will be. The Sabi Abyad system is easy to use and fairly straightforward. Moreover, classes can be added when new vessel, wall or rim shapes appear during fieldwork. In this way some shape numbers were added while others were discarded. For practical reasons, the shape numbers used in the field were retained here. Therefore, the sequence of numbers might not seem completely logical to the reader. The complete shape classification is presented in Appendix B.

The shape classification was checked through a comparison with all the drawings from Late Bronze Age ceramics at Sabi Abyad. It was designed and used completely independently from the other variables like temper or decoration. A “shape type” in this study refers to the shape of the vessel only. The shape classification is not *a priori* meant to be a classification in functional types. Because the classification is artificial rather than a reflection of any ancient “Assyrian” classification, the distinction between two classes may sometimes seem somewhat forced or subjective. Differences in wall orientation often change gradually, for example from slightly carinated to strongly carinated and from vertical to flaring. Compare for instance type 1.4.1 and the small vessels of type 2.2.1. The first are bowls because their walls are flaring and the vessel can be classified as an unrestricted shape. The second are pots because their walls are vertically oriented. However, the shapes of these two types are closely related and when considering vessel function, this similarity is taken into account.
After fieldwork, the shape classification was further elaborated upon by adding information on apparent size groups within rim types and on manufacturing technology. This was necessary to enable the comparison of similar groups (size groups, technological groups) in the analysis of production organization in Chapter V. The related information can be found in Chapter V or directly in Appendix B with the shape classification.

### Surface treatment

After the initial shaping of the vessel, the surface could be treated further to improve the shape and properties of the vessel.

Most bases and lower vessel parts, especially those of larger, thick-walled vessels, show traces of *scraping* the surface with a sharp object to make the wall thickness more even throughout the vessel. Sometimes also the upper parts of vessels show traces of scraping. It is possible that scraping traces were smoothed away by the potter before drying the vessel. The surface of most vessels was *smoothed* with wet hands or a wet cloth. A small percentage of the pottery has a *burnished* surface: a shiny, smooth surface produced by rubbing the leather-hard surface with a hard tool.

A very small amount of the pottery is covered with a *slip*: a thin coating of clay covering the whole surface. A coating is called a slip when it is clearly different from the sherd itself, and different in colour. When the coating is very thin and of the same colour as the sherd, it is often called a “self-slip”. A self-slip may easily arise by just smoothing the vessel with wet hands while throwing the vessel, without the intention to cover the surface of the vessel with a second coating, and the term was therefore not used in this study. A very small percentage of the pottery is covered with a *glaze*: a coating of (coloured) glass. In the Late Bronze Age at Sabi Abyad, the glazed vessels had a greenish colour that quickly turned whitish after excavation and exposure to air and light. The chemical composition of the glaze was not studied. However, the thin-section analysis (see Appendix D) did not yield any evidence for the use of a colourant. Perhaps the green colour on excavation was the result of the humidity of the crackled glaze, showing the underlying greenish colour of the high-fired sherd. The glaze is certainly an alkaline glaze, as no lead or tin glazes have yet been identified in Mesopotamia before the Islamic period (Moorey 1994: 162). The majority of the pottery has no coating at all.
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Colour and Firing

The temperature of firing and the firing conditions may be estimated with the help of the colour of the in- and outside surface of the sherd and of the core of the sherd (to be determined in a fresh fracture). Of course these are very rough estimates and should not be taken as definite values. Colours were not measured with Munsell charts, but instead divided in nine general and rather coarse categories: cream, buff, orange, red, black, grey, green, brown and white. In reality all colours are of course different shades of earthy colours. Because description was usually done by the same person each season and with the aid of a colour sample collection of sherds, I feel that the description of colour is detailed enough. Anyway, a colour will vary between different areas of the vessel and according to the place of the vessel in the kiln. Because of this, and because the estimates necessarily remain very general anyway, the use of Munsell charts was felt to be unnecessarily labour-intensive. The estimates of firing temperatures are based on firing tests with sherds and clays from Tell Sheikh Hamad (Middle Assyrian ceramics) and the Khabur region (Schneider 2006: 395), as well as on the thin-section analysis of the Sabi Abyad sherds (Appendix D). Because the chemical and physical characteristics of the clays in the Khabur and in the Balikh regions are similar and because the technical features of the Middle Assyrian Sheikh Hamad ceramics are similar to those found at Sabi Abyad, the relation between firing temperature and sherd colour can be expected to be roughly similar as well. Brownish and reddish sherds are estimated as having been fired at 700-800 °C (low temperatures), sherds with orange to buff colours at 800-950 °C (medium temperatures), and sherds with light buff to greenish colours at 950-1000 °C (high temperatures) (Schneider 2006: 399-400; Pfälzner 1995:35). Cooking pots were always fired at low temperatures below 700 °C. When lime spalling occurred, this indicates a firing temperature between about 750 and 950 °C (and an oxidizing or incompletely oxidizing atmosphere) (Rice 1987:429). Sherds with a brittle texture and bright-to-dark-green or green-greyish colours have been overfired, at temperatures above about 1100 °C. The cores of these often warped vessels are sometimes dark grey, because of the reduction of iron oxides (Rye 1981: 108-109). It has to be noted that these temperatures can only be approximate estimates, since the behaviour of the clay minerals and inclusions does not only depend on the temperature but also on the amount of time this temperature was kept, and on the kiln atmosphere (Schneider 2006: 399).

Sherds with light colours (reddish to greenish) and with a core of the same colour or of a different (but not dark-grey or black) colour are taken to have been fired under oxidizing circumstances. Sherds with a dark-grey or black core colour (“sandwich” effect) have been fired in incompletely oxidizing circumstances, and/or at lower temperatures. Sherds with grey, dark-grey and black inner and outer surfaces and dark cores have probably been fired at medium temperatures but in reducing circumstances. Cooking ware was most probably fired at temperatures around 800 °C in reducing atmospheres, or around 700 °C in oxidizing or incompletely oxidizing atmospheres, and for relatively short firing periods (Schneider 1994: 106). All this is summarized in the following table:
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<table>
<thead>
<tr>
<th>Surface Core</th>
<th>brown, dark red</th>
<th>dark brown, grey, black</th>
<th>light red, orange, buff</th>
<th>buff, cream, greenish</th>
<th>green, warped</th>
</tr>
</thead>
<tbody>
<tr>
<td>same core colour as surface</td>
<td>oxidizing, low temperature. +cooking ware.</td>
<td>reducing, medium temperature.</td>
<td>oxidizing, medium temperature.</td>
<td>oxidizing, medium temperature.</td>
<td>Over-fired</td>
</tr>
<tr>
<td>dark (grey/black) core</td>
<td>incompletely oxidizing, low temperature and/or shorter period</td>
<td>reducing, medium temperature</td>
<td>incompletely oxidizing, medium temperature</td>
<td>incompletely oxidizing, medium temperature</td>
<td>Over-fired</td>
</tr>
<tr>
<td>other (red, orange, buff) core</td>
<td>oxidizing, low or varying temperature or shorter period</td>
<td>reducing in later stage of firing period, medium temperature</td>
<td>oxidizing, medium or varying temperature</td>
<td>oxidizing, higher or varying temperature</td>
<td>Over-fired</td>
</tr>
</tbody>
</table>

Table II.2 Estimates of firing temperatures based on sherd colour.

The firing temperature estimates were checked afterwards by the analysis of a selected number of thin-sections from the Sabi Abyad sherds (see Appendix D). Sherds described in the field as having been fired at a high temperature indeed also appear to have been fired at such high temperatures when examined under the microscope (6 samples). Sherds described in the field as having been fired at medium temperatures, based on the colour of the surface, show a very diverse picture under the microscope. Of the 33 samples described as such, 5 appear to have been fired at high temperatures (and show buff and cream outer surface colours), 5 at medium to high temperatures, 6 at medium temperatures, 10 at low to medium temperatures, and 7 at low temperatures (and showing orange or reddish outer surface colours). Firing temperatures of sherds with a grey or other core colour were most often estimated too highly. Also it appeared that the outer surface colour of the sherd is more indicative of the original firing temperature than the core or inner surface colours. All sherds estimated in the field as fired at a low temperature (6 samples) indeed appeared to have been fired at low temperatures under or around 700 °C. The thin-section analysis therefore showed that both sherds that had been fired at very high temperatures and sherds fired at very low temperatures were easily recognizable in the field. Other field estimates were generally in the right direction, but often too low for sherds with lighter colours and often too high for sherds with more orange-reddish colours. This again underlines the very rough nature of firing-temperature estimates on the basis of colour only. In general, the thin-section analysis confirmed that firing temperatures varied between 700 and 1000 °C.

Decoration

Little pottery in the Late Bronze Age assemblage of Sabi Abyad is decorated, and when, decoration is mostly confined to a limited number of patterns and techniques. The techniques most often used for decoration are incision, impression, applied decoration or painting, or combinations of them. Simple horizontal incised lines and wavy incised lines are common decorations. In most cases these lines have been drawn while the vessel was rotating and while the clay was in an almost leather-hard or a leather-hard stage of drying. Incisions applied on stationary vessels include wavy lines, crosses or other “signs”, and notches at the base and on the rim.

Impressions occur mostly in the shape of finger or nail impressions on appliqué bands. These
impressions give the appliqué bands the appearance of thick cables. Also, circles and crescents or S-shapes are impressed. Sometimes impressed circles and triangles are filled with a white substance, probably calcite, enhancing the decorative effect on the mostly dark burnished bowls. Exceptional occurrences of impressions are represented by a cylinder-seal rolling on the wall of a goblet, a stamp-seal impression on a bowl, impressed cuneiform signs and by a small impression perhaps depicting a schematized human being. Rope impressions occur on larger vessels but are connected with the shaping method and were probably not meant as a decoration.

An applied decoration is a separate band or piece of clay attached to the surface of the vessel. Applied decoration mostly takes the shape of horizontal bands or cables, most often in combination with wavy incised lines on large vessels. The cables sometimes mask joints between clay slabs or vessel parts. Sometimes vertical appliqués are attached to the rim of the vessel. The handles of some large cooking vessels were decorated by applied curves. Somewhat more artistic but very exceptionally applied decorations take the shape of animals or humans.

Painted decoration is not very common and it was mostly used in the earlier phases of Late Bronze Age occupation at Sabi Abyad. Mostly a dark red or red-brown clay-based iron-rich “paint” was used, made of clay slurry perhaps mixed with pigments. Also a non-clay substance, probably bitumen, was used to create dark brown or brown-black figures. Horizontal bands, along the rim or on the wall of the vessels, as well as circles-with-crosses or Y-shapes are among the most frequent painted motifs. Crescents, circles, triangles, squares, vertical lines and “scratchy” bands as well as irregular motifs occur less often. A special type of painted decoration is represented by the so-called “Nuzi” decoration: fine, white-painted motifs (geometrical or vegetal patterns) on dark-brown or dark-red painted bands.

Some incised, impressed or painted figures, especially when occurring alone and on restricted parts of the vessel, might represent potters’ marks rather than decorations. See Chapter V and Appendix E for a more detailed discussion of these marks.

Special features

Any characteristic of a vessel other than its basic shape and appearance has been described under the heading of “special features”. They are burning traces, gypsum/lime crusts, bitumen crusts, base cracks and other damages, repairs, deformations, rope impressions and warping.

Burning traces, blackened areas, are often visible on sherds from burnt contexts. Sometimes the traces suggest that they arose during or because of the use of the vessel. The burning traces on the rims of some bowls may indicate their use as oil lamps, for example.

Gypsum/lime crusts are white, calcareous crusts or coatings. Generally they were applied to repair cracks or other damages in the base or wall of the vessel. As the material re-hydrated during deposition in the ground, the damages often became worse because of the lime crust. Some bowls contain a thick layer of lime, and they were probably used to prepare or contain the lime for the repair of other vessels.

Bitumen, a black, shiny and brittle substance similar to asphalt, was often used to repair cracks and damages. Bitumen was also used on the inside and outside of vessels to improve the impermeability of the vessel wall. In that case the complete surface of the vessel was covered with a bitumen layer.

Base cracks are often present, especially in the smaller bowls. In most cases they are S-shaped or straight. They are caused by the manufacturing techniques. The bowls were thrown from the cone, and therefore the bases could not be pressed to strengthen them. This caused cracks in the base during the drying stage (L. Jacobs, personal communication). Other cracks sometimes appear in the walls of

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12 The paint of three “Nuzi”-style vessels and a red-slipped jar is discussed in Appendix D (archaeometric results), samples 38, 40, 43, 45. Iron-rich clays do not occur in the region of Sabi Abyad, but the fabric of the vessel is very similar to the rest of the locally made pottery. Perhaps only the raw materials for the paint were imported?
vessels (horizontally or spirally, parallel to the throwing ridges) and vertically in the rim. These damages might have arisen during both drying and firing of the vessel, although in the case of more serious fractures it is more logical for them to have arisen during firing. An already heavily damaged vessel would not have been fired. Some vessels have serious damages or holes in the vessel wall. Most probably they came about during the use of the vessel.

Repairs of damages mostly took place as described above, with lime or bitumen fillings. It is only rarely that fractures were repaired by drilling holes on both sides of the fracture and then securing the fracture with rope.

Deformations of the vessel before firing include dents in the wall, slanted cutting from the cone, oval rims, etc. Sometimes these deformations were repaired or reshaped. Sometimes another object touched the still wet vessel, which would leave impressions from textile or sharp objects on the wall. Rope impressions occur mostly on very large vessels. During the shaping and drying of the vessel, ropes were wound around the vessel to support the heavy weight of the wet clay.

Vessels that were completely over-fired have started to melt. Their walls were warped and seriously deformed. Their texture became very brittle and often these vessels could not be used anymore. They are called wasters.

**Measurements**

Several measurements were taken, all in millimetres. Rim diameter and base diameter were measured either directly on the vessel or, for fragments, with the help of a diameter chart. For rim fragments comprising less than half of the circumference, the diameter could be measured up to about 400 mm with a diameter chart with lines at 10 mm intervals. For smaller rim fragments with a diameter larger than 400 mm, it could only be noted that the rim diameter was larger than 400 mm. Because of the diameter chart measurements at 10 mm intervals are overrepresented. Rim thickness (at the rim), wall thickness (for body sherds and complete shapes) and base thickness (not including the ring in the case of ring bases) were measured with callipers, while the total vessel height (complete shapes only) was measured with a measuring rod.

Moreover, to get some idea of the amount of pottery and the fragmentation, the percentage of the total rim or base circumference was recorded for each sherd. In this way, a 360° rim or base is complete (100%), while a 90° rim is only preserved for 25%. This was measured in 5° intervals. The sum of this attribute per shape, divided by 360, gives a very rough indication of the minimum number of original vessels. The mean percentage per type may give an indication of the fragmentation of the sample. Moreover, these measurements proved that sherds with a rim portion less than 5° do not give reliable information on the rim diameter. By recording this attribute, these sherds can be left out when analysing rim diameters.

Other aids for estimating vessel numbers are sherd count, sorting and refitting (see above). The difference between the amount of rims counted before mending and described after mending gives a second rough indication of the fragmentation of the pottery.

The estimated capacity of complete vessels was calculated from the drawings using the “stacked cylinders” method (Fig. II.8). With this method the inside diameter is measured at regular intervals from rim to base, as if the vessel is divided horizontally in a number of slices of equal height. The volume of the vessel is then estimated by calculating the volume of each cylindrical slice, and adding the resulting volumes, with the formula $V=(\sum r^2)\pi h$ (where $V =$ volume in cc, $r =$ radius of the slices in cm, $h =$ height of the slices or the distance between measurements in cm; Rice 1987: 222). The capacity is given in litres with an accuracy of 1 dl. This measurement must remain an estimate, however. First of all, the calculation presumes a perfectly round vessel while most vessels are not. Secondly, the capacity is calculated up to the rim of the vessel, because it is mostly impossible to know up to which level a vessel was filled in antiquity (and so the resulting estimate is nearly always too high). Finally, the smaller the intervals between the measurements, the more measurements have to be taken and the more accurate the result. For reasons of feasibility, however, it was decided to
measure at 0.5 cm intervals for very small vessels, at 1 cm intervals for small, middle and large vessels, and at 2 or 3 cm intervals for vessels drawn to scale. This limits the number of measurements and speeds up the calculations, but it yields a somewhat less accurate result. For reasons of feasibility, it was decided to measure several smallest, largest and middle-size vessels for each type group to obtain average values for capacity, instead of measuring all complete shapes.

**Level and provenance**

For each sherd it was recorded to which level in the Sabi Abyad stratigraphy it belongs. This might be one level, but when the context of the sherd was mixed or disturbed, more level numbers have been recorded. Through the use of the level numbers, contemporary batches of pottery can be analysed separately from batches dating from another level.

At the same time the provenance of every sherd was recorded. This attribute describes the context: a room in a specific building, or the pit, burial, street, courtyard, oven or other area where the sherd was found.

**II.3 Statistics and computer programs**

For matters of readability and convenience, the discussion of methods and theory pertaining to each of the subjects dealt with in chapters IV - VI will be presented in their respective chapters. The methods used in the archaeometric studies of a selected sample of sherds are presented in Appendix D. Here a short presentation will follow of statistical methods and computer programs used in evaluating the data.

For the processing of all data and the writing of the thesis, several computer programs were used. Plain text was written in Word (2003) for Windows XP. The databases with data on the ceramics were organized using Visual DBase 5.5. Stratigraphical databases were available in Access format, while Excel was used for the calculation of some data (both Microsoft Office). The drawings of the pottery and the site plans were digitized using Adobe Illustrator 9.0 and a Genius digitizing tablet and pen. Pictures were scanned or taken with a digital camera and processed in Adobe Photoshop CS 8.0. The figures were compiled using Adobe Indesign 3.0. For statistical procedures, the computer program SPSS 9.0 for Windows was used. Shannon’s H and E were calculated by hand.

**Measures of variation and diversity**

When describing an assemblage, the diversity and the variation or standardization within an assemblage is important. For this several measurements have been used:

- The minimum, maximum and mean value of the measurement, and simple percentages.
- The standard deviation, indicating the dispersion of values around the mean. The smaller the standard deviation, the more values are close to the mean value.
- The Coefficient of Variation (CV) in percent. Because the size of the standard deviation depends on the size of the mean value, it is impossible to compare two assemblages with different mean values. Therefore, the CV is expressed as a percentage of the mean value: CV = (standard deviation / mean value) x 100. Although the statistical testing of similarity between CV values is not very straightforward, the CV has been proven to be the most reliable statistic in studies of variation (Eerkens and Bettinger 2001; idem p. 499 for a statistical test using CV).
- Shannon’s H and E. This diversity index (H) and equitability index (E) are measures derived from biology and ecology. They are used to measure the richness and evenness of species in a community. For example, biologists use them to express the biodiversity in a plot of pristine
rain forest and compare it with the biodiversity in a plot of cultivated land. In archaeology they are used to form an idea of, for example, the typological richness of a ceramic assemblage. How do we compare an assemblage with a thousand diagnostics and 50 different rim types with another assemblage, having 40 rim types but only 600 diagnostics? It is clear that assemblage size matters: the more diagnostics, the higher the chance that more types are included. The evenness of the assemblage also matters: how do we compare two assemblages with each five types and 100 diagnostics, when in the first assemblage each type is represented by 20 sherds while in the second assemblage 90% of the sherds is of one type? Shannon’s H and E are indices used to express these differences in a number so that assemblages of different sizes can be compared. Diversity (H) is calculated as

\[ H = - \sum_{i=1}^{n} p_i \ln p_i \]

where \( p_i \) is the proportion of the type relative to the total number of cases. \( p_i \) is then multiplied by the natural logarithm of this proportion (\( \ln p_i \)). The resulting products per type are summed and multiplied by -1. The value of H can vary between 0 for assemblages with one type only, to large for assemblages with many different types of which each type is only represented a few times. The equitability or evenness of the assemblage can be measured with Shannon’s \( E_I \):

\[ E_I = H / H_{\text{max}} \]

\( H_{\text{max}} \) is the natural logarithm of the total number of types in the assemblage. \( E_I \) can assume values between 0 and 1, with 1 being complete evenness and values close to 0 indicating extreme unevenness.

It can be useful to test whether observed patterns are statistically significant, or whether a suggested association between variables is statistically meaningful and how strong this association is. The test is briefly described here, to ease the understanding of test scores as presented in the various chapters (based on Fletcher and Lock 1994, Schreuder 1991).

**Chi-Square Test**

The Chi-Square Test is used to answer the following questions:

- Is there a significant difference between an *observed* distribution of frequencies and an *expected* distribution of frequencies? In other words, does a value of a variable occur significantly more or less than was expected? (Goodness-of-fit test).
- Is there a significant association between two categorical variables? In other words, are two variables related statistically?

In both cases the test calculates the expected distribution of frequencies in a random situation and compares it with the observed values. If the observed values differ a lot from the expected values the value of Chi-Square will be high, suggesting that the distribution is not random but due to some cause. Whether the differences are statistically relevant can be looked up with the help of a table that is provided in statistics textbooks. Next to the Chi-Square value, the “degrees of freedom” (d.f.) and the desired level of significance (90%, 95%, 99%) are needed to decide whether differences in an observed pattern are significant or not. To establish whether a statistically significant association between variables is a strong or a weak association, the value “Phi” and “Contingency Coefficient (CC)” can be calculated. For both values, 0 indicates absolutely no association, while 1 indicates a maximal association (very strong association).

The Chi-Square test works best with categorical data. If data are continuous (such as measurements), other tests are better suited to see whether variables are associated.
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It is important to realize that archaeological questions and supposed patterns and meaningful relations must always be at the basis of statistical tests. If the results of a test cannot be translated into an archaeologically meaningful conclusion, the test results are useless.